
THE UNIVERSITY OF
AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

GOCPI

A Scalable Energy Modelling Solution

Developed by Connor McDowall

Supervised by Rosalind Archer

Facing the Energy Transition

- ✓ The imminence of the energy transition is clear after working at ExxonMobil Australia.
- ✓ Literature review informs the need for rapid transformation as economic models predict unfavourable consequences if no swift action.
- ✓ Sustainable investment is driven by Net Present Value (NPV) analysis and the ability to generate returns for investors.
- ✓ Sustainable technologies have seen significant cost reductions over the last decade improving the feasibility of the transition.
- ✓ However, there are educational disparities between policy makers, government, private companies, stakeholders and voters.

Empower users to influence policy

- ✓ The reasons creating these issues is the sophistication and inaccessibility of energy modelling.
- ✓ Energy modelling usually requires:
  - Proprietary data.
  - The understanding of LP, Integer LP, MIP and/or NLP optimisation techniques.
  - Access to expensive commercial solvers.
  - A thorough understanding of energy systems, mathematics, economics and finance.
- ✓ This complexity creates difficulties in evaluating energy investment, policy and their alignment to the United Nation's Sustainable Development Goals and Paris Agreements.
- ✓ My proposed solution is to develop an accessible, scalable energy system modelling tool.
- ✓ The product will remove this sophistication and enable users to model their own energy systems to inform investment and policy.

Methodology and Implementation

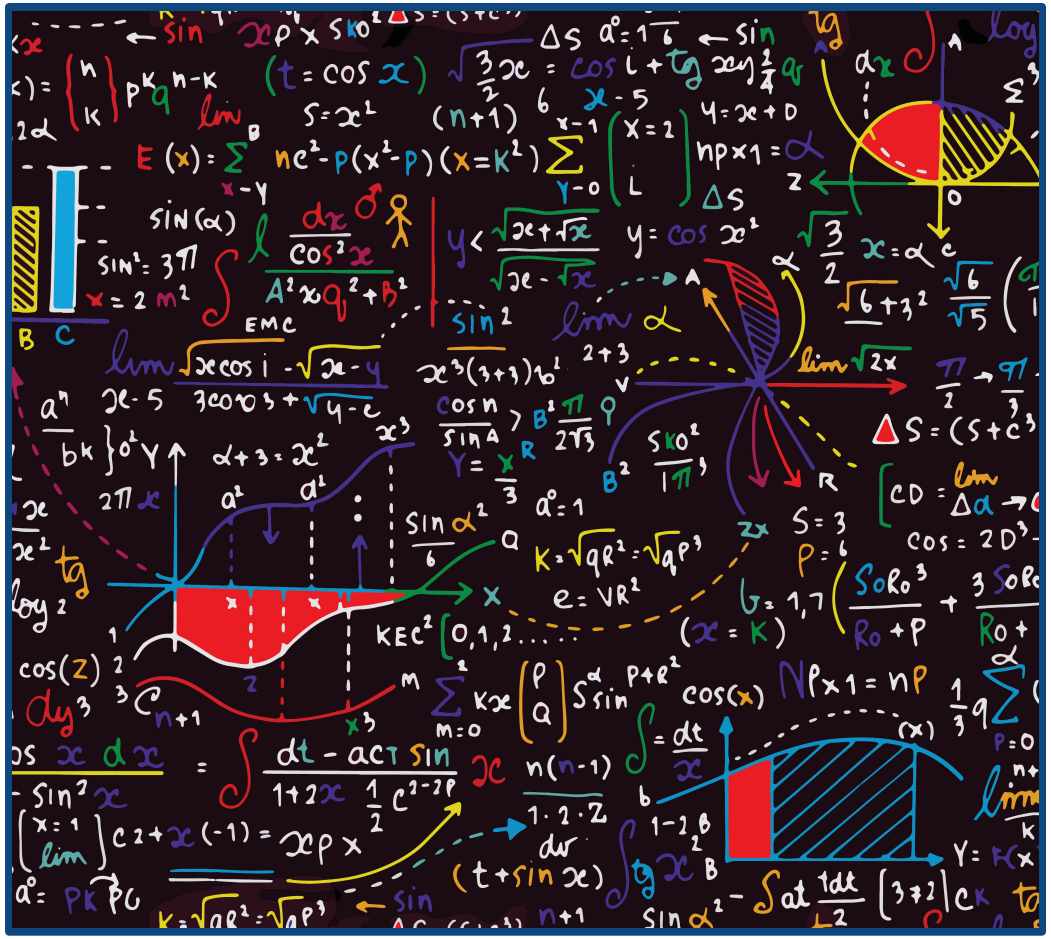
- ✓ A comprehensive literature review on energy, emissions, the economy, policy, obstacles, challenges and energy modelling framed the problem and addressed the product needs.
- ✓ A high-level overview of the methods and implementation for the GOCPI project follows:
  - ✓ Adapt The Integrated Markel E-Form System (TIMES) modelling methodology.
  - ✓ Adapt the OseMOSYS modelling methodology.
  - ✓ Understand and create energy systems.
  - ✓ Develop a Python-based open source scalable energy modelling tool.
  - ✓ Develop forecasting methodologies for energy systems.
  - ✓ Adapt IBM technologies to facilitate optimisation.
  - ✓ Develop an web-based user interface to both inform and distribute the product.

The Incumbent's Limitations – TIMES

- ✓ The Integrated Markel E-Form System (TIMES) is the legacy methodology used to inform the energy scenarios for both the World Energy Council and New Zealand Business Energy Council.

- ✓ A existing modelling system was adapted using enterprise versions of GAMS Studio and the Versatile Data Analyst (VEDA).
- ✓ Excel-based functions and custom macros were to be used to create a scalable template.
- ✓ Reproducibility, integration and complexity issues led to the abandonment of this approach in favour of an alternative.

Discovering an Alternative – OseMOSYS



- ✓ The Open Source Energy Modelling System (OseMOSYS) was the chosen alternative for modelling energy systems.
- ✓ OseMOSYS is developed by a community of developers who make contributions directly to the OseMOSYS GitHub Repository. There are a couple versions available: GAMS, GNU Mathprog and Python.
- ✓ OseMOSYS is a linear optimisation problem describing an energy system. There are 11 sets, 52 parameters, 67 variables, 94 constraints and 1 objective function.
- ✓ Several sets underpin parameters, constraints and variables: Year, Technology, Timeslice, Fuel, Emission, Mode of Operation, Region, Season, Day Type, Daily Time Bracket and Storage.

$$\text{Min:} \sum_{r} \sum_{y} \text{TotalDiscountedCost}_{r,y}$$

Breaking Down Energy Systems

- ✓ A reference energy system underpins the system. It describes the network flows amongst the production, conversion and consumption of different fuels using different technologies.
- ✓ The system models trade relationships between regions. Individuals, companies, towns, cities, countries and continents are examples of all regions you can represent using the OseMOSYS methodology.
- ✓ The objective function minimises total discounted costs derived by each regions' discount rate. Salvage, operating and capital expenditure are considered with the discount rate depending a region's mix of equity, debt and financing costs.
- ✓ The OseMOSYS model uses emissions and renewable technology constraints to drive sustainable outcomes.

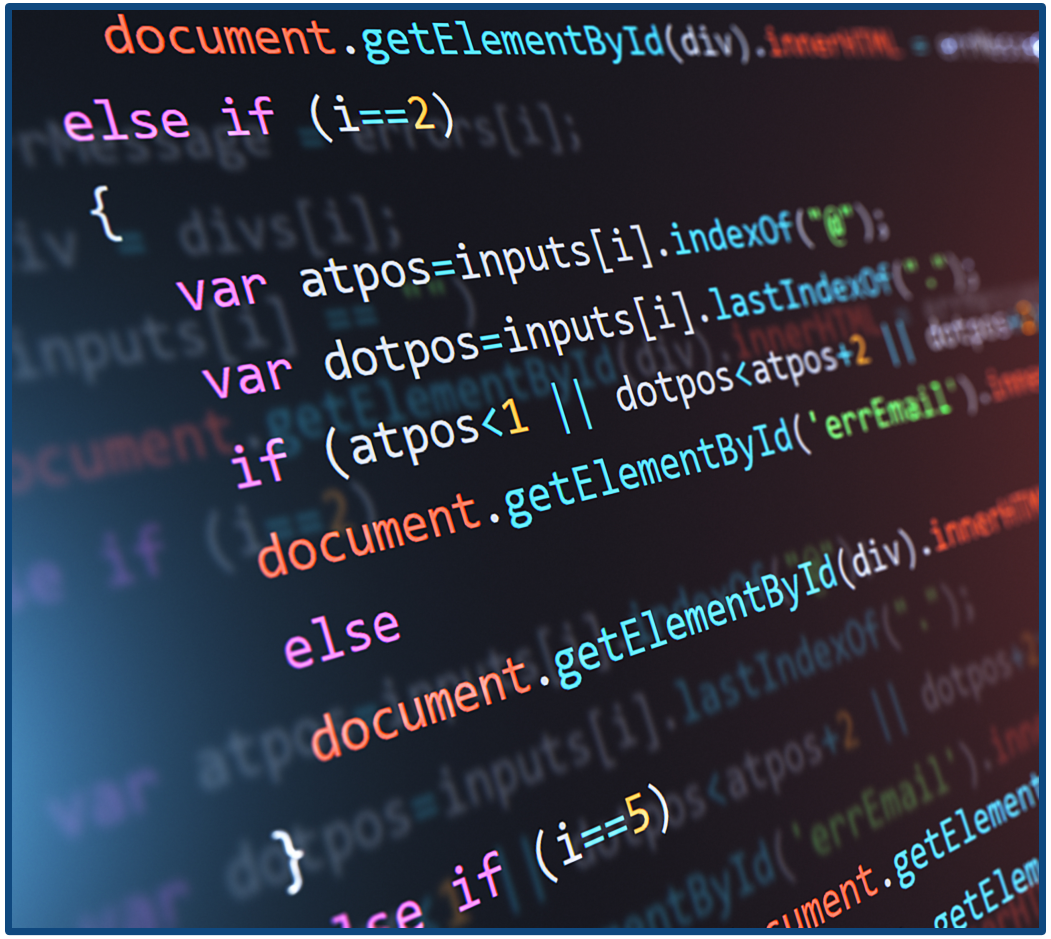
A Powerful Package

- ✓ The GOCPI prototype was developed and distributed as a Python-based open source scalable energy modelling tool.
- ✓ GOCPI required best practise software development. The project made use of several technologies: Version control using Git and GitHub, Python 3.7.6, Anaconda, PyPI, IBM ILOG CPLEX Optimization Studio (CPLEX Python APIs), IBM Watson Machine Learning and Yapf.
- ✓ The model is an adaptation of the OseMOSYS methodology, formulated in GNU Mathprog and integrated into Excel and Python. The GNU Mathprog structure is stored within an Excel spreadsheet. A user may toggle constraints or adapt the objective function to drive different outcomes.
- ✓ The prototype enables the user to formulate their own energy systems in python, perform forecasting functionalities, generate linear programmes and solve them using commercial solvers.

Intersecting Technology, Energy & Finance

- ✓ The GOCPI saw the intersection of technology, energy and finance in the construction of energy systems.
- ✓ Deconstructed the Utopian energy system exemplar from OseMOSYS to formulate standardised modelling approach.
- ✓ Partially developed an Australia/New Zealand energy system with a bi-lateral trade relationship.
- ✓ Developed a reference energy system for both countries using data available from the Ministry of Business, Innovation and Education (MBIE, NZ) and the Department of Environment and Energy (AUS).
- ✓ Determined discount rates for both New Zealand and Australia using treasury reports and financial statements.

Programming the Foundations



- ✓ The GOCPI prototype is built with several classes.
- ✓ EnergySystems: A class containing modules to load in existing energy systems. Additionally, this class creates energy model files from the OseMOSYS structure and energy data files to form LP files.
- ✓ CreateCases: A class containing modules to enable the user to build their own energy systems.
- ✓ Forecasting: A class containing modules to formulate base year energy balances from the International Energy Agency's (IEA) energy balances and forecast both energy and financial values.
- ✓ Optimisation: A class containing modules to solve energy system optimisation problems locally using CPLEX or remotely using the IBM Watson Machine Learning service.
- ✓ Navigation: A class containing modules to enable the user to navigate their local directory to access files.

Driving Optimisation with IBM

- ✓ CPLEX was selected as the commercial solver of choice for the GOCPI prototype. It is readily available for educational institutions and individuals using IBM's Academic Initiative.
- ✓ IBM ILOG Optimisation Studio was installed locally using the IBM Academic Initiative.
- ✓ LP files are created using the glpsol terminal command, from the GLPK package, in a custom python environment.
- ✓ Small LP files are solved locally using the CPLEX APIs accessible from the Optimisation class.
- ✓ Large LP files must be solved using a Python-based OseMOSYS formulation and the IBM Decision Optimisation on the IBM Watson Machine Learning service.
- ✓ Created a standardised method to access IBM cloud services, create deployments, request jobs and solve requests.

Distributable on the GOCPI Interface

- ✓ The package is distributed on PyPI and GitHub, accessible through a web-based interface (https://connormcdowall.com)
- ✓ Developed a GitHub repository to version control all code and resources.
- ✓ Developed a custom Python package for deployment. New distribution are uploaded using Twine and downloaded using Pip, Python's package management software.
- ✓ Developed a website to act as an interface for the GOCPI prototype. The website is built using Jekyll, a simple static site generator. Jekyll is written in Ruby and converts Markdown files to HTML. The website is hosted using GitHub pages.
- ✓ Enabled a Google domain to direct a user to the interface. The website displays this presentation and will include links needed to access the GOCPI prototype.

Success So Far

- ✓ The GOCPI Prototype is readily available and distributable.
- ✓ Created a standardised modelling process to create user-defined energy systems.
- ✓ Partially developed an Australia and New Zealand energy system with a bi-directional trade relationship.
- ✓ Created 80+ new distributions for the GOCPI Prototype as at Monday 19th of October.
- ✓ Created a Web-based interface on my personal website. I used my personal website as I purchased a domain name for additional purposes outside the scope of the project.
- ✓ Created a pipeline to continue developing the GOCPI prototype.

Pursuing GOCPI's Full Potential

- ✓ Continue developing Australia and New Zealand energy system example.
- ✓ Adopt new forecasting methodologies to project the needs of energy systems in the future. These include methods common in financial services and data science.
- ✓ Make adjustments to the objective function to account for emissions and carbon taxes.
- ✓ Continue to develop GOCPI classes to improve usability and convert the OseMOSYS model to Python to utilise IBM Watson Machine Learning and Cloud services.
- ✓ Create user interfaces to display the outputs of energy systems and make comparisons to align with the United Nation's Sustainable Development Goals (UNSDG) and Paris Agreements.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NEW ZEALAND

ENGSCI 700A/B

Research Compendium

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November 3, 2020

Declaration of Contribution

I proposed this project. I am the sole contributor.

Contents

List of Figures

1 GitHub Repository

All files related to the project are stored within a GitHub Repository. This repository is accessible here and summarised as follows:

1.1 Data

- Energy Balances from the International Energy Agency (IEA) csv files to create energy balances for user defined energy systems. Source: International Energy Agency
- Australian and New Zealand Energy Statistics to build a New Zealand and Australian reference energy systems. Source: MBIE and The Australian Government.
- Sets of geographies for partitioning and creating regions to model user defined energy systems.
- Images for website design.
- Input data sources for TIMES and OseMOSYS modelling and developing user defined energy systems.
- GNU Mathprog, GAMS and Pyomo versions of OseMOSYS folked from the OseMOSYS GitHub Repository.
- The TIMES model and twelve demo versions of varying complexity.

1.2 Documents

- Notes related to the project.
- Presentations related to the project.
- Research Compendium, Project Report and all images, figures and sources used in these documents.
- Academic journals, articles and technical reports related to the literature review.

1.3 Source Files

- GOCPI package for creating, formulating, forecasting and solving user-defined energy systems.
- Processing and development scripts used to design the GOCPI package.
- The prototype webpage adapted from a W3 school template.
- Git, IBM, Microsoft Visual Studio Code configurations/formatting related files.

1.4 Additional

- Build files for producing GOCPI documentation using sphinx.

2 Website

2.1 Jekyll, Markdown, Ruby, GitHub Pages

The website was improved using Jekyll, Ruby and Markdown technologies. The website includes links to documentation required to build systems and software required. The repository used to build the website is separate from the GOCPI repository. **You can access the website here**

2.2 W3 Schools Adaptation

This iteration was adapted from an W3 schools template to create a prototype website for the project. This prototype describes key information related the project.

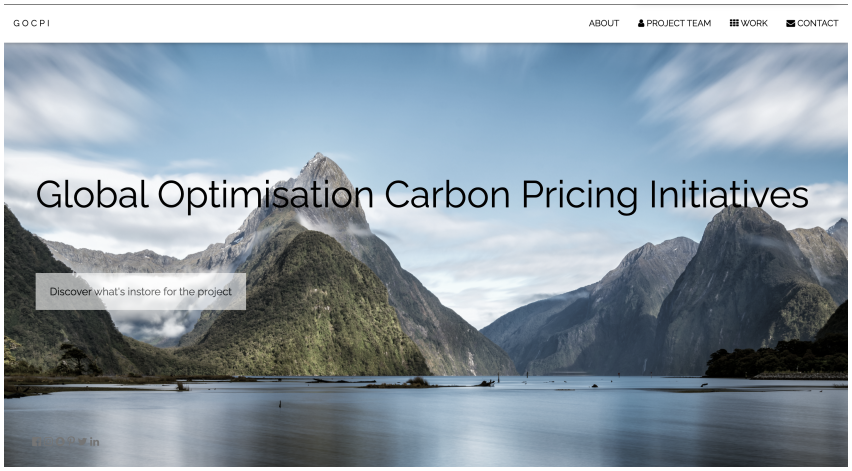

Figure 1: GOCPI Website V1 Cover Page

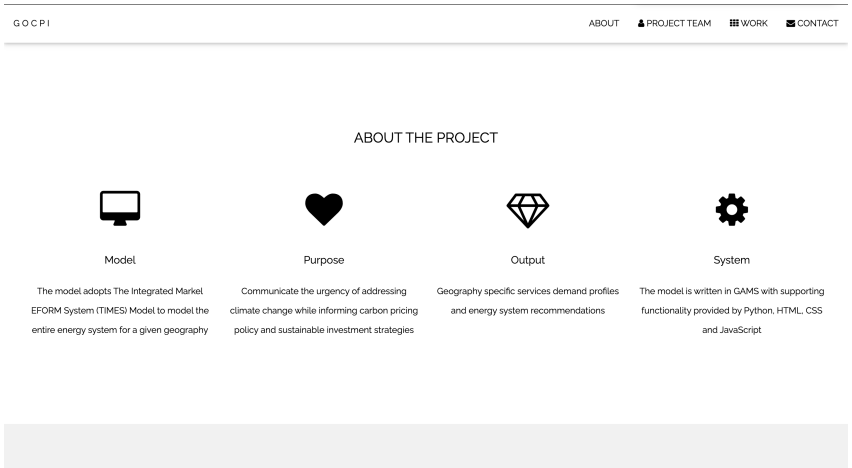

Figure 2: GOCPI Website V1 Project Information

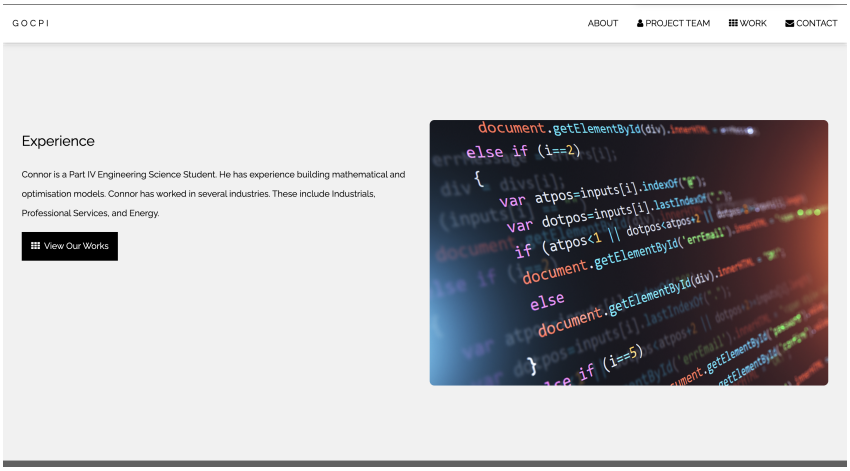

Figure 3: GOCPI Website V1 Project Access

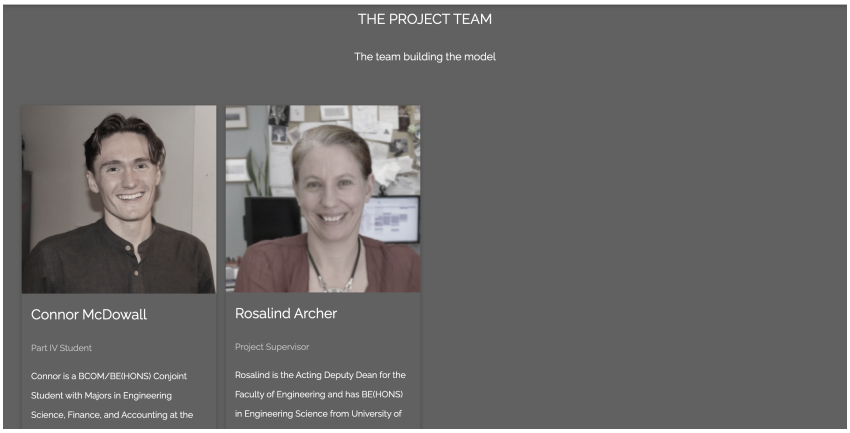

Figure 4: GOCPI Website V1 Project Contributors

Figure 5: GOCPI Website V1 Project Documents

3 Project Log Book

Disclaimer: Contributions to the Project Log Book grew inconsistent toward the later stages of the project.

January - February

- Began scoping energy related project during experience in the Commercial team at ExxonMobil Australia
- Emailed and Meet with Rosalind
- Decided to look at Carbon Pricing Initiatives to inform reinvestment and carbon pricing initiatives
- Rosalind tasked with with investigating GAMS

March 1st - May 30th

- Coronavirus was classified a worldwide pandemic
- New Zealand was sent into lockdown
- Researched 30+ Academic reports, articles, websites for Literature Review
- Wrote 10 page Literature Review
- Scoped the project
- Submitted Mid-Semester Literature Review on May 5th
- Installed GAMS on my local device
- Began researching the construction of an energy system with Excel, VEDA FE, GAMS, VEDA BE, Python
- Created GOCPI Geographies.gyp script to combined cities, countries and continents while providing granularity to the modelling process
- Created GOCPI.html as a project display for selling the project
- Ran into a series of installation and usage issues with VEDA and GAMS
- Requested VM to work from home
- Installed VMware and GAMS on FlexIT systems
- Faced GAMS Licensing issues on FlexIT

May 31st 2020

1. Installed Microsoft Remote Desktop and FortiClient VPN to access UoA Virtual Machine
2. Set up Virtual Machine

June 1st 2020

1. Installed VEDA FE and VEDA FE on Virtual Machine
2. Downloaded 12 Demo Models to build my TIMES Model

June 3rd

1. Begun testing the Model the Demo Models

June 4th - June 10th

1. Meeting with Rosalind. Discussed set up and action points moving forward.
2. Showed VEDA-FE. Four assessments were discussed.
3. Continued researching how to use VEDA

June 11th - Approximately 4 hours

1. Meeting with Rosalind at 10:30am via Zoom
2. Discussed action points moving forward.
3. Continued to adapt excel spreadsheets for Excel Data.
4. There is still an issue with GAMS Installation (Check with Tony. He knows a guy)
5. VEDA FE creates the necessary DD files. Continue to work through the DEMO Models to understand GAMS.

June 16th - July 1st

- No Progress - Study Break and Exams for ACCTG 371, FINANCE 362 and ENGSCI 711

July 2nd

- Last meeting in Rosalind's corner office. Discussed online exams, Chegg, cheating and project next steps.
- Agreed to adapt spreadsheets for user input and use BP's World Energy Outlook Statistics to determine production, conversion and consumption rates.

July 3rd

- Began adapting Demo 12 model for custom inputs
- Began using the openpyxl python library to manipulate excel (GOCPI Input.gyp)

July 4rd

- Continue to work on openpyxl adaptation with xls and xlsx excel sheets

July 6th

- Created a proper file directory for managing the project
- Continued to adapt GOCPI Inputs.gyp to scale across multiple sheets
- Adapted GOCPI.html, GOCPI Inputs.gyp and GOCPI Geographies to work after rearranging the geographies
- Nearly had a heart attacked as I was led to believe issues with Github and Git meant I deleted my entire project
- Recovered entire project and reports

July 7th

- Worked on file manipulation in Google Drive via Google Cloud APIs
- Discovered IEA Energy Balances on stats.OECD.org via Uni library databases
- Found 20GB csv on Energy Balances data
- Processed 20GB csv to create two 80MB csv for 2017 energy balance data using Microsoft Access

July 7th

- Developed and resolved issues relating to git and Github
- Developed processing methods for Energy Balance statistics using pandas pivot table function

July 17th

- Meeting with Kiti (NZ TIMES Energy Modeler)
- Discuss constraints associated TIMES and GAMS modelling
- Introduced to OseMOSYS (Open Source, Energy Modelling Tool)
- Introduced to MBIE,EECA (https://www.eeca.govt.nz/)
- Agreed to explore OseMOSYS and alternative datasources to build an alternative product.
- Agreed to keep Kiti updated on projec process moving forward.

July 18th

- Downloaded MBIE Energy
- Research OseMOSYS energy modelling Approach
- Downloaded OseMOSYS energy modelling tools
- Tested Pyomo, GNU and GAMS approaches. GNU optimised using glpsol in conda environment. Progress works well.

- Decision: Move away from TIMES/GAMS modelling to using Osemosys.
- Began Scripting Sheet to generate model input text file

July 19th

- Created excel spreadsheet to store OseMOSYS energy model inputs
- Began adapting sets, parameters, variables, equations and constraints to excel template.
- Researched more about OseMOSYS

July 20th

- Continued to adapt 200+ lines of model code in the excel templates

July 21st

- Learned to create custom python packages.
- Began working on adjustable sets

July 22nd

-

July 23rd

- Productive meeting with Rosalind, showed model output. (Rosalind said progress was really exciting)

July 24th

- Continued creating a custom package for the GCOPI module.

July 25th

- Started GOCPI module to create scalable data files

July 26th

- Continued to adapt GOCPI custom package to create scalable data files (Completed)

July 27th

- Edited report headings and created a structure for the Research Report.

July 28th

- Investigated CPLEX Solvers
- Registered for the IBM Academic Initiative
- Downloaded and Installed IBM ILOG CPLEX Optimizer Studio
- Installed cplex and docplex Python APIs from the IBM ILOG CPLEX Optimizer Studio
- Added create model file model to GOCPI

July 30th - August 9th

- Spent a day fixing git commit and push issues
- Installed GIT LFS and the functionality of .gitignore to prevent the committing .mp4 and .lp files
- Installed yapf in Microsoft Visual Studio Code to enable PEP-8 Autoformatting
- Wrote 4.5 pages for the technical, mainly focusing on the setup of Python, Anaconda, CPLEX, Git, GitHub, folder structure suggested by Wilson et al and the OseMOSYS methodology.
- Submitted the 4-6 page technical report.
- Created presentation structure

August 10th

- Drafted and submitted four slide summary for presentation.
- Recorded and submitted 5 minute presentation

August 12th

- Lockdown and Became Ill
- Went and got COVID-19 Testing (Stood in Queue for 4.5 hours)

August 13th

- Very productive meeting with Rosalind
- Discussed project process, presentation and mid-year technical report
- Continuing doing what I am doing.
- Continued developing NZ Example
- Abandoned developing the NZ Example as faced severe limitations
- Continued developing the Navigation, Forecasting, Energysystems and CreateCases modules.

September 2nd - September 30th

- IBM Cloud Installation and Application.
- Discussed project process, presentation and mid-year technical report
- Investigated adopting DOCPLEX optimisation technologies.
- Discovered limitations in the IBM Decision Optimisation service. This was no longer viable as imported to IBM Watson Machine Learning service.
- Began exploring the implementation of the IBM Watson Machine Learning service to engage with this pipeline.
- Developed the optimisation module to use

October 1st - October 29th

- Systems week interfered with the construction of the report.
- Wrote the report
- Edited the report
- Reviewed the report
- Had three productive meetings with my supervisor about the report.

October 30th

- Submitted the final report

4 GOCPI Documentation

The GOCPI classes and modules are described in the following document. This document was generated from docstrings using sphinx.

University of Auckland
Department of Engineering Science

Global Optimisation Carbon Pricing Initiative (GOCPI) Modules

Author: Connor McDowall
Supervisor: Rosalind Archer

Monday 26th October, 2020

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List of tables

1 GOCPI package

1.1 Submodules

1.2 GOCPI.CreateCases module

class GOCPI.CreateCases.CreateCases
Bases: object

A class of methods to create user-defined data cases

set_accumulated_annual_demand(*accumulated_forecast*)

Sets the accumulated annual demand for fuels per region over the forecast period.
This function relies on a similar forecasting methodology as set_specific_demand.
Fuels set in this function cannot be defined in set_specific_demand.

Parameters accumulated_forecast (*float , array*) – The forecast array of size (len(region),len(fuel),len(year))

set_accumulated_fuel(*accumulated_fuel*)
Sets the case's accumulated fuel types

Parameters specified_fuel (*list*) – list of specified fuels

set_annual_emission_limit(*annual_emission_limits*)
Sets Annual Emission Limits

Parameters annual_emission_limits (*float , array*) – Annual Emission Limits

set_annual_exogenous_emission(*annual_exogenous_emission*)
Sets Annual Exogneous Emissions

Parameters annual_exogenous_emission (*float , array*) – Annual Exogenous Emissions

set_availability_factor(*availablility_matrix*)
Sets the availability factors

Parameters availablility_matrix (*float , array*) – Matrix describing availability factors for given technologies

set_availability_technology(*availability_technology*)
Sets the cases availability_technology type

Parameters availability_technology (*list*) – List of technologies

set_capacity_factor(*factor_matrix*)
Sets capacity factors for conversion technologies.

Parameters `factor_matrix` (*float , array*) –

`set_capacity_of_one_technology_unit`(*capacity_ of_ one_ technology_ unit*)
Set the capacity of one technology units for all technologies

Parameters `capacity_of_one_technology_unit` (*float , array*) – capacities for one technology units

`set_capacity_technology`(*capacity_ technology*)
Sets the cases capacity_technology type

Parameters `capacity_technology` (*list*) – List of technologies

`set_capacity_to_activity_unit`(*region*, *technology*, *capacity_ dictionaries*, *override*)
Sets the capacity to activity parameter

Parameters
- `region` (*list*) – List of regions
- `technology` (*list*) – List of technologies
- `capacity_dictionaries` (*list*) – List of dictionaries to assign value
- `override` (*float , array*) –

`set_capital_cost`(*capital_ costs*)
Sets capital costs

Parameters `capital_costs` (*float , array*) – capital cost paramters

`set_capital_cost_storage`(*capital_ cost_ storage*)
Sets the capital costs of using storage technologies

Parameters `capital_cost_storage` (*float , array*) – capital cost of storage technologies

`set_conversion_ld`(*timeslice*, *daytype*, *link*)
Sets the Conversionld parameter

Parameters
- `timeslice` (*list*) – List of timeslices
- `daytype` (*list*) – List of daytypes
- `link` (*dict*) – Dictionary describing the connection between timeslices and daytypes

`set_conversion_lh`(*timeslice*, *dailytimebracket*, *link*, *override*)
Sets the Conversionlh parameter

Parameters
- `timeslice` (*list*) – List of timeslices
- `dailytimebracket` (*list*) – List of dailytimebracket
- `link` (*dict*) – Dictionary describing the connection between timeslices and dailytimebrackets
- `override` (*int , array*) – Override if want to manually put in the array

`set_conversion_ls`(*timeslice*, *season*, *link*)
Sets the Conversionls parameter

Parameters

- `timeslice` (*list*) – List of timeslices
- `season` (*list*) – List of seasons
- `link` (*dict*) – Dictionary describing the connection between timeslices and seasons

`set_daily_time_bracket(`*num_dailytimebrackets*`)`

Creates set of daily time brackets

Parameters `dailytimebracket` (*int*) – [description]

`set_day_split(`*daily_time_bracket*, *years*, *hour_split*, *num_days*, *num_hours*`)`

Sets the day split parameter

Parameters

- `daily_time_bracket` (*list*) – List of daily time brackets
- `years` (*list*) – List of year
- `hour_split` (*dict*) – Dictonary of hours in a daily time bracket
- `num_days` (*int*) – Number of days in a year
- `num_hours` (*int*) – Number of hours in a day

`set_days_in_day_type(`*season*, *daytype*, *year*, *link*, *override*`)`

Sets the DaysInDayType parameter

Parameters

- `season` (*list*) – List of seasons
- `daytype` (*list*) – List of daytypes
- `year` (*list*) – List of years
- `link` (*dict*) – Dictionary relating seasons to daytypes
- `override` (*int , array*) – Override if want to manually put in the array

`set_daytype(`*num_daytypes*`)`

[summary]

Parameters `num_daytypes` (*int*) – Number of daytypes

`set_depreciation_method(`*region*, *methods*, *override*`)`

Sets DepreciationMethod (1 = Sinking Fund Depreciation, 2 = Straightline Depreciation)

Parameters

- `region` (*list*) – List of regions
- `override` (*int , array*) – Manual array for setting depreciation methods
- `methods` (*dict*) – Dictionary assigning methods to regions

`set_discount_rate(`*equity*, *debt*, *market_index*, *cost_of_debt_pre_tax*, *risk_free_rate*, *effective_tax_rate*, *preference_equity*, *market_value_preference_shares*, *preference_dividends*, *market_risk_coefficient*`)`

[summary]

Parameters

- `equity` (*dict*) – Dictionary of equity totals from treasury balance sheets
- `debt` (*dict*) – Dictionary of equity totals from treasury balance sheets
- `market_index` (*int , array*) – Regional monthly index returns (Arrays)
- `cost_of_debt_pre_tax` (*dict*) – Dictionary of pre-tax cost of debts calculated from treasury balance sheets
- `risk_free_rate` (*dict*) – Dictionary of risk free rates from 10 year swap rates for each region
- `effective_tax_rate` (*dict*) – Dictionary of company tax rates for each region
- `preference_equity` (*dict*) – Dictionary of preference equity for each region
- `market_value_preference_shares` (*dict*) – Dictionary of the market value of prefence shares for each region
- `preference_dividends` (*dict*) – Dictionary of prefence dividends for each region
- `market_risk_coefficient` (*dict*) – Dictionary of markey risk coefficients

Returns Numpy array of discount rates

Return type [int, array]

`set_emission(`*emissions*`)`

Sets the cases emission types

Parameters `emissions` (*List*) – list of emission types

`set_emission_activity_ratio(`*emission_activity_ratios*`)`

Sets Emission Activity Ratios

Parameters `emission_activity_ratios` (*[float , array*) – Emission Activity Ratios

`set_emissions_penalty(`*emissions_penalties*`)`

Sets Emissions Penalties

Parameters `emissions_penalties` (*float , penalties*) – Emissions Penalties

`set_fixed_cost(`*fixed_costs*`)`

Set fixed costs

Parameters `fixed_costs` (*float , array*) – fixed cost parameters

`set_fuel(`*fuel*`)`

Sets the case's fuel types

Parameters `fuel` (*list*) – list of fuels

`set_input_activity_ratio(`*input_activity_ratios*`)`

Sets input activity ratios

Parameters `input_activity_ratios` (*float , array*) – Sets the input activity ratio

`set_min_storage_charge(`*minimum_storage_charges*`)`
Sets the minimum storage charges

Parameters `minimum_storage_charges` (*float , array*) – minimum storage parameters

`set_mode_of_operation(`*num_modes_of_operation*`)`
Create the number of modes of operation (n = 1,. . . ,num_modes_of_operation)

Parameters `num_modes_of_operation` (*int*) –

`set_model_period_emission_limit(`*model_period_emission_limits*`)`
Sets Model Period Emission Limits

Parameters `model_period_emission_limits` (*float , array*) – Model Period Emission Limits

`set_model_period_exogenous_emission(`*model_period_exogenous_emissions*`)`
Sets Model Period Exogenous Emissions

Parameters `model_period_exogenous_emissions` (*float , array*) – Model Period Exogenous Emissions

`set_operational_life(`*operational_lives*`)`
Sets operational life

Parameters `operational_lives` (*list*) –

`set_operational_life_storage(`*operational_life_storage*`)`
Sets the operational life storage

Parameters `operational_life_storage` (*float , array*) – operational life storage parameters

`set_output_activity_ratio(`*output_activity_ratios*`)`
Sets output activity ratio

Parameters `output_activity_ratios` (*float , array*) – output activity ratio parameters

`set_re_min_production_target(`*re_min_production_targets*`)`
Sets Renewable Energy Minimum Production Targets

Parameters `re_min_production_targets` (*float , array*) – Renewable Energy Minimum Production Targets

`set_re_tag_fuel(`*re_tag_fuels*`)`
Sets RE Tag Fuels

Parameters `re_tag_fuels` (*float , array*) – RE Tag Fuels

`set_re_tag_technology(`*re_tag_technologies*`)`
Sets RE Tag Technology

Parameters `re_tag_technologies` (*float , array*) – RE Tag Technologies

`set_region(`*regions*`)`
Sets the datacase's regions analysis

Parameters `regions` (*list*) – list of regions

`set_reserve_margin(`*reserve_ margins*`)`
Sets reserve margins

Parameters `reserve_margins` (*float , array*) – Reserve Margins

`set_reserve_margin_tag_fuel(`*reserve_ margin_ fuel_ tags*`)`
Sets the reserve margin tag fuels

Parameters `reserve_margin_fuel_tags` (*float , array*) – Sets the reserve margin tag fuel parameters

`set_reserve_margin_tag_technology(`*reserve_ margin_ tag_ technologies*`)`
Sets Reserve Margin Tag Technology

Parameters `reserve_margin_tag_technologies` (*float , array*) – Reserve Margin Tag Technologies

`set_residual_capacity(`*residential_ capacities*`)`
Set residual capacity

Parameters `residential_capacities` (*float , array*) – residual capacities parameter

`set_residual_storage_capacity(`*residual_ storage_ capacities*`)`
Sets residual storage capacities

Parameters `residual_storage_capacities` (*float , array*) – residual storage capacities

`set_season(`*num_ seasons*`)`
Creates set of seasons

Parameters `num_seasons` (*int*) – Number of seasons

`set_specified_annual_demand(`*specified_ forecast*`)`
Sets the annual demand for fuels per region over the forecast period (Must be accurate)

Parameters `forecast` (*float , array*) – The forecast array of size (len(region),len(fuel),len(year))

`set_specified_demand_profile(`*specified_ annual_ demand*, *region*, *fuel*, *year*, *timeslice*, *profile*, *override*`)`
Sets the specified annual demand profiles using the specified annual demand.

Parameters

- `specified_annual_demand` (*float , array*) – Specified annual demand profiles
- `region` (*list*) – List of regions
- `fuel` (*list*) – List of fuels
- `year` (*list*) – List of years
- `timeslice` (*list*) – List of timeslices
- `profile` (*Dict*) – Dictionary of fuel allocations to timeslices

- `override` (*float , array*) – Manual override for the specified annual demand profiles.

`set_specified_fuel(`*specified_fuel*`)`
Sets the case's specified fuel types

Parameters `specified_fuel` (*list*) – list of specified fuels

`set_storage(`*storage*`)`
Sets storage set of the datacase

Parameters `storage` (*list*) – list of storage types

`set_storage_level_start(`*storage_level_start*`)`
Sets the storage level starting point

Parameters `storage_level_start` (*float , array*) – storage starting level

`set_storage_max_charge_rate(`*storage_max_level_charge_rates*`)`
Sets the storgae max charge rate

Parameters `storage_max_level_charge_rates` (*float , array*) – Storage max level charge rates

`set_storage_max_discharge_rate(`*storage_max_level_discharge_rates*`)`
Sets storage technologies maximum discharge rates

Parameters `storage_max_level_discharge_rates` (*float , array*) – Discharge rates for storage paramters

`set_technology(`*technology*`)`
Sets the cases technology type

Parameters `technology` (*list*) – List of technologies

`set_technology_from_storage(`*technology_from_storage*`)`
Sets technology from storage binary paramter

Parameters `technology_from_storage` (*float , array*) – technology from storage parameter

`set_technology_to_storage(`*technology_to_storage*`)`
Sets the technology to storage parameter

Parameters `technology_to_storage` (*float , array*) – technology to storage parameter

`set_timeslice(`*timeslice*`)`
Set of timeslices

Parameters `timeslice` (*list*) – list of timeslices

`set_total_annual_max_capacity(`*total_annual_max_capacities*`)`
Sets the total annual maximum capacities

Parameters `total_annual_max_capacities` (*float , array*) – Total Annual Max Capacities

set_total_annual_min_capacity(*total_annual_min_capacities*)
Sets the totoal annual minimum capacities

Parameters total_annual_min_capacities (*float , array*) – Total Annual Min Capacities

set_total_technology_annual_activity_lower_limit(*total_technology_activity_lower_limits*)
Sets the Total Technology Activity Lower Limits

Parameters total_technology_activity_lower_limits (*float , array*) – Technology Activity Lower Limits

set_total_technology_annual_activity_upper_limit(*total_technology_annual_activity_upper_*
Sets the Total Technology Activity Upper Limits

Parameters total_technology_annual_activity_upper_limits (*float , array*) – Technology Activity Upper Limits

set_total_technology_period_activity_lower_limit(*total_technology_period_activity_lower_*
Sets Total Technology Period Activity Lower Limits

Parameters total_technology_period_activity_lower_limits (*[type]*) – Total Technology Period Activity Lower Limit

set_total_technology_period_activity_upper_limit(*total_technology_period_activity_upper_*
Sets Total Technology Period Activity Upper Limits

Parameters total_technology_period_activity_upper_limits (*float , array*) – Total Technology Period Activity Upper Limit

set_trade_route(*trade*)

Sets the TradeRoute parameter between regions (Assume it is the same across fuels and years)

Parameters trade (*int , array*) – 4D array representing trade relationships between regions, fuels and years. You must model this manually.

set_variable_cost(*variable_costs*)
Sets variable costs

Parameters variable_costs (*float , array*) – variable costs parameters

set_year(*start_year*, *end_year*, *interval*)
Sets a list of forecast years

Parameters

- start_year (*int*) – Starting year for forecasting (Less than end_year)
- end_year (*int*) – Ending year for forecasting (Greater than start_year)
- interval (*int*) – Gap for forecasting period

set_year_split(*timeslices*, *years*, *splits*)

Creates 2D Numpy Array Parameter Splits. (Note: The index positions of timelices and splits must match)

Parameters

- `timeslices` (*list*) – List of timeslices
- `years` (*list*) – List of years
- `splits` (*dict*) – A dictionary linking yearsplits to timeslices

1.3 GOCPI.Energysystems module

`class GOCPI.Energysystems.Energy_Systems(`*year*, *region*, *emission*, *technology*, *capacity_technology*, *availability_technology*, *fuel*, *specified_fuel*, *accumulated_fuel*, *timeslice*, *mode_of_operation*, *storage*, *daytype*, *season*, *dailytimebracket*`)`

Bases: `object`

A class of methods to initialise energy sytems and create the data/model files needed for optimisation.

`create_data_file(`*file_location*, *defaults_dictionary*, *toggle_defaults*`)`

Creates the osemosys datafile

Parameters

- `file_location` (*str*) – String of directory to save data file
- `defaults_dictionary` (*dict*) – Dictionary setting the default values for parameters
- `toggle_defaults` (*Bool*) – Boolean (True/False to only print the default functions

`create_model_file(`*root*, *file*`)`

Creates the model file necessary for the project to run

Parameters `for the basic problem` (*Parameters*) –
Returns The loaded in parameters and sets

`load_datacase(`*case*, *system*`)`

Loads the data case to a correct configured and intialised energy system

(The load status dictionary must be compatible with the data_case and system_case)

Parameters

- `case` (*object*) – Energy system datacase
- `system` (*object*) – Initialised energy system
- `load_status` (*dict*) – Dictionary setting the required sets and parameters to load

Returns Returns the updated dictionary
Return type system_case (dict)

1.4 GOCPI.Forecasting module

class GOCPI.Forecasting.Forecasting

Bases: object

calculate_cagr_forecasts(*cagr_dictionary*, *base_year_dictionary*, *fuel*, *year*)

Forecasts base year fuels by a constant average growth rate for a forecast period

Parameters

- cagr_dictionary (*Dict*) – Dictionary of constant average growth rates per fuel
- base_year_dictionary (*[type]*) – Dictionary of base year fuel consumption in energy types
- fuel (*list*) – List of Fuels
- year (*list*) – List of forecast years

Returns 2D Array of demand forecasts per fuel

Return type [float, array]

calculate_constant_average_growth_rate(*start_year*, *end_year*, *start_value*, *end_value*)

Calculates the constant average growth rate (CAGR)

Parameters

- start_year (*int*) – Starting year
- end_year (*int*) – Ending year
- start_value (*int*) – Initial value
- end_value (*int*) – Final value

Returns Constant average growth rate (1+ decimal)

Return type cagr

energy_balance_base(*root*, *IEA_World_Energy_Balances_1*, *IEA_World_Energy_Balances_2*, *create_excel_spreadsheet*, *output_file*)

Creates the baseline energy balance for forecasting

Parameters

- root (*path*) – Path to provide access to all the files
- IEA_World_Energy_Balances_1 (*str*) – File name for Energy Balance A to K
- IEA_World_Energy_Balances_2 (*[type]*) – File name for Energy Balance L to Z
- create_excel_spreadsheet (*boolean*) – True/false on whether to create a spreadsheet
- output_file (*str*) – Name of output energy balance spreadsheet

Returns Dictionary of energy balances and unique lists (Use these key words to access: Energy Balances, Fuel, Geography, Technology)

Return type (dict)

1.5 GOCPI.Navigation module

class GOCPI.Navigation.Navigation(*target_root*, *target_file*)

Bases: object

Navigation is a class for navigating, manipulating and editing data in the GOCPI model.

Find_File

Type string

TODO: Fill out all functions below

Find_File()

Find_File searches for a target file, from a base directory, to construct a target directory.

Inputs: target_root = The base directory to search from (string). target_file = The name of the target file (string).

Outputs: f = Combinated target file location (string).

create_linear_programme_file(*directory*, *data_file*, *model_file*, *output_file*)

Creates the model file through executing model system commands

Parameters

- **directory** (*str*) – Name of directory to put data into
- **data_file** (*str*) – Name of energy system data file
- **model_file** (*str*) – Name of energy system model file
- **output_file** (*str*) – Name of output linear programme

1.6 GOCPI.Optimisation module

class GOCPI.Optimisation.Optimisation

Bases: object

Prepare and runs optimisation with IBM ILOG CPLEX Optimisation Studio

create_linear_programme_file(*directory*, *data_file*, *model_file*, *output_file*)

Creates the model file through executing model system commands

Parameters

- **directory** (*str*) – Name of directory to put data into
- **data_file** (*str*) – Name of energy system data file
- **model_file** (*str*) – Name of energy system model file
- **output_file** (*str*) – Name of output linear programme

reset(*tarinfo*)

Resets the tarfile information when creating tar files This is to input into the filter when using tar.add()

Parameters **tarinfo** (*Object*) – Tar Object containing an ID of 0 and the root as the name

Returns Tar Object containing an ID of 0 and the root as the name
Return type tarinfo (Object)

`run_cplex_local(`*model_file*`)`
This function runs cplex on the local device if the energy system is of a small enough complexity

`run_ibm_wml_do(`*apikey*, *url*, *deployment_space_name*, *cloud_object_storage_credential*, *service_instance_id*, *deployment_space_exists*, *data_assets_exist*, *data_asset_dictionary*, *model_name*, *model_type*, *model_runtime_uid*, *model_tar_file*, *num_nodes*, *deployment_exists*, *payload_input_data_id*, *payload_input_data_file*, *payload_output_data_id*`)`

This function enables the user to solve python-based optimisation models. The legacy offering to solve optimisation models on IBM cloud was using the docplex python api to run Cplex on DOcloud. As of September 2020, the DOcloud was discontinued with Decision Optimisation functionalities imported to IBM's Watson Machine Learning Service. The new process requires the energy system model to be written in python. This project saw the implementation of the osemosys modelling methodology in GNU Mathprog written into LP Files. IBM Decision Optimisation in cannot deploy models in LP File formats to get jobs. Therefore, this function is for future work in converting the entire energy system modelling tool to python-based only. This is well-documented the report in the Future Work Section. Note: You must have access to IBM Watson Studio and Cloud Products through the IBM Academic Initiative or Similar.

Parameters

- `apikey` (*str*) – API key from user's IBM Cloud Account
- `url` (*[type]*) – URL for the server the user is using for the IBM services
- `deployment_space_name` (*str*) – Name of the deployment space
- `cloud_object_storage_credential` (*str*) – Credential for the cloud object storage asset
- `service_instance_id` (*str*) – Service instance id for the service being used (IBM WML)
- `deployment_space_exists` (*boolean*) – True/False if the deployment space already exists
- `data_assets_exist` (*boolean*) – True/False if the data assets (e.g. input data stored on cloud)
- `data_asset_dictionary` (*dict*) – A dictionary of data assets to stored on IBM cloud
- `model_name` (*str*) – Name of the model
- `model_type` (*str*) – Name of the model
- `model_runtime_uid` (*str*) – Runtime ID for the model
- `model_tar_file` (*tar*) – Tar file containing the python model
- `num_nodes` (*int*) – Number of nodes the model is run off.
- `deployment_exists` (*boolean*) – True/False if the deployment already exists
- `payload_input_data_id` (*str*) – Name of input data

- `payload_input_data_file` (*dataframe*) – Input data file in the form of a dataframe
- `payload_output_data_id` (*str*) – Name of output data file

`use_bash_shell(`*command*`)`

Execute bash commands in python scripts

Parameters `command` (*str*) – Command to execute

1.7 Module contents

Indices and tables

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5 Programming

These section contains all programming scripts for the project.

5.1 GOCPI NZ Energy Systems Example

The GOCPI NZ Example file is the Python file

```
# GOCPI_NZ_Example.gyp is an exemplar script in how to build a
# data case for the Model

#
    ##############################################################################

# This is a major input script for creating data files.
#
    ##############################################################################

# Import all necessary python packages
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy as sc
import sklearn as skl
import csv as csv
import openpyxl
import pathlib
import os
from pathlib import Path
from openpyxl import load_workbook
import GOCPI as GF
import cplex as cp
import docplex as dp

# Sets sets (All must be one word)
# Creates a New Zealand Energy System Scenario using the CreateCases
    Module
nz_energy_system = GF.CreateCases()

# Set Definitions
#
    ##############################################################################

#
    ##############################################################################


# Defines the forecast period
nz_energy_system.set_year(2020, 2030, 1)

# Defines the regions
REGION = ['NEWZEALAND', 'AUSTRALIA']
nz_energy_system.set_region(REGION)

# Defines the Emissions
EMISSION = ['CO2', 'NOX', 'CO', 'METHANE']
nz_energy_system.set_emission(EMISSION)

```

```
# Technology
#
    ##############################################################################

#
    ##############################################################################

# Defines the technology set (MBIE Energy Statistics Energy Supply and
    Demand -
# Gross PJ (Higher Heating Value))
Production = [
    'Indigenous_Production', 'Imports', 'Exports', 'Stock_Change',
    'International_Transport'
]
Conversion = [
    'Electricity_Generation', 'Cogeneration', 'Fuel_Production',
    'Other_Transformation', 'Losses_and_Own_Use'
]
Non_Energy = ['Non_Energy_Use']
Consumption = [
    'Agriculture', 'Forestry_and_Logging', 'Fishing', 'Mining',
    'Food_Processing', 'Textiles', 'Wood_Pulp_Paper_and_Printing', '
    Chemicals',
    'Non_Metallic_Minerals', 'Basic_Metals',
    'Mechanical_Electrical_Equippment', 'Building_and_Construction',
    'Unallocated', 'Commercial', 'Transport', 'Residential'
]
Statistical_Differences = ['Statistical_Differences']
TECHNOLOGY_ALL = [
    Production, Conversion, Non_Energy, Consumption,
    Statistical_Differences
]
TECHNOLOGY = []
for tech in TECHNOLOGY_ALL:
    for i in range(0, len(tech), 1):
        TECHNOLOGY.append(tech[i])

# Sets the technology set
nz_energy_system.set_technology(TECHNOLOGY)

# Sets capacity technologies for energy production
CAPACITY_TECHNOLOGY = Conversion
CONSUMPTION_TECHNOLOGY = Consumption
nz_energy_system.set_capacity_technology(TECHNOLOGY)
nz_energy_system.set_availability_technology(TECHNOLOGY)
# Sets the Conversion Sets

#
    ##############################################################################

# Calculates Energy Balances Base Year
#
    ##############################################################################


# Sets names for the energy balance sheets
NZ_energy_balances = GF.Forecasting()
root_energy_balance = pathlib.Path(
```

```
    '/Users/connor/Google Drive/Documents/University/Courses/2020/ENGSCI 700A&B/GOCPI/data/Energy Balances'
)
IEA_World_Energy_Balances_A2K = 'IEAWorldEnergyBalances2017A-K.csv'
IEA_World_Energy_Balances_L2Z = 'IEAWorldEnergyBalances2017L-Z.csv'
create_excel_spreadsheet = True
output_file = "Geo EB.xlsx"

# Creates the geography dataframe
outputs = NZ_energy_balances.energy_balance_base(
    root_energy_balance, IEA_World_Energy_Balances_A2K,
    IEA_World_Energy_Balances_L2Z, create_excel_spreadsheet,
    output_file)

#
    ##############################################################################

# Calculates Fuels
#
    ##############################################################################

# Defines the fuel set (MBIE Energy Statistics Energy Supply and Demand - Gross PJ (Higher Heating Value))
Coal = ['Bituminous', 'Sub_Bitumious', 'Lignite']
Oil = [
    'Crude_Feedstocks_NGL', 'LPG', 'Petrol', 'Diesel', 'Fuel_Oil',
    'Aviation_Fuel_and_Kerosine', 'Oil_Other'
]
Natural_Gas = ['Natural_Gas']
Renewables = [
    'Hydro', 'Geothermal', 'Solar', 'Wind', 'Liquid_Biofuels', 'Biogas', 'Wood'
]
Electricity = ['Electricity']
Waste_Heat = ['Waste_Heat']

FUEL_ALL = [Coal, Oil, Natural_Gas, Renewables, Electricity, Waste_Heat]
FUEL = []
for fuel_type in FUEL_ALL:
    for i in range(0, len(fuel_type), 1):
        FUEL.append(fuel_type[i])

# Sets Specified Fuels
SPECIFIED_FUEL_ALL = [
    Coal, Oil, Natural_Gas, Renewables, Electricity, Waste_Heat
]
SPECIFIED_FUEL = []
for fuel_type in SPECIFIED_FUEL_ALL:
    for i in range(0, len(fuel_type), 1):
        SPECIFIED_FUEL.append(fuel_type[i])

# Sets Accumulated Fuels
ACCUMULATED_FUEL_ALL = [
    Coal, Oil, Natural_Gas, Renewables, Electricity, Waste_Heat
]
ACCUMULATED_FUEL = []
for fuel_type in ACCUMULATED_FUEL_ALL:
```

```
138     for i in range(0, len(fuel_type), 1):
139         ACCUMULATED_FUEL.append(fuel_type[i])
140 
141 # Sets the total fuels
142 nz_energy_system.set_fuel(FUEL)
143 nz_energy_system.set_specified_fuel(FUEL)
144 nz_energy_system.set_accumulated_fuel(FUEL)
145 #
    ##############################################################################

146 # Continues defining sets
147 #
    ##############################################################################

148 # Defines timeslices
149 TIMESLICE = [
150     'DAY_SUMMER', 'NIGHT_SUMMER', 'DAY_WINTER', 'NIGHT_WINTER',
151     'DAY_INTERMEDIATE', 'NIGHT_INTERMEDIATE'
152 ]
153 nz_energy_system.set_timeslice(TIMESLICE)
154 
155 # Defines Modes of Operation
156 nz_energy_system.set_mode_of_operation(1)
157 
158 # Defines the storage set
159 STORAGE = ['DAM']
160 nz_energy_system.set_storage(STORAGE)
161 
162 # Defines the daytype (numbers represent different daytypes)
163 # 1 = Weekday (Mon - Fri), 2 = Weekend (Sat & Sun)
164 nz_energy_system.set_daytype(2)
165 
166 # Defines the seasons
167 # (Three seasons (Summer (1), Winter (2) and Intermediate (3)))
168 nz_energy_system.set_season(3)
169 
170 # Defines the dailytimebracket (Number of distinct periods in a day)
171 # 4 = Morning (6hrs), Afternoon (6hrs), Evening (6hrs), Night (6hrs)
172 nz_energy_system.set_daily_time_bracket(4)
173 
174 #
    ##############################################################################

175 # Defines Global Parameters
176 #
    ##############################################################################

177 # Defines the YearSplit parameter
178 # Creates Dictionary for number of days
179 days = {
180     'January': 31,
181     'February': 28,
182     'March': 31,
183     'April': 30,
184     'May': 31,
185     'June': 30,
186     'July': 31,
187     'August': 31,
```

```
    'September': 30,
    'October': 31,
    'November': 30,
    'December': 31
}

# Combines summer, winter and intermediate nights
days_summer = days['January'] + days['February'] + days['December']
days_winter = days['June'] + days['July'] + days['August']
days_intermediate = days['April'] + days['May'] + days['March'] + days[
    'September'] + days['October'] + days['November']
days_total = days_summer + days_winter + days_intermediate

# Creates fractions and stores values in a dictionary
day_summer = (0.5 * days_summer / days_total)
night_summer = (0.5 * days_summer / days_total)
day_winter = (0.5 * days_winter / days_total)
night_winter = (0.5 * days_winter / days_total)
day_intermediate = (0.5 * days_intermediate / days_total)
night_intermediate = (0.5 * days_intermediate / days_total)

# Dictionaries
splits = {
    'DAY_SUMMER': day_summer,
    'NIGHT_SUMMER': night_summer,
    'DAY_WINTER': day_winter,
    'NIGHT_WINTER': night_winter,
    'DAY_INTERMEDIATE': day_intermediate,
    'NIGHT_INTERMEDIATE': night_intermediate
}
# Creates the YearSplit parameter 2D Matrix
nz_energy_system.set_year_split(TIMESLICE, nz_energy_system.year,
    splits)

# Imports S&P NZX:50 and S&P ASX:200 Indices Arrays to calculate market
    returns
root = '/Users/connor/Google Drive/Documents/University/Courses/2020/
    ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI OseMOSYS'
file_root = Path(root)
file_spreadsheet = 'Returns.xls'
location = GF.Navigation(file_root, file_spreadsheet)
market_returns = location.Find_File()
nz_df = pd.read_excel(market_returns, sheet_name='NZ')
aus_df = pd.read_excel(market_returns, sheet_name='AUS')
nz_index = nz_df[["Monthly_Returns"]].to_numpy()
aus_index = aus_df[["Monthly_Returns"]].to_numpy()

# Defines the Dictionaries required for Region. All regions should have
    the same names
# Creates a dictionary of market indices
market_index = {'NEWZEALAND': nz_index, 'AUSTRALIA': aus_index}
# Tresury Equity Balances as at 2019
# (Australia has negative equity, New Zealand has $139746000000)
# However, Governments do not have market equity so should be zer for
    both
equity = {'NEWZEALAND': 0, 'AUSTRALIA': 0}
# Tresury Debt Balance as at 2019
debt = {'NEWZEALAND': 110477000000, 'AUSTRALIA': 619219000000}
```

```
# Tresury Finance Cost(Interest Expenses on Debt as at 2019
cost_of_debt_pre_tax = {'NEWZEALAND': 4059000000, 'AUSTRALIA':
    17088000000}
# Preference Equity (None for governments)
preference_equity = {'NEWZEALAND': 0, 'AUSTRALIA': 0}
market_value_preference_shares = {'NEWZEALAND': 1, 'AUSTRALIA': 1}
# (Set to zero if none otherwise you get an error)
preference_dividends = {'NEWZEALAND': 0, 'AUSTRALIA': 0}
# Calculated from 10 Year Treasury Bonds (10 Year Average)
risk_free_rate = {'NEWZEALAND': 0.0360, 'AUSTRALIA': 0.0335}
# Company Tax Rates
effective_tax_rate = {'NEWZEALAND': 0.28, 'AUSTRALIA': 0.30}
# Beta for region modelled
market_risk_coefficient = {'NEWZEALAND': 0, 'AUSTRALIA': 0}

# Sets the discount rates
nz_energy_system.set_discount_rate(equity, debt, market_index,
                                   cost_of_debt_pre_tax, risk_free_rate
    ,
                                   effective_tax_rate,
    preference_equity,
                                   market_value_preference_shares,
                                   preference_dividends,
                                   market_risk_coefficient)

# Creates Dictionary of day splits (assumes constant accross years)
# Preserve the order of the split.
hour_split = {"1": 6, "2": 6, "3": 6, "4": 6}
num_days = 365
num_hours = 24
nz_energy_system.set_day_split(nz_energy_system.dailytimebracket,
                               nz_energy_system.year, hour_split,
    num_days,
                               num_hours)

# Sets a dictionary to match the timeslice with season
link_ls = {
    "DAY_SUMMER": "1",
    "NIGHT_SUMMER": "1",
    "DAY_WINTER": "2",
    "NIGHT_WINTER": "2",
    "DAY_INTERMEDIATE": "3",
    "NIGHT_INTERMEDIATE": "3"
}
nz_energy_system.set_conversion_ls(nz_energy_system.timeslice,
                                   nz_energy_system.season, link_ls)
# Sets a dictionary to match the timeslice with daytype
# Daytypes: 1 = Weekday (Mon - Fri), 2 = Weekend (Sat & Sun)
# Order must be preserved
link_ld = {
    "DAY_SUMMER": np.ones((1, 2)),
    "NIGHT_SUMMER": np.ones((1, 2)),
    "DAY_WINTER": np.ones((1, 2)),
    "NIGHT_WINTER": np.ones((1, 2)),
    "DAY_INTERMEDIATE": np.ones((1, 2)),
    "NIGHT_INTERMEDIATE": np.ones((1, 2))
}
nz_energy_system.set_conversion_ld(nz_energy_system.timeslice,
```

```
                                        nz_energy_system.daytype, link_ld)
# Sets a dictionary to match the timeslice with daytype
# 1). Morning (6hrs), 2).Afternoon (6hrs), 3).Evening (6hrs), 4).Night (6hrs)
# Order must be preserved in the arrays
link_lh = {
    "DAY_SUMMER": np.array([1, 1, 0, 0]),
    "NIGHT_SUMMER": np.array([0, 0, 1, 1]),
    "DAY_WINTER": np.array([1, 1, 0, 0]),
    "NIGHT_WINTER": np.array([0, 0, 1, 1]),
    "DAY_INTERMEDIATE": np.array([1, 1, 0, 0]),
    "NIGHT_INTERMEDIATE": np.array([0, 0, 1, 1])
}
override_conversionlh = None
# Sets the Conversionlh parameter

nz_energy_system.set_conversion_lh(nz_energy_system.timeslice,
                                        nz_energy_system.dailytimebracket, link_lh,
                                        override_conversionlh)
# Creates season dictionary for daytypes (Assumed to be the same each year)
link_dtdt = {
    "1": np.array([5, 2]),
    "2": np.array([5, 2]),
    "3": np.array([5, 2])
}
override_dtdt = None
# Sets the DaysInDayType parameter
nz_energy_system.set_days_in_day_type(nz_energy_system.season,
                                      nz_energy_system.daytype,
                                      nz_energy_system.year, link_dtdt,
                                      override_dtdt)

# Creates trade relationships using an 2D numpy array
# Must [NEWZEALAND, AUSTRALIA],[NEWZEALAND, AUSTRALIA]
# Hypothetically, you can model any trade relationship for any fuel in any year
# FUELS = As above
# YEAR = 2020 - 2030 (11)
trade = np.zeros((len(nz_energy_system.region), len(nz_energy_system.region),
                  len(nz_energy_system.fuel), len(nz_energy_system.year)))
trade_all_fuels = np.array([[0, 1], [1, 0]])
for i in range(0, len(nz_energy_system.fuel), 1):
    for j in range(0, len(nz_energy_system.year), 1):
        trade[:, :, i, j] = trade_all_fuels
nz_energy_system.set_trade_route(trade)

# Creates depreciation methods dictionary
depreciation_methods = {"NEWZEALAND": 2, "AUSTRALIA": 2}
override_depreciation = None
nz_energy_system.set_depreciation_method(nz_energy_system.region,
                                         depreciation_methods,
                                         override_depreciation)

```

```
346 #
    ##############################################################################
347 # Initialisation and Definition of demand parameters (Including
    forecasting)
348 #
    ##############################################################################
349 # Sets dictionaries to calculate CAGR for Fuels Forecasts
350 nz_cagr_fuels = {}
351 aus_cagr_fuels = {}
352 cagr_dictionaries_regions = [nz_cagr_fuels, aus_cagr_fuels]
353 # Initialises cagr parameters
354 nz_start_year_fuels = {}
355 nz_end_year_fuels = {}
356 nz_start_value_fuels = {}
357 nz_end_value_fuels = {}
358 aus_start_year_fuels = {}
359 aus_end_year_fuels = {}
360 aus_start_value_fuels = {}
361 aus_end_value_fuels = {}
362 nz_cagr_dictionaries_parameters = [
363     nz_start_year_fuels, nz_end_year_fuels, nz_start_value_fuels,
364     nz_end_value_fuels
365 ]
366 aus_cagr_dictionaries_parameters = [
367     aus_start_year_fuels, aus_end_year_fuels, aus_start_value_fuels,
368     aus_end_value_fuels
369 ]
370
371 # Populates regional dictionaries with new entry, all fuel types with
    default cagr values
372 for region_fuels in cagr_dictionaries_regions:
373     for i in range(0, len(nz_energy_system.fuel), 1):
374         region_fuels[nz_energy_system.fuel[i]] = 0.05
375
376 # Populates regional dictionaries with new entry, all fuel types with
    default values
377 for parameters in nz_cagr_dictionaries_parameters:
378     for i in range(0, len(nz_energy_system.fuel), 1):
379         region_fuels[nz_energy_system.fuel[i]] = 1
380
381 for parameters in nz_cagr_dictionaries_parameters:
382     for i in range(0, len(nz_energy_system.fuel), 1):
383         region_fuels[nz_energy_system.fuel[i]] = 1
384 # Loads demand data to the parameter dictionaries (Energy units are in
    PJs)
385 # New Zealand
386
387 nz_start_years = np.zeros(len(nz_energy_system.fuel))
388 nz_start_years[:] = 2010
389 nz_end_years = np.zeros(len(nz_energy_system.fuel))
390 nz_end_years[:] = 2018
391 nz_start_values = np.array([
392     7.23, 13.24, 4.19, 0, 7.11, 110.43, 106.09, 7.11, 14.62, 0, 60.29,
    0, 9.21,
393     0.35, 0, 0, 0.33, 55.89, 146.49, 0
394 ])
```

```
nz_end_values = np.zeros(len(nz_energy_system.fuel))
nz_end_values = np.array([
    3.07, 16.26, 5.14, 0, 8.71, 113.22, 138.79, 5.82, 16.23, 0, 73.97, 0, 8.03,
    0.36, 0, 0, 0.33, 56.61, 142.87, 0
])
# Australia
aus_start_years = np.zeros(len(nz_energy_system.fuel))
aus_start_years[:] = 2017
aus_end_years = np.zeros(len(nz_energy_system.fuel))
aus_end_years[:] = 2018
aus_start_values = np.array([
    104.9, 9.0, 0.5, 2.3, 72.4, 847.9724, 1038.76619, 42.39862, 190.79379, 0.0,
    0.0, 0.0, 0, 15.7, 0.0, 8.4, 94.7, 79.2, 821.8, 0
])
aus_end_values = np.zeros(len(nz_energy_system.fuel))
aus_end_values = np.array([
    104.445, 8.737, 0.38, 2.019, 67.499, 904.7584, 1108.32904, 45.23792,
    135.71376, 0.35788, 942.965, 0, 0, 16.56, 0, 8.642, 83.592, 76.81, 835.439,
    0
])
# Assign values to the dictionary
for i in range(0, len(nz_energy_system.fuel), 1):
    aus_start_year_fuels[nz_energy_system.fuel[i]] = aus_start_years[i]
    aus_end_year_fuels[nz_energy_system.fuel[i]] = aus_end_years[i]
    aus_start_value_fuels[nz_energy_system.fuel[i]] = aus_start_values[i]
    aus_end_value_fuels[nz_energy_system.fuel[i]] = aus_end_values[i]
    nz_start_year_fuels[nz_energy_system.fuel[i]] = nz_start_years[i]
    nz_end_year_fuels[nz_energy_system.fuel[i]] = nz_end_years[i]
    nz_start_value_fuels[nz_energy_system.fuel[i]] = nz_start_values[i]
    nz_end_value_fuels[nz_energy_system.fuel[i]] = nz_end_values[i]

print("nz_start_year_fuels", nz_start_year_fuels)
print("nz_end_year_fuels", nz_end_year_fuels)
print("nz_start_value_fuels", nz_start_value_fuels)
print("nz_end_value_fuels", nz_end_value_fuels)
print("aus_start_year_fuels", aus_start_year_fuels)
print("aus_end_year_fuels", aus_end_year_fuels)
print("aus_start_value_fuels", aus_start_value_fuels)
print("aus_end_value_fuels", aus_end_value_fuels)

# Calculates the cagr dictionary
forecasting_functions = GF.Forecasting()
for fuel in nz_cagr_fuels:
    nz_cagr_fuels[
        fuel] = forecasting_functions.
    calculate_constant_average_growth_rate(
            nz_start_year_fuels[fuel], nz_end_year_fuels[fuel],
            nz_start_value_fuels[fuel], nz_end_value_fuels[fuel])
for fuel in aus_cagr_fuels:
    aus_cagr_fuels[
        fuel] = forecasting_functions.
    calculate_constant_average_growth_rate(
            aus_start_year_fuels[fuel], aus_end_year_fuels[fuel],
```

```
            aus_start_value_fuels[fuel], aus_end_value_fuels[fuel])

# Calculates NZ CAGR forecasts
nz_fuel_forecast = forecasting_functions.calculate_cagr_forecasts(
    nz_cagr_fuels, nz_end_value_fuels, nz_energy_system.fuel,
    nz_energy_system.year)

# Calculates AUS CAGR forecasts
aus_fuel_forecast = forecasting_functions.calculate_cagr_forecasts(
    aus_cagr_fuels, aus_end_value_fuels, nz_energy_system.fuel,
    nz_energy_system.year)

fuel_forecasts = [nz_fuel_forecast, aus_fuel_forecast]

# Creates the forecast 3D array
forecast = np.zeros((len(nz_energy_system.region), len(nz_energy_system
    .fuel),
                     len(nz_energy_system.year)))

# Sets the forecast 3D array with CAGR forecast values
for i in range(0, len(fuel_forecasts), 1):
    forecast[i, :, :] = fuel_forecasts[i]

# Sets the Specified Demand Profiles
# nz_energy_system.set_specified_annual_demand(forecast[:, 0:-1, :])
nz_energy_system.set_specified_annual_demand(forecast[:, :, :])
# Sets the Accumulated Demand Profiles (Hack to make sure 3D Array)
acc_forecast = np.zeros(
    (len(nz_energy_system.region), len(nz_energy_system.
    accumulated_fuel),
     len(nz_energy_system.year)))
acc_forecast[:, 0, :] = forecast[:, -1, :]

# Make adjustments to the accumumulated fuel forecasts
nz_energy_system.set_accumulated_annual_demand(forecast[:, :, :])
# Sets linear profile for timeslices (In this example, is is assumed
    the fuel is consumed uniformally in time splits)
linear_profile = splits
override = None
# Sets the Specifief Demand Profiles
nz_energy_system.set_specified_demand_profile(
    nz_energy_system.SpecifiedAnnualDemand, nz_energy_system.region,
    nz_energy_system.specified_fuel, nz_energy_system.year,
    nz_energy_system.timeslice, linear_profile, override)

# Sets the Capacity to Activity Factors (Assume conversion of GW to PJ)
nz_capacity_to_activity = {}
aus_capacity_to_activity = {}
for tech in nz_energy_system.capacity_technology:
    nz_capacity_to_activity[tech] = 31.536
    aus_capacity_to_activity[tech] = 31.536

capacity_dictionaries = [nz_capacity_to_activity,
    aus_capacity_to_activity]
# Sets the CapacityToActivty Function
override = None
nz_energy_system.set_capacity_to_activity_unit(
    nz_energy_system.region, nz_energy_system.capacity_technology,
```

```
    capacity_dictionaries, override)
print(nz_energy_system.capacity_technology)
print(nz_energy_system.CapacityToActivityUnit)

# Sets capacity factor matrix to operate in every timeslice (Assumes operate 0.8 of the time).
capacity_factors = np.zeros(
    (len(nz_energy_system.region), len(nz_energy_system.capacity_technology),
     len(nz_energy_system.timeslice), len(nz_energy_system.year)))
capacity_factors[:, :, :, :] = 0.8

nz_energy_system.set_capacity_factor(capacity_factors)

# Set availability factors
availability_factors = np.zeros((len(nz_energy_system.region),
                                 len(nz_energy_system.availability_technology),
                                 len(nz_energy_system.year)))

availability_factors[:, :, :] = 1
nz_energy_system.set_availability_factor(availability_factors)

# Sets up operational life

#
#
# print(nz_energy_system.YearSplit)
# print(nz_energy_system.DiscountRate)
# print(nz_energy_system.DaySplit)
# print(nz_energy_system.Conversionld)
# print(nz_energy_system.Conversionls)
# print(nz_energy_system.Conversionlh)
# print(nz_energy_system.TradeRoute)
# print(nz_energy_system.DaysInDayType)
# print(nz_energy_system.DepreciationMethod)

# Initialises yet to be written parameters to check progress / load Parameters (Delete later)
ly = len(nz_energy_system.year)
lr = len(nz_energy_system.region)
le = len(nz_energy_system.emission)
lt = len(nz_energy_system.technology)
lf = len(nz_energy_system.fuel)
ll = len(nz_energy_system.timeslice)
lm = len(nz_energy_system.mode_of_operation)
ls = len(nz_energy_system.storage)
lld = len(nz_energy_system.daytype)
lls = len(nz_energy_system.season)
llh = len(nz_energy_system.dailytimebracket)

#nz_energy_system.YearSplit = np.ones((ll, ly))
#nz_energy_system.DiscountRate = np.ones((lr))
#nz_energy_system.DaySplit = np.ones((llh, ly))
#nz_energy_system.Conversionls = np.ones((ll, lls))
#nz_energy_system.Conversionld = np.ones((ll, lld))
#nz_energy_system.Conversionlh = np.ones((ll, llh))
#nz_energy_system.DaysInDayType = np.ones((lls, lld, ly))
```

```
#nz_energy_system.TradeRoute = np.ones((lr, lr, lf, ly))
#nz_energy_system.DepreciationMethod = np.ones((lr))
#nz_energy_system.SpecifiedAnnualDemand = np.ones((lr, lf, ly))
#nz_energy_system.SpecifiedDemandProfile = np.ones((lr, lf, ll, ly))
#nz_energy_system.AccumulatedAnnualDemand = np.ones((lr, lf, ly))
#nz_energy_system.CapacityToActivityUnit = np.ones((lr, lt))
#nz_energy_system.CapacityFactor = np.ones((lr, lt, ll, ly))
#nz_energy_system.AvailabilityFactor = np.ones((lr, lt, ly))
nz_energy_system.OperationalLife = np.ones((lr, lt))
nz_energy_system.ResidualCapacity = np.ones((lr, lt, ly))
nz_energy_system.InputActivityRatio = np.ones((lr, lt, lf, lm, ly))
nz_energy_system.OutputActivityRatio = np.ones((lr, lt, lf, lm, ly))
nz_energy_system.CapitalCost = np.ones((lr, lt, ly))
nz_energy_system.VariableCost = np.ones((lr, lt, lm, ly))
nz_energy_system.FixedCost = np.ones((lr, lt, ly))
nz_energy_system.TechnologyToStorage = np.ones((lr, lt, ls, lm))
nz_energy_system.TechnologyFromStorage = np.ones((lr, lt, ls, lm))
nz_energy_system.StorageLevelStart = np.ones((lr, ls))
nz_energy_system.StorageMaxChargeRate = np.ones((lr, ls))
nz_energy_system.StorageMaxDischargeRate = np.ones((lr, ls))
nz_energy_system.MinStorageCharge = np.ones((lr, ls, ly))
nz_energy_system.OperationalLifeStorage = np.ones((lr, ls))
nz_energy_system.CapitalCostStorage = np.ones((lr, ls, ly))
nz_energy_system.ResidualStorageCapacity = np.ones((lr, ls, ly))
nz_energy_system.CapacityOfOneTechnologyUnit = np.ones((lr, lt, ly))
nz_energy_system.TotalAnnualMaxCapacity = np.ones((lr, lt, ly))
nz_energy_system.TotalAnnualMinCapacity = np.ones((lr, lt, ly))
nz_energy_system.TotalAnnualMaxCapacityInvestment = np.ones((lr, lt, ly
    ))
nz_energy_system.TotalAnnualMinCapacityInvestment = np.ones((lr, lt, ly
    ))
nz_energy_system.TotalTechnologyAnnualActivityLowerLimit = np.ones(
    (lr, lt, ly))
nz_energy_system.TotalTechnologyAnnualActivityUpperLimit = np.ones(
    (lr, lt, ly))
nz_energy_system.TotalTechnologyModelPeriodActivityUpperLimit = np.ones
    (
    (lr, lt))
nz_energy_system.TotalTechnologyModelPeriodActivityLowerLimit = np.ones
    (
    (lr, lt))
nz_energy_system.ReserveMarginTagTechnology = np.ones((lr, lt, ly))
nz_energy_system.ReserveMarginTagFuel = np.ones((lr, lf, ly))
nz_energy_system.ReserveMargin = np.ones((lr, ly))
nz_energy_system.RETagTechnology = np.ones((lr, lt, ly))
nz_energy_system.RETagFuel = np.ones((lr, lf, ly))
nz_energy_system.REMinProductionTarget = np.ones((lr, ly))
nz_energy_system.EmissionActivityRatio = np.ones((lr, lt, le, lm, ly))
nz_energy_system.EmissionsPenalty = np.ones((lr, le, ly))
nz_energy_system.AnnualExogenousEmission = np.ones((lr, le, ly))
nz_energy_system.AnnualEmissionLimit = np.ones((lr, le, ly))
nz_energy_system.ModelPeriodExogenousEmission = np.ones((lr, le))
nz_energy_system.ModelPeriodEmissionLimit = np.ones((lr, le))

# Sets the case (Toggle depending on the data set you choose to use)
case = nz_energy_system

# Initialises the energy system
```

```
608 system = GF.Energy_Systems(
609     nz_energy_system.year, nz_energy_system.region, nz_energy_system.
    emission,
610     nz_energy_system.technology, nz_energy_system.capacity_technology,
611     nz_energy_system.availability_technology, nz_energy_system.fuel,
612     nz_energy_system.specified_fuel, nz_energy_system.accumulated_fuel,
613     nz_energy_system.timeslice, nz_energy_system.mode_of_operation,
614     nz_energy_system.storage, nz_energy_system.daytype,
615     nz_energy_system.season, nz_energy_system.dailytimebracket)
616
617 # Loads the datacase to the system
618 system.load_datacase(case, system)
619
620 # Sets up location information
621 data_txt = 'GOCPI_NZ_Example_Data.txt'
622 model_source_file = 'GOCPI_OseMOSYS_Structure.xlsx'
623 root = '/Users/connor/Google Drive/Documents/University/Courses/2020/
    ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI OseMOSYS'
624 data_roots = Path(root)
625 data_location_1 = os.path.join(data_roots, data_txt)
626
627 # Sets the default parameters
628 default_parameters = {
629     'YearSplit': 1,
630     'DiscountRate': 0.05,
631     'DaySplit': 1,
632     'Conversionls': 1,
633     'Conversionld': 1,
634     'Conversionlh': 1,
635     'DaysInDayType': 1,
636     'TradeRoute': 1,
637     'DepreciationMethod': 2,
638     'SpecifiedAnnualDemand': 1,
639     'SpecifiedDemandProfile': 1,
640     'AccumulatedAnnualDemand': 1,
641     'CapacityToActivityUnit': 1,
642     'CapacityFactor': 1,
643     'AvailabilityFactor': 1,
644     'OperationalLife': 1,
645     'ResidualCapacity': 1,
646     'InputActivityRatio': 1,
647     'OutputActivityRatio': 1,
648     'CapitalCost': 1,
649     'VariableCost': 1,
650     'FixedCost': 1,
651     'TechnologyToStorage': 1,
652     'TechnologyFromStorage': 1,
653     'StorageLevelStart': 1,
654     'StorageMaxChargeRate': 1,
655     'StorageMaxDischargeRate': 1,
656     'MinStorageCharge': 1,
657     'OperationalLifeStorage': 1,
658     'CapitalCostStorage': 1,
659     'ResidualStorageCapacity': 1,
660     'CapacityOfOneTechnologyUnit': 1,
661     'TotalAnnualMaxCapacity': 99999,
662     'TotalAnnualMinCapacity': 1,
663     'TotalAnnualMaxCapacityInvestment': 999999,
```

```
    'TotalAnnualMinCapacityInvestment': 0,
    'TotalTechnologyAnnualActivityLowerLimit': 0,
    'TotalTechnologyAnnualActivityUpperLimit': 999999,
    'TotalTechnologyModelPeriodActivityUpperLimit': 999999,
    'TotalTechnologyModelPeriodActivityLowerLimit': 0,
    'ReserveMarginTagTechnology': 1,
    'ReserveMarginTagFuel': 1,
    'ReserveMargin': 1,
    'RETagTechnology': 1,
    'RETagFuel': 1,
    'REMinProductionTarget': 1,
    'EmissionActivityRatio': 1,
    'EmissionsPenalty': 1,
    'AnnualExogenousEmission': 1,
    'AnnualEmissionLimit': 1,
    'ModelPeriodExogenousEmission': 1,
    'ModelPeriodEmissionLimit': 1
}

# Sets the default toggles (To only use defaults)
toggle_defaults = {
    'YearSplit': False,
    'DiscountRate': False,
    'DaySplit': False,
    'Conversionls': False,
    'Conversionld': False,
    'Conversionlh': False,
    'DaysInDayType': False,
    'TradeRoute': False,
    'DepreciationMethod': False,
    'SpecifiedAnnualDemand': False,
    'SpecifiedDemandProfile': False,
    'AccumulatedAnnualDemand': False,
    'CapacityToActivityUnit': False,
    'CapacityFactor': False,
    'AvailabilityFactor': False,
    'OperationalLife': False,
    'ResidualCapacity': False,
    'InputActivityRatio': False,
    'OutputActivityRatio': False,
    'CapitalCost': False,
    'VariableCost': False,
    'FixedCost': False,
    'TechnologyToStorage': False,
    'TechnologyFromStorage': False,
    'StorageLevelStart': False,
    'StorageMaxChargeRate': False,
    'StorageMaxDischargeRate': False,
    'MinStorageCharge': False,
    'OperationalLifeStorage': False,
    'CapitalCostStorage': False,
    'ResidualStorageCapacity': False,
    'CapacityOfOneTechnologyUnit': False,
    'TotalAnnualMaxCapacity': False,
    'TotalAnnualMinCapacity': False,
    'TotalAnnualMaxCapacityInvestment': False,
    'TotalAnnualMinCapacityInvestment': False,
    'TotalTechnologyAnnualActivityLowerLimit': False,
```

```
    'TotalTechnologyAnnualActivityUpperLimit': False,
    'TotalTechnologyModelPeriodActivityUpperLimit': False,
    'TotalTechnologyModelPeriodActivityLowerLimit': False,
    'ReserveMarginTagTechnology': False,
    'ReserveMarginTagFuel': False,
    'ReserveMargin': False,
    'RETagTechnology': False,
    'RETagFuel': False,
    'REMinProductionTarget': False,
    'EmissionActivityRatio': False,
    'EmissionsPenalty': False,
    'AnnualExogenousEmission': False,
    'AnnualEmissionLimit': False,
    'ModelPeriodExogenousEmission': False,
    'ModelPeriodEmissionLimit': False
}
# Sets the default toggles (To only use defaults)
# toggle_defaults = {
#     'YearSplit': False,
#     'DiscountRate': False,
#     'DaySplit': False,
#     'Conversionls': False,
#     'Conversionld': True,
#     'Conversionlh': True,
#     'DaysInDayType': True,
#     'TradeRoute': True,
#     'DepreciationMethod': True,
#     'SpecifiedAnnualDemand': True,
#     'SpecifiedDemandProfile': True,
#     'AccumulatedAnnualDemand': True,
#     'CapacityToActivityUnit': True,
#     'CapacityFactor': True,
#     'AvailabilityFactor': True,
#     'OperationalLife': True,
#     'ResidualCapacity': True,
#     'InputActivityRatio': True,
#     'OutputActivityRatio': True,
#     'CapitalCost': True,
#     'VariableCost': True,
#     'FixedCost': True,
#     'TechnologyToStorage': True,
#     'TechnologyFromStorage': True,
#     'StorageLevelStart': True,
#     'StorageMaxChargeRate': True,
#     'StorageMaxDischargeRate': True,
#     'MinStorageCharge': True,
#     'OperationalLifeStorage': True,
#     'CapitalCostStorage': True,
#     'ResidualStorageCapacity': True,
#     'CapacityOfOneTechnologyUnit': True,
#     'TotalAnnualMaxCapacity': True,
#     'TotalAnnualMinCapacity': True,
#     'TotalAnnualMaxCapacityInvestment': True,
#     'TotalAnnualMinCapacityInvestment': True,
#     'TotalTechnologyAnnualActivityLowerLimit': True,
#     'TotalTechnologyAnnualActivityUpperLimit': True,
#     'TotalTechnologyModelPeriodActivityUpperLimit': True,
#     'TotalTechnologyModelPeriodActivityLowerLimit': True,
```

```
#     'ReserveMarginTagTechnology': True,
#     'ReserveMarginTagFuel': True,
#     'ReserveMargin': True,
#     'RETagTechnology': True,
#     'RETagFuel': True,
#     'REMinProductionTarget': True,
#     'EmissionActivityRatio': False,
#     'EmissionsPenalty': False,
#     'AnnualExogenousEmission': False,
#     'AnnualEmissionLimit': False,
#     'ModelPeriodExogenousEmission': False,
#     'ModelPeriodEmissionLimit': False
# }

# Create the Data File
system.create_data_file(data_location_1, default_parameters,
    toggle_defaults)

# Cereate the Model File
system.create_model_file(root, model_source_file)
```

The GOCPI NZ Energy Systems Example is the processing script for designing NZ and AUS Energy Systems

5.2 GOCPI Module

5.2.1 Navigation

The module to provide navigation functionalities to access files in directories.

```
import os


class Navigation:
    """ Navigation is a class for navigating, manipulating and editing
    data in the GOCPI model.

    Attributes:
        Find_File(string) representing a string to the file path


    TODO: Fill out all functions below

    """
    def __init__(self, target_root, target_file):
        """ Initialises the navigation functions

        Args:
            target_root (str): Base directory to search from
            target_file (str): Name of file to search for
        """
        self.target_root = target_root
        self.target_file = target_file

    def Find_File(self):
        """ Find_File searches for a target file, from a base directory
    , to construct
        a target directory.
```

```
27
28          Returns:
29              str: File path for file
30          """
31
32          for root, dirs, files in os.walk(self.target_root):
33              for name in files:
34                  if name == self.target_file:
35                      f = os.path.abspath(os.path.join(root, name))
36          return f
37
38      def create_linear_programme_file(self, directory, data_file,
    model_file,
39                                       output_file):
40          """ Creates the model file through executing model system
    commands
41              (Work in Progress)
42
43          Args:
44              directory (str): Name of directory to put data into
45              data_file (str): Name of energy system data file
46              model_file (str): Name of energy system model file
47              output_file (str): Name of output linear programme
48          """
49          # Change the working directory
50          os.chdir(directory)
51          # Load the custom anaconda environment
52          # This assumes the conda environment has already been
    initialised.
53          os.system('conda activate osemosys')
54          # Execute the file structure to create the linear programming
    file
55          # (glpsol -m GOCPI_OSeMOSYS_Model.txt -d GOCPI_NZ_Example_Data.
    txt --wlp GOCPI_NZ_Example.lp)
56          command = 'glpsol -m ' + data_file + ' -d ' + model_file + '--
    wlp ' + output_file
57          os.system(command)
```

5.2.2 Energysystems

The module to load in existing energy systems to create model and data files.

```
1  import os
2  import numpy as np
3  import pandas as pd
4
5
6  class Energy_Systems:
7      """ A class of methods to initialise energy sytems and create the
    data/model files needed for optimisation.
8      """
9      def __init__(self, year, region, emission, technology,
    capacity_technology,
10                 availability_technology, fuel, specified_fuel,
11                 accumulated_fuel, timeslice, mode_of_operation,
    storage,
12                 daytype, season, dailytimebracket):
```

```
13          """ Function to create complete energy system set to prepare
    datafile, as per the established model.
14
15          Args:
16              year (list): List of years
17              region (list): List of regions
18              emission (list): List of emissions
19              technology (list): List of technologies
20              capacity_technology (list): List of technologies
21              availability_technology (list): List of technologies
22              fuel (list): List of fuels
23              specified_fuel (list): List of fuels
24              accumulated_fuel (list): List of fuels
25              timeslice (list): List of timeslices
26              mode_of_operation (list): List of modes of operation
27              storage (list): List of storage
28              daytype (list): List of daytypes
29              season (list): List of seasons
30              dailytimebracket (list): List of dailytimebrackets
31          """
32          self.year = year
33          self.region = region
34          self.emission = emission
35          self.technology = technology
36          self.capacity_technology = capacity_technology
37          self.availability_technology = availability_technology
38          self.fuel = fuel
39          self.specified_fuel = specified_fuel
40          self.accumulated_fuel = accumulated_fuel
41          self.timeslice = timeslice
42          self.mode_of_operation = mode_of_operation
43          self.storage = storage
44          self.daytype = daytype
45          self.season = season
46          self.dailytimebracket = dailytimebracket
47
48          ly = len(self.year)
49          lr = len(self.region)
50          le = len(self.emission)
51          lt = len(self.technology)
52          lct = len(self.capacity_technology)
53          lat = len(self.availability_technology)
54          lf = len(self.fuel)
55          lsf = len(self.specified_fuel)
56          laf = len(self.accumulated_fuel)
57          ll = len(self.timeslice)
58          lm = len(self.mode_of_operation)
59          ls = len(self.storage)
60          lld = len(self.daytype)
61          lls = len(self.season)
62          llh = len(self.dailytimebracket)
63
64          self.ly = ly
65          self.lr = lr
66          self.le = le
67          self.lt = lt
68          self.lct = lct
69          self.lat = lat
```

```
70          self.lf = lf
71          self.lsf = lsf
72          self.laf = laf
73          self.ll = ll
74          self.lm = lm
75          self.ls = ls
76          self.lld = lld
77          self.lls = lls
78          self.llh = llh
79
80          self.YearSplit = np.ones((ll, ly))
81          self.DiscountRate = np.ones((lr))
82          self.DaySplit = np.ones((llh, ly))
83          self.Conversionls = np.ones((ll, lls))
84          self.Conversionld = np.ones((ll, lld))
85          self.Conversionlh = np.ones((ll, llh))
86          self.DaysInDayType = np.ones((lls, lld, ly))
87          self.TradeRoute = np.ones((lr, lr, lf, ly))
88          self.DepreciationMethod = np.ones((lr))
89          self.SpecifiedAnnualDemand = np.ones((lr, lsf, ly))
90          self.SpecifiedDemandProfile = np.ones((lr, lsf, ll, ly))
91          self.AccumulatedAnnualDemand = np.ones((lr, laf, ly))
92          self.CapacityToActivityUnit = np.ones((lr, lct))
93          self.CapacityFactor = np.ones((lr, lct, ll, ly))
94          self.AvailabilityFactor = np.ones((lr, lat, ly))
95          self.OperationalLife = np.ones((lr, lct))
96          self.ResidualCapacity = np.ones((lr, lt, ly))
97          self.InputActivityRatio = np.ones((lr, lt, lf, lm, ly))
98          self.OutputActivityRatio = np.ones((lr, lt, lf, lm, ly))
99          self.CapitalCost = np.ones((lr, lt, ly))
100         self.VariableCost = np.ones((lr, lt, lm, ly))
101         self.FixedCost = np.ones((lr, lt, ly))
102         self.TechnologyToStorage = np.ones((lr, lt, ls, lm))
103         self.TechnologyFromStorage = np.ones((lr, lt, ls, lm))
104         self.StorageLevelStart = np.ones((lr, ls))
105         self.StorageMaxChargeRate = np.ones((lr, ls))
106         self.StorageMaxDischargeRate = np.ones((lr, ls))
107         self.MinStorageCharge = np.ones((lr, ls, ly))
108         self.OperationalLifeStorage = np.ones((lr, ls))
109         self.CapitalCostStorage = np.ones((lr, ls, ly))
110         self.ResidualStorageCapacity = np.ones((lr, ls, ly))
111         self.CapacityOfOneTechnologyUnit = np.ones((lr, lt, ly))
112         self.TotalAnnualMaxCapacity = np.ones((lr, lt, ly))
113         self.TotalAnnualMinCapacity = np.ones((lr, lt, ly))
114         self.TotalAnnualMaxCapacityInvestment = np.ones((lr, lt, ly))
115         self.TotalAnnualMinCapacityInvestment = np.ones((lr, lt, ly))
116         self.TotalTechnologyAnnualActivityLowerLimit = np.ones((lr, lt,
    ly))
117         self.TotalTechnologyAnnualActivityUpperLimit = np.ones((lr, lt,
    ly))
118         self.TotalTechnologyModelPeriodActivityUpperLimit = np.ones((lr
    , lt))
119         self.TotalTechnologyModelPeriodActivityLowerLimit = np.ones((lr
    , lt))
120         self.ReserveMarginTagTechnology = np.ones((lr, lt, ly))
121         self.ReserveMarginTagFuel = np.ones((lr, lf, ly))
122         self.ReserveMargin = np.ones((lr, ly))
123         self.RETagTechnology = np.ones((lr, lt, ly))
```

```
        self.RETagFuel = np.ones((lr, lf, ly))
        self.REMinProductionTarget = np.ones((lr, ly))
        self.EmissionActivityRatio = np.ones((lr, lt, le, lm, ly))
        self.EmissionsPenalty = np.ones((lr, le, ly))
        self.AnnualExogenousEmission = np.ones((lr, le, ly))
        self.AnnualEmissionLimit = np.ones((lr, le, ly))
        self.ModelPeriodExogenousEmission = np.ones((lr, le))
        self.ModelPeriodEmissionLimit = np.ones((lr, le))

    def load_datacase(self, case, system):
        """ Loads the data case to a correct configured and intialised energy system

        Args:
            case (object): Energy system datacase
            system (object): Initialised energy system

        Returns:
            system_case (dict): Returns the updated dictionary
        """
        # Loads the sets to the energy system
        system.year = case.year
        system.region = case.region
        system.emission = case.emission
        system.capacity_technology = case.capacity_technology
        system.availability_technology = case.availability_technology
        system.technology = case.technology
        system.fuel = case.fuel
        system.specified_fuel = case.specified_fuel
        system.accumulated_fuel = case.accumulated_fuel
        system.timeslice = case.timeslice
        system.mode_of_operation = case.mode_of_operation
        system.storage = case.storage
        system.daytype = case.daytype
        system.season = case.season
        system.dailytimebracket = case.dailytimebracket
        # Loads the parameters to the energy system
        system.YearSplit = case.YearSplit
        system.DiscountRate = case.DiscountRate
        system.DaySplit = case.DaySplit
        system.Conversionls = case.Conversionls
        system.Conversionld = case.Conversionld
        system.Conversionlh = case.Conversionlh
        system.DaysInDayType = case.DaysInDayType
        system.TradeRoute = case.TradeRoute
        system.DepreciationMethod = case.DepreciationMethod
        system.SpecifiedAnnualDemand = case.SpecifiedAnnualDemand
        system.SpecifiedDemandProfile = case.SpecifiedDemandProfile
        system.AccumulatedAnnualDemand = case.AccumulatedAnnualDemand
        system.CapacityToActivityUnit = case.CapacityToActivityUnit
        system.CapacityFactor = case.CapacityFactor
        system.AvailabilityFactor = case.AvailabilityFactor
        system.OperationalLife = case.OperationalLife
        system.ResidualCapacity = case.ResidualCapacity
        system.InputActivityRatio = case.InputActivityRatio
        system.OutputActivityRatio = case.OutputActivityRatio
        system.CapitalCost = case.CapitalCost
        system.VariableCost = case.VariableCost
```

```
        system.FixedCost = case.FixedCost
        system.TechnologyToStorage = case.TechnologyToStorage
        system.TechnologyFromStorage = case.TechnologyFromStorage
        system.StorageLevelStart = case.StorageLevelStart
        system.StorageMaxChargeRate = case.StorageMaxChargeRate
        system.StorageMaxDischargeRate = case.StorageMaxDischargeRate
        system.MinStorageCharge = case.MinStorageCharge
        system.OperationalLifeStorage = case.OperationalLifeStorage
        system.CapitalCostStorage = case.CapitalCostStorage
        system.ResidualStorageCapacity = case.ResidualStorageCapacity
        system.CapacityOfOneTechnologyUnit = case.
    CapacityOfOneTechnologyUnit
        system.TotalAnnualMaxCapacity = case.TotalAnnualMaxCapacity
        system.TotalAnnualMinCapacity = case.TotalAnnualMinCapacity
        system.TotalAnnualMaxCapacityInvestment = case.
    TotalAnnualMaxCapacityInvestment
        system.TotalAnnualMinCapacityInvestment = case.
    TotalAnnualMinCapacityInvestment
        system.TotalTechnologyAnnualActivityLowerLimit = case.
    TotalTechnologyAnnualActivityLowerLimit
        system.TotalTechnologyAnnualActivityUpperLimit = case.
    TotalTechnologyAnnualActivityUpperLimit
        system.TotalTechnologyModelPeriodActivityUpperLimit = case.
    TotalTechnologyModelPeriodActivityUpperLimit
        system.TotalTechnologyModelPeriodActivityLowerLimit = case.
    TotalTechnologyModelPeriodActivityLowerLimit
        system.ReserveMarginTagTechnology = case.
    ReserveMarginTagTechnology
        system.ReserveMarginTagFuel = case.ReserveMarginTagFuel
        system.ReserveMargin = case.ReserveMargin
        system.RETagTechnology = case.RETagTechnology
        system.RETagFuel = case.RETagFuel
        system.REMinProductionTarget = case.REMinProductionTarget
        system.EmissionActivityRatio = case.EmissionActivityRatio
        system.EmissionsPenalty = case.EmissionsPenalty
        system.AnnualExogenousEmission = case.AnnualExogenousEmission
        system.AnnualEmissionLimit = case.AnnualEmissionLimit
        system.ModelPeriodExogenousEmission = case.
    ModelPeriodExogenousEmission
        system.ModelPeriodEmissionLimit = case.ModelPeriodEmissionLimit

    def create_model_file(self, root, file):
        """ Creates the model file necessary for the project to run

        Args:
            root (str): File path of root to start the search from
            file ([type]): File path of model file
        """
        # Finds the file
        # data = Find_File(data_file,model_file)
        model_location = os.path.join(root, file)
        df = pd.read_excel(model_location, sheet_name='Model')
        # Creates a new dataframe based on the variables on the Include
     column values
        df_Include = df[df.Include == 'Yes']
        df_model = df_Include[['Name']].copy()

        # Creates a file location and write the model to a text file
```

```
229         model_txt = 'GOCPI_OseMOSYS_Model.txt'
230         model_location = os.path.join(root, model_txt)
231 
232         # Saves the user defined model to a text file
233         np.savetxt(model_location, df_model.values, fmt='%s')
234 
235     def create_data_file(self, file_location, defaults_dictionary,
236                          toggle_defaults):
237         """ Creates the osemosys datafile
238 
239         Args:
240             file_location (str): String of directory to save data file
241             defaults_dictionary (dict): Dictionary setting the default
    values for parameters
242             toggle_defaults (Bool): Boolean (True/False to only print
    the default functions
243         """
244         # Opens the file for write the data
245         with open(file_location, 'w') as f:
246             # Sets up the preamble for the data file
247             f.write('# GOCPI Energy System Data File\n')
248             f.write(
249                 '# Insert instructions when the file is running
    properly\n')
250             f.write('#\n')
251             # Sets
252             f.write('# Sets\n#\n')
253             # year
254             set_string = ' '.join(self.year)
255             f.write('set YEAR\t:=\t{0};\n'.format(set_string))
256             # region
257             set_string = ' '.join(self.region)
258             f.write('set REGION\t:=\t{0};\n'.format(set_string))
259             # emission
260             set_string = ' '.join(self.emission)
261             f.write('set EMISSION\t:=\t{0};\n'.format(set_string))
262             # technology
263             set_string = ' '.join(self.technology)
264             f.write('set TECHNOLOGY\t:=\t{0};\n'.format(set_string))
265             # fuel
266             set_string = ' '.join(self.fuel)
267             f.write('set FUEL\t:=\t{0};\n'.format(set_string))
268             # timeslice
269             set_string = ' '.join(self.timeslice)
270             f.write('set TIMESLICE\t:=\t{0};\n'.format(set_string))
271             # mode_of_operation
272             set_string = ' '.join(self.mode_of_operation)
273             f.write('set MODE_OF_OPERATION\t:=\t{0};\n'.format(
    set_string))
274             # storage
275             set_string = ' '.join(self.storage)
276             f.write('set STORAGE\t:=\t{0};\n'.format(set_string))
277             # daytype
278             set_string = ' '.join(self.daytype)
279             f.write('set DAYTYPE\t:=\t{0};\n'.format(set_string))
280             # season
281             set_string = ' '.join(self.season)
282             f.write('set SEASON\t:=\t{0};\n'.format(set_string))
```

```
283             # dailytimebracket
284             set_string = ' '.join(self.dailytimebracket)
285             f.write('set DAILYTIMEBRACKET\t:=\t{0};\n'.format(
    set_string))
286             f.write('#\n')
287             # Parameters
288 
289             # YearSplit = np.zeros((ll,ly))
290             param = 'YearSplit'
291             f.write('#\n')
292             columns = self.year
293             column_string = ' '.join(columns)
294             # Writes index specific parameter values to the text files
295             if toggle_defaults[param] == True:
296                 f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
297                     param, defaults_dictionary[param], column_string))
298                 # Converts maxtrix rows to list
299                 array = np.array(self.timeslice)
300                 array = array.T
301                 lt = array.tolist()
302                 # Creates 2D matrix for this value
303                 mat = self.YearSplit[:, :]
304                 # Converts combined matrix to list and combines lists
305                 matlist = mat.tolist()
306                 #Combines the two lists
307                 combined_list = list(zip(lt, matlist))
308                 for line in combined_list:
309                     combinedflat = ''.join(str(line))
310                     combinedflat = combinedflat.replace('[', '')
311                     combinedflat = combinedflat.replace(']', '')
312                     combinedflat = combinedflat.replace("'", '')
313                     combinedflat = combinedflat.replace(",", '')
314                     combinedflat = combinedflat.replace("(", '')
315                     combinedflat = combinedflat.replace(")", '')
316                     f.write("{0}\n".format(combinedflat))
317             else:
318                 f.write("param\t{0}\tdefault\t{1}:=\n".format(
319                     param, defaults_dictionary[param]))
320             f.write(';\n')
321 
322             # DiscountRate = np.zeros((lr))
323             param = 'DiscountRate'
324             f.write('#\n')
325             if toggle_defaults[param] == True:
326                 f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
327                     param, defaults_dictionary[param], column_string))
328                 # Converts maxtrix rows to list
329                 array = np.array(self.region)
330                 array = array.T
331                 lt = array.tolist()
332                 # Creates 2D matrix for this value
333                 mat = self.DiscountRate[:]
334                 # Converts combined matrix to list and combines lists
335                 matlist = mat.tolist()
336                 #Combines the two lists
337                 combined_list = list(zip(lt, matlist))
338                 # Writes index specific parameter values to the text
    files
```

```
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # DaySplit = np.zeros((llh,ly))
            param = 'DaySplit'
            f.write('#\n')
            columns = self.year
            column_string = ' '.join(columns)
            # Writes index specific parameter values to the text files
            if toggle_defaults[param] == True:
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.dailytimebracket)
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.DaySplit[:, :]
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                # Writes index specific parameter values to the text
files
                f.write("param\t{0}\t:{1}:=\n".format(param,
column_string))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # Conversionls = np.zeros((ll,ls))
            param = 'Conversionls'  # Change this line
            f.write('#\n')
            columns = self.season  # Change this line
            column_string = ' '.join(columns)
            # Writes index specific parameter values to the text files
            if toggle_defaults[param] == True:
```

```
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.timeslice)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.Conversionls[:, :]  # Change this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # Conversionld = np.zeros((ll,lld))
            param = 'Conversionld'  # Change this line
            f.write('#\n')
            columns = self.daytype  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.timeslice)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.Conversionld[:, :]  # Change this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

```

```
453             # Conversionlh = np.zeros((ll,llh))
454             param = 'Conversionlh'  # Change this line
455             f.write('#\n')
456             columns = self.dailytimebracket  # Change this line
457             column_string = ' '.join(columns)
458             if toggle_defaults[param] == True:
459                 f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
460                     param, defaults_dictionary[param], column_string))
461                 # Converts maxtrix rows to list
462                 array = np.array(self.timeslice)  # Change this line
463                 array = array.T
464                 lt = array.tolist()
465                 # Creates 2D matrix for this value
466                 mat = self.Conversionlh[:, :]  # Change this line
467                 # Converts combined matrix to list and combines lists
468                 matlist = mat.tolist()
469                 #Combines the two lists
470                 combined_list = list(zip(lt, matlist))
471                 for line in combined_list:
472                     combinedflat = ''.join(str(line))
473                     combinedflat = combinedflat.replace('[', '')
474                     combinedflat = combinedflat.replace(']', '')
475                     combinedflat = combinedflat.replace("'", '')
476                     combinedflat = combinedflat.replace(",", '')
477                     combinedflat = combinedflat.replace("(", '')
478                     combinedflat = combinedflat.replace(")", '')
479                     f.write("{0}\n".format(combinedflat))
480             else:
481                 f.write("param\t{0}\tdefault\t{1}:=\n".format(
482                     param, defaults_dictionary[param]))
483             f.write(';\n')
484 
485             # DaysInDayType = np.zeros((lls,lld,ly))
486             #Writes new line character at parameter metadata to the
    text file
487             param = 'DaysInDayType'
488             f.write('#\n')
489             f.write("param\t{0}\tdefault\t{1}:=\n".format(
490                 param, defaults_dictionary[param]))
491             if toggle_defaults[param] == True:
492                 # Writes parameter values to the text files
493                 for k in range(self.ly):
494                     # Sets index value for format string
495                     y = self.year[k]
496                     # Converts matrix columns to strings columns to
    strings
497                     columns = self.daytype
498                     column_string = ' '.join(columns)
499                     # Converts maxtrix rows to list
500                     array = np.array(self.season)
501                     array = array.T
502                     lt = array.tolist()
503                     # Creates 2D matrix for this value
504                     mat = self.DaysInDayType[:, :, k]
505                     # Converts combined matrix to list and combines
    lists
506                     matlist = mat.tolist()
507                     #Combines the two lists
```

```
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # TradeRoute = np.zeros((lr,lr,lf,ly))
            param = 'TradeRoute'  # Change this line
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for j in range(self.lf):
                    # Sets index value for format string
                    fl = self.fuel[j]
                    for k in range(self.ly):
                        # Sets index value for format string
                        y = self.year[k]
                        # Converts matrix columns to strings columns to
     strings
                        columns = self.region
                        column_string = ' '.join(columns)
                        # Converts maxtrix rows to list
                        array = np.array(self.region)
                        array = array.T
                        lt = array.tolist()
                        # Creates 2D matrix for this value
                        mat = self.TradeRoute[:, :, j, k]
                        # Converts combined matrix to list and combines
     lists
                        matlist = mat.tolist()
                        #Combines the two lists
                        combined_list = list(zip(lt, matlist))
                        # Writes index specific parameter values to the
     text files
                        f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
                            fl, y, column_string))
                        for line in combined_list:
                            combinedflat = ''.join(str(line))
                            combinedflat = combinedflat.replace('[', ''
    )
                            combinedflat = combinedflat.replace(']', ''
    )
                            combinedflat = combinedflat.replace("'", ''
    )
                            combinedflat = combinedflat.replace(",", ''
    )
```

```
                                combinedflat = combinedflat.replace("(", '')
                                combinedflat = combinedflat.replace(")", '')
                                f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # DepreciationMethod = np.zeros((lr))
            param = 'DepreciationMethod'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Converts maxtrix rows to list
                array = np.array(self.region)
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.DepreciationMethod[:]
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                # Writes index specific parameter values to the text files
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # SpecifiedAnnualDemand = np.zeros((lr,lsf,ly))
            param = 'SpecifiedAnnualDemand'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to strings
                    columns = self.specified_fuel
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.SpecifiedAnnualDemand[:, :, k]
                    # Converts combined matrix to list and combines lists
```

```
610                     matlist = mat.tolist()
611                     #Combines the two lists
612                     combined_list = list(zip(lt, matlist))
613                     # Writes index specific parameter values to the
    text files
614                     f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
615                     for line in combined_list:
616                         combinedflat = ''.join(str(line))
617                         combinedflat = combinedflat.replace('[', '')
618                         combinedflat = combinedflat.replace(']', '')
619                         combinedflat = combinedflat.replace("'", '')
620                         combinedflat = combinedflat.replace(",", '')
621                         combinedflat = combinedflat.replace("(", '')
622                         combinedflat = combinedflat.replace(")", '')
623                         f.write("{0}\n".format(combinedflat))
624             f.write(';\n')
625 
626             # SpecifiedDemandProfile = np.zeros((lr,lf,ll,ly))
627             param = 'SpecifiedDemandProfile'  # Change this line
628             f.write('#\n')
629             f.write("param\t{0}\tdefault\t{1}:=\n".format(
630                 param, defaults_dictionary[param]))
631             if toggle_defaults[param] == True:
632                 # Writes parameter values to the text files
633                 for j in range(self.ll):
634                     # Sets index value for format string
635                     x = self.timeslice[j]
636                     for k in range(self.ly):
637                         # Sets index value for format string
638                         y = self.year[k]
639                         # Converts matrix columns to strings columns to
    strings
640                         columns = self.specified_fuel
641                         column_string = ' '.join(columns)
642                         # Converts maxtrix rows to list
643                         array = np.array(self.region)
644                         array = array.T
645                         lt = array.tolist()
646                         # Creates 2D matrix for this value
647                         mat = self.SpecifiedDemandProfile[:, :, j, k]
648                         # Converts combined matrix to list and combines
    lists
649                         matlist = mat.tolist()
650                         #Combines the two lists
651                         combined_list = list(zip(lt, matlist))
652                         # Writes index specific parameter values to the
    text files
653                         f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
654                             x, y, column_string))
655                         for line in combined_list:
656                             combinedflat = ''.join(str(line))
657                             combinedflat = combinedflat.replace('[', ''
    )
658                             combinedflat = combinedflat.replace(']', ''
    )
659                             combinedflat = combinedflat.replace("'", ''
    )
```

```
660                             combinedflat = combinedflat.replace(",", ''
    )
661                             combinedflat = combinedflat.replace("(", ''
    )
662                             combinedflat = combinedflat.replace(")", ''
    )
663                             f.write("{0}\n".format(combinedflat))
664             f.write(';\n')
665 
666             # AccumulatedAnnualDemand = np.zeros((lr,lf,ly))
667             param = 'AccumulatedAnnualDemand'
668             f.write('#\n')
669             f.write("param\t{0}\tdefault\t{1}:=\n".format(
670                 param, defaults_dictionary[param]))
671             if toggle_defaults[param] == True:
672                 # Writes parameter values to the text files
673                 for k in range(self.ly):
674                     # Sets index value for format string
675                     y = self.year[k]
676                     # Converts matrix columns to strings columns to
    strings
677                     columns = self.accumulated_fuel
678                     column_string = ' '.join(columns)
679                     # Converts maxtrix rows to list
680                     array = np.array(self.region)
681                     array = array.T
682                     lt = array.tolist()
683                     # Creates 2D matrix for this value
684                     mat = self.AccumulatedAnnualDemand[:, :, k]
685                     # Converts combined matrix to list and combines
    lists
686                     matlist = mat.tolist()
687                     #Combines the two lists
688                     combined_list = list(zip(lt, matlist))
689                     # Writes index specific parameter values to the
    text files
690                     f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
691                     for line in combined_list:
692                         combinedflat = ''.join(str(line))
693                         combinedflat = combinedflat.replace('[', '')
694                         combinedflat = combinedflat.replace(']', '')
695                         combinedflat = combinedflat.replace("'", '')
696                         combinedflat = combinedflat.replace(",", '')
697                         combinedflat = combinedflat.replace("(", '')
698                         combinedflat = combinedflat.replace(")", '')
699                         f.write("{0}\n".format(combinedflat))
700             f.write(';\n')
701 
702             # CapacityToActivityUnit = np.zeros((lr,lt))
703             param = 'CapacityToActivityUnit'  # Change this line
704             f.write('#\n')
705             columns = self.capacity_technology  # Change this line
706             column_string = ' '.join(columns)
707             if toggle_defaults[param] == True:
708                 f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
709                     param, defaults_dictionary[param], column_string))
710                 # Converts maxtrix rows to list
```

```
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.CapacityToActivityUnit[:, :]  # Change this
    line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # CapacityFactor = np.zeros((lr,lt,ll,ly))
            param = 'CapacityFactor'  # Change this line
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for j in range(self.ll):
                    # Sets index value for format string
                    x = self.timeslice[j]
                    for k in range(self.ly):
                        # Sets index value for format string
                        y = self.year[k]
                        # Converts matrix columns to strings columns to
    strings
                        columns = self.capacity_technology
                        column_string = ' '.join(columns)
                        # Converts maxtrix rows to list
                        array = np.array(self.region)
                        array = array.T
                        lt = array.tolist()
                        # Creates 2D matrix for this value
                        mat = self.CapacityFactor[:, :, j, k]
                        # Converts combined matrix to list and combines
    lists
                        matlist = mat.tolist()
                        #Combines the two lists
                        combined_list = list(zip(lt, matlist))
                        # Writes index specific parameter values to the
    text files
                        f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
                            x, y, column_string))
                        for line in combined_list:
                            combinedflat = ''.join(str(line))
```

```
765                             combinedflat = combinedflat.replace('[', ''
    )
766                             combinedflat = combinedflat.replace(']', ''
    )
767                             combinedflat = combinedflat.replace("'", ''
    )
768                             combinedflat = combinedflat.replace(",", ''
    )
769                             combinedflat = combinedflat.replace("(", ''
    )
770                             combinedflat = combinedflat.replace(")", ''
    )
771                             f.write("{0}\n".format(combinedflat))
772             f.write(';\n')
773
774             # AvailabilityFactor = np.zeros((lr,lt,ly))
775             param = 'AvailabilityFactor'
776             f.write('#\n')
777             f.write("param\t{0}\tdefault\t{1}:=\n".format(
778                 param, defaults_dictionary[param]))
779             if toggle_defaults[param] == True:
780                 # Writes parameter values to the text files
781                 for k in range(self.ly):
782                     # Sets index value for format string
783                     y = self.year[k]
784                     # Converts matrix columns to strings columns to
    strings
785                     columns = self.availability_technology
786                     column_string = ' '.join(columns)
787                     # Converts maxtrix rows to list
788                     array = np.array(self.region)
789                     array = array.T
790                     lt = array.tolist()
791                     # Creates 2D matrix for this value
792                     mat = self.AvailabilityFactor[:, :, k]
793                     # Converts combined matrix to list and combines
    lists
794                     matlist = mat.tolist()
795                     #Combines the two lists
796                     combined_list = list(zip(lt, matlist))
797                     # Writes index specific parameter values to the
    text files
798                     f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
799                     for line in combined_list:
800                         combinedflat = ''.join(str(line))
801                         combinedflat = combinedflat.replace('[', '')
802                         combinedflat = combinedflat.replace(']', '')
803                         combinedflat = combinedflat.replace("'", '')
804                         combinedflat = combinedflat.replace(",", '')
805                         combinedflat = combinedflat.replace("(", '')
806                         combinedflat = combinedflat.replace(")", '')
807                         f.write("{0}\n".format(combinedflat))
808             f.write(';\n')
809
810             # OperationalLife = np.zeros((lr,lt))
811             param = 'OperationalLife'  # Change this line
812             f.write('#\n')
```

```
            columns = self.technology  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.OperationalLife[:, :]  # Change this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # ResidualCapacity = np.zeros((lr,lt,ly))
            param = 'ResidualCapacity'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.ResidualCapacity[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
```

```
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # InputActivityRatio = np.zeros((lr,lt,lf,lm,ly))
            param = 'InputActivityRatio'  # Change this line
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for i in range(self.lf):  # Change loops if you need
                    # Sets index value for format string
                    x = self.fuel[i]
                    for j in range(self.lm):
                        # Sets index value for format string
                        y = self.mode_of_operation[j]
                        for k in range(self.ly):
                            # Sets index value for format string
                            z = self.year[k]
                            # Converts matrix columns to strings
    columns to strings
                            columns = self.technology
                            column_string = ' '.join(columns)
                            # Converts maxtrix rows to list
                            array = np.array(self.region)
                            array = array.T
                            lt = array.tolist()
                            # Creates 2D matrix for this value
                            mat = self.InputActivityRatio[:, :, i, j, k
    ]
                            # Converts combined matrix to list and
    combines lists
                            matlist = mat.tolist()
                            #Combines the two lists
                            combined_list = list(zip(lt, matlist))
                            # Writes index specific parameter values to
     the text files
                            f.write("\t[*,*,{0},{1},{2}]:\t{3}\t:=\n".
    format(
                                x, y, z, column_string))
                            for line in combined_list:
                                combinedflat = ''.join(str(line))
                                combinedflat = combinedflat.replace('['
    , '')
                                combinedflat = combinedflat.replace(']'
    , '')
                                combinedflat = combinedflat.replace("'"
    , '')
                                combinedflat = combinedflat.replace(","
    , '')
```

```
                                combinedflat = combinedflat.replace("("
, '')
                                combinedflat = combinedflat.replace(")"
, '')
                                f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # OutputActivityRatio = np.zeros((lr,lt,lf,lm,ly))
            param = 'OutputActivityRatio'  # Change this line
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for i in range(self.lf):  # Change loops if you need
                    # Sets index value for format string
                    x = self.fuel[i]
                    for j in range(self.lm):
                        # Sets index value for format string
                        y = self.mode_of_operation[j]
                        for k in range(self.ly):
                            # Sets index value for format string
                            z = self.year[k]
                            # Converts matrix columns to strings
columns to strings
                            columns = self.technology
                            column_string = ' '.join(columns)
                            # Converts maxtrix rows to list
                            array = np.array(self.region)
                            array = array.T
                            lt = array.tolist()
                            # Creates 2D matrix for this value
                            mat = self.OutputActivityRatio[:, :, i, j,
k]
                            # Converts combined matrix to list and
combines lists
                            matlist = mat.tolist()
                            #Combines the two lists
                            combined_list = list(zip(lt, matlist))
                            # Writes index specific parameter values to
 the text files
                            f.write("\t[*,*,{0},{1},{2}]:\t{3}\t:=\n".
format(
                                x, y, z, column_string))
                            for line in combined_list:
                                combinedflat = ''.join(str(line))
                                combinedflat = combinedflat.replace('['
, '')
                                combinedflat = combinedflat.replace(']'
, '')
                                combinedflat = combinedflat.replace("'"
, '')
                                combinedflat = combinedflat.replace(","
, '')
                                combinedflat = combinedflat.replace("("
, '')
                                combinedflat = combinedflat.replace(")"
, '')
```

```
                                    f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # CapitalCost = np.zeros((lr,lt,ly))
            param = 'CapitalCost'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.CapitalCost[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # VariableCost = np.zeros((lr,lt,lm,ly))
            param = 'VariableCost'  # Change this line
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for j in range(self.lm):
                    # Sets index value for format string
                    x = self.mode_of_operation[j]
                    for k in range(self.ly):
                        # Sets index value for format string
                        y = self.year[k]
                        # Converts matrix columns to strings columns to
     strings
```

```
                        columns = self.technology
                        column_string = ' '.join(columns)
                        # Converts maxtrix rows to list
                        array = np.array(self.region)
                        array = array.T
                        lt = array.tolist()
                        # Creates 2D matrix for this value
                        mat = self.VariableCost[:, :, j, k]
                        # Converts combined matrix to list and combines lists
                        matlist = mat.tolist()
                        #Combines the two lists
                        combined_list = list(zip(lt, matlist))
                        # Writes index specific parameter values to the text files
                        f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
                            x, y, column_string))
                        for line in combined_list:
                            combinedflat = ''.join(str(line))
                            combinedflat = combinedflat.replace('[', '')
                            combinedflat = combinedflat.replace(']', '')
                            combinedflat = combinedflat.replace("'", '')
                            combinedflat = combinedflat.replace(",", '')
                            combinedflat = combinedflat.replace("(", '')
                            combinedflat = combinedflat.replace(")", '')
                            f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # FixedCost = np.zeros((lr,lt,ly))
            param = 'FixedCost'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.FixedCost[:, :, k]
                    # Converts combined matrix to list and combines lists
                    matlist = mat.tolist()
                    #Combines the two lists
```

```
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y, column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # TechnologyToStorage = np.zeros((lr,lt,ls,lm))
            param = 'TechnologyToStorage'  # Change this line
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for j in range(self.ls):
                    # Sets index value for format string
                    x = self.storage[j]
                    for k in range(self.lm):
                        # Sets index value for format string
                        y = self.mode_of_operation[k]
                        # Converts matrix columns to strings columns to strings
                        columns = self.technology
                        column_string = ' '.join(columns)
                        # Converts maxtrix rows to list
                        array = np.array(self.region)
                        array = array.T
                        lt = array.tolist()
                        # Creates 2D matrix for this value
                        mat = self.TechnologyToStorage[:, :, j, k]
                        # Converts combined matrix to list and combines lists
                        matlist = mat.tolist()
                        #Combines the two lists
                        combined_list = list(zip(lt, matlist))
                        # Writes index specific parameter values to the text files
                        f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
                            x, y, column_string))
                        for line in combined_list:
                            combinedflat = ''.join(str(line))
                            combinedflat = combinedflat.replace('[', '')
                            combinedflat = combinedflat.replace(']', '')
                            combinedflat = combinedflat.replace("'", '')
                            combinedflat = combinedflat.replace(",", '')
```

```
                                combinedflat = combinedflat.replace("(", ''
    )
                                combinedflat = combinedflat.replace(")", ''
    )
                                f.write("{0}\n".format(combinedflat))
                f.write(';\n')

                # TechnologyFromStorage = np.zeros((lr,lt,ls,lm))
                param = 'TechnologyFromStorage'  # Change this line
                f.write('#\n')
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
                if toggle_defaults[param] == True:
                    # Writes parameter values to the text files
                    for j in range(self.ls):
                        # Sets index value for format string
                        x = self.storage[j]
                        for k in range(self.lm):
                            # Sets index value for format string
                            y = self.mode_of_operation[k]
                            # Converts matrix columns to strings columns to
    strings
                            columns = self.technology
                            column_string = ' '.join(columns)
                            # Converts maxtrix rows to list
                            array = np.array(self.region)
                            array = array.T
                            lt = array.tolist()
                            # Creates 2D matrix for this value
                            mat = self.TechnologyFromStorage[:, :, j, k]
                            # Converts combined matrix to list and combines
    lists
                            matlist = mat.tolist()
                            #Combines the two lists
                            combined_list = list(zip(lt, matlist))
                            # Writes index specific parameter values to the
    text files
                            f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
                                x, y, column_string))
                            for line in combined_list:
                                combinedflat = ''.join(str(line))
                                combinedflat = combinedflat.replace('[', ''
    )
                                combinedflat = combinedflat.replace(']', ''
    )
                                combinedflat = combinedflat.replace("'", ''
    )
                                combinedflat = combinedflat.replace(",", ''
    )
                                combinedflat = combinedflat.replace("(", ''
    )
                                combinedflat = combinedflat.replace(")", ''
    )
                                f.write("{0}\n".format(combinedflat))
                f.write(';\n')

                # StorageLevelStart = np.zeros((lr,ls))
                param = 'StorageLevelStart'  # Change this line
```

```
            f.write('#\n')
            columns = self.storage  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.StorageLevelStart[:, :]  # Change this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # StorageMaxChargeRate = np.zeros((lr,ls))
            param = 'StorageMaxChargeRate'  # Change this line
            f.write('#\n')
            columns = self.storage  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.StorageMaxChargeRate[:, :]  # Change this
    line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
```

```
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # StorageMaxDischargeRate = np.zeros((lr,ls))
            param = 'StorageMaxDischargeRate'  # Change this line
            f.write('#\n')
            columns = self.storage  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.StorageMaxDischargeRate[:, :]  # Change this
 line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                # Writes index specific parameter values to the text
files
                f.write("param\t{0}\t:{1}:=\n".format(param,
column_string))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # MinStorageCharge = np.zeros((lr,ls,ly))
            param = 'MinStorageCharge'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
strings
                    columns = self.storage
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
```

```
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.MinStorageCharge[:, :, k]
                    # Converts combined matrix to list and combines lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y, column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # OperationalLifeStorage = np.zeros((lr,ls))
            param = 'OperationalLifeStorage'  # Change this line
            f.write('#\n')
            columns = self.storage  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.OperationalLifeStorage[:, :]  # Change this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                # Writes index specific parameter values to the text files
                f.write("param\t{0}\t:{1}:=\n".format(param, column_string))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
```

```
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # CapitalCostStorage = np.zeros((lr,ls,ly))
            param = 'CapitalCostStorage'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.storage
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.CapitalCostStorage[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # ResidualStorageCapacity = np.zeros((lr,ls,ly))
            param = 'ResidualStorageCapacity'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.storage
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
```

```
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.ResidualStorageCapacity[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # CapacityOfOneTechnologyUnit = np.zeros((lr,lt,ly))
            param = 'CapacityOfOneTechnologyUnit'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.CapacityOfOneTechnologyUnit[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
```

```
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # TotalAnnualMaxCapacity = np.zeros((lr,lt,ly))
            param = 'TotalAnnualMaxCapacity'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.TotalAnnualMaxCapacity[:, :, k]
                    # Converts combined matrix to list and combines
lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # TotalAnnualMinCapacity = np.zeros((lr,lt,ly))
            param = 'TotalAnnualMinCapacity'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
```

```
                    # Converts matrix columns to strings columns to strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.TotalAnnualMinCapacity[:, :, k]
                    # Converts combined matrix to list and combines lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y, column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # TotalAnnualMaxCapacityInvestment = np.zeros((lr,lt,ly))
            param = 'TotalAnnualMaxCapacityInvestment'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.TotalAnnualMaxCapacityInvestment[:, :, k]
                    # Converts combined matrix to list and combines lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the text files
```

```
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # TotalAnnualMinCapacityInvestment = np.zeros((lr,lt,ly))
            param = 'TotalAnnualMinCapacityInvestment'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.TotalAnnualMinCapacityInvestment[:, :, k
    ]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # TotalTechnologyAnnualActivityLowerLimit= np.zeros((lr,lt,
    ly))
            param = 'TotalTechnologyAnnualActivityLowerLimit'
            f.write('#\n')
```

```
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.TotalTechnologyAnnualActivityLowerLimit[:, :, k]
                    # Converts combined matrix to list and combines lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y, column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # TotalTechnologyAnnualActivityUpperLimit = np.zeros((lr,lt,ly))
            param = 'TotalTechnologyAnnualActivityUpperLimit'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
```

```
1630                    mat = self.TotalTechnologyAnnualActivityUpperLimit
    [:, :, k]
1631                    # Converts combined matrix to list and combines
    lists
1632                    matlist = mat.tolist()
1633                    #Combines the two lists
1634                    combined_list = list(zip(lt, matlist))
1635                    # Writes index specific parameter values to the
    text files
1636                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
1637                    for line in combined_list:
1638                        combinedflat = ''.join(str(line))
1639                        combinedflat = combinedflat.replace('[', '')
1640                        combinedflat = combinedflat.replace(']', '')
1641                        combinedflat = combinedflat.replace("'", '')
1642                        combinedflat = combinedflat.replace(",", '')
1643                        combinedflat = combinedflat.replace("(", '')
1644                        combinedflat = combinedflat.replace(")", '')
1645                        f.write("{0}\n".format(combinedflat))
1646            f.write(';\n')
1647
1648            # TotalTechnologyModelPeriodActivityUpperLimit = np.zeros((
    lr,lt))
1649            param = 'TotalTechnologyModelPeriodActivityUpperLimit'  #
    Change this line
1650            f.write('#\n')
1651            columns = self.technology  # Change this line
1652            column_string = ' '.join(columns)
1653            if toggle_defaults[param] == True:
1654                # Writes index specific parameter values to the text
    files
1655                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
1656                    param, defaults_dictionary[param], column_string))
1657                # Converts maxtrix rows to list
1658                array = np.array(self.region)  # Change this line
1659                array = array.T
1660                lt = array.tolist()
1661                # Creates 2D matrix for this value
1662                mat = self.TotalTechnologyModelPeriodActivityUpperLimit
    [:, :]  # Change this line
1663                # Converts combined matrix to list and combines lists
1664                matlist = mat.tolist()
1665                #Combines the two lists
1666                combined_list = list(zip(lt, matlist))
1667                for line in combined_list:
1668                    combinedflat = ''.join(str(line))
1669                    combinedflat = combinedflat.replace('[', '')
1670                    combinedflat = combinedflat.replace(']', '')
1671                    combinedflat = combinedflat.replace("'", '')
1672                    combinedflat = combinedflat.replace(",", '')
1673                    combinedflat = combinedflat.replace("(", '')
1674                    combinedflat = combinedflat.replace(")", '')
1675                    f.write("{0}\n".format(combinedflat))
1676            else:
1677                f.write("param\t{0}\tdefault\t{1}:=\n".format(
1678                    param, defaults_dictionary[param]))
1679            f.write(';\n')
```

```
1680
1681            # TotalTechnologyModelPeriodActivityLowerLimit = np.zeros((
    lr,lt))
1682            param = 'TotalTechnologyModelPeriodActivityLowerLimit'  #
    Change this line
1683            f.write('#\n')
1684            columns = self.technology  # Change this line
1685            column_string = ' '.join(columns)
1686            if toggle_defaults[param] == True:
1687                # Writes index specific parameter values to the text
    files
1688                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
1689                    param, defaults_dictionary[param], column_string))
1690                # Converts maxtrix rows to list
1691                array = np.array(self.region)  # Change this line
1692                array = array.T
1693                lt = array.tolist()
1694                # Creates 2D matrix for this value
1695                mat = self.TotalTechnologyModelPeriodActivityLowerLimit
    [:, :]  # Change this line
1696                # Converts combined matrix to list and combines lists
1697                matlist = mat.tolist()
1698                #Combines the two lists
1699                combined_list = list(zip(lt, matlist))
1700                for line in combined_list:
1701                    combinedflat = ''.join(str(line))
1702                    combinedflat = combinedflat.replace('[', '')
1703                    combinedflat = combinedflat.replace(']', '')
1704                    combinedflat = combinedflat.replace("'", '')
1705                    combinedflat = combinedflat.replace(",", '')
1706                    combinedflat = combinedflat.replace("(", '')
1707                    combinedflat = combinedflat.replace(")", '')
1708                    f.write("{0}\n".format(combinedflat))
1709            else:
1710                f.write("param\t{0}\tdefault\t{1}:=\n".format(
1711                    param, defaults_dictionary[param]))
1712            f.write(';\n')
1713
1714            # ReserveMarginTagTechnology = np.zeros((lr,lt,ly))
1715            param = 'ReserveMarginTagTechnology'
1716            f.write('#\n')
1717            f.write("param\t{0}\tdefault\t{1}:=\n".format(
1718                param, defaults_dictionary[param]))
1719            if toggle_defaults[param] == True:
1720                # Writes parameter values to the text files
1721                for k in range(self.ly):
1722                    # Sets index value for format string
1723                    y = self.year[k]
1724                    # Converts matrix columns to strings columns to
    strings
1725                    columns = self.technology
1726                    column_string = ' '.join(columns)
1727                    # Converts maxtrix rows to list
1728                    array = np.array(self.region)
1729                    array = array.T
1730                    lt = array.tolist()
1731                    # Creates 2D matrix for this value
1732                    mat = self.ReserveMarginTagTechnology[:, :, k]
```

```
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # ReserveMarginTagFuel = np.zeros((lr,lf,ly))
            param = 'ReserveMarginTagFuel'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.fuel
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.ReserveMarginTagFuel[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
```

```
            f.write(';\n')

            # ReserveMargin = np.zeros((lr,ly))
            param = 'ReserveMargin'  # Change this line
            f.write('#\n')
            columns = self.year  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                # Writes index specific parameter values to the text files
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.ReserveMargin[:, :]  # Change this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # RETagTechnology = np.zeros((lr,lt,ly))
            param = 'RETagTechnology'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to strings
                    columns = self.technology
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.RETagTechnology[:, :, k]
                    # Converts combined matrix to list and combines lists
```

```
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y, column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # RETagFuel = np.zeros((lr,lf,ly))
            param = 'RETagFuel'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to strings
                    columns = self.fuel
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.RETagFuel[:, :, k]
                    # Converts combined matrix to list and combines lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y, column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

```

```
            # REMinProductionTarget = np.zeros((lr,ly))
            param = 'REMinProductionTarget'  # Change this line
            f.write('#\n')
            columns = self.year  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                # Writes index specific parameter values to the text files
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.REMinProductionTarget[:, :]  # Change this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # EmissionActivityRatio = np.zeros((lr,lt,le,lm,ly))
            #Writes new line character at parameter metadata to the text file
            param = 'EmissionActivityRatio'  # Change this line
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for i in range(self.le):  # Change loops if you need
                    # Sets index value for format string
                    emission = self.emission[i]
                    for j in range(self.lm):
                        # Sets index value for format string
                        MOO = self.mode_of_operation[j]
                        for k in range(self.ly):
                            # Sets index value for format string
                            y = self.year[k]
                            # Converts matrix columns to strings columns to strings
                            columns = self.technology
                            column_string = ' '.join(columns)
                            # Converts maxtrix rows to list
```

```
                                array = np.array(self.region)
                                array = array.T
                                lt = array.tolist()
                                # Creates 2D matrix for this value
                                mat = self.EmissionActivityRatio[:, :, i, j
    , k]
                                # Converts combined matrix to list and
    combines lists
                                matlist = mat.tolist()
                                #Combines the two lists
                                combined_list = list(zip(lt, matlist))
                                # Writes index specific parameter values to
     the text files
                                f.write("\t[*,*,{0},{1},{2}]:\t{3}\t:=\n".
    format(
                                    emission, MOO, y, column_string))
                                for line in combined_list:
                                    combinedflat = ''.join(str(line))
                                    combinedflat = combinedflat.replace('['
    , '')
                                    combinedflat = combinedflat.replace(']'
    , '')
                                    combinedflat = combinedflat.replace("'"
    , '')
                                    combinedflat = combinedflat.replace(","
    , '')
                                    combinedflat = combinedflat.replace("("
    , '')
                                    combinedflat = combinedflat.replace(")"
    , '')
                                    f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # EmissionsPenalty = np.zeros((lr,le,ly))
            param = 'EmissionsPenalty'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.emission
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.EmissionsPenalty[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
```

```
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # AnnualExogenousEmission = np.zeros((lr,le,ly))
            param = 'AnnualExogenousEmission'
            f.write('#\n')
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.emission
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.AnnualExogenousEmission[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # AnnualEmissionLimit = np.zeros((lr,le,ly))
            param = 'AnnualEmissionLimit'
            f.write('#\n')
```

```
            f.write("param\t{0}\tdefault\t{1}:=\n".format(
                param, defaults_dictionary[param]))
            if toggle_defaults[param] == True:
                # Writes parameter values to the text files
                for k in range(self.ly):
                    # Sets index value for format string
                    y = self.year[k]
                    # Converts matrix columns to strings columns to
    strings
                    columns = self.emission
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.region)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.AnnualExogenousEmission[:, :, k]
                    # Converts combined matrix to list and combines
    lists
                    matlist = mat.tolist()
                    #Combines the two lists
                    combined_list = list(zip(lt, matlist))
                    # Writes index specific parameter values to the
    text files
                    f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
    column_string))
                    for line in combined_list:
                        combinedflat = ''.join(str(line))
                        combinedflat = combinedflat.replace('[', '')
                        combinedflat = combinedflat.replace(']', '')
                        combinedflat = combinedflat.replace("'", '')
                        combinedflat = combinedflat.replace(",", '')
                        combinedflat = combinedflat.replace("(", '')
                        combinedflat = combinedflat.replace(")", '')
                        f.write("{0}\n".format(combinedflat))
            f.write(';\n')

            # ModelPeriodExogenousEmission = np.zeros((lr,le))
            param = 'ModelPeriodExogenousEmission'  # Change this line
            f.write('#\n')
            columns = self.emission  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                # Writes index specific parameter values to the text
    files
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.ModelPeriodExogenousEmission[:, :]  # Change
     this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
```

```
                # Writes index specific parameter values to the text files
                f.write("param\t{0}\t:{1}:=\n".format(param, column_string))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')

            # ModelPeriodEmissionLimit = np.zeros((lr,le))
            param = 'ModelPeriodEmissionLimit'  # Change this line
            f.write('#\n')
            columns = self.emission  # Change this line
            column_string = ' '.join(columns)
            if toggle_defaults[param] == True:
                # Writes index specific parameter values to the text files
                f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
                    param, defaults_dictionary[param], column_string))
                # Converts maxtrix rows to list
                array = np.array(self.region)  # Change this line
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.ModelPeriodEmissionLimit[:, :]  # Change this line
                # Converts combined matrix to list and combines lists
                matlist = mat.tolist()
                #Combines the two lists
                combined_list = list(zip(lt, matlist))
                # Writes index specific parameter values to the text files
                f.write("param\t{0}\t:{1}:=\n".format(param, column_string))
                for line in combined_list:
                    combinedflat = ''.join(str(line))
                    combinedflat = combinedflat.replace('[', '')
                    combinedflat = combinedflat.replace(']', '')
                    combinedflat = combinedflat.replace("'", '')
                    combinedflat = combinedflat.replace(",", '')
                    combinedflat = combinedflat.replace("(", '')
                    combinedflat = combinedflat.replace(")", '')
                    f.write("{0}\n".format(combinedflat))
            else:
                f.write("param\t{0}\tdefault\t{1}:=\n".format(
                    param, defaults_dictionary[param]))
            f.write(';\n')
            f.write('end;\n')
            f.write('#')
```

```
2147            return
```

5.2.3 CreateCases

The module to create user-defined energy systems.

```
import os
import numpy as np
import pandas as pd


class CreateCases:
    """ A class of methods to create user-defined energy system
    """
    def __unit__(self):
        """ Sets the parameters and sets for the energy case
        """
        # Sets (placeholders for setting values)
        self.year = None
        self.region = None
        self.emission = None
        self.technology = None
        self.capacity_technology = None
        self.availability_technology = None
        self.fuel = None
        self.specified_fuel = None
        self.accumulated_fuel = None
        self.timeslice = None
        self.mode_of_operation = None
        self.storage = None
        self.daytype = None
        self.season = None
        self.dailytimebracket = None

        # Parameters
        self.Conversionls = None
        self.Conversionld = None
        self.Conversionlh = None
        self.DaysInDayType = None
        self.TradeRoute = None
        self.DepreciationMethod = None
        self.SpecifiedAnnualDemand = None
        self.SpecifiedDemandProfile = None
        self.AccumulatedAnnualDemand = None
        self.CapacityToActivityUnit = None
        self.CapacityFactor = None
        self.AvailabilityFactor = None
        self.OperationalLife = None
        self.ResidualCapacity = None
        self.InputActivityRatio = None
        self.OutputActivityRatio = None
        self.CapitalCost = None
        self.VariableCost = None
        self.FixedCost = None
        self.TechnologyToStorage = None
        self.TechnologyFromStorage = None
        self.StorageLevelStart = None
        self.StorageMaxChargeRate = None
```

```
53          self.StorageMaxDischargeRate = None
54          self.MinStorageCharge = None
55          self.OperationalLifeStorage = None
56          self.CapitalCostStorage = None
57          self.ResidualStorageCapacity = None
58          self.CapacityOfOneTechnologyUnit = None
59          self.TotalAnnualMaxCapacity = None
60          self.TotalAnnualMinCapacity = None
61          self.TotalAnnualMaxCapacityInvestment = None
62          self.TotalAnnualMinCapacityInvestment = None
63          self.TotalTechnologyAnnualActivityLowerLimit = None
64          self.TotalTechnologyAnnualActivityUpperLimit = None
65          self.TotalTechnologyModelPeriodActivityUpperLimit = None
66          self.TotalTechnologyModelPeriodActivityLowerLimit = None
67          self.ReserveMarginTagTechnology = None
68          self.ReserveMarginTagFuel = None
69          self.ReserveMargin = None
70          self.RETagTechnology = None
71          self.RETagFuel = None
72          self.REMinProductionTarget = None
73          self.EmissionActivityRatio = None
74          self.EmissionsPenalty = None
75          self.AnnualExogenousEmission = None
76          self.AnnualEmissionLimit = None
77          self.ModelPeriodExogenousEmission = None
78          self.ModelPeriodEmissionLimit = None
79
80      def set_year(self, start_year, end_year, interval):
81          """ Sets a list of forecast years
82
83          Args:
84              start_year (int): Starting year for forecasting (Less than
    end_year)
85              end_year (int): Ending year for forecasting (Greater than
    start_year)
86              interval (int): Gap for forecasting period
87          """
88          # Sets year array for new value
89          year = []
90          count = start_year
91          while count <= end_year:
92              year.append(str(count))
93              count = count + interval
94          self.year = year
95
96      def set_region(self, regions):
97          """ Sets the datacase's regions analysis
98
99          Args:
100             regions (list): list of regions
101         """
102         self.region = regions
103
104     def set_emission(self, emissions):
105         """Sets the cases emission types
106
107         Args:
108             emissions (List): list of emission types
```

```
109         """
110         self.emission = emissions
111 
112     def set_technology(self, technology):
113         """ Sets the cases technology type
114 
115         Args:
116             technology (list): List of technologies
117         """
118         self.technology = technology
119 
120     def set_capacity_technology(self, capacity_technology):
121         """ Sets the cases capacity_technology type
122 
123         Args:
124             capacity_technology (list): List of technologies
125         """
126         self.capacity_technology = capacity_technology
127 
128     def set_availability_technology(self, availability_technology):
129         """ Sets the cases availability_technology type
130 
131         Args:
132             availability_technology (list): List of technologies
133         """
134         self.availability_technology = availability_technology
135 
136     def set_fuel(self, fuel):
137         """ Sets the case's fuel types
138 
139         Args:
140             fuel (list): list of fuels
141         """
142         self.fuel = fuel
143 
144     def set_specified_fuel(self, specified_fuel):
145         """ Sets the case's specified fuel types
146 
147         Args:
148             specified_fuel (list): list of specified fuels
149         """
150         self.specified_fuel = specified_fuel
151 
152     def set_accumulated_fuel(self, accumulated_fuel):
153         """ Sets the case's accumulated fuel types
154 
155         Args:
156             specified_fuel (list): list of specified fuels
157         """
158         self.accumulated_fuel = accumulated_fuel
159 
160     def set_timeslice(self, timeslice):
161         """ Set of timeslices
162 
163         Args:
164             timeslice (list): list of timeslices
165         """
166         self.timeslice = timeslice
```

```
167
168     def set_mode_of_operation(self, num_modes_of_operation):
169         """ Create the number of modes of operation (n = 1,..., num_modes_of_operation)
170
171         Args:
172             num_modes_of_operation (int): Number of modes of operation
173         """
174         # Create set of mode_of_operation
175         mode_of_operation = []
176         count = 1
177         while count <= num_modes_of_operation:
178             mode_of_operation.append(str(count))
179             count = count + 1
180         self.mode_of_operation = mode_of_operation
181
182     def set_storage(self, storage):
183         """ Sets storage set of the datacase
184
185         Args:
186             storage (list): list of storage types
187         """
188         self.storage = storage
189
190     def set_daytype(self, num_daytypes):
191         """ Sets the daytypes for the energy case
192
193         Args:
194             num_daytypes (int): Number of daytypes
195         """
196         # Create set of daytypes
197         daytype = []
198         count = 1
199         while count <= num_daytypes:
200             daytype.append(str(count))
201             count = count + 1
202         self.daytype = daytype
203
204     def set_season(self, num_seasons):
205         """ Creates set of seasons
206
207         Args:
208             num_seasons (int): Number of seasons
209         """
210         # Create set of seasons
211         season = []
212         count = 1
213         while count <= num_seasons:
214             season.append(str(count))
215             count = count + 1
216         self.season = season
217
218     def set_daily_time_bracket(self, num_dailytimebrackets):
219         """ Creates set of daily time brackets
220
221         Args:
222             dailytimebracket (int): Number of daily time brackets
223         """
```

```
224         # Create set of dailytimebrackets
225         dailytimebracket = []
226         count = 1
227         while count <= num_dailytimebrackets:
228             dailytimebracket.append(str(count))
229             count = count + 1
230         self.dailytimebracket = dailytimebracket
231 
232     # Functions to define the parameters moving forward.
233     def set_year_split(self, timeslices, years, splits):
234         """ Creates 2D Numpy Array Parameter Splits.
235             (Note: The index positions of timelices and splits must
    match)
236 
237         Args:
238             timeslices (list): List of timeslices
239             years (list): List of years
240             splits (dict): A dictionary linking yearsplits to
    timeslices
241         """
242         # Creates a 2D YearSplit parameter
243         YearSplit = np.ones((len(timeslices), len(years)))
244         index = 0
245         for time in timeslices:
246             YearSplit[index, :] = splits[time]
247             index = index + 1
248         self.YearSplit = YearSplit
249 
250     def set_discount_rate(self, equity, debt, market_index,
251                           cost_of_debt_pre_tax, risk_free_rate,
252                           effective_tax_rate, preference_equity,
253                           market_value_preference_shares,
    preference_dividends,
254                           market_risk_coefficient):
255         """[summary]
256 
257         Args:
258             equity (dict): Dictionary of equity totals from treasury
    balance sheets
259             debt (dict): Dictionary of equity totals from treasury
    balance sheets
260             market_index (int, array): Regional monthly index returns (
    Arrays)
261             cost_of_debt_pre_tax (dict): Dictionary of pre-tax cost of
    debts calculated from treasury balance sheets
262             risk_free_rate (dict): Dictionary of risk free rates from
    10 year swap rates for each region
263             effective_tax_rate (dict): Dictionary of company tax rates
    for each region
264             preference_equity (dict): Dictionary of preference equity
    for each region
265             market_value_preference_shares (dict): Dictionary of the
    market value of prefence shares for each region
266             preference_dividends (dict): Dictionary of prefence
    dividends for each region
267             market_risk_coefficient (dict): Dictionary of markey risk
    co-efficients
268 
```

```
269         Returns:
270             [int, array]: Numpy array of discount rates
271         """
272         # Creates empty dictionaries to stored values
273         annualised_returns = {}
274         cost_of_equity = {}
275         cost_of_debt = {}
276         cost_of_preference_equity = {}
277         WACC = {}
278         discount_rates = []
279         # Calculates
280         for region in market_index:
281             # Calculates annualised returns for each regions market
    index
282             annualised_rate_of_return = (np.power(
283                 (1 + ((market_index[region][-1] - market_index[region
    ][0]) /
284                       market_index[region][0])),
285                 (12 / len(market_index[region]))) - 1)
286             annualised_returns[region] = annualised_rate_of_return
287             # Calculates cost of equity
288             cost_of_equity[region] = (
289                 risk_free_rate[region] + (market_risk_coefficient[
    region]) *
290                 (annualised_returns[region] - risk_free_rate[region]))
291             # Calculates cost of debt
292             cost_of_debt[region] = (cost_of_debt_pre_tax[region] / debt
    [region]
293                                     ) * (1 - effective_tax_rate[region
    ])
294             # Calculates cost of preference equity
295             cost_of_preference_equity[region] = preference_dividends[
296                 region] / market_value_preference_shares[region]
297             # Calculates WACC
298             WACC[region] = (
299                 cost_of_equity[region] *
300                 (equity[region] /
301                  (equity[region] + debt[region] + preference_equity[
    region])) +
302                 cost_of_debt[region] *
303                 (debt[region] /
304                  (equity[region] + debt[region] + preference_equity[
    region])) +
305                 cost_of_preference_equity[region] *
306                 (preference_equity[region] /
307                  (equity[region] + debt[region] + preference_equity[
    region])))
308             # Sets discount rates for each region
309             discount_rates.append(WACC[region])
310         # Set discount array
311         self.DiscountRate = np.asarray(discount_rates)
312 
313     def set_day_split(self, daily_time_bracket, years, hour_split,
    num_days,
314                       num_hours):
315         """ Sets the day split parameter
316 
317         Args:
```

```
318             daily_time_bracket (list): List of daily time brackets
319             years (list): List of years
320             hour_split (dict): Dictonary of hours in a daily time
    bracket
321             num_days (int): Number of days in a year
322             num_hours (int): Number of hours in a day
323         """
324         # Initilises the DaySplit Array
325         DaySplit = np.ones((len(daily_time_bracket), len(years)))
326         index = 0
327         for split in daily_time_bracket:
328             DaySplit[index, :] = hour_split[split] / (num_days *
    num_hours)
329             index = index + 1
330         self.DaySplit = DaySplit
331
332     def set_conversion_ls(self, timeslice, season, link):
333         """ Sets the conversionls parameter
334
335         Args:
336             timeslice (list): List of timeslices
337             season (list): List of seasons
338             link (dict): Dictionary describing the connection between
    timeslices and seasons
339         """
340         Conversionls = np.zeros((len(timeslice), len(season)))
341         for i in range(0, len(timeslice), 1):
342             for j in range(0, len(season), 1):
343                 if link[timeslice[i]] == season[j]:
344                     Conversionls[i, j] = 1
345
346         self.Conversionls = Conversionls
347
348     def set_conversion_ld(self, timeslice, daytype, link):
349         """ Sets the Conversionld parameter
350
351         Args:
352             timeslice (list): List of timeslices
353             daytype (list): List of daytypes
354             link (dict): Dictionary describing the connection between
    timeslices and daytypes
355         """
356         Conversionld = np.zeros((len(timeslice), len(daytype)))
357         for i in range(0, len(timeslice), 1):
358             Conversionld[i, :] = link[timeslice[i]]
359
360         self.Conversionld = Conversionld
361
362     def set_conversion_lh(self, timeslice, dailytimebracket, link,
    override):
363         """ Sets the Conversionlh parameter
364
365         Args:
366             timeslice (list): List of timeslices
367             dailytimebracket (list): List of dailytimebracket
368             link (dict): Dictionary describing the connection between
    timeslices and dailytimebrackets
```

```
            override (int, array): Override if want to manually put in
    the array
        """
        if override == None:
            Conversionlh = np.zeros((len(timeslice), len(
    dailytimebracket)))
            for i in range(0, len(timeslice), 1):
                Conversionlh[i, :] = link[timeslice[i]]
            self.Conversionlh = Conversionlh
        else:
            self.Conversionlh = override

    def set_days_in_day_type(self, season, daytype, year, link,
    override):
        """ Sets the DaysInDayType parameter

        Args:
            season (list): List of seasons
            daytype (list): List of daytypes
            year (list): List of years
            link (dict): Dictionary relating seasons to daytypes
            override (int, array): Override if want to manually put in
    the array
        """
        if override == None:
            DaysInDayType = np.zeros((len(season), len(daytype), len(
    year)))
            for i in range(0, len(season), 1):
                for j in range(0, len(year), 1):
                    DaysInDayType[i, :, j] = link[season[i]]
            self.DaysInDayType = DaysInDayType
        else:
            self.DaysInDayType = override

    def set_trade_route(self, trade):
        """ Sets the TradeRoute parameter between regions
            (Assume it is the same across fuels and years)

        Args:
            trade (int ,array): 4D array representing trade
    relationships
                                between regions, fuels and years. You
                                must model this manually.
        """
        self.TradeRoute = trade

    def set_depreciation_method(self, region, methods, override):
        """ Sets DepreciationMethod
            (1 = Sinking Fund Depreciation, 2 = Straightline
    Depreciation)

        Args:
            region (list): List of regions
            override (int, array): Manual array for setting
    depreciation methods
            methods (dict): Dictionary assigning methods to regions
        """

```

```
419         if override == None:
420             depreciation_method = np.ones((len(region)))
421             for i in range(0, len(region), 1):
422                 depreciation_method[i] = methods[region[i]]
423             self.DepreciationMethod = depreciation_method
424         else:
425             self.DepreciationMethod = override
426 
427     def set_specified_annual_demand(self, specified_forecast):
428         """ Sets the annual demand for fuels per region over the
    forecast period (Must be accurate)
429 
430         Args:
431             forecast (float, array): The forecast array of size (len(
    region),len(fuel),len(year))
432         """
433         self.SpecifiedAnnualDemand = specified_forecast
434 
435     def set_specified_demand_profile(self, specified_annual_demand,
    region,
436                                      fuel, year, timeslice, profile,
    override):
437         """ Sets the specified annual demand profiles using the
    specified annual demand.
438 
439         Args:
440             specified_annual_demand (float, array): Specified annual
    demand profiles
441             region (list): List of regions
442             fuel (list): List of fuels
443             year (list): List of years
444             timeslice (list): List of timeslices
445             profile (Dict): Dictionary of fuel allocations to
    timeslices
446             override (float, array): Manual override for the specified
    annual demand profiles.
447         """
448         # Initialises the linear array
449         demand_profile = np.zeros(
450             (len(region), len(fuel), len(timeslice), len(year)))
451         if override == None:
452             # Calculates the demand profile
453             for place in region:
454                 for fuel_type in fuel:
455                     for time in timeslice:
456                         for year_num in year:
457                             region_index = region.index(place)
458                             fuel_index = fuel.index(fuel_type)
459                             timeslice_index = timeslice.index(time)
460                             year_index = year.index(year_num)
461                             demand_profile[region_index, fuel_index,
462                                            timeslice_index,
463                                            year_index] = profile[time]
464 
465             self.SpecifiedDemandProfile = demand_profile
466         else:
467             self.SpecifiedDemandProfile = override
468 
```

```
469     def set_accumulated_annual_demand(self, accumulated_forecast):
470         """ Sets the accumulated annual demand for fuels per region
    over the forecast period.
471             This function relies on a similar forecasting methodology
    as set_specific_demand.
472             Fuels set in this function cannot be defined in
    set_specific_demand.
473 
474         Args:
475             accumulated_forecast (float, array): The forecast array of
    size (len(region),len(fuel),len(year))
476         """
477         self.AccumulatedAnnualDemand = accumulated_forecast
478 
479     def set_capacity_to_activity_unit(self, region, technology,
480                                       capacity_dictionaries, override):
481         """ Sets the capacity to activity parameter
482 
483         Args:
484             region (list): List of regions
485             technology (list): List of technologies
486             capacity_dictionaries (list): List of dictionaries to
    assign value
487             override (float, array) = 2D Array to assign override
    values
488         """
489         if override == None:
490             cap_to_act = np.zeros((len(region), len(technology)))
491             for i in range(0, len(capacity_dictionaries), 1):
492                 for j in range(0, len(technology), 1):
493                     cap_to_act[i, j] = capacity_dictionaries[i][
    technology[j]]
494             self.CapacityToActivityUnit = cap_to_act
495         else:
496             self.CapacityToActivityUnit = override
497 
498     def set_capacity_factor(self, factor_matrix):
499         """ Sets capacity factors for conversion technologies.
500 
501         Args:
502             factor_matrix (float, array); Capacity Factors
503         """
504         self.CapacityFactor = factor_matrix
505 
506     def set_availability_factor(self, availablility_matrix):
507         """ Sets the availability factors
508 
509         Args:
510             availablility_matrix (float, array): Matrix describing
    availability factors for given technologies
511         """
512         self.AvailabilityFactor = availablility_matrix
513 
514     def set_operational_life(self, operational_lives):
515         """ Sets operational life
516 
517         Args:
518             operational_lives (list):
```

```
519         """
520         self.OperationalLife = operational_lives
521 
522     def set_residual_capacity(self, residential_capacities):
523         """ Set residual capacity
524 
525         Args:
526             residential_capacities (float, array): residual capacities
    parameter
527         """
528         self.ResidualCapacity = residential_capacities
529 
530     def set_input_activity_ratio(self, input_activity_ratios):
531         """ Sets input activity ratios
532 
533         Args:
534             input_activity_ratios (float, array): Sets the input
    activity ratio
535         """
536         self.InputActivityRatio = input_activity_ratios
537 
538     def set_output_activity_ratio(self, output_activity_ratios):
539         """ Sets output activity ratio
540 
541         Args:
542             output_activity_ratios (float, array): output activity
    ratio parameters
543         """
544 
545     def set_capital_cost(self, capital_costs):
546         """ Sets capital costs
547 
548         Args:
549             capital_costs (float, array): capital cost paramters
550         """
551         self.CapitalCost = capital_costs
552 
553     def set_variable_cost(self, variable_costs):
554         """ Sets variable costs
555 
556         Args:
557             variable_costs (float, array): variable costs parameters
558         """
559         self.VariableCost = variable_costs
560 
561     def set_fixed_cost(self, fixed_costs):
562         """ Set fixed costs
563 
564         Args:
565             fixed_costs (float, array): fixed cost parameters
566         """
567         self.FixedCost = fixed_costs
568 
569     def set_technology_to_storage(self, technology_to_storage):
570         """ Sets the technology to storage parameter
571 
572         Args:
```

```
573             technology_to_storage (float, array): technology to storage
     parameter
574         """
575         self.TechnologyToStorage = technology_to_storage
576 
577     def set_technology_from_storage(self, technology_from_storage):
578         """ Sets technology from storage binary paramter
579 
580         Args:
581             technology_from_storage (float, array): technology from
    storage parameter
582         """
583         self.TechnologyFromStorage = technology_from_storage
584 
585     def set_min_storage_charge(self, minimum_storage_charges):
586         """ Sets the minimum storage charges
587 
588         Args:
589             minimum_storage_charges (float, array): minimum storage
    parameters
590         """
591         self.MinStorageCharge = minimum_storage_charges
592 
593     def set_operational_life_storage(self, operational_life_storage):
594         """ Sets the operational life storage
595 
596         Args:
597             operational_life_storage (float, array): operational life
    storage parameters
598         """
599         self.OperationalLifeStorage = operational_life_storage
600 
601     def set_capital_cost_storage(self, capital_cost_storage):
602         """ Sets the capital costs of using storage technologies
603 
604         Args:
605             capital_cost_storage (float, array): capital cost of
    storage technologies
606         """
607         self.CapitalCostStorage = capital_cost_storage
608 
609     def set_storage_level_start(self, storage_level_start):
610         """ Sets the storage level starting point
611 
612         Args:
613             storage_level_start (float, array): storage starting level
614         """
615         self.StorageLevelStart = storage_level_start
616 
617     def set_storage_max_charge_rate(self,
    storage_max_level_charge_rates):
618         """ Sets the storgae max charge rate
619 
620         Args:
621             storage_max_level_charge_rates (float, array): Storage max
    level charge rates
622         """
623         self.StorageMaxChargeRate = storage_max_level_charge_rates
```

```
624
625     def set_storage_max_discharge_rate(self,
626 
    storage_max_level_discharge_rates):
627         """ Sets storage technologies maximum discharge rates
628 
629         Args:
630             storage_max_level_discharge_rates (float, array): Discharge
     rates for storage paramters
631         """
632         self.StorageMaxDischargeRate =
    storage_max_level_discharge_rates
633 
634     def set_residual_storage_capacity(self, residual_storage_capacities
    ):
635         """ Sets residual storage capacities
636 
637         Args:
638             residual_storage_capacities (float, array): residual
    storage capacities
639         """
640         self.ResidualStorageCapacity = residual_storage_capacities
641 
642     def set_capacity_of_one_technology_unit(self,
643 
    capacity_of_one_technology_unit):
644         """ Set the capacity of one technology units for all
    technologies
645 
646         Args:
647             capacity_of_one_technology_unit (float, array): capacities
    for one technology units
648         """
649         self.CapacityOfOneTechnologyUnit =
    capacity_of_one_technology_unit
650 
651     def set_total_annual_max_capacity(self, total_annual_max_capacities
    ):
652         """ Sets the total annual maximum capacities
653 
654         Args:
655             total_annual_max_capacities (float, array): Total Annual
    Max Capacities
656         """
657         self.TotalAnnualMaxCapacity = total_annual_max_capacities
658 
659     def set_total_annual_min_capacity(self, total_annual_min_capacities
    ):
660         """ Sets the totoal annual minimum capacities
661 
662         Args:
663             total_annual_min_capacities (float, array): Total Annual
    Min Capacities
664         """
665         self.TotalAnnualMinCapacity = total_annual_min_capacities
666 
667     def set_total_technology_annual_activity_lower_limit(
668             self, total_technology_activity_lower_limits):
```

```
669         """ Sets the Total Technology Activity Lower Limits
670 
671         Args:
672             total_technology_activity_lower_limits (float, array):
    Technology Activity Lower Limits
673         """
674         self.TotalTechnologyAnnualActivityLowerLimit =
    total_technology_activity_lower_limits
675 
676     def set_total_technology_annual_activity_upper_limit(
677             self, total_technology_annual_activity_upper_limits):
678         """ Sets the Total Technology Activity Upper Limits
679 
680         Args:
681             total_technology_annual_activity_upper_limits (float, array
    ): Technology Activity Upper Limits
682         """
683         self.TotalTechnologyAnnualActivityUpperLimit =
    total_technology_annual_activity_upper_limits
684 
685     def set_total_technology_period_activity_upper_limit(
686             self, total_technology_period_activity_upper_limits):
687         """ Sets Total Technology Period Activity Upper Limits
688 
689         Args:
690             total_technology_period_activity_upper_limits (float, array
    ): Total Technology Period Activity Upper Limit
691         """
692         self.TotalTechnologyModelPeriodActivityUpperLimit =
    total_technology_period_activity_upper_limits
693 
694     def set_total_technology_period_activity_lower_limit(
695             self, total_technology_period_activity_lower_limits):
696         """Sets Total Technology Period Activity Lower Limits
697 
698         Args:
699             total_technology_period_activity_lower_limits ([type]):
    Total Technology Period Activity Lower Limit
700         """
701         self.TotalTechnologyModelPeriodActivityLowerLimit =
    total_technology_period_activity_lower_limits
702 
703     def set_reserve_margin_tag_technology(self,
704 
    reserve_margin_tag_technologies):
705         """ Sets Reserve Margin Tag Technology
706 
707         Args:
708             reserve_margin_tag_technologies (float, array): Reserve
    Margin Tag Technologies
709         """
710         self.ReserveMarginTagTechnology =
    reserve_margin_tag_technologies
711 
712     def set_reserve_margin_tag_fuel(self, reserve_margin_fuel_tags):
713         """ Sets the reserve margin tag fuels
714 
715         Args:
```

```
716             reserve_margin_fuel_tags (float, array): Sets the reserve
    margin tag fuel parameters
717         """
718         self.ReserveMarginTagFuel = reserve_margin_fuel_tags
719 
720     def set_reserve_margin(self, reserve_margins):
721         """ Sets reserve margins
722 
723         Args:
724             reserve_margins (float, array): Reserve Margins
725         """
726         self.ReserveMargin = reserve_margins
727 
728     def set_re_tag_technology(self, re_tag_technologies):
729         """ Sets RE Tag Technology
730 
731         Args:
732             re_tag_technologies (float, array): RE Tag Technologies
733         """
734         self.RETagTechnology = re_tag_technologies
735 
736     def set_re_tag_fuel(self, re_tag_fuels):
737         """ Sets RE Tag Fuels
738 
739         Args:
740             re_tag_fuels (float, array): RE Tag Fuels
741         """
742         self.RETagFuel = re_tag_fuels
743 
744     def set_re_min_production_target(self, re_min_production_targets):
745         """ Sets Renewable Energy Minimum Production Targets
746 
747         Args:
748             re_min_production_targets (float, array): Renewable Energy
    Minimum Production Targets
749         """
750         self.REMinProductionTarget = re_min_production_targets
751 
752     def set_emission_activity_ratio(self, emission_activity_ratios):
753         """ Sets Emission Activity Ratios
754 
755         Args:
756             emission_activity_ratios ([float, array): Emission Activity
     Ratios
757         """
758         self.EmissionActivityRatio = emission_activity_ratios
759 
760     def set_emissions_penalty(self, emissions_penalties):
761         """ Sets Emissions Penalties
762 
763         Args:
764             emissions_penalties (float, penalties): Emissions Penalties
765         """
766         self.EmissionsPenalty = emissions_penalties
767 
768     def set_annual_exogenous_emission(self, annual_exogenous_emission):
769         """ Sets Annual Exogneous Emissions
770 
```

```
771         Args:
772             annual_exogenous_emission (float, array): Annual Exogenous
    Emissions
773         """
774         self.AnnualExogenousEmission = annual_exogenous_emission
775 
776     def set_annual_emission_limit(self, annual_emission_limits):
777         """ Sets Annual Emission Limits
778 
779         Args:
780             annual_emission_limits (float, array): Annual Emission
    Limits
781         """
782         self.AnnualEmissionLimit = annual_emission_limits
783 
784     def set_model_period_exogenous_emission(self,
785 
    model_period_exogenous_emissions):
786         """ Sets Model Period Exogenous Emissions
787 
788         Args:
789             model_period_exogenous_emissions (float, array): Model
    Period Exogenous Emissions
790         """
791         self.ModelPeriodExogenousEmission =
    model_period_exogenous_emissions
792 
793     def set_model_period_emission_limit(self,
    model_period_emission_limits):
794         """ Sets Model Period Emission Limits
795 
796         Args:
797             model_period_emission_limits (float, array): Model Period
    Emission Limits
798         """
799         self.ModelPeriodEmissionLimit = model_period_emission_limits
```

5.2.4 Forecasting

The module to forecast energy and finance-related values.

```
1  import os
2  import numpy as np
3  import pandas as pd
4  import inquirer as iq
5  
6  
7  class Forecasting:
8      def __unit__(self):
9          """Initialises the forecasting class
10         """
11         self.forecasts = None
12 
13     def energy_balance_base(self, root, IEA_World_Energy_Balances_1,
14                             IEA_World_Energy_Balances_2,
15                             create_excel_spreadsheet, output_file):
16         """ Creates the baseline energy balance for forecasting
17 
```

```
18          Args:
19              root (path): Path to provide access to all the files
20              IEA_World_Energy_Balances_1 (str): File name for Energy
    Balance A to K
21              IEA_World_Energy_Balances_2 ([type]): File name for Energy
    Balance L to Z
22              create_excel_spreadsheet (boolean): True/false on whether
    to create a spreadsheet
23              output_file (str): Name of output energy balance
    spreadsheet
24
25          Returns:
26              (dict): Dictionary of energy balances and unique lists (Use
     these key words to access: Energy Balances, Fuel, Geography,
    Technology)
27          """
28          IEAWEBAK = root / IEA_World_Energy_Balances_1
29          IEAWEBLZ = root / IEA_World_Energy_Balances_2
30
31          # Creates dataframes from IEA World Energy Statistics and
    Balances CSVs from Stats.OECD.org in the OECDiLibrary
32          # Note the data is from #https:s//stats.oecd.org/ and #https://
    www-oecd-ilibrary-org.ezproxy.auckland.ac.nz/
33          column_headers = [
34              'ID', 'Unit', 'Geo_Code', 'Geo_Description', 'Prod_Code',
35              'Prod_Description', 'Flow_Code', 'Flow_Description', 'Year'
    ,
36              'Value(TJ)'
37          ]
38          f1 = open(IEAWEBAK, 'r')
39          df_A = pd.read_csv(f1, header=None)
40          df_A.columns = column_headers
41          df_A.info(verbose=True)
42          f2 = open(IEAWEBLZ, 'r')
43          df_B = pd.read_csv(f2, header=None)
44          df_B.columns = column_headers
45          df_B.info(verbose=True)
46          frames = [df_A, df_B]
47          df = pd.concat(frames)
48          df.info(verbose=True)
49
50          # Closes the files
51          f1.close()
52          f2.close()
53
54          # Finds the unique items in each list of the energy balance
    sheets
55          unique_fuel = df.Prod_Description.unique()
56          unique_geography = df.Geo_Description.unique()
57          unique_technology = df.Flow_Description.unique()
58          print(unique_geography)
59
60          # Asks for a user to select a geography using the inquirer
    function
61          selected_geo = input(
62              "Please enter the geography you wish to extract energy
    balances:  "
63          )
```

```
64
65          # Creates a pivot table to display the data in the way similar
    to the Energy Balance Sheet (cols = Energy Product, rows = Energy
    Flows)
66          energy_balance_pivot_table = pd.pivot_table(
67              df,
68              index=['Geo_Description', 'Flow_Description'],
69              # Converted values to PJ
70              values=['Value(TJ)'],
71              columns=['Prod_Description'],
72              aggfunc=[np.sum],
73              fill_value=0)
74          # Filters to the geography the user has selected
75          Input_String = 'Geo_Description == ["' + selected_geo + '"]'
76          geography_energy_balance_pivot_table =
    energy_balance_pivot_table.query(
77              Input_String)
78
79          if create_excel_spreadsheet == True:
80              # Write the filtered pivot table to an excel file
81              writer = pd.ExcelWriter(root / output_file)
82              geography_energy_balance_pivot_table.to_excel(writer,
    selected_geo)
83              writer.save()
84
85          # Returns the unique lists and filtered pivot table as a
    dataframe
86          return {
87              "Energy Balances": geography_energy_balance_pivot_table,
88              "Fuel": unique_fuel,
89              "Geography": unique_geography,
90              "Technology": unique_technology
91          }
92
93      def calculate_constant_average_growth_rate(self, start_year,
    end_year,
94                                                 start_value, end_value):
95          """ Calculates the constant average growth rate (CAGR)
96
97          Args:
98              start_year (int): Starting year
99              end_year (int): Ending year
100             start_value (int): Initial value
101             end_value (int): Final value
102
103         Returns:
104             cagr: Constant average growth rate (1+ decimal)
105         """
106         if start_value == 0 or (end_year - start_year) == 0:
107             cagr = 1
108         else:
109             cagr = np.power((end_value / start_value),
110                             (1 / (end_year - start_year)))
111         return cagr
112
113     def calculate_cagr_forecasts(self, cagr_dictionary,
    base_year_dictionary,
114                                  fuel, year):
```

```
115         """ Forecasts base year fuels by a constant average growth rate
    for a forecast period
116 
117         Args:
118             cagr_dictionary (Dict): Dictionary of constant average
    growth rates per fuel
119             base_year_dictionary ([type]): Dictionary of base year fuel
     consumption in energy types
120             fuel (list): List of Fuels
121             year (list): List of forecast years
122 
123         Returns:
124             [float, array]: 2D Array of demand forecasts per fuel
125         """
126         # Initialises the size of the array
127         forecast = np.ones((len(fuel), len(year)))
128 
129         # Set the first forecast as the base year
130         for i in range(0, len(fuel), 1):
131             forecast[i, 0] = base_year_dictionary[fuel[i]]
132 
133         # Calculates the forecasting
134         for i in range(0, len(fuel), 1):
135             for j in range(1, len(year), 1):
136                 forecast[i, j] = forecast[i, j - 1] * cagr_dictionary[
    fuel[j]]
137 
138         return forecast
```

5.2.5 Optimisation

The module to solve energy systems either locally or remotely using IBM technologies.

```
1  ######################################################################
2  # Optimisation contains the Optimisation Class to use CPLEX
3  ######################################################################
4  
5  # Import python modules
6  import os
7  import cplex as cp
8  import docplex as dp
9  import subprocess as sp
10 from ibm_watson_machine_learning import APIClient
11 import tarfile as tf
12 import time
13 
14 
15 # Begin class breakdown
16 class Optimisation:
17     """ Prepares and runs optimisation with IBM ILOG CPLEX Optimisation
      Studio
18     """
19     def __init__(self):
20         """ Initialise the optimisation class
21         """
22 
23     def use_bash_shell(self, command):
```

```
24          """ Execute bash commands in python scripts
25
26          Args:
27              command (str): Command to execute
28          """
29          # Execute the demand
30          sp.Popen([['/bin/bash', '-c', command]])
31
32      def create_linear_programme_file(self, directory, data_file,
    model_file,
33                                       output_file):
34          """ Creates the model file through executing model system
    commands
35
36              Args:
37                  directory (str): Name of directory to put data into
38                  data_file (str): Name of energy system data file
39                  model_file (str): Name of energy system model file
40                  output_file (str): Name of output linear programme
41              """
42          # Change the working directory
43          os.chdir(directory)
44          # Load the custom anaconda environment
45          # This assumes the conda environment has already been
    initialised.
46          os.system('conda activate osemosys')
47          # Execute the file structure to create the linear programming
    file
48          # (glpsol -m GOCPI_Model.txt -d GOCPI_Data.txt --wlp GOCPI.lp)
49          command = 'glpsol -m ' + data_file + ' -d ' + model_file + '--
    wlp ' + output_file
50          os.system(command)
51
52      def run_cplex_local(self, model_file):
53          """ This function runs cplex on the local device if the energy
    system
54              is of a small enough scale
55
56          Args:
57              model_file (str): Path of model file
58
59          Returns:
60              [int]: Objective value
61          """
62          # Creates the model structure
63          model = cp.Cplex()
64          # Produces the results stream and log streams
65          output = model.set_results_stream(None)
66          output = model.set_log_stream(None)
67          # Write the energy system model to Cplex
68          model.read(model_file)
69          # Solve the model using the version of Cplex installed on the
    local
70          # device (IBM ILOG CPLEX Optimisation Studio)
71          model.solve()
72          # Return the value of the objective function
73          objective_value = model.solution.get_objective_value()
74          return objective_value
```

```
75
76      def run_ibm_wml_do(self, apikey, url, deployment_space_name,
77                         cloud_object_storage_credential,
    service_instance_id,
78                         deployment_space_exists, data_assets_exist,
79                         data_asset_dictionary, model_name, model_type,
80                         model_runtime_uid, model_tar_file, num_nodes,
81                         deployment_exists, payload_input_data_id,
82                         payload_input_data_file, payload_output_data_id)
    :
83          """ This function enables the user to solve python-based
84              optimisation models. The legacy offering
85              to solve optimisation models on IBM cloud was using
86              the docplex python api to run Cplex on DOcloud.
87              As of September 2020, the DOcloud
88              was discontinued with Decision Optimisation
89              functionalities imported to IBM's Watson Machine
90              Learning Service. The new process requires the
91              energy system model to be written in python. This
92              project saw the implementation of the osemosys
93              modelling methodology in GNU Mathprog written into
94              LP Files. IBM Decision Optimisation in cannot deploy
95              models in LP File formats to get jobs. Therefore,
96              this function is for future work in converting the
97              entire energy system modelling tool to python-based only.
98              This is well-documented the report in the Future Work
99              Section. Note: You must have access to IBM Watson Studio
100             and Cloud Products through the IBM Academic Initiative or
101             Similar.
102
103         Args:
104             apikey (str): API key from user's IBM Cloud Account
105             url ([type]): URL for the server the user is using for the
    IBM services
106             deployment_space_name (str): Name of the deployment space
107             cloud_object_storage_credential (str): Credential for the
    cloud object storage asset
108             service_instance_id (str): Service instance id for the
    service being used (IBM WML)
109             deployment_space_exists (boolean): True/False if the
    deployment space already exists
110             data_assets_exist (boolean): True/False if the data assets
    (e.g. input data stored on cloud)
111             data_asset_dictionary (dict): A dictionary of data assets
    to stored on IBM cloud
112             model_name (str): Name of the model
113             model_type (str): Name of the model
114             model_runtime_uid (str): Runtime ID for the model
115             model_tar_file (tar): Tar file containing the python model
116             num_nodes (int): Number of nodes the model is run off.
117             deployment_exists (boolean): True/False if the deployment
    already exists
118             payload_input_data_id (str): Name of input data
119             payload_input_data_file (dataframe): Input data file in the
     form of a dataframe
120             payload_output_data_id (str): Name of output data file
121         """
122
```

```
        # Creates the Watson Machine learning Credientials
        api_wml_credentials = {
            # IBM Cloud User Account Access Code
            "apikey": apikey,
            # Url to code repository
            "url": url
        }
        # Initials the clent credientials
        client = APIClient(api_wml_credentials)

        # Create a deployment space on the IBM Cloud Service
        space_metadata = {
            # Configures deployment space name
            client.spaces.ConfigurationMetaNames.NAME:
            deployment_space_name,
            # Configures deployment space description
            client.spaces.ConfigurationMetaNames.DESCRIPTION:
            deployment_space_name + ' Deployment for energy systems
    models',
            # Configures deployment space storage location
            client.spaces.ConfigurationMetaNames.STORAGE: {
                "type": "bmcos_object_storage",
                "resource_crn": cloud_object_storage_credential
            },
            # Configures deployment
            client.spaces.ConfigurationMetaNames.COMPUTE: {
                "name": "existing_instance_id",
                "crn": service_instance_id
            }
        }
        # Bypasses the creation of the deployment space if is already
    exists
        if deployment_space_exists == True:
            client.spaces.list()
            # Asks user to input the Space ID of the Input Space
            space_id = input('Please input the Space ID: ')
        else:
            # Stores the newly created space in the depositories spaces
     list
            space = client.spaces.store(meta_props=space_metadata)
            space_id = client.spaces.get_id(space)

        # Sets the client space
        client.set.default_space(space_id)

        # Creates input and output data assets if they don't exist
        if data_assets_exist == False:
            # Loop through dictionary of data assets to create
            for key in data_asset_dictionary:
                client.data_assets.create(key, data_asset_dictionary[
    key])

        # Creates software mane and specification for the deployment
        client.software_specifications.list()
        software_name = input("Please Input Software Name: ")
        software_spec_uid = client.software_specifications.
    get_uid_by_name(
            software_name)
```

```
176
177         # Creates the model deployment
178         model_metadata = {
179             client.repository.ModelMetaNames.NAME: model_name,
180             client.repository.ModelMetaNames.DESCRIPTION: model_name +
    'Model',
181             client.repository.ModelMetaNames.TYPE: model_type,
182             client.repository.ModelMetaNames.RUNTIME_UID:
    model_runtime_uid,
183             client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:
184             software_spec_uid
185         }
186         # Creates the energy model details
187         model_details = client.repository.store_model(
188             model=model_tar_file, meta_props=model_metadata)
189         # Creates model uid
190         model_uid = client.repository.get_model_uid(model_details)
191
192         # Creates a deployment
193         meta_props = {
194             client.deployments.ConfigurationMetaNames.NAME:
195             "Deployment " + str(num_nodes),
196             client.deployments.ConfigurationMetaNames.DESCRIPTION:
197             "Deployment " + str(num_nodes),
198             # client.deployments.ConfigurationMetaNames.HARDWARE_SPEC:
199             client.deployments.ConfigurationMetaNames.BATCH: {},
200             client.deployments.ConfigurationMetaNames.COMPUTE: {
201                 'name': 'S',
202                 'nodes': num_nodes
203             }
204         }
205
206         # Tests if deployment already exists
207         if deployment_exists == True:
208             client.deployments.list()
209             deployment_uid = input('Please input the Deployment UID: ')
210         else:
211             deployment_details = client.deployments.create(
212                 model_uid, meta_props=meta_props)
213             deployment_uid = client.deployments.get_uid(
    deployment_details)
214
215         # Creates a payload for the solver to solve (Note: Ammend based
     on the model you are solving)
216         payload = {
217             client.deployments.DecisionOptimizationMetaNames.INPUT_DATA
    : [{
218                 "id":
219                 payload_input_data_id,
220                 "values":
221                 payload_input_data_file
222             }],
223             client.deployments.DecisionOptimizationMetaNames.
    OUTPUT_DATA: [{
224                 "id":
225                 payload_output_data_id
226             }]
227         }
```

```
228
229         # Creates a new job using the deployment and payload
230         job_details = client.deployments.create_job(deployment_uid,
    payload)
231         job_uid = client.deployments.get_job_uid(job_details)
232
233         # Print the status of the job until competition
234         while job_details['entity']['decision_optimization']['status'][
235                 'state'] not in ['completed', 'failed', 'canceled']:
236             print(job_details['entity']['decision_optimization']['
    status']
237                   ['state'] + '...')
238             job_details = client.deployments.get_job_details(job_uid)
239             time.sleep(5)
240             print(job_details['entity']['decision_optimization']['
    status']
241                   ['state'])
242
243     # Reset tarfile function (Source: IBM Watson Machine Learning)
244     def reset(self, tarinfo):
245         """ Resets the tarfile information when creating tar files
246             This is to input into the filter when using tar.add()
247
248         Args:
249             tarinfo (Object): Tar Object containing an ID of 0 and the
    root as the name
250
251         Returns:
252             tarinfo (Object): Tar Object containing an ID of 0 and the
    root as the name
253         """
254         tarinfo.uid = tarinfo.gid = 0
255         tarinfo.uname = tarinfo.gname = "root"
256         return tarinfo
```

6 Development Scripting

The scripts within this section were used to design the GOCPI modules needed for the project.

6.1 GOCPI Data Cases

This script helped set the structure to build the model and data files for energy systems.

```
# GOCPI_Data_Cases is a methodology to import scenario data
# across multiple files. These are the
# sets and parameters for the Energy System Optimisation Model.
# A python script was chosen over other storage methods (e.g. excel)
# as values can be stored in matrices and many values are configured
   differently

# Import useful python packages
# Git reposistory
# https://github.com/CMCD1996/GOCPI.git
# Make more changes from the pull request
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy as sc
import sklearn as skl
import csv as csv
import openpyxl
import pathlib
import os
from pathlib import Path
from openpyxl import load_workbook
import GOCPI as GF
import cplex as cp
import docplex as dp

# Creates sets for the demo model
YEAR = [
    '1990', '1991', '1992', '1993', '1994', '1995', '1996', '1997', '
   1998',
    '1999', '2000', '2001', '2002', '2003', '2004', '2005', '2006', '
   2007',
    '2008', '2009', '2010'
]
REGION = ['NEWZEALAND', 'AUSTRALIA']
EMISSION = ['CO2', 'NOX', 'CO', 'METHANE']
TECHNOLOGY = [
    'E01', 'E21', 'E31', 'E51', 'E70', 'IMPDSL1', 'IMPGSL1', 'IMPHCO1',
    'IMPOIL1', 'IMPURN1', 'RHE', 'RHO', 'RL1', 'SRE', 'TXD', 'TXE', '
   TXG',
    'RIV', 'RHu', 'RLu', 'TXu'
]
FUEL = [
    'CSV', 'DSL', 'ELC', 'GSL', 'HCO', 'HYD', 'LTH', 'OIL', 'URN', 'RH'
   , 'RL',
    'TX'
]
```

```
TIMESLICE = [
    'INTERMEDIATE_DAY', 'INTERMEDIATE_NIGHT', 'SUMMER_DAY', '
    SUMMER_NIGHT',
    'WINTER_DAY', 'WINTER_NIGHT'
]
MODE_OF_OPERATION = ['1', '2']
STORAGE = ['DAM']
DAYTYPE = ['1', '2', '3']
SEASON = [
    '1', '2', '3', '4'
]  # Must be denoted in numbers to match constraints in model (1:
    Summer, 2: Autumn, 3: Winter, 4): Spring)
DAILYTIMEBRACKET = ['1', '2', '3']

# Sets
sets = [
    YEAR, REGION, EMISSION, TECHNOLOGY, FUEL, TIMESLICE,
    MODE_OF_OPERATION,
    STORAGE, DAYTYPE, SEASON, DAILYTIMEBRACKET
]

# Create the energy system with sets and initialised parameters. The
    parameter have the necessary parameters
Demo = GF.Energy_Systems(YEAR, REGION, EMISSION, TECHNOLOGY, FUEL,
    TIMESLICE,
                         MODE_OF_OPERATION, STORAGE, DAYTYPE, SEASON,
                         DAILYTIMEBRACKET)

# This user must now initialise the parameters as they choose to
    configure the energy system for the optimisation model.
# This is incredibly important. The user must understand the
    configuration of the energy system to do this! Consult the
# User manual to build this optimisation.

# End of user defined inputs in this script

# Sets the textfile saved locations
data_txt = 'GOCPI_OseMOSYS_Data.txt'
model_source_file = 'GOCPI_OseMOSYS_Structure.xlsx'
root = '/Users/connor/Google Drive/Documents/University/Courses/2020/
    ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI OseMOSYS'
data_roots = Path(root)
data_location_1 = os.path.join(data_roots, data_txt)

# Dictionary of default parameters for creating a model file
default_parameters = {
    'YearSplit': 1,
    'DiscountRate': 1,
    'DaySplit': 1,
    'Conversionls': 1,
    'Conversionld': 1,
    'Conversionlh': 1,
    'DaysInDayType': 1,
    'TradeRoute': 1,
    'DepreciationMethod': 1,
    'SpecifiedAnnualDemand': 1,
    'SpecifiedDemandProfile': 1,
    'AccumulatedAnnualDemand': 1,
```

```
    'CapacityToActivityUnit': 1,
    'CapacityFactor': 1,
    'AvailabilityFactor': 1,
    'OperationalLife': 1,
    'ResidualCapacity': 1,
    'InputActivityRatio': 1,
    'OutputActivityRatio': 1,
    'CapitalCost': 1,
    'VariableCost': 1,
    'FixedCost': 1,
    'TechnologyToStorage': 1,
    'TechnologyFromStorage': 1,
    'StorageLevelStart': 1,
    'StorageMaxChargeRate': 1,
    'StorageMaxDischargeRate': 1,
    'MinStorageCharge': 1,
    'OperationalLifeStorage': 1,
    'CapitalCostStorage': 1,
    'ResidualStorageCapacity': 1,
    'CapacityOfOneTechnologyUnit': 1,
    'TotalAnnualMaxCapacity': 1,
    'TotalAnnualMinCapacity': 1,
    'TotalAnnualMaxCapacityInvestment': 1,
    'TotalAnnualMinCapacityInvestment': 1,
    'TotalTechnologyAnnualActivityLowerLimit': 1,
    'TotalTechnologyAnnualActivityUpperLimit': 1,
    'TotalTechnologyModelPeriodActivityUpperLimit': 1,
    'TotalTechnologyModelPeriodActivityLowerLimit': 1,
    'ReserveMarginTagTechnology': 1,
    'ReserveMarginTagFuel': 1,
    'ReserveMargin': 1,
    'RETagTechnology': 1,
    'RETagFuel': 1,
    'REMinProductionTarget': 1,
    'EmissionActivityRatio': 1,
    'EmissionsPenalty': 1,
    'AnnualExogenousEmission': 1,
    'AnnualEmissionLimit': 1,
    'ModelPeriodExogenousEmission': 1,
    'ModelPeriodEmissionLimit': 1
}

# Create the Data File
Demo.create_data_file(data_location_1, default_parameters)

# Cereate the Model File
Demo.create_model_file(root, model_source_file)

# Convert created model and data files into a Linear Problem file (lp)
# Test the formatting
```

6.2 GOCPI Energy Balances

This script helped extract energy balances from the International Energy Agency's World Energy Balances.

```
# GOCPI_EB prepares the energy balance across time for certain geographies
# This script was adapted into the GOCPI Module

# Import useful python packages
# Git reposistory
# https://github.com/CMCD1996/GOCPI.git
# Make more changes from the pull request
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy as sc
import sklearn as skl
import csv as csv
import openpyxl as pyxl
import pathlib
import os
import pydrive

# Very Important Step: Sets directory root for file operations.
source_root = pathlib.Path(
    '/Users/connor/Google Drive/Documents/University/Courses/2020/ENGSCI 700A&B/GOCPI/data/Energy Balances'
)

# Load in the EnergyBalance.csv file found from the University of Auckland SourceOECD Database.
# This csv contains the energy balances around the world

# Important Step: Sets the Energy Balances Folder ID in my personal google drive
folderID = '1PCUMeT8c9dJE1ES8JDg62w2rKMASOxSW'  # Energy Balance

# Loads in appropriate pydrive functions for access
from pydrive.auth import GoogleAuth
from pydrive.drive import GoogleDrive

# # Creates the authorisation to access the google drive
# gauth = GoogleAuth()
# gauth.LocalWebserverAuth() # Gains authorisation using the clients_secrets.json file in the src directory
# # Creates a google drive object to handle files
# drive = GoogleDrive(gauth)

# # Tests the access to the google drive and finds all IEAEnergyBalances.csv File IDs in the EnergyBalances Directory
# file_list = []
# title_list = []
# files = drive.ListFile({'q': "'1MD5ewAKAy2McqyCfjivwavj278giRvmR' in parents and trashed=false"}).GetList()
# for filex in files:
#     print(filex['id'])
#     print(filex['title'])
#     file_list.append(filex['id'])  # IEAEnergyBalance.csvs File IDs
#     title_list.append(filex['title']) # IEAEnergyBalance.csvs Titles

# Gets the linksto the two files wanted
```

```
# Links for IEA Energy Balance for 2018 (A-K) and IEA Energy Balance for 2017 (L-Z)
IEAWEBAK = source_root / 'IEAWorldEnergyBalances2017A-K.csv'
IEAWEBLZ = source_root / 'IEAWorldEnergyBalances2017L-Z.csv'

# Creates dataframes from IEA World Energy Statistics and Balances CSVs from Stats.OECD.org in the OECDiLibrary
# Note the data is from #https:s//stats.oecd.org/ and #https://www-oecd-ilibrary-org.ezproxy.auckland.ac.nz/
column_headers = [
    'ID', 'Unit', 'Geo_Code', 'Geo_Description', 'Prod_Code',
    'Prod_Description', 'Flow_Code', 'Flow_Description', 'Year', 'Value (TJ)'
]
f1 = open(IEAWEBAK, 'r')
df_A = pd.read_csv(f1, header=None)
df_A.columns = column_headers
df_A.info(verbose=True)
f2 = open(IEAWEBLZ, 'r')
df_B = pd.read_csv(f2, header=None)
df_B.columns = column_headers
df_B.info(verbose=True)
frames = [df_A, df_B]
df = pd.concat(frames)
df.info(verbose=True)

# Closes the files
f1.close()
f2.close()

# Find the unique items in each list of the energy balance sheets
uv_prod = df.Prod_Description.unique()
uv_geo = df.Geo_Description.unique()
uv_flow = df.Flow_Description.unique()

# Establishes the rows and columns for the EnergyBalance.xlsm spreadsheet
# Note: Most likely in the calculation, Other will be a sink so Total Energy Supply - Conversion Losses = Total Energy Consumed
# Rows (Energy uses)
Primary = ['Domestic Supply', 'Imports', 'Exports', 'Total Primary Supply']
Conversion = [
    'Energy Sector Consumption', 'Electricity Plants', 'Heat Plants',
    'Petroluem Refineries', 'Total Conversion'
]
Consumption = [
    'Residential', 'Commercial', 'Industry', 'Agriculture', 'Transport',
    'Other', 'Non Energy', 'Bunkers', 'Total Final Consumption'
]

# Primary (To complete)
DomesticSupply = ['Production']
Imports = ['Imports']
Exports = ['Exports']
TotalPrimarySupply = ['Total primary energy supply']

```

```
# Conversion (To complete)
Energy_Sector_Consumption = ['']
Electricity_Plants = ['']
Heat_Plants = ['']
Petroleum_Refineries = ['']
Total_Conversion = ['']

# Consumption (To complete)
Residential = ['']
Commercial = ['']
Industry = ['']
Agriculture = ['']
Transport = ['']
Other = ['Stock changes', 'Transfers', 'Statistical differences']
Non_Energy = ['']
Bunkers = ['International marine bunkers', 'International aviation
    bunkers']
Total_Final_Consumption = ['']

# Energy Flows
Energy_Flows = [
    'Production', 'Imports', 'Exports', 'International marine bunkers',
    'International aviation bunkers', 'Stock changes',
    'Total primary energy supply', 'Transfers', 'Statistical
   differences',
    'Transformation processes', 'Main activity producer electricity
   plants',
    'Autoproducer electricity plants', 'Main activity producer CHP
   plants',
    'Autoproducer CHP plants', 'Main activity producer heat plants',
    'Autoproducer heat plants', 'Heat pumps', 'Electric boilers',
    'Chemical heat for electricity production', 'Blast furnaces', 'Gas
   works',
    'Coke ovens', 'Patent fuel plants', 'BKB/peat briquette plants',
    'Oil refineries', 'Petrochemical plants', 'Coal liquefaction plants
   ',
    'Gas-to-liquids (GTL) plants', 'For blended natural gas',
    'Charcoal production plants', 'Non-specified (transformation)',
    'Energy industry own use', 'Coal mines', 'Oil and gas extraction',
    'Gasification plants for biogases',
    'Liquefaction (LNG) / regasification plants',
    '"Own use in electricity, CHP and heat plants"', 'Pumped storage
   plants',
    'Nuclear industry', 'Non-specified (energy)', 'Losses',
    'Total final consumption', 'Industry', 'Mining and quarrying',
    'Construction', 'Manufacturing', 'Iron and steel',
    'Chemical and petrochemical', 'Non-ferrous metals',
    'Non-metallic minerals', 'Transport equipment', 'Machinery',
    'Food and tobacco', '"Paper, pulp and printing"', 'Wood and wood
   products',
    'Textile and leather', 'Industry not elsewhere specified', '
   Transport',
    'World aviation bunkers', 'Domestic aviation', 'Road', 'Rail',
    'Pipeline transport', 'World marine bunkers', 'Domestic navigation'
   ,
    'Non-specified (transport)', 'Residential',
    'Commercial and public services', 'Agriculture/forestry', 'Fishing'
   ,
```

```
    'Final consumption not elsewhere specified', 'Non-energy use',
    'Non-energy use industry/transformation/energy',
    'Memo: Non-energy use in industry', 'Memo: Non-energy use in
   construction',
    'Memo: Non-energy use in mining and quarrying',
    'Memo: Non-energy use in iron and steel',
    'Memo: Non-energy use in chemical/petrochemical',
    'Memo: Non-energy use in non-ferrous metals',
    'Memo: Non-energy use in non-metallic minerals',
    'Memo: Non-energy use in transport equipment',
    'Memo: Non-energy use in machinery',
    'Memo: Non-energy use in food/beverages/tobacco',
    'Memo: Non-energy use in paper/pulp and printing',
    'Memo: Non-energy use in wood and wood products',
    'Memo: Non-energy use in textiles and leather',
    'Memo: Non-energy use in industry not elsewhere specified',
    'Non-energy use in transport', 'Non-energy use in other',
    'Electricity output (GWh)',
    'Electricity output (GWh)-main activity producer electricity plants
   ',
    'Electricity output (GWh)-autoproducer electricity plants',
    'Electricity output (GWh)-main activity producer CHP plants',
    'Electricity output (GWh)-autoproducer CHP plants'
    'Heat output', 'Heat output-main activity producer CHP plants',
    'Heat output-autoproducer CHP plants',
    'Heat output-main activity producer heat plants',
    'Heat output-autoproducer heat plants'
]

#  Columns (Energy Types)
Energy = [
    'Solid Fuels', 'Natural Gas', 'Crude Oil', 'Diesel Oil', 'Kerosene'
   , 'LPG',
    'Motor Spirit', 'Naphtha', 'Heavy Fuel Oil', 'Other Petroleum
   Products',
    'Nuclear Energy', 'Biomass', 'Hydro power', 'Wind energy', 'Solar
   Energy',
    'Industrial Wastes', 'Derived Heat', 'Electricity', 'Total'
]

Solid_Fuels = ['']
Natural_Gas = ['']
Crude_Oil = ['']
Diesel_Oil = ['']
Kerosene = ['']
LPG = ['']
Motor_Spirit = ['']
Naphtha = ['']
Heavy_Fuel_Oil = ['']
Other_Petroleum_Products = ['']
Nuclear_Energy = ['']
Biomass = ['']
Hydro_power = ['']
Wind_Energy = ['']
Solar_Energy = ['']
Industrial_Wastes = ['']
Derived_Heat = ['']
Electricity = ['']
```

```
Total = ['']

Enery_Types = [
    'Hard coal (if no detail)', 'Brown coal (if no detail)', '
   Anthracite',
    'Coking coal', 'Other bituminous coal', 'Sub-bituminous coal', '
   Lignite',
    'Patent fuel', 'Coke oven coke', 'Gas coke', 'Coal tar'
    'BKB', 'Gas works gas', 'Coke oven gas', 'Blast furnace gas',
    'Other recovered gases', 'Peat', 'Peat products',
    'Oil shale and oil sands', 'Natural gas',
    'Crude/NGL/feedstocks (if no detail)', 'Crude oil', 'Natural gas
   liquids',
    'Refinery feedstocks', 'Additives/blending components',
    'Other hydrocarbons', 'Refinery gas', 'Ethane',
    'Liquefied petroleum gases (LPG)', 'Motor gasoline excl. biofuels',
    'Aviation gasoline', 'Gasoline type jet fuel',
    'Kerosene type jet fuel excl. biofuels', 'Other kerosene',
    'Gas/diesel oil excl. biofuels', 'Fuel oil', 'Naphtha',
    'White spirit & SBP', 'Lubricants', 'Bitumen', 'Paraffin waxes',
    'Petroleum coke', 'Other oil products', 'Industrial waste',
    'Municipal waste (renewable)', 'Municipal waste (non-renewable)',
    'Primary solid biofuels', 'Biogases'
    'Biogasoline'
    'Biodiesels', 'Bio jet kerosene', 'Other liquid biofuels',
    'Non-specified primary biofuels and waste', 'Charcoal',
    'Elec/heat output from non-specified manufactured gases',
    'Heat output from non-specified combustible fuels', 'Nuclear', '
   Hydro',
    'Geothermal', 'Solar photovoltaics', 'Solar thermal',
    '"Tide, wave and ocean"', 'Wind', 'Other sources', 'Electricity', '
   Heat',
    'Total', 'Memo: Renewables'
]

# Creates a pivot table to display the data in the way similar to the
   Energy Balance Sheet (cols = Energy Product, rows = Energy Flows)
EBPT = pd.pivot_table(df,
                      index=['Geo_Description', 'Flow_Description'],
                      values=['Value(TJ)'],
                      columns=['Prod_Description'],
                      aggfunc=[np.sum],
                      fill_value=0)
# Filters to the geography the user has selected
Selected_Geo = uv_geo[0]  # Update once turned into a custom function
Input_String = 'Geo_Description == ["' + Selected_Geo + '"]'
EBPTG = EBPT.query(Input_String)

# Write the filtered pivot table to an excel file
writer = pd.ExcelWriter(source_root / "Geo EB.xlsx")
EBPTG.to_excel(writer, Selected_Geo)
writer.save()

# Keep assigning this variables
# Energy_Flows = [,
# , , ,
#  , ,
```

```
#   'Autoproducer electricity plants', 'Main activity producer CHP
    plants',
#   'Autoproducer CHP plants', 'Main activity producer heat plants',
#   'Autoproducer heat plants', 'Heat pumps', 'Electric boilers',
#   'Chemical heat for electricity production', 'Blast furnaces', 'Gas
    works',
#   'Coke ovens', 'Patent fuel plants', 'BKB/peat briquette plants',
#   'Oil refineries','Petrochemical plants', 'Coal liquefaction plants',
#   'Gas-to-liquids (GTL) plants', 'For blended natural gas',
#   'Charcoal production plants', 'Non-specified (transformation)',
#   'Energy industry own use', 'Coal mines', 'Oil and gas extraction',
#   'Gasification plants for biogases',
#   'Liquefaction (LNG) / regasification plants',
#   '"Own use in electricity, CHP and heat plants"', 'Pumped storage
    plants',
#   'Nuclear industry', 'Non-specified (energy)', 'Losses',
#   'Total final consumption', 'Industry', 'Mining and quarrying',
#   'Construction', 'Manufacturing', 'Iron and steel',
#   'Chemical and petrochemical', 'Non-ferrous metals', 'Non-metallic
    minerals',
#   'Transport equipment', 'Machinery', 'Food and tobacco',
#   '"Paper, pulp and printing"', 'Wood and wood products',
#   'Textile and leather', 'Industry not elsewhere specified', '
    Transport',
#   'World aviation bunkers', 'Domestic aviation', 'Road', 'Rail',
#   'Pipeline transport', 'World marine bunkers', 'Domestic navigation',
#   'Non-specified (transport)', 'Residential',
#   'Commercial and public services', 'Agriculture/forestry', 'Fishing',
#   'Final consumption not elsewhere specified', 'Non-energy use',
#   'Non-energy use industry/transformation/energy',
#   'Memo: Non-energy use in industry', 'Memo: Non-energy use in
    construction',
#   'Memo: Non-energy use in mining and quarrying',
#   'Memo: Non-energy use in iron and steel',
#   'Memo: Non-energy use in chemical/petrochemical',
#   'Memo: Non-energy use in non-ferrous metals',
#   'Memo: Non-energy use in non-metallic minerals',
#   'Memo: Non-energy use in transport equipment',
#   'Memo: Non-energy use in machinery',
#   'Memo: Non-energy use in food/beverages/tobacco',
#   'Memo: Non-energy use in paper/pulp and printing',
#   'Memo: Non-energy use in wood and wood products',
#   'Memo: Non-energy use in textiles and leather',
#   'Memo: Non-energy use in industry not elsewhere specified',
#   'Non-energy use in transport', 'Non-energy use in other',
#   'Electricity output (GWh)',
#   'Electricity output (GWh)-main activity producer electricity plants
    ',
#   'Electricity output (GWh)-autoproducer electricity plants',
#   'Electricity output (GWh)-main activity producer CHP plants',
#   'Electricity output (GWh)-autoproducer CHP plants' 'Heat output',
#   'Heat output-main activity producer CHP plants',
#   'Heat output-autoproducer CHP plants',
#   'Heat output-main activity producer heat plants',
#   'Heat output-autoproducer heat plants']

#  Enery_Types = ['Hard coal (if no detail)', 'Brown coal (if no detail
    )', 'Anthracite',
```

```
#  'Coking coal', 'Other bituminous coal', 'Sub-bituminous coal', '
   Lignite',
#  'Patent fuel', 'Coke oven coke', 'Gas coke', 'Coal tar' 'BKB',
#  'Gas works gas', 'Coke oven gas', 'Blast furnace gas',
#  'Other recovered gases', 'Peat', 'Peat products', 'Oil shale and oil
    sands',
#  'Natural gas', 'Crude/NGL/feedstocks (if no detail)', 'Crude oil',
#  'Natural gas liquids', 'Refinery feedstocks',
#  'Additives/blending components', 'Other hydrocarbons', 'Refinery gas
   ',
#  'Ethane', 'Liquefied petroleum gases (LPG)',
#  'Motor gasoline excl. biofuels', 'Aviation gasoline',
#  'Gasoline type jet fuel', 'Kerosene type jet fuel excl. biofuels',
#  'Other kerosene', 'Gas/diesel oil excl. biofuels', 'Fuel oil', '
   Naphtha',
#  'White spirit & SBP', 'Lubricants', 'Bitumen', 'Paraffin waxes',
#  'Petroleum coke', 'Other oil products', 'Industrial waste',
#  'Municipal waste (renewable)', 'Municipal waste (non-renewable)',
#  'Primary solid biofuels', 'Biogases' 'Biogasoline' 'Biodiesels',
#  'Bio jet kerosene', 'Other liquid biofuels',
#  'Non-specified primary biofuels and waste', 'Charcoal',
#  'Elec/heat output from non-specified manufactured gases',
#  'Heat output from non-specified combustible fuels', 'Nuclear', '
   Hydro',
#  'Geothermal', 'Solar photovoltaics', 'Solar thermal',
#  '"Tide, wave and ocean"', 'Wind', 'Other sources', 'Electricity', '
   Heat',
#  'Total', 'Memo: Renewables']
```

6.3 GOCPI Geographies

This script helped create the geographical subsets for modelling energy regions.

```
# GOCPI_Geographies Structures the geographies into Countries, Cities
   and Continents

# Import useful python packages
# Git reposistory
# https://github.com/CMCD1996/GOCPI.git
# Make more changes from the pull request
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy as sc
import sklearn as skl
import csv as csv
import pathlib
import os

# Very Important Step: Sets directory root for file operations.
source_root = pathlib.Path('/Users/connor/Google Drive/Documents/
   University/Courses/2020/ENGSCI 700A&B/GOCPI/data/Geographies')

# Finds the relevant files needed to create csvs with the relationships
    between cities, countries and continents
# Finds a file within a function
def Find_File(target_root,target_file):
```

```
    for root, dirs, files in os.walk(target_root):
        for name in files:
            if name == target_file:
                f = os.path.abspath(os.path.join(root, name))
    return f

# Find the necessary files for the geography conversions
f1 = Find_File(source_root,"Country and Continent.txt")
f2 = Find_File(source_root,"countries.csv")
f3 = Find_File(source_root,"Cities.csv")
f4 = Find_File(source_root,"geography_set.csv")

# Creates python list for geographies, starting with countries
# Creates an empty list
countries = []

# Creates a geography set
geography_set = [['AFRICA'],
                 ['ASIA'],
                 ['EUROPE'],
                 ['NORTH AMERICA'],
                 ['OCEANIA'],
                 ['SOUTH AMERICA']]
continents = ['AFRICA','ASIA','EUROPE','NORTH AMERICA','OCEANIA','SOUTH
    AMERICA']

# Sets up a for loop to append countries to the continents in the
   geography sets
file = open(f1,'r')
for line in file:
    string = line.split('\n')
    string = string[0].split(',')
    countries.append(string[1].upper())
    for i in range(0,6,1):
        if string[0].upper() == geography_set[i][0]:
            geography_set[i].append(string[1].upper())

# This code block is to inform count
with open(f2, 'w') as file:
    writer = csv.writer(file, delimiter = ',')
    writer.writerow(countries)
file.close()

# Creates array of world cities
data = pd.read_csv(f3)
cities_df = pd.concat([data['city'],data['country'],data['population'
   ]],axis = 1)
cities_df['continent'] = ""
cities_df.dropna(inplace = True)

# Capitalises country and city names
cities_df['country'] = cities_df['country'].str.upper()
cities_df['city'] = cities_df['city'].str.upper()

# Places the continent required in the row
for index, row in cities_df.iterrows():
    for i in range(0,6,1):
        for j in range(0,len(geography_set[i]),1):
```

```
            if geography_set[i][j] == row['country']:
                cities_df.at[index,'continent'] = geography_set[i][0]

# Saves dataframe as new CSV
cities_df.to_csv(f4,index=False)
```

6.4 GOCPI Inputs

This script helped update values in the Excel spreadsheet when developing a standardised modelling process for the TIMES Methodology.

```
# GOCPI_Inputs is a file processing script. This script prepare the
    spreadsheets for VEDA processing to
# be feed into the GAMS Optimisation
# This script was adpated into the GOCPI module

# Import useful python packages
# Git reposistory
# https://github.com/CMCD1996/GOCPI.git
# Make more changes from the pull request
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy as sc
import sklearn as skl
import csv as csv
import openpyxl
import pathlib
import os
from pathlib import Path
from openpyxl import load_workbook

# Very Important Step: Set directory root for file operations.
source_root = Path(
    '/Users/connor/Google Drive/Documents/University/Courses/2020/
    ENGSCI 700A&B/GOCPI/data/Inputs'
)
print(source_root)


# Finds a file within a function
def Find_File(target_root, target_file):
    for root, dirs, files in os.walk(target_root):
        for name in files:
            if name == target_file:
                f = os.path.abspath(os.path.join(root, name))
    return f


# Defines custom functions necessary for excel script processing
# Set_Values updates single cell inputs for the VEDA spreadsheet
def Set_Values(source_root, source_file, source_sheet, source_range,
               updated_value, destination_file):
    from openpyxl import load_workbook
    from pathlib import Path
    # Finds the source file from the assign root directory
    f = Find_File(source_root, source_file)
```

```
    # Performs the workbook manipulation and updates values
    workbook = load_workbook(filename=f)
    sheet = workbook[source_sheet]
    defined_range = workbook.defined_names[source_range]
    split_string = defined_range.attr_text.split('$')
    address = split_string[1] + split_string[2]
    sheet[str(address)].value = updated_value
    # Finds the destination file
    f = Find_File(source_root, destination_file)
    # Saves the updated file
    workbook.save(filename=f)


# Initialises all variables in the System Settings. These are created in arrays and interated through via for loops.

# Book Region_Maps (Number of Regions Base Sheet Mechanics relate to,
# This will be expanded upon depending on the sets of geographies to be included.
# We will begin with two regions (Based off TIMES Demo Model 12)s
REG1 = 'REG1'  # Ideally two selected Regions (New Zealand)
REG2 = 'REG2'  # (Australia)

# Timeslices
SZN1 = "S"  # Summer
SZN2 = "W"  # Winter
DN1 = "D"  # Day
DN2 = "N"  # Night

# Time Periods
StartYear = 2030

# ActivePDef
# This variable defines how split up the forecast period into smaller time intervals
# Pdef-1 is a two period definition (1 Year then 2 years for a total of 3 years)
# Pdef-5 is a 5 period definition of 1,2,5,5,5 year periods respectively.
# Pdef-11 is an 11 period definition of 1,2,5,5,5,5,5,5,5,5,5 year periods respectively.
# Pdef-1,5 and 11 are the only available options at the moment.
APDEF = "Pdef-11"

#Import Settings have been left unchanged in the SysSettings Sheet. See the import
# settings for a proper definition

# Interpolation and Extrapolation Defaults are unchanged as well. See details in the
# System settings spreadsheet if you want to make changes.

# Constants for the modelling process in the modelling sheet
# (TFM_INS)
GDY = StartYear  # Discount Year
Discount = 0.05  # Discount Rate (This discount rate will change depending on the region in question
# Figure out how to vary dicount rates depending on financial inputs)
```

```
94
95 # Fraction of year for season and day/night level (Should change
       depending on the geography)
96 # Determine how to make these changes after you get a baseline model
       running
97 REG_Num_Sum_Days = 175
98 REG_Num_Days = 365
99 REG_Num_Win_Days = (REG_Num_Days - REG_Num_Sum_Days)
100 Frac_REG_Num_Sum_Days = REG_Num_Sum_Days / REG_Num_Days
101 Frac_REG_Num_Win_Days = REG_Num_Win_Days / REG_Num_Days
102
103 Sum_Hours_Per_Day = 12.5
104 Win_Hours_Per_Day = 11.5
105 Hours_Per_Day = 24
106
107 Frac_Sum_Hours_Per_Day = Sum_Hours_Per_Day / (Hours_Per_Day)
108 Frac_Win_Hours_Per_Day = Sum_Hours_Per_Day / (Hours_Per_Day)
109 Frac_Sum_Hours_Per_Night = (1 - Frac_Sum_Hours_Per_Day)
110 Frac_Win_Hours_Per_Night = (1 - Frac_Win_Hours_Per_Day)
111
112 SD_YRFR = Frac_REG_Num_Sum_Days * Frac_Sum_Hours_Per_Day
113 SN_YRFR = Frac_REG_Num_Sum_Days * Frac_Sum_Hours_Per_Night
114 WD_YRFR = Frac_REG_Num_Win_Days * Frac_Win_Hours_Per_Day
115 WN_YRFR = Frac_REG_Num_Win_Days * Frac_Win_Hours_Per_Night
116
117 # Currency for investment decisions underpinning the model
118 CUR = "MEuro05"
119
120 # Default Units (Review and come back to this commodity part of the
       model)
121 # Explicitly Commodity Groups are not required in the modelling process
        at this stage.
122
123 # Creates a function to update the spreadsheet relative to those feed
       in to the function
124 # Inserts the various cells in python as required
125 # Imports the various functions needed for the file
126
127 source_file = "SysSettings.xlsm"
128 source_sheet = "TimePeriods"
129 source_range = "StartYear"
130 updated_value = StartYear
131 destination_file = "SysSettings.xls"
132
133 # Update the StartYear
134 Set_Values(source_root, source_file, source_sheet, source_range,
       updated_value,
135             destination_file)
```

6.5 GOCPI Model Import

This script helped import OseMOSYS models.

```
1 # GOCPI_Model_Import is a file processing script. This script prepares
       the text files from an Excel spreadsheet
2 # for the user defined energy systems model.
3 #
       ###############################################################################
```

```
# This script was adapted into the GOCPI module.
#
    ##############################################################################


# Import useful python packages
# Git reposistory
# https://github.com/CMCD1996/GOCPI.git
# Make more changes from the pull request
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy as sc
import sklearn as skl
import csv as csv
import openpyxl
import pathlib
import os
from pathlib import Path
from openpyxl import load_workbook

# Import custom functions for navigation
import GOCPI as GF
# Import data case for the model

# Beginning of scripting
# Very Important Step: Set directory root for file operations.
root = '/Users/connor/Google Drive/Documents/University/Courses/2020/
    ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI OseMOSYS'
model_roots = Path(root)

# sets strings as excel file names for the model and parameter data.
model_file = 'GOCPI_OseMOSYS_Structure.xlsx'
data_file = 'GOCPI_OseMOSYS_Structure.xlsx'

# Finds the files necessary to create pandas dataframes.
# model = Find_File(model_roots,model_file)
Location = GF.Navigation(model_roots, model_file)
model = Location.Find_File()
print(model)

# data = Find_File(data_file,model_file)
df = pd.read_excel(model, sheet_name='Model')
# Creates a new dataframe based on the variables on the Include column
    values
df_Include = df[df.Include == 'Yes']
df_model = df_Include[['Name']].copy()

# Creates a file location and write the model to a text file
model_txt = 'GOCPI_OseMOSYS_Model.txt'
model_location = os.path.join(model_roots, model_txt)

# Saves the user defined model to a text file
np.savetxt(model_location, df_model.values, fmt='%s')

# Creates array of parameters from select sets and functions
df_Include = df[df.Include == 'Yes']
```

```
df_target_sets = df_Include[df.Type == "Sets"]
df_sets = df_target_sets[['Name']].copy()
df_target_parameters = df_Include[df.Type == "Parameters"]
df_parameters = df_target_parameters[['Name']].copy()

# Import the scenario with all sets and
```

6.6 GOCPI Optimisation

This script helped incorporate IBM optimisation technologies into the package.

```
#
    ################################################################################

# GOCPI_Optimsation runs the optimsation through docplex
#
    ################################################################################


# Imports the necessary python modules
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy as sc
import sklearn as skl
import csv as csv
import openpyxl
import pathlib
import os
from pathlib import Path
from openpyxl import load_workbook
import GOCPI as GF
import cplex as cp
import subprocess as sb
import docplex.mp as dpmp
import tarfile as tf
from ibm_watson_machine_learning import APIClient

#
    ################################################################################

# Processing
#
    ################################################################################

# Initialise Optimisation Class
energy_system_optimisation = GF.Optimisation()
# Use Cplex on the IBM Cloud to create the optimisation techniques.
# Create APIClient to use your cloud platform
# API Key: (Bxhv-kuLYXfle61GiFIbR_uM7n_LA0Ou4X-RrMcgztE0) - IBM Cloud
    Access
apikey = "Bxhv-kuLYXfle61GiFIbR_uM7n_LA0Ou4X-RrMcgztE0"
url = "https://us-south.ml.cloud.ibm.com"
directory = '/Users/connor/Google Drive/Documents/University/Courses
    /2020/ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI OseMOSYS/'
data = 'GOCPI_Data.txt'
model = 'GOCPI_Model.txt'
```

```
output = 'GOCPI.lp'
payload_input = directory + output
payload_output = directory + "GOCPI.csv"
results = directory + "GOCPI_Output.txt"
tar_file = directory + "GOCPI.tar.gz"
csv = "GOCPI.csv"
csv_file = directory + csv
lp_file = directory + output
space_exists = True
deployment_exists = True
create_data_assets = False
string = 'glpsol -m ' + data + ' -d ' + model + '--wlp ' + output

api_wml_credentials = {
    "apikey": apikey,  # User Account API
    #"instance_id":
    #"2dc64ea2-6be8-43d0-b217-ec2a5743e8c9",  # Watson Machine Learning
    "url": url
}

# Initialises client credentials
client = APIClient(api_wml_credentials)

# Create a deployment space and set it
space_name = 'gocpi_deployment_space'
cos_resource_crn = 'crn:v1:bluemix:public:cloud-object-storage:global:a
   /09d7320da1734f7e84aaedf597c37111:83e6751a-cefc-49ce-93de-4
   fbaee7e52af::'
instance_crn = 'crn:v1:bluemix:public:pm-20:us-south:a/09
   d7320da1734f7e84aaedf597c37111:2dc64ea2-6be8-43d0-b217-ec2a5743e8c9
   ::'

metadata = {
    client.spaces.ConfigurationMetaNames.NAME: space_name,
    client.spaces.ConfigurationMetaNames.DESCRIPTION:
    space_name + ' for Deployment ',
    client.spaces.ConfigurationMetaNames.STORAGE: {
        "type": "bmcos_object_storage",
        "resource_crn": cos_resource_crn
    },
    client.spaces.ConfigurationMetaNames.COMPUTE: {
        "name": "existing_instance_id",
        "crn": instance_crn
    }
}
# Set the default spaces based on the outcomess
if space_exists == True:
    client.spaces.list()
    space_id = input('Please input the Space ID: ')
else:
    space = client.spaces.store(meta_props=metadata)
    space_id = client.spaces.get_id(space)

# Set the client space
client.set.default_space(space_id)

# Create input and output data assets
if create_data_assets == True:
```

```
    client.data_assets.create('GOCPI_Energy_System_Lp_File', lp_file)
    client.data_assets.create('GOCPI_Energy_System_CSV_File', csv_file)


# Deploy model files
# Get location of model deployment
# Create  tar file for model deployment
# Reset tarfile function (Source: IBM Watson Machine Learning)
def reset(tarinfo):
    tarinfo.uid = tarinfo.gid = 0
    tarinfo.uname = tarinfo.gname = "root"
    return tarinfo


# Create the tar file
tar = tf.open(tar_file, "w:gz")
tar.add(lp_file, arcname="GOCPI.lp", filter=reset)
tar.close()

# List deployments using python API
print(client.deployments.list())

# Get the list of software available
client.software_specifications.list()
software_name = input("Please Input Software Name: ")
software_spec_uid = client.software_specifications.get_uid_by_name(
    software_name)

# Create the model deployment using the created arc file
energy_system_model_metadata = {
    client.repository.ModelMetaNames.NAME: "Energy System",
    client.repository.ModelMetaNames.DESCRIPTION: "Model for Energy
   System",
    client.repository.ModelMetaNames.TYPE: "do-cplex_12.10",
    client.repository.ModelMetaNames.RUNTIME_UID: "do_12.10",
    client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:
   software_spec_uid
}

energy_system_model_details = client.repository.store_model(
    model=tar_file, meta_props=energy_system_model_metadata)

energy_system_model_uid = client.repository.get_model_uid(
    energy_system_model_details)

# Create deployment
n_nodes = 1

meta_props = {
    client.deployments.ConfigurationMetaNames.NAME:
    "Energy System Deployment " + str(n_nodes),
    client.deployments.ConfigurationMetaNames.DESCRIPTION:
    "Energy System",
    # client.deployments.ConfigurationMetaNames.HARDWARE_SPEC:
    client.deployments.ConfigurationMetaNames.BATCH: {},
    client.deployments.ConfigurationMetaNames.COMPUTE: {
        'name': 'S',
        'nodes': n_nodes
```

```
    }
}

# Test if deployment already exists
if deployment_exists == True:
    client.deployments.list()
    deployment_uid = input('Please input the Deployment UID: ')
else:
    deployment_details = client.deployments.create(energy_system_model_uid,
                                                   meta_props=meta_props)
    deployment_uid = client.deployments.get_uid(deployment_details)

# Designs Payload for deployment
# solve_payload = {
#     client.deployments.DecisionOptimizationMetaNames.SOLVE_PARAMETERS: {
#         'oaas.logAttachmentName': 'log.txt',
#         'oaas.logTailEnabled': 'true',
#         'oaas.resultsFormat': 'JSON'
#     },
#     client.deployments.DecisionOptimizationMetaNames.INPUT_DATA_REFERENCES: [{
#         'id':
#         'GOCPI.lp',
#         'type':
#         's3',
#         'connection': {
#             'endpoint_url':
#             COS_ENDPOINT,
#             'access_key_id':
#             cos_resource_crn['cos_hmac_keys']["access_key_id"],
#             'secret_access_key':
#             cos_resource_crn['cos_hmac_keys']["secret_access_key"]
#         },
#         'location': {
#             'bucket': COS_BUCKET,
#             'path': lp_file
#         }
#     }],
#     client.deployments.DecisionOptimizationMetaNames.OUTPUT_DATA_REFERENCES: [{
#         'id':
#         'solution.json',
#         'type':
#         's3',
#         'connection': {
#             'endpoint_url':
#             url,
#             'access_key_id':
#             cos_resource_crn['cos_hmac_keys']["access_key_id"],
#             'secret_access_key':
#             cos_resource_crn['cos_hmac_keys']["secret_access_key"]
#         },
#         'location': {
#             'bucket': COS_BUCKET,
#             'path': 'solution.json'
```

```
#         }
#     }, {
#         'id':
#         'log.txt',
#         'type':
#         's3',
#         'connection': {
#             'endpoint_url':
#             url,
#             'access_key_id':
#             cos_credentials['cos_hmac_keys']["access_key_id"],
#             'secret_access_key':
#             cos_credentials['cos_hmac_keys']["secret_access_key"]
#         },
#         'location': {
#             'bucket': COS_BUCKET,
#             'path': 'log.txt'
#         }
#     }]
# }
energy_system_payload = {
    client.deployments.DecisionOptimizationMetaNames.SOLVE_PARAMETERS:
    {
        "oaas.logTailEnabled": "true"
    }
    # client.deployments.DecisionOptimizationMetaNames.INPUT_DATA: [{
    #     "id": lp_file
    # }],
    # client.deployments.DecisionOptimizationMetaNames.OUTPUT_DATA: [{
    #     "id":
    #     csv_file
    # }]
}
# job_details = client.deployments.create_job(deployment_uid,
    solve_payload)
# job_uid = client.deployments.get_job_uid(job_details)

# Create jobs for the deployment
# job_details = client.deployments.create_job(deployment_uid,
#                                             energy_system_payload)
# job_uid = client.deployments.get_job_uid(job_details)

# Run job using deployment

# Deletes deployment

# # Find deployment pace ID
# def guid_from_space_name(client, space_name):
#     instance_details = client.service_instance.get_details()
#     space = client.spaces.get_details()
#     return (next(item for item in space['resources']
#                  if item['entity']["name"] == space_name)['metadata
    ']['guid'])

#

# Set the default client space
# instance_details = client.service_instance.get_instance_id()
```

```
# client.set.default_space()
# client.set.default_project()
# print(instance_details)
# client.set.default_space()
# client.set.default_project()
# # Create a data asset to the IBM Cloud

# files = {
#     'Energy Balances 1':
#     '/Users/connor/Google Drive/Documents/University/Courses/2020/ENGSCI 700A&B/GOCPI/data/Energy Balances/IEAWorldEnergyBalances2017A-K.csv',
#     'Energy Balances 2':
#     '/Users/connor/Google Drive/Documents/University/Courses/2020/ENGSCI 700A&B/GOCPI/data/Energy Balances/IEAWorldEnergyBalances2017L-Z.csv'
# }

# data_assets_to_create = ['Energy Balances 1', 'Energy Balances 2']
# created_assets = {}
# for assets in data_assets_to_create:
#     asset_details = client.data_assets.create(name="Energy_System_Test",
#                                               file_path=files[assets])
#     created_assets[assets] = asset_details

# Get information of assets

Optimise = GF.Optimisation()
directory = '/Users/connor/Google Drive/Documents/University/Courses/2020/ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI OseMOSYS/'
data = 'GOCPI_Data.txt'
model = 'GOCPI_Model.txt'
output = 'GOCPI.lp'
results = directory + "GOCPI_Output.txt"
string = 'glpsol -m ' + data + ' -d ' + model + '--wlp ' + output
# os.chdir(directory)
# os.system('conda init bash')
# os.system('conda activate osemosys')

# Solve locally using Cplex
energy_system_cplex = cp.Cplex()
# Read in the model file
output = energy_system_cplex.set_results_stream(None)
output = energy_system_cplex.set_log_stream(None)
# Write the loaded model to the energy system
energy_system_cplex.read(lp_file)
# Solve the model
energy_system_cplex.solve()
# Returns the objective value
objective_value = energy_system_cplex.solution.get_objective_value()
values = energy_system_cplex.solution.get_values()
print(np.size(values))

# Creates a prints model outputs
with cp.Cplex() as c, open(results, "w") as f:
    output = c.set_results_stream(f)
```

```
306     output.write("GOCPI Example")
307 
308 # Creates Docplex example
309 # energy_system_docplex = docplex.cp.model.CpoModel(name="GOCPI_Docplex
        ")
310 energy_system_docplex_lp = dpmp.model_reader.ModelReader.read(
311     lp_file, model_name='GOCPI_Docplex_Lp')
312 
313 mdl = energy_system_docplex_lp.solve(url=url, api=apikey)
314 # print('mdl', mdl)
315 # return_code = sb.call("conda init bash", shell=True)
316 # return_code = sb.call("conda activate osemosys", shell=True)
317 # os.system('conda activate osemosys')
318 # Optimise.create_linear_programme_file(directory, data, model, output)
```

7 OseMOSYS

This section displays the text files formulated to create the lp file. These are formulated using Python-based processing scripts and the GOCPI Energysystems module.

7.1 Model File

```
set YEAR;
set TECHNOLOGY;
set TIMESLICE;
set FUEL;
set EMISSION;
set MODE_OF_OPERATION;
set REGION;
set SEASON;
set DAYTYPE;
set DAILYTIMEBRACKET;
set STORAGE;
param YearSplit{l in TIMESLICE,y in YEAR};
param DiscountRate{r in REGION};
param DaySplit{lh in DAILYTIMEBRACKET,y in YEAR};
param Conversionls{l in TIMESLICE,ls in SEASON};
param Conversionld{l in TIMESLICE,ld in DAYTYPE};
param Conversionlh{l in TIMESLICE,lh in DAILYTIMEBRACKET};
param DaysInDayType{ls in SEASON ,ld in DAYTYPE,y in YEAR};
param TradeRoute{r in REGION,rr in REGION,f in FUEL,y in YEAR};
param DepreciationMethod{r in REGION};
param SpecifiedAnnualDemand{r in REGION,f in FUEL,y in YEAR};
param SpecifiedDemandProfile{r in REGION,f in FUEL,l in TIMESLICE,y in
    YEAR};
param AccumulatedAnnualDemand{r in REGION,f in FUEL,y in YEAR};
param CapacityToActivityUnit{r in REGION,t in TECHNOLOGY};
param CapacityFactor{r in REGION,t in TECHNOLOGY,l in TIMESLICE,y in
    YEAR};
param AvailabilityFactor{r in REGION,t in TECHNOLOGY,y in YEAR};
param OperationalLife{r in REGION,t in TECHNOLOGY};
param ResidualCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
param InputActivityRatio{r in REGION,t in TECHNOLOGY,f in FUEL,m in
    MODE_OF_OPERATION,y in YEAR};
param OutputActivityRatio{r in REGION,t in TECHNOLOGY,f in FUEL,m in
    MODE_OF_OPERATION,y in YEAR};
param CapitalCost{r in REGION,t in TECHNOLOGY,y in YEAR};
param VariableCost{r in REGION,t in TECHNOLOGY,m in MODE_OF_OPERATION,y
     in YEAR};
param FixedCost{r in REGION,t in TECHNOLOGY,y in YEAR};
param TechnologyToStorage{r in REGION,t in TECHNOLOGY,s in STORAGE,m in
     MODE_OF_OPERATION};
param TechnologyFromStorage{r in REGION,t in TECHNOLOGY,s in STORAGE,m
    in MODE_OF_OPERATION};
param StorageLevelStart{r in REGION,s in STORAGE};
param StorageMaxChargeRate{r in REGION,s in STORAGE};
param StorageMaxDischargeRate{r in REGION,s in STORAGE};
param MinStorageCharge{r in REGION,s in STORAGE,y in YEAR};
param OperationalLifeStorage{r in REGION, s in STORAGE};
param CapitalCostStorage{r in REGION,s in STORAGE,y in YEAR};
param ResidualStorageCapacity{r in REGION,s in STORAGE,y in YEAR};
```

```
param CapacityOfOneTechnologyUnit{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalAnnualMaxCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalAnnualMinCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalAnnualMaxCapacityInvestment{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalAnnualMinCapacityInvestment{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalTechnologyAnnualActivityUpperLimit{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalTechnologyAnnualActivityLowerLimit{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalTechnologyModelPeriodActivityUpperLimit{r in REGION,t in TECHNOLOGY};
param TotalTechnologyModelPeriodActivityLowerLimit{r in REGION,t in TECHNOLOGY};
param ReserveMarginTagTechnology{r in REGION,t in TECHNOLOGY,y in YEAR};
param ReserveMarginTagFuel{r in REGION,f in FUEL,y in YEAR};
param ReserveMargin{r in REGION,y in YEAR};
param RETagTechnology{r in REGION,t in TECHNOLOGY,y in YEAR};
param RETagFuel{r in REGION,f in FUEL,y in YEAR};
param REMinProductionTarget{r in REGION,y in YEAR};
param EmissionActivityRatio{r in REGION,t in TECHNOLOGY,e in EMISSION,m in MODE_OF_OPERATION,y in YEAR};
param EmissionsPenalty{r in REGION,e in EMISSION,y in YEAR};
param AnnualExogenousEmission{r in REGION,e in EMISSION,y in YEAR};
param AnnualEmissionLimit{r in REGION,e in EMISSION,y in YEAR};
param ModelPeriodExogenousEmission{r in REGION,e in EMISSION};
param ModelPeriodEmissionLimit{r in REGION,e in EMISSION};
var RateOfDemand{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
var Demand{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR}>=0;
var RateOfStorageCharge{r in REGION,s in STORAGE,ls in SEASON,ld in DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
var RateOfStorageDischarge{r in REGION,s in STORAGE,ls in SEASON,ld in DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
var NetChargeWithinYear{r in REGION,s in STORAGE,ls in SEASON,ld in DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
var NetChargeWithinDay{r in REGION,s in STORAGE,ls in SEASON,ld in DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
var StorageLevelYearStart{r in REGION,s in STORAGE,y in YEAR}>=0;
var StorageLevelYearFinish{r in REGION,s in STORAGE,y in YEAR}>=0;
var StorageLevelSeasonStart{r in REGION,s in STORAGE,ls in SEASON,y in YEAR}>=0;
var StorageLevelDayTypeStart{r in REGION,s in STORAGE,ls in SEASON,ld in DAYTYPE,y in YEAR}>=0;
var StorageLevelDayTypeFinish{r in REGION,s in STORAGE,ls in SEASON,ld in DAYTYPE,y in YEAR}>=0;
var StorageLowerLimit{r in REGION,s in STORAGE,y in YEAR}>=0;
var StorageUpperLimit{r in REGION,s in STORAGE,y in YEAR}>=0;
var AccumulatedNewStorageCapacity{r in REGION,s in STORAGE,y in YEAR}>=0;
var NewStorageCapacity{r in REGION,s in STORAGE,y in YEAR}>=0;
var CapitalInvestmentStorage{r in REGION,s in STORAGE,y in YEAR}>=0;
var DiscountedCapitalInvestmentStorage{r in REGION,s in STORAGE,y in YEAR}>=0;
var SalvageValueStorage{r in REGION,s in STORAGE,y in YEAR}>=0;
```

```
82 var DiscountedSalvageValueStorage{r in REGION,s in STORAGE,y in YEAR
   }>=0;
83 var TotalDiscountedStorageCost{r in REGION,s in STORAGE,y in YEAR}>=0;
84 var NumberOfNewTechnologyUnits{r in REGION,t in TECHNOLOGY,y in YEAR
   }>=0, integer;
85 var NewCapacity{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
86 var AccumulatedNewCapacity{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
87 var TotalCapacityAnnual{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
88 var RateOfActivity{r in REGION,l in TIMESLICE,t in TECHNOLOGY,m in
   MODE_OF_OPERATION,y in YEAR} >=0;
89 var RateOfTotalActivity{r in REGION,t in TECHNOLOGY,l in TIMESLICE,y in
    YEAR} >=0;
90 var TotalTechnologyAnnualActivity{r in REGION,t in TECHNOLOGY,y in YEAR
   } >=0;
91 var TotalAnnualTechnologyActivityByMode{r in REGION,t in TECHNOLOGY,m
   in MODE_OF_OPERATION,y in YEAR} >=0;
92 var TotalTechnologyModelPeriodActivity{r in REGION,t in TECHNOLOGY};
93 var RateOfProductionByTechnologyByMode{r in REGION,l in TIMESLICE,t in
   TECHNOLOGY,m in MODE_OF_OPERATION,f in FUEL,y in YEAR}>=0;
94 var RateOfProductionByTechnology{r in REGION,l in TIMESLICE,t in
   TECHNOLOGY,f in FUEL,y in YEAR} >=0;
95 var ProductionByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f
    in FUEL,y in YEAR} >=0;
96 var ProductionByTechnologyAnnual{r in REGION,t in TECHNOLOGY,f in FUEL,
   y in YEAR} >=0;
97 var RateOfProduction{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR
   }>=0;
98 var Production{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
99 var RateOfUseByTechnologyByMode{r in REGION,l in TIMESLICE,t in
   TECHNOLOGY,m in MODE_OF_OPERATION,f in FUEL,y in YEAR} >=0;
100 var RateOfUseByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f
   in FUEL,y in YEAR} >=0;
101 var UseByTechnologyAnnual{r in REGION,t in TECHNOLOGY,f in FUEL,y in
   YEAR} >=0;
102 var UseByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f in
   FUEL,y in YEAR} >=0;
103 var RateOfUse{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR}>=0;
104 var Use{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
105 var Trade{r in REGION,rr in REGION,l in TIMESLICE,f in FUEL,y in YEAR};
106 var TradeAnnual{r in REGION,rr in REGION,f in FUEL,y in YEAR};
107 var ProductionAnnual{r in REGION,f in FUEL,y in YEAR} >=0;
108 var UseAnnual{r in REGION,f in FUEL,y in YEAR}>=0;
109 var CapitalInvestment{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
110 var DiscountedCapitalInvestment{r in REGION,t in TECHNOLOGY,y in YEAR}
   >=0;
111 var SalvageValue{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
112 var DiscountedSalvageValue{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
113 var OperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
114 var DiscountedOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
115 var AnnualVariableOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR}
   >=0;
116 var AnnualFixedOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR}
   >=0;
117 var TotalDiscountedCostByTechnology{r in REGION,t in TECHNOLOGY,y in
   YEAR} >=0;
118 var TotalDiscountedCost{r in REGION,y in YEAR} >=0;
119 var ModelPeriodCostByRegion{r in REGION}>=0;
120 var TotalCapacityInReserveMargin{r in REGION,y in YEAR} >=0;
```

```
121 var DemandNeedingReserveMargin{r in REGION,l in TIMESLICE,y in YEAR}
    >=0;
122 var TotalREProductionAnnual{r in REGION,y in YEAR};
123 var RETotalProductionOfTargetFuelAnnual{r in REGION,y in YEAR};
124 var AnnualTechnologyEmissionByMode{r in REGION,t in TECHNOLOGY,e in
    EMISSION,m in MODE_OF_OPERATION,y in YEAR} >=0;
125 var AnnualTechnologyEmission{r in REGION,t in TECHNOLOGY,e in EMISSION,
    y in YEAR} >=0;
126 var AnnualTechnologyEmissionPenaltyByEmission{r in REGION,t in
    TECHNOLOGY,e in EMISSION,y in YEAR} >=0;
127 var AnnualTechnologyEmissionsPenalty{r in REGION,t in TECHNOLOGY,y in
    YEAR} >=0;
128 var DiscountedTechnologyEmissionsPenalty{r in REGION,t in TECHNOLOGY,y
    in YEAR} >=0;
129 var AnnualEmissions{r in REGION,e in EMISSION,y in YEAR} >=0;
130 var ModelPeriodEmissions{r in REGION,e in EMISSION} >=0;
131 minimize cost: sum{r in REGION, y in YEAR} TotalDiscountedCost[r,y];
132 s.t. EQ_SpecifiedDemand{r in REGION, l in TIMESLICE, f in FUEL, y in
    YEAR}: SpecifiedAnnualDemand[r,f,y]*SpecifiedDemandProfile[r,f,l,y]
    / YearSplit[l,y]=RateOfDemand[r,l,f,y];
133 s.t. CAa1_TotalNewCapacity{r in REGION, t in TECHNOLOGY, y in YEAR}:
    AccumulatedNewCapacity[r,t,y] = sum{yy in YEAR: y-yy <
    OperationalLife[r,t] && y-yy>=0} NewCapacity[r,t,yy];
134 s.t. CAa2_TotalAnnualCapacity{r in REGION, t in TECHNOLOGY, y in YEAR}:
     AccumulatedNewCapacity[r,t,y]+ ResidualCapacity[r,t,y] =
    TotalCapacityAnnual[r,t,y];
135 s.t. CAa3_TotalActivityOfEachTechnology{r in REGION, t in TECHNOLOGY, l
     in TIMESLICE, y in YEAR}: sum{m in MODE_OF_OPERATION}
    RateOfActivity[r,l,t,m,y] = RateOfTotalActivity[r,t,l,y];
136 s.t. CAa4_Constraint_Capacity{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, y in YEAR}: RateOfTotalActivity[r,t,l,y] <=
    TotalCapacityAnnual[r,t,y] * CapacityFactor[r,t,l,y]*
    CapacityToActivityUnit[r,t];
137 s.t. CAa5_TotalNewCapacity{r in REGION, t in TECHNOLOGY, y in YEAR:
    CapacityOfOneTechnologyUnit[r,t,y]<>0}: CapacityOfOneTechnologyUnit[
    r,t,y]*NumberOfNewTechnologyUnits[r,t,y] = NewCapacity[r,t,y];
138 s.t. CAb1_PlannedMaintenance{r in REGION, t in TECHNOLOGY, y in YEAR}:
    sum{l in TIMESLICE} RateOfTotalActivity[r,t,l,y]*YearSplit[l,y] <=
    sum{l in TIMESLICE} (TotalCapacityAnnual[r,t,y]*CapacityFactor[r,t,l
    ,y]*YearSplit[l,y])* AvailabilityFactor[r,t,y]*
    CapacityToActivityUnit[r,t];
139 s.t. EBa1_RateOfFuelProduction1{r in REGION, l in TIMESLICE, f in FUEL,
     t in TECHNOLOGY, m in MODE_OF_OPERATION, y in YEAR:
    OutputActivityRatio[r,t,f,m,y] <>0}: RateOfActivity[r,l,t,m,y]*
    OutputActivityRatio[r,t,f,m,y]  = RateOfProductionByTechnologyByMode
    [r,l,t,m,f,y];
140 s.t. EBa2_RateOfFuelProduction2{r in REGION, l in TIMESLICE, f in FUEL,
     t in TECHNOLOGY, y in YEAR}: sum{m in MODE_OF_OPERATION:
    OutputActivityRatio[r,t,f,m,y] <>0}
    RateOfProductionByTechnologyByMode[r,l,t,m,f,y] =
    RateOfProductionByTechnology[r,l,t,f,y];
141 s.t. EBa3_RateOfFuelProduction3{r in REGION, l in TIMESLICE, f in FUEL,
     y in YEAR}: sum{t in TECHNOLOGY} RateOfProductionByTechnology[r,l,t
    ,f,y]  =  RateOfProduction[r,l,f,y];
142 s.t. EBa4_RateOfFuelUse1{r in REGION, l in TIMESLICE, f in FUEL, t in
    TECHNOLOGY, m in MODE_OF_OPERATION, y in YEAR: InputActivityRatio[r,
    t,f,m,y]<>0}: RateOfActivity[r,l,t,m,y]*InputActivityRatio[r,t,f,m,y
    ]  = RateOfUseByTechnologyByMode[r,l,t,m,f,y];
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143 s.t. EBa5_RateOfFuelUse2{r in REGION, l in TIMESLICE, f in FUEL, t in
    TECHNOLOGY, y in YEAR}: sum{m in MODE_OF_OPERATION:
    InputActivityRatio[r,t,f,m,y]<>0} RateOfUseByTechnologyByMode[r,l,t,
    m,f,y] = RateOfUseByTechnology[r,l,t,f,y];
144 s.t. EBa6_RateOfFuelUse3{r in REGION, l in TIMESLICE, f in FUEL, y in
    YEAR}: sum{t in TECHNOLOGY} RateOfUseByTechnology[r,l,t,f,y]  =
    RateOfUse[r,l,f,y];
145 s.t. EBa7_EnergyBalanceEachTS1{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfProduction[r,l,f,y]*YearSplit[l,y] = Production[r,
    l,f,y];
146 s.t. EBa8_EnergyBalanceEachTS2{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfUse[r,l,f,y]*YearSplit[l,y] = Use[r,l,f,y];
147 s.t. EBa9_EnergyBalanceEachTS3{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfDemand[r,l,f,y]*YearSplit[l,y] = Demand[r,l,f,y];
148 s.t. EBa10_EnergyBalanceEachTS4{r in REGION, rr in REGION, l in
    TIMESLICE, f in FUEL, y in YEAR}: Trade[r,rr,l,f,y] = -Trade[rr,r,l,
    f,y];
149 s.t. EBa11_EnergyBalanceEachTS5{r in REGION, l in TIMESLICE, f in FUEL,
     y in YEAR}: Production[r,l,f,y] >= Demand[r,l,f,y] + Use[r,l,f,y] +
     sum{rr in REGION} Trade[r,rr,l,f,y]*TradeRoute[r,rr,f,y];
150 s.t. EBb1_EnergyBalanceEachYear1{r in REGION, f in FUEL, y in YEAR}:
    sum{l in TIMESLICE} Production[r,l,f,y] = ProductionAnnual[r,f,y];
151 s.t. EBb2_EnergyBalanceEachYear2{r in REGION, f in FUEL, y in YEAR}:
    sum{l in TIMESLICE} Use[r,l,f,y] = UseAnnual[r,f,y];
152 s.t. EBb3_EnergyBalanceEachYear3{r in REGION, rr in REGION, f in FUEL,
    y in YEAR}: sum{l in TIMESLICE} Trade[r,rr,l,f,y] = TradeAnnual[r,rr
    ,f,y];
153 s.t. EBb4_EnergyBalanceEachYear4{r in REGION, f in FUEL, y in YEAR}:
    ProductionAnnual[r,f,y] >= UseAnnual[r,f,y] + sum{rr in REGION}
    TradeAnnual[r,rr,f,y]*TradeRoute[r,rr,f,y] + AccumulatedAnnualDemand
    [r,f,y];
154 s.t. Acc1_FuelProductionByTechnology{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, f in FUEL, y in YEAR}: RateOfProductionByTechnology[r,l,
    t,f,y] * YearSplit[l,y] = ProductionByTechnology[r,l,t,f,y];
155 s.t. Acc2_FuelUseByTechnology{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, f in FUEL, y in YEAR}: RateOfUseByTechnology[r,l,t,f,y]
    * YearSplit[l,y] = UseByTechnology[r,l,t,f,y];
156 s.t. Acc3_AverageAnnualRateOfActivity{r in REGION, t in TECHNOLOGY, m
    in MODE_OF_OPERATION, y in YEAR}: sum{l in TIMESLICE} RateOfActivity
    [r,l,t,m,y]*YearSplit[l,y] = TotalAnnualTechnologyActivityByMode[r,t
    ,m,y];
157 s.t. Acc4_ModelPeriodCostByRegion{r in REGION}: sum{y in YEAR}
    TotalDiscountedCost[r,y] = ModelPeriodCostByRegion[r];
158 s.t. S1_RateOfStorageCharge{r in REGION, s in STORAGE, ls in SEASON, ld
     in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{t in TECHNOLOGY
    , m in MODE_OF_OPERATION, l in TIMESLICE:TechnologyToStorage[r,t,s,m
    ]>0} RateOfActivity[r,l,t,m,y] * TechnologyToStorage[r,t,s,m] *
    Conversionls[l,ls] * Conversionld[l,ld] * Conversionlh[l,lh] =
    RateOfStorageCharge[r,s,ls,ld,lh,y];
159 s.t. S2_RateOfStorageDischarge{r in REGION, s in STORAGE, ls in SEASON,
     ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{t in
    TECHNOLOGY, m in MODE_OF_OPERATION, l in TIMESLICE:
    TechnologyFromStorage[r,t,s,m]>0} RateOfActivity[r,l,t,m,y] *
    TechnologyFromStorage[r,t,s,m] * Conversionls[l,ls] * Conversionld[l
    ,ld] * Conversionlh[l,lh] = RateOfStorageDischarge[r,s,ls,ld,lh,y];
160 s.t. S3_NetChargeWithinYear{r in REGION, s in STORAGE, ls in SEASON, ld
     in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{l in TIMESLICE:
    Conversionls[l,ls]>0&&Conversionld[l,ld]>0&&Conversionlh[l,lh]>0}  (
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    RateOfStorageCharge[r,s,ls,ld,lh,y] - RateOfStorageDischarge[r,s,ls,
    ld,lh,y]) * YearSplit[l,y] * Conversionls[l,ls] * Conversionld[l,ld]
     * Conversionlh[l,lh] = NetChargeWithinYear[r,s,ls,ld,lh,y];
161 s.t. S4_NetChargeWithinDay{r in REGION, s in STORAGE, ls in SEASON, ld
    in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: (RateOfStorageCharge
    [r,s,ls,ld,lh,y] - RateOfStorageDischarge[r,s,ls,ld,lh,y]) *
    DaySplit[lh,y] = NetChargeWithinDay[r,s,ls,ld,lh,y];
162 s.t. S5_and_S6_StorageLevelYearStart{r in REGION, s in STORAGE, y in
    YEAR}: if y = min{yy in YEAR} min(yy) then StorageLevelStart[r,s]
    else StorageLevelYearStart[r,s,y-1] + sum{ls in SEASON, ld in
    DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r,s,ls,ld,lh,y
    -1] = StorageLevelYearStart[r,s,y];
163 s.t. S7_and_S8_StorageLevelYearFinish{r in REGION, s in STORAGE, y in
    YEAR}: if y < max{yy in YEAR} max(yy) then StorageLevelYearStart[r,s
    ,y+1] else StorageLevelYearStart[r,s,y] + sum{ls in SEASON, ld in
    DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r,s,ls,ld,lh,y]
     = StorageLevelYearFinish[r,s,y];
164 s.t. S9_and_S10_StorageLevelSeasonStart{r in REGION, s in STORAGE, ls
    in SEASON, y in YEAR}: if ls = min{lsls in SEASON} min(lsls) then
    StorageLevelYearStart[r,s,y] else StorageLevelSeasonStart[r,s,ls-1,y
    ] + sum{ld in DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r
    ,s,ls-1,ld,lh,y] = StorageLevelSeasonStart[r,s,ls,y];
165 s.t. S11_and_S12_StorageLevelDayTypeStart{r in REGION, s in STORAGE, ls
     in SEASON, ld in DAYTYPE, y in YEAR}: if ld = min{ldld in DAYTYPE}
    min(ldld) then StorageLevelSeasonStart[r,s,ls,y] else
    StorageLevelDayTypeStart[r,s,ls,ld-1,y] + sum{lh in DAILYTIMEBRACKET
    } NetChargeWithinDay[r,s,ls,ld-1,lh,y] * DaysInDayType[ls,ld-1,y] =
    StorageLevelDayTypeStart[r,s,ls,ld,y];
166 s.t. S13_and_S14_and_S15_StorageLevelDayTypeFinish{r in REGION, s in
    STORAGE, ls in SEASON, ld in DAYTYPE, y in YEAR}:  if ls = max{lsls
    in SEASON} max(lsls) && ld = max{ldld in DAYTYPE} max(ldld) then
    StorageLevelYearFinish[r,s,y] else if ld = max{ldld in DAYTYPE} max(
    ldld) then StorageLevelSeasonStart[r,s,ls+1,y] else
    StorageLevelDayTypeFinish[r,s,ls,ld+1,y] - sum{lh in
    DAILYTIMEBRACKET} NetChargeWithinDay[r,s,ls,ld+1,lh,y] *
    DaysInDayType[ls,ld+1,y] = StorageLevelDayTypeFinish[r,s,ls,ld,y];
167 s.t.
    SC1_LowerLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInFirstWeekCons
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: 0 <= (StorageLevelDayTypeStart[r,s,ls,
    ld,y]+sum{lhlh in DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s
    ,ls,ld,lhlh,y])-StorageLowerLimit[r,s,y];
168 s.t.
    SC1_UpperLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInFirstWeekCons
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: (StorageLevelDayTypeStart[r,s,ls,ld,y
    ]+sum{lhlh in DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s,ls,
    ld,lhlh,y])-StorageUpperLimit[r,s,y] <= 0;
169 s.t.
    SC2_LowerLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInFirstWeekConstraint
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: 0 <= if ld > min{ldld in DAYTYPE} min(
    ldld) then (StorageLevelDayTypeStart[r,s,ls,ld,y]-sum{lhlh in
    DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[r,s,ls,ld-1,lhlh,y])-
    StorageLowerLimit[r,s,y];
170 s.t.
    SC2_UpperLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInFirstWeekConstraint
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
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    DAILYTIMEBRACKET, y in YEAR}: if ld > min{ldld in DAYTYPE} min(ldld)
     then (StorageLevelDayTypeStart[r,s,ls,ld,y]-sum{lhlh in
    DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[r,s,ls,ld-1,lhlh,y])-
    StorageUpperLimit[r,s,y] <= 0;
171 s.t.
    SC3_LowerLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInLastWeekConstraint
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: 0 <= (StorageLevelDayTypeFinish[r,s,ls
    ,ld,y] - sum{lhlh in DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[
    r,s,ls,ld,lhlh,y])-StorageLowerLimit[r,s,y];
172 s.t.
    SC3_UpperLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInLastWeekConstraint
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: (StorageLevelDayTypeFinish[r,s,ls,ld,y
    ] - sum{lhlh in DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[r,s,
    ls,ld,lhlh,y])-StorageUpperLimit[r,s,y] <= 0;
173 s.t.
    SC4_LowerLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInLastWeekCons
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: 0 <= if ld > min{ldld in DAYTYPE} min(
    ldld) then (StorageLevelDayTypeFinish[r,s,ls,ld-1,y]+sum{lhlh in
    DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s,ls,ld,lhlh,y])-
    StorageLowerLimit[r,s,y];
174 s.t.
    SC4_UpperLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInLastWeekCons
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: if ld > min{ldld in DAYTYPE} min(ldld)
     then (StorageLevelDayTypeFinish[r,s,ls,ld-1,y]+sum{lhlh in
    DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s,ls,ld,lhlh,y])-
    StorageUpperLimit[r,s,y] <= 0;
175 s.t. SC5_MaxChargeConstraint{r in REGION, s in STORAGE, ls in SEASON,
    ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}:
    RateOfStorageCharge[r,s,ls,ld,lh,y] <= StorageMaxChargeRate[r,s];
176 s.t. SC6_MaxDischargeConstraint{r in REGION, s in STORAGE, ls in SEASON
    , ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}:
    RateOfStorageDischarge[r,s,ls,ld,lh,y] <= StorageMaxDischargeRate[r,
    s];
177 s.t. SI1_StorageUpperLimit{r in REGION, s in STORAGE, y in YEAR}:
    AccumulatedNewStorageCapacity[r,s,y]+ResidualStorageCapacity[r,s,y]
    = StorageUpperLimit[r,s,y];
178 s.t. SI2_StorageLowerLimit{r in REGION, s in STORAGE, y in YEAR}:
    MinStorageCharge[r,s,y]*StorageUpperLimit[r,s,y] = StorageLowerLimit
    [r,s,y];
179 s.t. SI3_TotalNewStorage{r in REGION, s in STORAGE, y in YEAR}: sum{yy
    in YEAR: y-yy < OperationalLifeStorage[r,s] && y-yy>=0}
    NewStorageCapacity[r,s,yy]=AccumulatedNewStorageCapacity[r,s,y];
180 s.t. SI4_UndiscountedCapitalInvestmentStorage{r in REGION, s in STORAGE
    , y in YEAR}: CapitalCostStorage[r,s,y] * NewStorageCapacity[r,s,y]
    = CapitalInvestmentStorage[r,s,y];
181 s.t. SI5_DiscountingCapitalInvestmentStorage{r in REGION, s in STORAGE,
     y in YEAR}: CapitalInvestmentStorage[r,s,y]/((1+DiscountRate[r])^(y
    -min{yy in YEAR} min(yy))) = DiscountedCapitalInvestmentStorage[r,s,
    y];
182 s.t. SI6_SalvageValueStorageAtEndOfPeriod1{r in REGION, s in STORAGE, y
     in YEAR: (y+OperationalLifeStorage[r,s]-1) <= (max{yy in YEAR} max(
    yy))}: 0 = SalvageValueStorage[r,s,y];
183 s.t. SI7_SalvageValueStorageAtEndOfPeriod2{r in REGION, s in STORAGE, y
     in YEAR: (DepreciationMethod[r]=1 && (y+OperationalLifeStorage[r,s
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    ]-1) > (max{yy in YEAR} max(yy)) && DiscountRate[r]=0) || (
    DepreciationMethod[r]=2 && (y+OperationalLifeStorage[r,s]-1) > (max{
    yy in YEAR} max(yy)))}: CapitalInvestmentStorage[r,s,y]*(1-(max{yy
    in YEAR} max(yy) - y+1)/OperationalLifeStorage[r,s]) =
    SalvageValueStorage[r,s,y];
184 s.t. SI8_SalvageValueStorageAtEndOfPeriod3{r in REGION, s in STORAGE, y
     in YEAR: DepreciationMethod[r]=1 && (y+OperationalLifeStorage[r,s
    ]-1) > (max{yy in YEAR} max(yy)) && DiscountRate[r]>0}:
    CapitalInvestmentStorage[r,s,y]*(1-(((1+DiscountRate[r])^(max{yy in
    YEAR} max(yy) - y+1)-1)/((1+DiscountRate[r])^OperationalLifeStorage[
    r,s]-1))) = SalvageValueStorage[r,s,y];
185 s.t. SI9_SalvageValueStorageDiscountedToStartYear{r in REGION, s in
    STORAGE, y in YEAR}: SalvageValueStorage[r,s,y]/((1+DiscountRate[r])
    ^(max{yy in YEAR} max(yy)-min{yy in YEAR} min(yy)+1)) =
    DiscountedSalvageValueStorage[r,s,y];
186 s.t. SI10_TotalDiscountedCostByStorage{r in REGION, s in STORAGE, y in
    YEAR}: DiscountedCapitalInvestmentStorage[r,s,y]-
    DiscountedSalvageValueStorage[r,s,y] = TotalDiscountedStorageCost[r,
    s,y];
187 s.t. CC1_UndiscountedCapitalInvestment{r in REGION, t in TECHNOLOGY, y
    in YEAR}: CapitalCost[r,t,y] * NewCapacity[r,t,y] =
    CapitalInvestment[r,t,y];
188 s.t. CC2_DiscountingCapitalInvestment{r in REGION, t in TECHNOLOGY, y
    in YEAR}: CapitalInvestment[r,t,y]/((1+DiscountRate[r])^(y-min{yy in
     YEAR} min(yy))) = DiscountedCapitalInvestment[r,t,y];
189 s.t. SV1_SalvageValueAtEndOfPeriod1{r in REGION, t in TECHNOLOGY, y in
    YEAR: DepreciationMethod[r]=1 && (y + OperationalLife[r,t]-1) > (max
    {yy in YEAR} max(yy)) && DiscountRate[r]>0}: SalvageValue[r,t,y] =
    CapitalCost[r,t,y]*NewCapacity[r,t,y]*(1-(((1+DiscountRate[r])^(max{
    yy in YEAR} max(yy) - y+1)-1)/((1+DiscountRate[r])^OperationalLife[r
    ,t]-1)));
190 s.t. SV2_SalvageValueAtEndOfPeriod2{r in REGION, t in TECHNOLOGY, y in
    YEAR: (DepreciationMethod[r]=1 && (y + OperationalLife[r,t]-1) > (
    max{yy in YEAR} max(yy)) && DiscountRate[r]=0) || (
    DepreciationMethod[r]=2 && (y + OperationalLife[r,t]-1) > (max{yy in
     YEAR} max(yy)))}: SalvageValue[r,t,y] = CapitalCost[r,t,y]*
    NewCapacity[r,t,y]*(1-(max{yy in YEAR} max(yy) - y+1)/
    OperationalLife[r,t]);
191 s.t. SV3_SalvageValueAtEndOfPeriod3{r in REGION, t in TECHNOLOGY, y in
    YEAR: (y + OperationalLife[r,t]-1) <= (max{yy in YEAR} max(yy))}:
    SalvageValue[r,t,y] = 0;
192 s.t. SV4_SalvageValueDiscountedToStartYear{r in REGION, t in TECHNOLOGY
    , y in YEAR}: DiscountedSalvageValue[r,t,y] = SalvageValue[r,t,y
    ]/((1+DiscountRate[r])^(1+max{yy in YEAR} max(yy)-min{yy in YEAR}
    min(yy)));
193 s.t. OC1_OperatingCostsVariable{r in REGION, t in TECHNOLOGY, l in
    TIMESLICE, y in YEAR}: sum{m in MODE_OF_OPERATION}
    TotalAnnualTechnologyActivityByMode[r,t,m,y]*VariableCost[r,t,m,y] =
     AnnualVariableOperatingCost[r,t,y];
194 s.t. OC2_OperatingCostsFixedAnnual{r in REGION, t in TECHNOLOGY, y in
    YEAR}: TotalCapacityAnnual[r,t,y]*FixedCost[r,t,y] =
    AnnualFixedOperatingCost[r,t,y];
195 s.t. OC3_OperatingCostsTotalAnnual{r in REGION, t in TECHNOLOGY, y in
    YEAR}: AnnualFixedOperatingCost[r,t,y]+AnnualVariableOperatingCost[r
    ,t,y] = OperatingCost[r,t,y];
196 s.t. OC4_DiscountedOperatingCostsTotalAnnual{r in REGION, t in
    TECHNOLOGY, y in YEAR}: OperatingCost[r,t,y]/((1+DiscountRate[r])^(y
    -min{yy in YEAR} min(yy)+0.5)) = DiscountedOperatingCost[r,t,y];
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197 s.t. TDC1_TotalDiscountedCostByTechnology{r in REGION, t in TECHNOLOGY,
        y in YEAR}: DiscountedOperatingCost[r,t,y]+
    DiscountedCapitalInvestment[r,t,y]+
    DiscountedTechnologyEmissionsPenalty[r,t,y]-DiscountedSalvageValue[r
    ,t,y] = TotalDiscountedCostByTechnology[r,t,y];
198 s.t. TDC2_TotalDiscountedCost{r in REGION, y in YEAR}: sum{t in
    TECHNOLOGY} TotalDiscountedCostByTechnology[r,t,y]+sum{s in STORAGE}
     TotalDiscountedStorageCost[r,s,y] = TotalDiscountedCost[r,y];
199 s.t. TCC1_TotalAnnualMaxCapacityConstraint{r in REGION, t in TECHNOLOGY
    , y in YEAR}: TotalCapacityAnnual[r,t,y] <= TotalAnnualMaxCapacity[r
    ,t,y];
200 s.t. TCC2_TotalAnnualMinCapacityConstraint{r in REGION, t in TECHNOLOGY
    , y in YEAR: TotalAnnualMinCapacity[r,t,y]>0}: TotalCapacityAnnual[r
    ,t,y] >= TotalAnnualMinCapacity[r,t,y];
201 s.t. NCC1_TotalAnnualMaxNewCapacityConstraint{r in REGION, t in
    TECHNOLOGY, y in YEAR}: NewCapacity[r,t,y] <=
    TotalAnnualMaxCapacityInvestment[r,t,y];
202 s.t. NCC2_TotalAnnualMinNewCapacityConstraint{r in REGION, t in
    TECHNOLOGY, y in YEAR: TotalAnnualMinCapacityInvestment[r,t,y]>0}:
    NewCapacity[r,t,y] >= TotalAnnualMinCapacityInvestment[r,t,y];
203 s.t. AAC1_TotalAnnualTechnologyActivity{r in REGION, t in TECHNOLOGY, y
     in YEAR}: sum{l in TIMESLICE} RateOfTotalActivity[r,t,l,y]*
    YearSplit[l,y] = TotalTechnologyAnnualActivity[r,t,y];
204 s.t. AAC2_TotalAnnualTechnologyActivityUpperLimit{r in REGION, t in
    TECHNOLOGY, y in YEAR}: TotalTechnologyAnnualActivity[r,t,y] <=
    TotalTechnologyAnnualActivityUpperLimit[r,t,y] ;
205 s.t. AAC3_TotalAnnualTechnologyActivityLowerLimit{r in REGION, t in
    TECHNOLOGY, y in YEAR: TotalTechnologyAnnualActivityLowerLimit[r,t,y
    ]>0}: TotalTechnologyAnnualActivity[r,t,y] >=
    TotalTechnologyAnnualActivityLowerLimit[r,t,y];
206 s.t. TAC1_TotalModelHorizonTechnologyActivity{r in REGION, t in
    TECHNOLOGY}: sum{y in YEAR} TotalTechnologyAnnualActivity[r,t,y] =
    TotalTechnologyModelPeriodActivity[r,t];
207 s.t. TAC2_TotalModelHorizonTechnologyActivityUpperLimit{r in REGION, t
    in TECHNOLOGY: TotalTechnologyModelPeriodActivityUpperLimit[r,t]>0}:
     TotalTechnologyModelPeriodActivity[r,t] <=
    TotalTechnologyModelPeriodActivityUpperLimit[r,t] ;
208 s.t. TAC3_TotalModelHorizenTechnologyActivityLowerLimit{r in REGION, t
    in TECHNOLOGY: TotalTechnologyModelPeriodActivityLowerLimit[r,t]>0}:
     TotalTechnologyModelPeriodActivity[r,t] >=
    TotalTechnologyModelPeriodActivityLowerLimit[r,t] ;
209 s.t. RM1_ReserveMargin_TechnologiesIncluded_In_Activity_Units{r in
    REGION, l in TIMESLICE, y in YEAR}: sum {t in TECHNOLOGY}
    TotalCapacityAnnual[r,t,y] * ReserveMarginTagTechnology[r,t,y] *
    CapacityToActivityUnit[r,t]       =
    TotalCapacityInReserveMargin[r,y];
210 s.t. RM2_ReserveMargin_FuelsIncluded{r in REGION, l in TIMESLICE, y in
    YEAR}: sum {f in FUEL} RateOfProduction[r,l,f,y] *
    ReserveMarginTagFuel[r,f,y] = DemandNeedingReserveMargin[r,l,y];
211 s.t. RM3_ReserveMargin_Constraint{r in REGION, l in TIMESLICE, y in
    YEAR}: DemandNeedingReserveMargin[r,l,y] * ReserveMargin[r,y]<=
    TotalCapacityInReserveMargin[r,y];
212 s.t. RE1_FuelProductionByTechnologyAnnual{r in REGION, t in TECHNOLOGY,
     f in FUEL, y in YEAR}: sum{l in TIMESLICE} ProductionByTechnology[r
    ,l,t,f,y] = ProductionByTechnologyAnnual[r,t,f,y];
213 s.t. RE2_TechIncluded{r in REGION, y in YEAR}: sum{t in TECHNOLOGY, f
    in FUEL} ProductionByTechnologyAnnual[r,t,f,y]*RETagTechnology[r,t,y
    ] = TotalREProductionAnnual[r,y];
```

```
s.t. RE3_FuelIncluded{r in REGION, y in YEAR}: sum{l in TIMESLICE, f in FUEL} RateOfProduction[r,l,f,y]*YearSplit[l,y]*RETagFuel[r,f,y] = RETotalProductionOfTargetFuelAnnual[r,y];
s.t. RE4_EnergyConstraint{r in REGION, y in YEAR}: REMinProductionTarget[r,y]*RETotalProductionOfTargetFuelAnnual[r,y] <= TotalREProductionAnnual[r,y];
s.t. RE5_FuelUseByTechnologyAnnual{r in REGION, t in TECHNOLOGY, f in FUEL, y in YEAR}: sum{l in TIMESLICE} RateOfUseByTechnology[r,l,t,f,y]*YearSplit[l,y] = UseByTechnologyAnnual[r,t,f,y];
s.t. E1_AnnualEmissionProductionByMode{r in REGION, t in TECHNOLOGY, e in EMISSION, m in MODE_OF_OPERATION, y in YEAR}: EmissionActivityRatio[r,t,e,m,y]*TotalAnnualTechnologyActivityByMode[r,t,m,y]=AnnualTechnologyEmissionByMode[r,t,e,m,y];
s.t. E2_AnnualEmissionProduction{r in REGION, t in TECHNOLOGY, e in EMISSION, y in YEAR}: sum{m in MODE_OF_OPERATION} AnnualTechnologyEmissionByMode[r,t,e,m,y] = AnnualTechnologyEmission[r,t,e,y];
s.t. E3_EmissionsPenaltyByTechAndEmission{r in REGION, t in TECHNOLOGY, e in EMISSION, y in YEAR}: AnnualTechnologyEmission[r,t,e,y]*EmissionsPenalty[r,e,y] = AnnualTechnologyEmissionPenaltyByEmission[r,t,e,y];
s.t. E4_EmissionsPenaltyByTechnology{r in REGION, t in TECHNOLOGY, y in YEAR}: sum{e in EMISSION} AnnualTechnologyEmissionPenaltyByEmission[r,t,e,y] = AnnualTechnologyEmissionsPenalty[r,t,y];
s.t. E5_DiscountedEmissionsPenaltyByTechnology{r in REGION, t in TECHNOLOGY, y in YEAR}: AnnualTechnologyEmissionsPenalty[r,t,y]/((1+DiscountRate[r])^(y-min{yy in YEAR} min(yy)+0.5)) = DiscountedTechnologyEmissionsPenalty[r,t,y];
s.t. E6_EmissionsAccounting1{r in REGION, e in EMISSION, y in YEAR}: sum{t in TECHNOLOGY} AnnualTechnologyEmission[r,t,e,y] = AnnualEmissions[r,e,y];
s.t. E7_EmissionsAccounting2{r in REGION, e in EMISSION}: sum{y in YEAR} AnnualEmissions[r,e,y] = ModelPeriodEmissions[r,e]-ModelPeriodExogenousEmission[r,e];
s.t. E8_AnnualEmissionsLimit{r in REGION, e in EMISSION, y in YEAR}: AnnualEmissions[r,e,y]+AnnualExogenousEmission[r,e,y] <= AnnualEmissionLimit[r,e,y];
s.t. E9_ModelPeriodEmissionsLimit{r in REGION, e in EMISSION}: ModelPeriodEmissions[r,e] <= ModelPeriodEmissionLimit[r,e];
solve;
end;
```

7.2 Data File

This data file is created from a partially complete NZ/AUS Energy system. The file shows the complexity of energy modelling and creating user-defined energy systems. The parameters to be modelled are mostly denoted by binary values.

```
# GOCPI Energy System Data File
# Insert instructions when the file is running properly
#
# Sets
#
set YEAR  :=  1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010;
set REGION  :=  NEWZEALAND AUSTRALIA;
set EMISSION  :=  CO2 NOX CO METHANE;
```

```
set TECHNOLOGY  :=  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu;
set FUEL  :=  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX;
set TIMESLICE :=  INTERMEDIATE_DAY INTERMEDIATE_NIGHT SUMMER_DAY SUMMER_NIGHT WINTER_DAY WINTER_NIGHT;
set MODE_OF_OPERATION :=  1 2;
set STORAGE :=  DAM;
set DAYTYPE :=  1 2 3;
set SEASON  :=  1 2 3 4;
set DAILYTIMEBRACKET  :=  1 2 3;
#
#
param YearSplit :1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010:=
INTERMEDIATE_DAY 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
INTERMEDIATE_NIGHT 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
SUMMER_DAY 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
SUMMER_NIGHT 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
WINTER_DAY 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
WINTER_NIGHT 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
;
#
param DiscountRate  default 1:=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
param DaySplit  :1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010:=
1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
2 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
3 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
;
#
param Conversionls  :1 2 3 4:=
INTERMEDIATE_DAY 1.0 1.0 1.0 1.0
INTERMEDIATE_NIGHT 1.0 1.0 1.0 1.0
SUMMER_DAY 1.0 1.0 1.0 1.0
SUMMER_NIGHT 1.0 1.0 1.0 1.0
WINTER_DAY 1.0 1.0 1.0 1.0
WINTER_NIGHT 1.0 1.0 1.0 1.0
;
#
param Conversionld  :1 2 3:=
INTERMEDIATE_DAY 1.0 1.0 1.0
INTERMEDIATE_NIGHT 1.0 1.0 1.0
SUMMER_DAY 1.0 1.0 1.0
SUMMER_NIGHT 1.0 1.0 1.0
WINTER_DAY 1.0 1.0 1.0
```

```
WINTER_NIGHT 1.0 1.0 1.0
;
#
param Conversionlh  :1 2 3:=
INTERMEDIATE_DAY 1.0 1.0 1.0
INTERMEDIATE_NIGHT 1.0 1.0 1.0
SUMMER_DAY 1.0 1.0 1.0
SUMMER_NIGHT 1.0 1.0 1.0
WINTER_DAY 1.0 1.0 1.0
WINTER_NIGHT 1.0 1.0 1.0
;
#
param DaysInDayType default 1:=
  [*,*,1990]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,1991]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,1992]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,1993]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,1994]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,1995]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,1996]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,1997]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,1998]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
```

```
  [*,*,1999]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2000]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2001]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2002]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2003]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2004]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2005]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2006]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2007]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2008]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2009]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
3 1.0 1.0 1.0
4 1.0 1.0 1.0
  [*,*,2010]: 1 2 3 :=
1 1.0 1.0 1.0
2 1.0 1.0 1.0
```

```
3 1.0 1.0 1.0
4 1.0 1.0 1.0
;
#
param TradeRoute  default 1:=
  [*,*,CSV,1990]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1991]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1992]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1993]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1994]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1995]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1996]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1997]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1998]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,1999]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2000]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2001]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2002]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2003]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2004]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2005]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2006]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2007]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
```

```
AUSTRALIA 1.0 1.0
  [*,*,CSV,2008]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2009]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,CSV,2010]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,1990]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,1991]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,1992]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,1993]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,1994]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,1995]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,1996]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,1997]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,1998]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,1999]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,2000]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,2001]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,2002]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,DSL,2003]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,2004]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,2005]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
```

```
  [*,*,DSL,2006]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,2007]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,2008]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,DSL,2009]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
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AUSTRALIA 1.0 1.0
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AUSTRALIA 1.0 1.0
  [*,*,ELC,1991]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,ELC,1992]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,ELC,1993]: NEWZEALAND AUSTRALIA  :=
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  [*,*,ELC,1994]: NEWZEALAND AUSTRALIA  :=
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  [*,*,ELC,1997]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,ELC,1998]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,ELC,1999]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
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NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
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AUSTRALIA 1.0 1.0
  [*,*,ELC,2002]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,ELC,2003]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,ELC,2004]: NEWZEALAND AUSTRALIA  :=
```

```
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  [*,*,ELC,2005]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,GSL,2002]: NEWZEALAND AUSTRALIA  :=
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```

```
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  [*,*,GSL,2003]: NEWZEALAND AUSTRALIA  :=
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  [*,*,GSL,2004]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
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  [*,*,GSL,2006]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,GSL,2007]: NEWZEALAND AUSTRALIA  :=
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  [*,*,GSL,2009]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
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  [*,*,HCO,1990]: NEWZEALAND AUSTRALIA  :=
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  [*,*,HCO,1991]: NEWZEALAND AUSTRALIA  :=
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  [*,*,HCO,1994]: NEWZEALAND AUSTRALIA  :=
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  [*,*,HCO,1999]: NEWZEALAND AUSTRALIA  :=
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  [*,*,HCO,2000]: NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
```

```
  [*,*,HCO,2001]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,HCO,2002]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
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AUSTRALIA 1.0 1.0
  [*,*,HCO,2004]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
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AUSTRALIA 1.0 1.0
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AUSTRALIA 1.0 1.0
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556   [*,*,LTH,1991]: NEWZEALAND AUSTRALIA  :=
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574   [*,*,LTH,1997]: NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,URN,1994]: NEWZEALAND AUSTRALIA  :=
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693 AUSTRALIA 1.0 1.0
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696 AUSTRALIA 1.0 1.0
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699 AUSTRALIA 1.0 1.0
700   [*,*,URN,1997]: NEWZEALAND AUSTRALIA  :=
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702 AUSTRALIA 1.0 1.0
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727   [*,*,URN,2006]: NEWZEALAND AUSTRALIA  :=
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733   [*,*,URN,2008]: NEWZEALAND AUSTRALIA  :=
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748   [*,*,RH,1992]:  NEWZEALAND AUSTRALIA  :=
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  [*,*,RL,2008]:  NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
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AUSTRALIA 1.0 1.0
  [*,*,TX,2008]:  NEWZEALAND AUSTRALIA  :=
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  [*,*,TX,2009]:  NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,TX,2010]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
;
#
param DepreciationMethod  default 1:=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
param SpecifiedAnnualDemand default 1:=
  [*,*,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
```

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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
;
#
param SpecifiedDemandProfile  default 1:=
  [*,*,INTERMEDIATE_DAY,1990]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1991]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1992]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1993]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1994]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1995]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1996]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1997]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1998]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1999]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2000]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2001]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2002]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2003]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2004]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2005]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2006]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2007]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2008]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2009]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2010]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH
   RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1990]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
   RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1991]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
   RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,INTERMEDIATE_NIGHT,1992]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1993]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1994]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1995]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1996]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1997]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1998]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1999]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2000]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2001]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2002]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2003]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2004]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2005]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2006]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
```

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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2007]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2008]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2009]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2010]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1990]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1991]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1992]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1993]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1994]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1995]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1996]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1997]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1998]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_DAY,1999]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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1161   [*,*,SUMMER_DAY,2000]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1162 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1163 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1164   [*,*,SUMMER_DAY,2001]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1165 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1166 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1167   [*,*,SUMMER_DAY,2002]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1168 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1169 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1170   [*,*,SUMMER_DAY,2003]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1171 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1172 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1173   [*,*,SUMMER_DAY,2004]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1174 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1175 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1176   [*,*,SUMMER_DAY,2005]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1177 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1178 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1179   [*,*,SUMMER_DAY,2006]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1180 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1181 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1182   [*,*,SUMMER_DAY,2007]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1183 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1184 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1185   [*,*,SUMMER_DAY,2008]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1186 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1187 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1188   [*,*,SUMMER_DAY,2009]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1189 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1190 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1191   [*,*,SUMMER_DAY,2010]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
       :=
1192 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1193 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1194   [*,*,SUMMER_NIGHT,1990]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
        TX  :=
1195 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1196 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1197   [*,*,SUMMER_NIGHT,1991]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
        TX  :=
1198 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1199 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1200   [*,*,SUMMER_NIGHT,1992]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
        TX  :=
1201 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1202 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1203   [*,*,SUMMER_NIGHT,1993]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
        TX  :=
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_NIGHT,1994]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_NIGHT,1995]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,SUMMER_NIGHT,1996]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
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  [*,*,SUMMER_NIGHT,1997]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
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  [*,*,SUMMER_NIGHT,1998]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,SUMMER_NIGHT,1999]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,SUMMER_NIGHT,2000]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,SUMMER_NIGHT,2001]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,SUMMER_NIGHT,2002]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,SUMMER_NIGHT,2003]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
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  [*,*,SUMMER_NIGHT,2004]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
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  [*,*,SUMMER_NIGHT,2005]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
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  [*,*,SUMMER_NIGHT,2006]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
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  [*,*,SUMMER_NIGHT,2007]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,SUMMER_NIGHT,2008]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_NIGHT,2009]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,SUMMER_NIGHT,2010]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
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  [*,*,WINTER_DAY,1990]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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  [*,*,WINTER_DAY,1991]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
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  [*,*,WINTER_DAY,1992]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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  [*,*,WINTER_DAY,1993]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,1995]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,1996]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,1997]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,1998]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,1999]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2000]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2001]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2002]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2003]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2004]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2005]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2006]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,WINTER_DAY,2007]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2008]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,WINTER_DAY,2009]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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  [*,*,WINTER_NIGHT,1991]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,WINTER_NIGHT,1994]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,WINTER_NIGHT,1995]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,WINTER_NIGHT,1997]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,WINTER_NIGHT,1998]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,WINTER_NIGHT,2000]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,WINTER_NIGHT,2003]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,2004]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,2005]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,2006]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,2007]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,2008]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,2009]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
```

```
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,2010]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
   TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
;
#
param AccumulatedAnnualDemand default 1:=
  [*,*,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
```

```
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
;
#
param CapacityToActivityUnit  :E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
   IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
   :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
;
#
param CapacityFactor  default 1:=
  [*,*,INTERMEDIATE_DAY,1990]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
   IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
   :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1991]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
   IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
   :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1992]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
   IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
   :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
   IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
   :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1994]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
   IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
   :=
```

```
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1995]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1996]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1997]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1998]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,1999]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2000]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2001]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_DAY,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
```

```
1495 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1496   [*,*,INTERMEDIATE_DAY,2003]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1497 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1498 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1499   [*,*,INTERMEDIATE_DAY,2004]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1500 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1501 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1502   [*,*,INTERMEDIATE_DAY,2005]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1503 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1504 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1505   [*,*,INTERMEDIATE_DAY,2006]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1506 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1507 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1508   [*,*,INTERMEDIATE_DAY,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1509 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1510 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1511   [*,*,INTERMEDIATE_DAY,2008]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1512 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1513 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1514   [*,*,INTERMEDIATE_DAY,2009]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1515 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1516 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1517   [*,*,INTERMEDIATE_DAY,2010]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1518 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1519 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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1520   [*,*,INTERMEDIATE_NIGHT,1990]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1521 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1522 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1523   [*,*,INTERMEDIATE_NIGHT,1991]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1524 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1525 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1526   [*,*,INTERMEDIATE_NIGHT,1992]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1527 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1528 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1529   [*,*,INTERMEDIATE_NIGHT,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1530 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1531 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1532   [*,*,INTERMEDIATE_NIGHT,1994]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1533 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1534 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1535   [*,*,INTERMEDIATE_NIGHT,1995]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
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       :=
1536 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1537 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1538   [*,*,INTERMEDIATE_NIGHT,1996]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1539 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1540 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1541   [*,*,INTERMEDIATE_NIGHT,1997]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1542 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1543 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1544   [*,*,INTERMEDIATE_NIGHT,1998]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
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    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,1999]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2000]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2001]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2003]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2004]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2005]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,INTERMEDIATE_NIGHT,2006]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
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    :=
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1569 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1570 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1571   [*,*,INTERMEDIATE_NIGHT,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
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       :=
1572 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1573 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1574   [*,*,INTERMEDIATE_NIGHT,2008]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1575 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1576 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1577   [*,*,INTERMEDIATE_NIGHT,2009]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
       IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
       :=
1578 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1579 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1580   [*,*,INTERMEDIATE_NIGHT,2010]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
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       :=
1581 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1582 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1583   [*,*,SUMMER_DAY,1990]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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1584 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1585 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1586   [*,*,SUMMER_DAY,1991]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1587 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1588 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1589   [*,*,SUMMER_DAY,1992]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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1590 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1591 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1592   [*,*,SUMMER_DAY,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1593 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1594 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1595   [*,*,SUMMER_DAY,1994]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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1596 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1597 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1598   [*,*,SUMMER_DAY,1995]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1599 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1600 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1601   [*,*,SUMMER_DAY,1996]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1602 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1603 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1604   [*,*,SUMMER_DAY,1997]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1605 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1606 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1607   [*,*,SUMMER_DAY,1998]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1608 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1609 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1610   [*,*,SUMMER_DAY,1999]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1611 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1612 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1613   [*,*,SUMMER_DAY,2000]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1614 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1615 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1616   [*,*,SUMMER_DAY,2001]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1617 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1618 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1619   [*,*,SUMMER_DAY,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1620 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1621 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1622   [*,*,SUMMER_DAY,2003]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1623 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1624 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,SUMMER_DAY,2004]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,SUMMER_DAY,2005]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,SUMMER_NIGHT,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2001]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2003]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2004]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2005]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2006]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2008]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2009]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_DAY,2010]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1990]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1991]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1992]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1994]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1995]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1996]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1997]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,WINTER_NIGHT,1998]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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1799   [*,*,WINTER_NIGHT,1999]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1800 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1801 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1802   [*,*,WINTER_NIGHT,2000]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1803 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1804 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1805   [*,*,WINTER_NIGHT,2001]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1806 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1807 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1808   [*,*,WINTER_NIGHT,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1809 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1810 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1811   [*,*,WINTER_NIGHT,2003]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1812 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1813 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1814   [*,*,WINTER_NIGHT,2004]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1815 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1816 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1817   [*,*,WINTER_NIGHT,2005]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1818 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1819 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1820   [*,*,WINTER_NIGHT,2006]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1821 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1822 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1823   [*,*,WINTER_NIGHT,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1824 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1825 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1826   [*,*,WINTER_NIGHT,2008]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1827 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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1828 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1829   [*,*,WINTER_NIGHT,2009]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1830 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1831 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1832   [*,*,WINTER_NIGHT,2010]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
         IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1833 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1834 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1835 ;
1836 #
1837 param AvailabilityFactor  default 1:=
1838   [*,*,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1839 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1840 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1841   [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1842 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1843 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1844   [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1845 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1846 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1847   [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1848 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1849 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1850   [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1851 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1852 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1853   [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1854 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1855 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1856   [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1857 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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1858 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1859   [*,*,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1860 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1861 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1862   [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1863 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1864 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1865   [*,*,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1866 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1867 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1868   [*,*,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1869 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1870 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1871   [*,*,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1872 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1873 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1874   [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1875 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1876 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1877   [*,*,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1878 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1879 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1880   [*,*,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1881 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1882 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1883   [*,*,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1884 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1885 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1886   [*,*,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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1887 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1888 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1889   [*,*,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1890 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1891 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1892   [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1893 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1894 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1895   [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1896 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1897 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1898   [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1899 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1900 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1901 ;
1902 #
1903 param OperationalLife :E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu:=
1904 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1905 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1906 ;
1907 #
1908 param ResidualCapacity  default 1:=
1909   [*,*,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1910 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1911 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1912   [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1913 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1914 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1915   [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1916 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
1917 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
```

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  [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
```

```
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
;
#
param InputActivityRatio  default 1:=
  [*,*,CSV,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
```

```
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CSV,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CSV,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,CSV,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CSV,2,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2094 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2098   [*,*,CSV,2,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2100 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2101   [*,*,DSL,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2102 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2103 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2104   [*,*,DSL,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2106 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2107   [*,*,DSL,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2108 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2109 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2110   [*,*,DSL,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2112 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2113   [*,*,DSL,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2114 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2115 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2116   [*,*,DSL,1,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2117 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2118 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2119   [*,*,DSL,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2120 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2121 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,1,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,1,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,1,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,2,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,2,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,2,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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2181 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2182   [*,*,DSL,2,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2184 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2185   [*,*,DSL,2,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2187 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2188   [*,*,DSL,2,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2189 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2190 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2191   [*,*,DSL,2,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2193 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2194   [*,*,DSL,2,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2195 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2196 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2197   [*,*,DSL,2,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2198 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2199 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2200   [*,*,DSL,2,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2202 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2203   [*,*,DSL,2,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2204 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2205 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2206   [*,*,DSL,2,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2207 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2208 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,2,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,DSL,2,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,ELC,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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  [*,*,ELC,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2277 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2278   [*,*,ELC,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2284   [*,*,ELC,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,ELC,2,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,ELC,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2373 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2442 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2443   [*,*,GSL,2,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2452   [*,*,GSL,2,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2455   [*,*,GSL,2,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2458   [*,*,GSL,2,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2461   [*,*,GSL,2,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2469 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,GSL,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2541 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2542   [*,*,HCO,2,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2544 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2545   [*,*,HCO,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2547 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2548   [*,*,HCO,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2550 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2553 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2554   [*,*,HCO,2,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2556 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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  [*,*,HCO,2,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,2,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,HCO,2,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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  [*,*,HCO,2,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,HCO,2,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,HYD,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,HYD,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,HYD,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,HYD,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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2616 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2617   [*,*,HYD,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2619 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2620   [*,*,HYD,1,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2622 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2623   [*,*,HYD,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2625 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2626   [*,*,HYD,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2628 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2629   [*,*,HYD,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2631 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2632   [*,*,HYD,1,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2634 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2635   [*,*,HYD,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2638   [*,*,HYD,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2641   [*,*,HYD,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2643 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HYD,2,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,LTH,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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  [*,*,LTH,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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  [*,*,LTH,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2790 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2793 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2796 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2800   [*,*,LTH,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2802 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2805 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2811 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2812   [*,*,LTH,2,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2814 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2815   [*,*,LTH,2,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2817 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,LTH,2,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,LTH,2,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,OIL,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,OIL,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,OIL,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,OIL,1,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2877 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2878   [*,*,OIL,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2880 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2881   [*,*,OIL,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2883 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
2884   [*,*,OIL,1,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2886 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2887   [*,*,OIL,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
2889 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2890   [*,*,OIL,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2892 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2893   [*,*,OIL,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2895 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2896   [*,*,OIL,1,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2898 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2899   [*,*,OIL,1,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2964 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2967 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2968   [*,*,OIL,2,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2970 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2977   [*,*,OIL,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2979 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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2980   [*,*,OIL,2,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2983   [*,*,URN,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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2989   [*,*,URN,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3024 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3033 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3040   [*,*,URN,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3042 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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       1.0 1.0 1.0 1.0 1.0 1.0
3045 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3048 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,RL,2,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,TX,1,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,1,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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#
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3690 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3691   [*,*,DSL,2,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3694   [*,*,DSL,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3696 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3700   [*,*,DSL,2,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3701 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3702 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3703   [*,*,DSL,2,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3704 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3705 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3706   [*,*,DSL,2,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3708 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3709   [*,*,DSL,2,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3710 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3711 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3712   [*,*,DSL,2,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3713 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3714 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3715   [*,*,DSL,2,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3716 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3717 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,2,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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  [*,*,DSL,2,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,2,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,2,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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  [*,*,DSL,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,DSL,2,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,ELC,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,ELC,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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3777 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3778   [*,*,ELC,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3779 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3780 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3781   [*,*,ELC,1,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3782 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3783 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3784   [*,*,ELC,1,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3785 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3786 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3787   [*,*,ELC,1,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
3789 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3790   [*,*,ELC,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3791 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3792 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3793   [*,*,ELC,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3795 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3796   [*,*,ELC,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3798 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3799   [*,*,ELC,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3800 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3801 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3802   [*,*,ELC,1,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3803 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3804 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3805   [*,*,ELC,2,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3807 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3808   [*,*,ELC,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3810 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
3811   [*,*,ELC,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
3813 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3814   [*,*,ELC,2,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3816 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3817   [*,*,ELC,2,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
3819 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3820   [*,*,ELC,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
3822 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3823   [*,*,ELC,2,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3825 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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3826   [*,*,ELC,2,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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3829   [*,*,ELC,2,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,GSL,2,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,GSL,2,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,GSL,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,GSL,2,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
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4009   [*,*,HCO,1,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4010 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4011 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4012   [*,*,HCO,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4014 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4015   [*,*,HCO,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4017 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4018   [*,*,HCO,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4020 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4021   [*,*,HCO,1,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4023 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4024   [*,*,HCO,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4026 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4027   [*,*,HCO,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4029 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4030   [*,*,HCO,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4032 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4033   [*,*,HCO,1,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4034 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4035 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4036   [*,*,HCO,1,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4038 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4039   [*,*,HCO,1,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4041 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4042   [*,*,HCO,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4044 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4045   [*,*,HCO,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4047 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4048   [*,*,HCO,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4050 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4051   [*,*,HCO,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4053 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4054   [*,*,HCO,1,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4056 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4057   [*,*,HCO,2,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4059 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4060   [*,*,HCO,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4062 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4063   [*,*,HCO,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4065 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HCO,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,HYD,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4125 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4126   [*,*,HYD,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4129   [*,*,HYD,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4131 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4132   [*,*,HYD,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4134 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4135   [*,*,HYD,1,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4137 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4138   [*,*,HYD,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4140 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4141   [*,*,HYD,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4143 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4144   [*,*,HYD,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4146 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4147   [*,*,HYD,1,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4149 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4150   [*,*,HYD,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4152 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
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4212 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4224 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4231   [*,*,HYD,2,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4237   [*,*,HYD,2,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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4299 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4300   [*,*,LTH,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4301 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4302 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4303   [*,*,LTH,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4304 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4305 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4306   [*,*,LTH,1,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4308 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4309   [*,*,LTH,2,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4311 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4312   [*,*,LTH,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4314 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4315   [*,*,LTH,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4316 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4317 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4318   [*,*,LTH,2,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4319 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4320 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4321   [*,*,LTH,2,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4322 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4323 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4324   [*,*,LTH,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4325 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4326 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,LTH,2,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,LTH,2,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,LTH,2,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,LTH,2,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
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4357   [*,*,LTH,2,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4359 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4360   [*,*,LTH,2,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4362 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4363   [*,*,LTH,2,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4365 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4366   [*,*,LTH,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4368 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4369   [*,*,LTH,2,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4371 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4372   [*,*,OIL,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4373 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4374 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4375   [*,*,OIL,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4377 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4378   [*,*,OIL,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4380 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4381   [*,*,OIL,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4383 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4384   [*,*,OIL,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4386 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4387   [*,*,OIL,1,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4389 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4392 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4407 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4408   [*,*,OIL,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4410 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4413 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,OIL,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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  [*,*,OIL,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,OIL,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,OIL,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,OIL,2,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4473 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4474   [*,*,OIL,2,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4476 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4477   [*,*,OIL,2,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4479 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4480   [*,*,OIL,2,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4482 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4483   [*,*,OIL,2,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4485 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4486   [*,*,OIL,2,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4488 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4489   [*,*,OIL,2,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4491 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4492   [*,*,OIL,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4497 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4498   [*,*,URN,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4499 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4500 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,URN,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,URN,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,URN,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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  [*,*,URN,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,URN,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,URN,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,URN,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,URN,1,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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4560 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4561   [*,*,URN,2,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4563 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4564   [*,*,URN,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4566 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4567   [*,*,URN,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4569 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4570   [*,*,URN,2,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4572 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4573   [*,*,URN,2,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4575 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4576   [*,*,URN,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4578 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4579   [*,*,URN,2,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4581 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4585   [*,*,URN,2,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4587 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RH,2,2004]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RH,2,2005]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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4733 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4734 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4735   [*,*,RH,2,2006]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4736 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4737 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4738   [*,*,RH,2,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4739 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4740 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4741   [*,*,RH,2,2008]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4742 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4743 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4744   [*,*,RH,2,2009]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4745 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4746 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4747   [*,*,RH,2,2010]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4748 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4749 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4750   [*,*,RL,1,1990]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4751 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4752 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4753   [*,*,RL,1,1991]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
4754 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4755 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4756   [*,*,RL,1,1992]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
4757 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4758 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4759   [*,*,RL,1,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4760 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4761 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,RL,1,1994]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,1,1995]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,1,1996]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,1,1997]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,1,1998]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,RL,1,1999]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,1,2000]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,1,2001]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,1,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,1,2003]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
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4791 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4792   [*,*,RL,1,2004]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4793 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4794 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4795   [*,*,RL,1,2005]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4797 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4798   [*,*,RL,1,2006]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4799 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4800 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4801   [*,*,RL,1,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4802 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4803 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4804   [*,*,RL,1,2008]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4806 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4807   [*,*,RL,1,2009]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4809 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4810   [*,*,RL,1,2010]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4812 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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4813   [*,*,RL,2,1990]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
4815 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4816   [*,*,RL,2,1991]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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4817 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4818 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
4819   [*,*,RL,2,1992]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,2,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,RL,2,1994]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,2,1995]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,2,1996]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,2,1997]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RL,2,1998]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,2,1995]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,TX,2,1996]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,TX,2,1997]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,2,1998]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,2,1999]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,2,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,2,2004]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,2,2005]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,2,2006]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,TX,2,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,TX,2,2008]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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        1.0 1.0 1.0 1.0 1.0 1.0
4995 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
        1.0 1.0 1.0 1.0 1.0 1.0
4996   [*,*,TX,2,2009]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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        1.0 1.0 1.0 1.0 1.0 1.0
4998 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
        1.0 1.0 1.0 1.0 1.0 1.0
4999   [*,*,TX,2,2010]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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        1.0 1.0 1.0 1.0 1.0 1.0
5001 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
        1.0 1.0 1.0 1.0 1.0 1.0
5002 ;
5003 #
5004 param CapitalCost default 1:=
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        1.0 1.0 1.0 1.0 1.0 1.0
5007 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
        1.0 1.0 1.0 1.0 1.0 1.0
5008   [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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        1.0 1.0 1.0 1.0 1.0 1.0
5010 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
        1.0 1.0 1.0 1.0 1.0 1.0
5011   [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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        1.0 1.0 1.0 1.0 1.0 1.0
5013 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
        1.0 1.0 1.0 1.0 1.0 1.0
5014   [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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        1.0 1.0 1.0 1.0 1.0 1.0
5016 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5017   [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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        1.0 1.0 1.0 1.0 1.0 1.0
5019 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
        1.0 1.0 1.0 1.0 1.0 1.0
5020   [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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        1.0 1.0 1.0 1.0 1.0 1.0
5022 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
        1.0 1.0 1.0 1.0 1.0 1.0
5023   [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
;
#
param VariableCost  default 1:=
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
;
#
param FixedCost default 1:=
```

```
  [*,*,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
```

```
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
```

```
5258 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5259 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5260   [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5261 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5262 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5263 ;
5264 #
5265 param TechnologyToStorage default 1:=
5266   [*,*,DAM,1]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5267 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5268 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5269   [*,*,DAM,2]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5270 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5271 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5272 ;
5273 #
5274 param TechnologyFromStorage default 1:=
5275   [*,*,DAM,1]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5276 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5277 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5278   [*,*,DAM,2]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5279 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5280 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5281 ;
5282 #
5283 param StorageLevelStart :DAM:=
5284 NEWZEALAND 1.0
5285 AUSTRALIA 1.0
5286 ;
5287 #
5288 param StorageMaxChargeRate  :DAM:=
5289 NEWZEALAND 1.0
5290 AUSTRALIA 1.0
5291 ;
5292 #
5293 param StorageMaxDischargeRate :DAM:=
5294 NEWZEALAND 1.0
5295 AUSTRALIA 1.0
5296 ;
5297 #
5298 param MinStorageCharge  default 1:=
```

```
  [*,*,1990]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1991]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1992]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1993]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1994]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1995]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1996]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1997]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1998]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1999]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2000]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2001]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2002]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2003]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2004]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2005]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2006]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2007]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2008]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2009]: DAM :=
```

```
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2010]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
param OperationalLifeStorage  :DAM:=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
param CapitalCostStorage  default 1:=
  [*,*,1990]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1991]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1992]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1993]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1994]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1995]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1996]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1997]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1998]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1999]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2000]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2001]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2002]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2003]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2004]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
```

```
  [*,*,2005]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2006]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2007]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2008]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2009]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2010]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
param ResidualStorageCapacity default 1:=
  [*,*,1990]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1991]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1992]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1993]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1994]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1995]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1996]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1997]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1998]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1999]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2000]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2001]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2002]: DAM :=
```

```
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2003]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2004]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2005]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2006]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2007]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2008]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2009]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,2010]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
param CapacityOfOneTechnologyUnit default 1:=
  [*,*,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5546 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5555 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5558 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5561 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5564 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5565 ;
5566 #
5567 param TotalAnnualMaxCapacity  default 1:=
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5570 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5573 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
;
#
param TotalAnnualMinCapacity  default 1:=
```

```
  [*,*,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0 1.0
```

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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
```

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5692 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5693 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5694   [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5695 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5696 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5697 ;
5698 #
5699 param TotalAnnualMaxCapacityInvestment  default 1:=
5700   [*,*,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5701 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5702 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5703   [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5704 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5705 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5706   [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5707 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5708 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5709   [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5710 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5711 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5712   [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5713 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5714 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5715   [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5716 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5717 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5718   [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5719 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5720 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5721   [*,*,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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       1.0 1.0 1.0 1.0 1.0 1.0
5753 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5754   [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5756 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5757   [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5759 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5760   [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5762 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5763 ;
5764 #
5765 param TotalAnnualMinCapacityInvestment  default 1:=
5766   [*,*,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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5767 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5768 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5769   [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5771 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5772   [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5774 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5775   [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5777 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5778   [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5780 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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param TotalTechnologyAnnualActivityLowerLimit default 1:=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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param TotalTechnologyAnnualActivityUpperLimit default 1:=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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    1.0 1.0 1.0 1.0 1.0 1.0
```

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5958   [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5959 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5960 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5961 ;
5962 #
5963 param TotalTechnologyModelPeriodActivityUpperLimit  :E01 E21 E31 E51
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       TXG RIV RHu RLu TXu:=
5964 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5965 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5966 ;
5967 #
5968 param TotalTechnologyModelPeriodActivityLowerLimit  :E01 E21 E31 E51
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       TXG RIV RHu RLu TXu:=
5969 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5970 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5971 ;
5972 #
5973 param ReserveMarginTagTechnology  default 1:=
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5975 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5976 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5977   [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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5979 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5980   [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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5981 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5982 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5983   [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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5985 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5986   [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
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5988 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5989   [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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5991 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5992   [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5994 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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5995   [*,*,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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       1.0 1.0 1.0 1.0 1.0 1.0
5997 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
5998   [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6000 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6001   [*,*,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6002 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6003 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6004   [*,*,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6005 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6006 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6007   [*,*,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6008 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6009 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6010   [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6011 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6012 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6013   [*,*,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6014 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6015 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6016   [*,*,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
```

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6017 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6018 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6019   [*,*,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6020 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6021 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6022   [*,*,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6023 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6024 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6025   [*,*,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6026 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6027 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6028   [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6029 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6030 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6031   [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6032 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6033 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6034   [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6035 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6036 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6037 ;
6038 #
6039 param ReserveMarginTagFuel  default 1:=
6040   [*,*,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
6041 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6042 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6043   [*,*,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
6044 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6045 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6046   [*,*,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
6047 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6048 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6049   [*,*,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
6050 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6051 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6052   [*,*,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
6053 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6054 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
```

```
  [*,*,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
;
#
param ReserveMargin :1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
   2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010:=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
;
#
```

```
param RETagTechnology default 1:=
  [*,*,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
```

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6139 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6140 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6141   [*,*,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6142 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6143 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6144   [*,*,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6145 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6146 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6147   [*,*,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6148 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6149 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6150   [*,*,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6151 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6152 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6153   [*,*,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6154 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6155 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6156   [*,*,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6157 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6158 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6159   [*,*,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6160 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6161 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6162   [*,*,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6163 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6164 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6165   [*,*,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6166 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6167 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
```

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  [*,*,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
;
#
param RETagFuel default 1:=
  [*,*,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
```

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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
;
#
param REMinProductionTarget :1990 1991 1992 1993 1994 1995 1996 1997
    1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010:=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
;
#
param EmissionActivityRatio default 1:=
  [*,*,CO2,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
```

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6261 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6262 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6263   [*,*,CO2,1,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6264 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6265 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6266   [*,*,CO2,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6267 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6268 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6269   [*,*,CO2,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6270 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6271 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6272   [*,*,CO2,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6273 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6274 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6275   [*,*,CO2,1,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6276 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6277 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6278   [*,*,CO2,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6279 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6280 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6281   [*,*,CO2,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6282 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6283 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6284   [*,*,CO2,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6285 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6286 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6287   [*,*,CO2,1,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
         IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6288 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6289 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
```

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  [*,*,CO2,1,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
   1.0 1.0 1.0 1.0 1.0 1.0
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6349 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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6362   [*,*,CO2,2,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6368   [*,*,CO2,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6376 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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6494   [*,*,NOX,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6500   [*,*,CO,1,1990]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6509   [*,*,CO,1,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6512   [*,*,CO,1,1994]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6515   [*,*,CO,1,1995]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6521   [*,*,CO,1,1997]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6610 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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6611   [*,*,CO,2,2006]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6613 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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6614   [*,*,CO,2,2007]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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6616 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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6626   [*,*,METHANE,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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6632   [*,*,METHANE,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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6635   [*,*,METHANE,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,1,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,1,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,2,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
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6696 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6697 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6698   [*,*,METHANE,2,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6699 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6700 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6701   [*,*,METHANE,2,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6702 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6703 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6704   [*,*,METHANE,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6705 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6706 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6707   [*,*,METHANE,2,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6708 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6709 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6710   [*,*,METHANE,2,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6711 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6712 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6713   [*,*,METHANE,2,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6714 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6715 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6716   [*,*,METHANE,2,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6717 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6718 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6719   [*,*,METHANE,2,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6720 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6721 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6722   [*,*,METHANE,2,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6723 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6724 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
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6725   [*,*,METHANE,2,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6726 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6727 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6728   [*,*,METHANE,2,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6729 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6730 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6731   [*,*,METHANE,2,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6732 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6733 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6734   [*,*,METHANE,2,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6735 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6736 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6737   [*,*,METHANE,2,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6738 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6739 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6740   [*,*,METHANE,2,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6741 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6742 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6743   [*,*,METHANE,2,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6744 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6745 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6746   [*,*,METHANE,2,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6747 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6748 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6749   [*,*,METHANE,2,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
       IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6750 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6751 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6752 ;
6753 #
6754 param EmissionsPenalty  default 1:=
6755   [*,*,1990]: CO2 NOX CO METHANE  :=
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NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1991]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1992]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1993]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1994]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1995]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1996]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1997]: CO2 NOX CO METHANE  :=
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end;
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7.3 Linear Programme File

This file is the lp formulation required to use CPLEX. The file is not included in this compendium as the Utopian example is nearly 1.2 million lines of code.

University of Auckland
Department of Engineering Science

Global Optimisation Carbon Pricing Initiative (GOCPI)

Author: Connor McDowall
Supervisor: Rosalind Archer

October 29, 2020

Abstract

The energy transition will require transparent energy investment and policy decisions to create equitable outcomes for major stakeholders. Energy modelling informs these decisions but existing complexities and technical challenges make the practice inaccessible. A thorough literature review informs the energy operating environment, current political action, opportunities, challenges and energy modelling practises. This project proposes the development of an accessible, scalable energy system modelling tool to address the aforementioned challenges and education disparities between stakeholders. Best practise software development informed product development. An exhaustive list of modelling regions was formulated. The legacy TIMES energy modelling method was attempted. TIMES was abandoned prematurely in favour of OseMOSYS, an alternatively energy modelling method which better aligned with the project scope. The GNU Mathprog version of OseMOSYS was chosen over GAMS and Pyomo versions as was further developed. This new methodology was transcribed to a user-friendly interface and deconstructed to build reference energy systems. The GOCPI package development started with the Energysystems module in order to load existing energy systems. The module also formulates data and model text files to create Lp format files for optimisation problems. The Navigation module supports file navigation. A New Zealand and Australia energy system example was partially developed simultaneously with the CreateCases module to enable the user to build their own energy systems. Core components required to build energy systems were developed further. IBM optimisation technologies were incorporated into the Optimisation module to solve energy systems. Limitations led to the development of a pipeline for remote optimisation using the IBM Watson Machine Learning service. A web-based interface was developed to distribute the product. A minimal viable product was successfully developed to set the foundation for building a scalable, open source energy system modelling tool. This tool will address educational disparities and aid in an equitable energy transition.

Acknowledgements

Rosalind Archer

I am most thankful for Rosalind. She was a guiding light in a most turbulent time. 2019 and 2020 were incredibly tough years. Our meetings were a weekly highlight, giving a sense of normalcy during the depths of the COVID-19 Lockdowns. Often accompanied by her two corgis, we embarked into the unknown in building a Python-based open source energy modelling tool. Surprisingly, energy modelling is quite complex. Our discussions encompassed a diverse range of intellectually stimulating topics, from the phenomena of the West Texas Intermediate (WTI) future contracts going negative, to speculating on the transformation we will see in the education sector moving forward. Thank you for helping foster a growth mindset and build the confidence to not be afraid to fail.

Declaration of Contribution

I proposed this project. I am the sole contributor.

Contents

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1 Introduction

The imminence of the energy transition is clear. The coronavirus pandemic accelerated a shift away from fossil fuels and adoption of sustainable technologies to drive economic recovery. A thorough literature review 2 informs the need for rapid transformation before irreversible damage is done. Economic models predict unfavourable consequences if no swift action is taken. Financial concepts such as Return on Investment (ROI) and Net Present Value (NPV) analysis drive decisions related to sustainable investment. Sustainable technologies have seen significant cost reductions over the last decade creating positive prospects for investors. These developments improve the feasibility of the energy transition in a timely manner. However, there are educational disparities between policy makers, governments, industry groups and consumers. Major stakeholders know a transition must happen swiftly, but not how a successful transition will impact their energy system or the implementation details. Stakeholders have different needs and reside within different energy systems. They may address changes in their best interest without considering the other stakeholders equitably. It is important to make the transition as transparent as possible to deliver equitable outcomes for all stakeholders.

The opaque nature of the transition, in terms of the implementation for different regions, is caused by the sophistication and inaccessibility of energy modelling. Energy modelling involves overcoming several technical barriers. Large volumes of energy-related data is required to build accurate systems. Most of the time this data is proprietary and hard to access. Energy systems are expressed as mathematical models. They can be linear, non linear, integer or mixed integer programmes. These models can be difficult to formulate and hard to understand. The complexity of energy modelling leads to the need for powerful commercial solvers to solve the energy systems. Most commercial solvers are expensive and inaccessible to most users. The concepts underpinning energy systems are interdisciplinary, often encompassing finance, economics, engineering, statistics and mathematics. These issues and complexities make it difficult to equitably evaluate energy policy and investment. Most noticeably, it is hard to define an effective transition strategy which aligns with both the United Nations Sustainable Development Goals and the Paris Agreement.

My proposed solution is to develop an accessible, scalable energy system modelling tool to address these issues. The intention is remove the aforementioned sophistication and enable users to model their own energy systems. This will remove educational disparities to bring more stakeholders to the table when discussing how to best implement the energy transition. Hopefully, this will lead to more equitable outcomes before it is too late.

2 Literature Review

2.1 An Introduction to Energy

Energy built the world we live in. Industrial sectors use energy to power machining and production processes. Trade uses oil-based products to fuel shipping and logistics networks. The technology sector uses energy to supply power to data centres to facilitate internet services. The manufacturing sector use the chemical properties of oil and natural gas to produce glass, synthetic, and explosive products. In summary, energy has a role in every industry. Energy comes in many forms. The International Energy Agency (IEA) aggregates energy products into six key fuels: Coal, Gas, Oil, Renewables, Electricity, and Nuclear [1]. Coal, Gas, and Oil are non-renewable fossil fuels with high energy intensities and carbon emissions. Nuclear energy is a non-renewable resource as the uranium used in production is finite. Renewables utilise technologies to produce energy from infinitely available wind, solar, geothermal and hydro resources. These technologies emit low to no carbon emissions. Regardless, energy will continue to drive our way of life.

2.2 Energy, Emissions, and the Economy

Academics spent decades hypothesizing causal relationships between economic growth, energy consumption, and carbon dioxide (CO_2) emissions. One study explored this hypothesis by applying panel unit root tests, panel co-integration methods, panel causality tests, Fully Modified Ordinary Least Squares (FMOLS), and Dynamic Ordinary Least Squares (DOLS) estimation methods [23]. Another study explored both linear and non-linear causality using Granger Causality and Vector Autoregressive models [12]. Although these modeling techniques are not explored further in this literature review or project, there results show a relationship between economic growth, energy consumption, and carbon dioxide (CO_2) emissions. Subsequently, we must improve our understanding of the three variables and how their relationship informs energy strategy.

2.2.1 Energy

Global energy consumption increased annually over the last decade. As outlined in BP's Statistical Review of World Energy, world consumption grew from 11705.1 Million Tonnes Oil Equivalent (Mtoe) in 2008 to 13864.9 Mtoe in 2018. World consumption grew 2.9% per annum in 2018 and 1.5% per annum for the period 2007-2017. In 2018, 85% of global energy consumption came from Oil, Natural Gas, and Coal. Global oil consumption increased by 1.2%, global coal by 1.4%, global gas by 5.3%, global nuclear by 2.4%, global hydro-electricity by 3.1%, and global renewables by 14.5% [44]. The 14.5% growth in renewables from 2017 to 2018 highlights how renewables are increasingly competitive as emphasised in the 2020 Deloitte US Renewable Energy Outlook. Flat electricity load growth, declining costs, and the maturation of energy storage all contribute to decreasing costs and increasing competitiveness. Decentralised energy networks with remote renewable micro-grids bolster resilence from increasingly frequent adverse weather events. Collaborative efforts lead to newly created efficiencies and the nurturing of new ideas, investment, and leadership. The combination of stakeholders' demand for increased resiliency in power networks, and collorative efforts to foster innovation in renewables, will continue to drive renewable uptake [52].

The fallout from the 2008 financial crisis led to a decrease in global consumption. The COVID-19 pandemic is ravaging global oil markets with an approximate 1550 Mtoe (33% [51]) decrease in consumption. The fall in demand from COVID-19, and the inability to store more oil, will catalyse significant change. Governments are distributing stimulus packages in response to the pandemic. Consumption is likely to bounce back after the fallout from COVID-19. Stimulus and the disruption to the energy industry may change the way energy is produced and consumed moving forward.

2.2.2 Emissions

Greenhouse gas emissions (GHG) are adverse by-products from the production or consumption of fossil fuels. Carbon dioxide (CO_2) and Nitrous Oxide (N_2O) originate from combusting fossil fuels. Methane (CH_4) is emitted from fossil fuel production processes. GHGs act as insulators, slowing the rate energy leaves the earth's atmosphere by absorbing energy. Global Warming Potential (GWP) measures how much energy one tonne of gas will absorb relative to one tonne of CO_2. The GWP for CO_2 is 1 and remains in the atmosphere for thousands of years. The GWP for N_2O is 265-298 over 100 years. Lastly, the GWP for CH_4 is 28-36 over 100 years [4]. Carbon dioxide emissions from the consumption of oil, gas, and coal for combustion increased annually over the last decade. This subset of global emissions rose from 30336.7 Mtoe in 2008 to 33890.8 Mtoe in 2018, growing 11.72% over this period [44].

It is hard to argue anthropomorphic contributions to global emissions are not playing a role in climate change. The Inter-government Panel on Climate Change (IPCC) are an inter-government body of the United Nations (UN). The IPCC inform relevant parties on the scientific basis of risk-induced climate change. The IPCC also convey it's natural, economic, and political implications. The IPCC prepared a special report on Global Warming of 1.5 °C, based on an assessment of around 6,000 peer-reviewed publications. This report confirms climate change is affecting livelihoods and ecosystems worldwide. Approximately between 0.8 °C and 1.2 °C of global warming above pre-industrial levels is attributable to human activities. It is likely to reach 1.5°C between 2030 and 2052 if the current rate of increase continues. The warming from the pre-industrial era to the present will persist for centuries to millennia. Climate models are predicting increased mean temperatures in land and sea regions, hot extremes, heavy precipitation, drought, and precipitation deficits. Biodiversity and ecosystem impacts, such as species loss and extinction, will increase. Ocean temperatures, acidity, and oxygen scarcity will increase. Global warming will impose risks to health, livelihoods, food security, water supply, human security, and economic growth. All expected to increase unless severe action is taken [17]. Subsequently, emissions will continue to play an important role in our future.

2.2.3 Economy

The global economy grew substantially over the last century. Worldwide Gross Domestic Product (GDP) per capita (constant 2010 USD) grew from $3746 in 1960 to $10891 in 2018 [10]. Gross Domestic Product increased from $66.1 trillion (Current USD) in 2010 to $85.9 trillion in 2018 (Current USD). The World Bank segments GDP into four key segments: Agriculture, Industry, Manufacturing, and Services. Agriculture corresponds to International Standard Industrial Classification (ISIC) divisions 1-5 which cover forestry,

fishing, cultivating crops, and livestock production. Industry corresponds to ISIC divisions 15-37 covering mining, manufacturing, construction, electricity, water, and gas. Manufacturing corresponds to ISIC divisions 10-45 covering businesses which physically or chemically transform materials of components into new products. Services corresponds to ISIC divisions 50-99 covering wholesale trade, retail trade, transport, and government, financial, professional, and personal services. In 2018, Agriculture, Industry, Manufacturing, and Services made up 3%, 25%, 16%, and 65% of GDP respectively [11]. On inspection, energy related products are key inputs to producing segment outputs. Traditionally, production is a function of capital and labour. Energy should be included in this set with theoretical and time series analysis supporting this claim. Empirical and theoretical evidence suggests energy availability, coupled with energy use and output, plays a key role in enabling growth [48]. Unfortunately, the COVID-19 pandemic drew to a close this period of unprecedented growth as the economy is forecast to plunge into a deep recession.

It is clear action must be taken to reduce anthropomorphic emissions while meeting the needs the economy after reviewing energy, emissions, and the economy.

2.3 Current Political Action

2.3.1 Paris Agreement

Over the last few decades, there has been debate on anthropomorphic emissions causing climate change. During this period, the UN began the United Nation's Climate Change Regime to ratify global agreements to combat climate change. There have been three major phases to this regime. The first phase was negotiating, adopting, and ratifying the United Nations Framework Convention on Climate Change from 1990 to 1995. The second phase was the adoption of the Kyoto Protocol on the 11th of December 1997. Unfortunately, the protocol took until the 16th of February 2005 to be ratified due to a complex ratification process. The Kyoto Protocol operationalized the United Nation's Framework Convention on Climate Change. Industrialised countries were committed to reduce and limit GHG emissions in accordance with targets agreed on an individual basis. The protocol only bound developed countries as they were deemed mostly responsible for the state of emissions. The protocol was split into two commitment periods. The first set binding emission targets for 36 industrialised countries, and the European Union, to reduce 5% of emissions compared to 1990 levels. The second commitment was set by the adoption of the Doha Amendment on the 8th of December 2012. This commitment was set to start 2013, end in 2020, and reduce emissions by 18% from 1990 levels. Unfortunately, the second commitment period was not ratified. The protocol established three flexible market mechanisms; International Emissions Trading, Clean Development Mechanisms, and Joint Implementation. The protocol held parties accountable by establishing rigorous monitoring, review, verification, and compliance systems [18].

This protocol was a step in the right direction but there were some inherent issues. A complex ratification process limited uptake. Participating countries had disproportionate obligations to reduce emissions. The commitment periods did not have a long term outlook, contained different subsets of participants, and were not global in nature.

There was another long term co-operative action promoted under the UNFCCC, launched in the Bali Action Plan. Both the second commitment and the co-operative action were to conclude at the 2009 Copenhagen Conference. However, this conference ended in

disappointment as there wasn't enough time before the conference to resolve the issues in the regime.

At the conference, the Copenhagen Accord, political in nature, was agreed upon on the final night by a group of states including most major economies. This accord established a bottom up architecture where both targets and actions were set individually then reported internationally. In 2010, the Cancun Agreements incorporated the Copenhagen Accord into the UNFCCC regime. However, all progress to date did not look pass 2020.

This issue was resolved at the 2011 Durban Conference when the Durban Platform for Enhanced Action launched the negotiations which lead to the Paris Agreement. Negotiations continued for years, addressing how to develop an instrument suitable for all parties, and requested the submission of nationally determined contributions (NDCs)[14].

The 2015 United Nations' Climate Change Conference was held in Paris. After some exceptional negotiating from French Foreign Minister Laurant Fabius, the Paris Agreement was adopted on the 12th of December 2015, and ratified on the 4th of November 2016.

The Paris Agreement's main objective is to strengthen the global response to climate change by keeping the temperature rise this century below 2° above pre-industrial levels. The agreement also pursues efforts to limit the increase to 1.5°. The agreement addresses the following across 29 articles: long term temperature goals, global peaking targets, mitigation efforts through nationally determined contributions (NDCs), sink and reservoir use, market/non-market approaches, adaptations, loss/damage mitigations from the adverse effects of climate change, financial support, technology support, capacity-building support, education, reporting systems, and global stocktake procedures [19], [41]. Article six of the Paris Agreement outlines mitigations and NDCs which include the following carbon pricing initiatives: Emissions Trading Schemes and Carbon Taxes.

2.3.2 Carbon Pricing Initiatives

Emissions Trading Systems (ETS) facilitate emission reductions where cheapest. Polluters who find it easier to reduce emissions can sell emission allowances to polluters who struggle to lower emissions. There are two types of ETS. Firstly, Cap and Trade. Secondly, Baseline and Credit Systems. Cap and Trade sets an upper limit on emissions with emission credits either grandfathered or auctioned. Most emission credits under this system are grandfathered with proceeds captured by existing polluters. Most cap and trade systems are localised regionally or nationally. However, the European Union (EU) implemented the EU ETS to trade across the EU. Baseline and credit systems don't have a fixed level of emissions. Polluters can reduce emissions to earn credits to sell to other polluters who need to meet regulations [9].

Carbon Taxes are either implicit or explicit. An implicit tax is incorporated into the price of a GHG intensive product e.g. retail fuels. An explicit tax is a price per quantity of emissions produced e.g. \$10 per tonne of CO_2 equivalent.

Carbon pricing initiatives are increasingly recognized as instrumental to cost-effectively deliver the transition to low-carbon societies. The Organisation for Economic Co-operation and Development (OECD), International Monetary Fund (IMF) and the IPCC all recognise the need to strengthen these initiatives.

57 carbon pricing initiatives are either currently implemented, or scheduled for implementation, as at April 1st 2019. 28 ETFs are spread across national and subnational jurisdictions with 29 carbon taxes primarily implemented at a national level. These pricing initiatives only cover approximately 20% of Greenhouse Gas Emissions (11 GtCO_2e). There is variation in carbon prices from less than US\$1/tCO_2e to US\$127/tCO_2e. Unfortunately most carbon tax price increases are linked to inflation only. Governments raised more than US\$44 billion in carbon pricing revenue during 2018. There are determined price trajectories that can deliver on the Paris Agreement which increase each decade on a non-discounted basis. IPCC trajectories show the marginal cost of reducing GHG emissions. Other sources provide carbon price ranges which consider ambitious climate policy. When setting carbon prices, local, ethical and distribution factors must be considered.

Internal carbon pricing is increasing in popularity within the private sector. 1300 companies, including 100 Fortune 500 companies, disclosed the current use or intent to use internal carbon pricing. Traditionally, internal carbon pricing drove investment planning for mandatory carbon policies. Internal carbon pricing is transitioning towards informing long-term climate investment and risk strategies. Financial policy frameworks are reassessed to use carbon pricing to support sustainable growth. Internal carbon pricing is informing the construction of market indexes e.g. S&P Carbon Price Adjusted Index to inform market climate risk. Internal carbon pricing will continue to catalyse both the investment in sustainable technology and the divestment in fossil fuels. Although new carbon pricing initiatives are emerging with an increased emphasis on global collaboration, it is clear the global community is far from reaching the objectives set by the Paris Agreement. Only 5% of carbon pricing initiatives are currently priced to meet the Paris Agreement's temperature goals [31].

2.4 Opportunities and Challenges

2.4.1 Market-Based Approaches

Both carbon pricing initiatives are market-based and can be less obtrusive for industry than regulatory controls. The prevalence of emissions across global industries sees a market-based approach more equitable, evenly distributed across industries, and quicker to implement.

Arguably, a carbon tax is the most straightforward approach. A carbon tax could be imposed on all emitting inputs and outputs of production. The marginal cost of carbon would be covered by a tax rate. Tax credits from sequestration or other initiatives could be used to invest directly into alternative technologies. Tax rates could be adjusted to illicit the desired market response. A carbon tax would align with existing systems used to facilitate inland revenue functions in the desired jurisdiction.

The effectiveness of cap and trade systems is undermined by grandfathering credits, using offsets in lieu of meaningful emission reduction targets, and the challenges of setting baselines. If credits are grandfathered, there are no tax revenues to invest in alternative energy or technology. In a cap and trade system, there is uncertainty around the price of those reductions, and the subsequent effect these credits have on lowering emissions. Cap and trade initiatives provide benefit certainty as you can ascertain the environmental benefits from an imposed ceiling on emissions. However, there is no cost certainty which

is provided through a carbon tax.

2.4.2 Benefits and Costs to a Carbon Tax

A carbon tax is simpler as is set at a cost per tCO_2e produced. In contracts, a cap and trade is more complex due to negotiating baselines, grandfathering/auctioning processes, monitoring systems, international trading guidelines, and cost uncertainty prevention. A carbon tax more easily generates revenue to invest in reducing greenhouse gas emissions and supporting businesses adopting more sustainable processes. A cap and trade system generates revenues using credit auctioning but is less effective than a carbon tax if grandfathering credits exists. A carbon tax ensures cost certainty as the exact cost of emissions is quantified. In addition, there is a clear message to polluters with a carbon tax. Under a cap and trade system, there is more uncertainty around the impact polluters have as they can merely purchase more credits to increase emissions. In light of these positives, there are also negatives to a carbon tax. There is significant political opposition in proposing a new form of tax. The benefits of a carbon tax will need to be clearly communicated to all stakeholders. The benefits of a carbon tax are uncertain in how they enact reductions in emissions. Tax exemptions may reduce the effectiveness of the carbon tax if granted inequitably. For example, if a super major was given a significant tax exemption on the basis of an existing political relationship. A carbon tax is also difficult to co-ordinate with other participants [9]. In addition to these disadvantages, there are misconceptions leading to the opposition of carbon taxes. These misconceptions include, but are not limited to, the following: Taxes reducing welfare, and increasing unemployment, from lower levels of consumption and production. Taxes perceived to put incumbents' business models at risk. Subsequently, these incumbents lobby heavily prevent change. Taxes increasing the prices of goods and services consumers consume, creating opposing public opinions [49].

Addressing the disadvantages and misconceptions of a carbon tax would help implement carbon taxes across geographies to reduce greenhouse gas emissions.

2.4.3 Decarbonization, Investment, and Technology

The revenue generated from carbon taxes would need to be reinvested to benefit regional, national, and global communities. One opportunity is investing in sustainable technologies. Fortunately, this type of investment is increasing. Between 2010 and 2019, renewable technology drew $2.6 trillion in investment. In 2019, $282 billion of renewable capacity was financed worldwide. Wind technologies (onshore and offshore) and solar were financed $138 billion and $131 billion respectively. This financing success was attributable to falling costs and maturing technologies. Renewable technologies are now profitable. Costs associated with solar and wind technologies have fallen 85% and 49% respectively in the last 10 years [30]. In Australia, New Zealand, Canada, Europe, Japan, and the United States, sustainable investments reached assets of $30.7 trillion in early 2018, one-third of total investment. By 2025, renewables will be competitive with natural gas. New technology is emerging in the Oil and Gas Industry to decarbonise the industry. These technologies include but are not limited to: renewable power sources, electrification, vapor recovery units, carbon capture, carbon storage, and green hydrogen [13]. Carbon tax revenues could be used in the following ways: investment into sustainable technologies, replacing existing infrastructure to support sustainable technology

growth, reinvestment into participating businesses, or addressing the adverse affects of climate change. It is important to communicate the benefit of sustainable investment to all relevant stakeholders.

2.5 Energy Modeling

It is important to understand how energy demand and supply is modeled before discussing emission levels, carbon taxes, and reinvestment opportunities. Unsurprisingly, energy modeling is complex.

2.5.1 Global and Domestic Energy Scenarios

Different scenarios define modeling processes. The World Energy Council devised three energy transition scenarios describing plausible pathways for the global energy transition to follow. The scenarios look forward to 2060. There is an inflection point in 2040 to assess the success of the strategies underpinning the scenarios. The council leveraged expert member communities and annual surveys to devise these strategies. The three global scenarios tell different narratives relating to the progression of global primary energy demand, electrification,mobility improvements, energy efficiency, infrastructure innovation, investment, new technologies, political action, and Paris Agreement alignment. There are three global scenarios: Modern Jazz, Unfinished Symphony, and Hard Rock. Modern Jazz is a market driven scenario. Unfinished Symphony is a highly collaborative, policy driven scenario. Hard Rock is a minimally collaborative, internal policy driven scenario [47].

Countries use the global scenarios to inform their regional and national scenarios. New Zealand has followed this methodology through devising the Tui and Kea scenarios. Tui follows the narrative of a global community effort. New Zealand does not generally have a common view on what is important. Subsequently, the country adopts a wait and see approach with some protection provided to local businesses. New Zealand will focus firstly on economic prosperity and individually wellbeing by leveraging off comparative advantages. This is purely a commercial response. Kea forecasts the New Zealand economy cannot remain internationally competitive under current emission intensity trends. The country will take leadership in lowering emissions, choosing to undergo an early and aggressive economic transformation. New Zealand will act before the global economy at the expense of its own.

Both scenarios are underpinned by 19 critical uncertainties. These vary from external sources such as global stability, international fuel markets, urban sustainability, energy affordability, and the allocation of natural resources. Both scenarios consider different service demands e.g. Number of km travelled, population, GDP ($), forecast carbon prices ($/t$CO_2$e), carbon emissions (Mt/p.a.), required investment ($), and commodity prices [20], [21]. These scenarios were feed into The Integrated MARKEL-EFORM System (TIMES) model to forecast their impact.

2.5.2 The Integrated MARKEL-EFORM System (TIMES) Model

The Integrated MARKEL-EFORM System (TIMES) model generator was developed as a component of the International Energy Authority's (IEA) Energy Technology Systems

Analysis Program (ETSAP). The IEA-ETSAP uses long term energy scenarios to conduct comprehensive environment and energy analyses [38]. Energy is modeled through combining complementary technical engineering and economic approaches. TIMES uses a technology rich bottom up architecture, using linear programming to produce least cost energy systems for medium to long term time horizons [39]. The TIMES model encompasses each step in the value chain to produce and supply energy to meet the demand for energy services by consumers. These include: primary resources, transformation processes, transportation methods and conversion processes. The supply side considers production methods and net exports. Energy is carried through to residential, commercial, agricultural, transport, and industrial sectors. The relationships between producers and consumers underpin the TIMES model. The nature of these relationships are mathematical, economic, and technological. TIMES considers technologies, commodities, flows, and scenarios constrained by policy decisions. Services demanded by consumers are the main inputs for the model. The model will make investment, supply, trade, and operating decisions when considering the inputs, constraints, and scenarios in the model. Consumer and producer surpluses are maximized from a mathematical perspective. The main outputs are energy system configurations at the lowest cost that meet end users' service demands. These include energy prices, flows, emission quantities, capacities, and costs [39], [25].

The TIMES model is useful for using energy scenarios to devise strategies for implementing carbon taxes.

2.5.3 General Algebraic Modeling System (GAMS)

GAMS is a high-level modeling system for optimization and mathematical programming. The system is suitable for large scale, complex modeling applications. The system gives you access to a diverse portfolio of solvers to solve linear, non-linear, and mixed integer optimization problems. GAMS is the ideal tool for modeling energy and carbon tax scenarios using TIMES Models [27].

2.5.4 Open Source Energy Modeling System (OseMOSYS)

The OseMOSYS project is an open source project to improve the accessibility of modeling energy systems. The modeling methodology is scalable from city to continental granularities. The approach is designed to require no upfront investment, little time commitment and provides a fast learning curve. This methodology is suitable for developer, modelers, academics and policy makers. The model structure includes pre-defined sets, parameters, objective function and constraints relating to energy systems. Python, GNU MathProg and GAMS versions are available for download in remote repositories on Github [43].

3 Project Scope and Research Objectives

The literature led to some interesting outcomes. Carbon taxes are an effective way to help meet the goals set by the Paris Agreement, reduce global emissions, and reinvest in both sustainable and decarbonizing technologies. However, there are significant obstacles stopping the implementation of carbon taxes. These obstacles include political opposition, effectiveness in reducing emissions, co-ordination with other local, regional, national and international carbon tax efforts, and the distribution of tax exemptions. Currently, the distribution and implementation of carbon pricing initiatives is inequitable as major polluters aren't enforcing these initiatives e.g the majority of the US and India. Producers who operate globally may pivot to produce and sell GHG intensive products elsewhere in the world if taxes are not correctly set and spread amongst geographies. In this context, geographies are defined as geographical areas where energy consumption and emission production occurs. Earth is the entire set of geographies. This set can be partitioned into continental, national, provincial, or regional geographies (subsets). Any carbon pricing initiative must consider the specific combination of energy factors for the associated geography. The aggregate outcome from all geographies should meet the objectives set by the Paris Agreement. The revenues generated should be distributed back to participants with commercial benefits communicated through key financial metrics relevant to that geography or business. Carbon pricing initiatives constrain energy systems. It is important to consider how carbon pricing initiatives affect the energy system in driving sustainable energy investment and policy. The overall research objective is:

Develop a Global Carbon Pricing Optimisation Model.

The model will be developed by the following process:

1. Understand the existing approach to forecasting services demand and develop a standardised forecasting process which aligns with emission targets.
2. Partition the global set of geographies into subsets with varying levels of granularity e.g. a continental subset with seven geographies (continents), a national subset with 195 geographies (sovereign states according to the United Nations) etc.
3. Forecast services demand for each geography in each subset.
4. Adapt an existing TIMES or OseMOSYS model to input standardised energy system parameters.
5. Run simulations using the adapted model to form distributions on model outputs. These distributions are to inform the negotiation of carbon pricing initiatives.
6. Develop and model investment strategies from subsequent key outputs including carbon prices.
7. Develop a model interface (UI and UX) to communicate optimal global carbon prices, performance metrics, and the carbon tax benefits to support co-ordinated efforts to negotiate and implement carbon pricing initiatives.

In conclusion, this project will attempt to address issues surrounding climate change. GOCPI will enable any user to design and model their own energy system to inform investment and policy decisions. The intention is to empower users to influence energy investment and policy decisions made by public and private parties.

4 Methodology and Implementation

4.1 Project organisation

GOCPI adopted Data Science best practice, as described by Wilson et al [54]. Although these practices are mostly reserved for data science projects, their principles are suitable for product development and version control. All data and results were saved regularly and reproducible. The retention of data in all forms received high levels of attention. Project files were synched continuously to Google Drive [28]. Git [37] was used to manage version control for GOCPI's source code, data, documentation and results. Git stores a complete history of versions using Git hashes. These hashes are strings unique to each state of the publicly available GOCPI repository[1]. Git hashes enabled the discretisation of GOCPI's development over time, enabling the accessibility and recollection of all previous states given a unique git hash. This functionality enabled reproducibility, error correction and the ability to revert to previous models.

4.1.1 Version Control

Git, hosted by GitHub, provided a comprehensive set of version control technologies. These technologies provided a range of benefits. Firstly, Git is excellent at providing and supporting collaborative functionalities. The master version of a project is accessible for all who have access to the repository. Each contributor could create custom copies of branches through pull requests on the master branch. Contributors could commit changes to custom branches and push these changes to the master branch through push requests. The product manager could review these push requests, approving suitable requests to integrate changes to the master branch. Collaborative efforts were possible with commit messages describing the contributions from each contributor. This project had one contributor. Git ensured the histories of code, work and authors are stored. The descriptive nature of the commit log ensured an accurate journal is kept.

4.1.2 Folder Structure

GOCPI maintained the file folder structure recommended in Wilson et al [54]. Project organisation was paramount as the modelling of energy systems involves integrating a range of optimisation models, data files and documents. Wilson et al's recommendations were appropriate as data science projects require similar organisational rigor. Subsequently, file management and structure was most efficient and comprehensive. **GOCPI** is the root directory of this project and contains several sub directories: bin, data, doc, src and results. The **bin** sub directory contained external scripts and compiled programmes related to the GOCPI project. The **data** sub directory contained all raw data associated with the project. This data included energy statistics, energy balance datasets, partitioned geographies, standardised optimisation models and TIMES modelling frameworks. The **doc** sub directory stored GOCPI's user guides, academic resources, research reports and project deliverables. The **results** sub directory contained the output from optimisation simulations and processed data to display on dashboards and websites to inform investment and policy decisions. The **src** sub directory stores the source code for preparing raw data, partitioning sets of geographies with varying granularities and the

[1] https://github.com/CMCD1996/GOCPI

GOCPI python package available to download using PyPI[2] and install using pip[3]. All files were continuously backed up using Google Drive.

4.1.3 Python

Python 3.7 was the primary coding language for the GOCPI project. GOCPI's objective is to enable any user to design and model their own energy system to inform investment and policy decisions. The intention is to empower users to discuss energy investment and policy decisions made by public and private parties. Additionally, GOCPI intends to reduce misinformation regarding energy policies and help assess the feasibility of meeting the International Energy Agency's Sustainable Development Scenario [3]. Python is omnipresent, widespread in software development. Python's language design makes the language highly productive and simple to use. Python can hand off computationally straining tasks to C/C++ and has first-class integration capabilities with these two languages. The language also has a very active and supportive community [40]. In addition, Python is the most popular coding language on the planet defined by the PYPL PopularitY of Programming Language Index. As at August 2020, Python had 31.59% of all language tutorial search instances on Google [46]. Python has many useful packages for creating the GOCPI package such as NumPy, Scikit-learn, os, csv and Pandas. Programming is quick due to Python's dynamic nature. The language is also open-source with no cost. Subsequently, Python was the best language to ensure the GOCPI model is accessible for many users to use and extend.

4.1.4 Package Management

The Anaconda package management platform for Python [6] was the chosen coding environment. Anaconda is a well defined, free platform with known versions of python packages such as matplotlib, numpy and pip. The use of this environment ensured both reproducibility and consistency across infrastructure. Although this project required no collaboration, the use of Anaconda will inform future developers on how to manage collaborative processes, especially for packages which are less well-maintained. Anaconda allows you to create custom environments which was necessary for creating scalable linear optimization problems to express energy systems. Pip is Python's default package manager and is included in the Anaconda package. Pip was used to install and update packages for python not available on Anaconda such as twine and the custom GOCPI package developed for this project.

4.1.5 Excel

It is important users are comfortable with using the GOCPI model. Energy modelling can be quite complex. The modelling process must be transparent to inform users how to build their own models. Excel is ubiquitous across academic and professional communities. Excel's omnipotence makes the software well-suited for describing the components of the GNU Mathprog energy system model. The **GOCPI OseMOSYS Structure.xlsx** file describes the sets, paramaters, constraints and objective function of a scalable energy system model. The User may toggle statement sets, parameters and constraints to adjust the complexity of the model. The model file was imported to a text file. However, data

[2]https://pypi.org/
[3]https://pypi.org/project/pip/

related to these energy systems was stored using Python dictionaries, lists and NumPy arrays. This Python formulation was later transcribed to a text file. Excel is best for two dimensional variables or data stored in Codd-Boyce relational databases [7]. The majority of parameters in energy systems were three or more dimensions. Therefore, Excel was not suitable to store these parameters. Python dictionaries, lists and NumPy arrays were preferred alternatives.

4.1.6 IBM ILOG CPLEX Optimization

The OseMOSYS methodology (see 4.5.1) translates energy systems into linear programming problems. A solver was required to optimise these user-defined energy systems. The IBM ILOG Optimization Studio [36], more commonly known as CPLEX, was chosen to be this solver. CPLEX solves very large linear programming problems using the Barrier Interior-point method [45] or primal/dual variants of the Simplex Method [15]. GOCPI's user-defined energy systems could be scaled up to model very large systems, creating large linear programming problems.

The IBM ILOG CPLEX Optimization Studio has an interface with the Python language based on a C programming interface. Subsequently, Python APIs were available to run the CPLEX solver when installed either locally or on a cloud service. The python packages are **cplex** and **docplex**. The cplex package contains classes for accessing CPLEX for the Python programming language. The Cplex class is the most important class in this package as provides methods for creating, modifying, querying, or solving optimisation problems. Docplex also enables the formulation of new linear programmes where one creates the model, defines the decision variables, sets the constraints and expresses the objective function. The user uses docplex to solve the linear programme on a local solver. Alternatively, the model can be solved on a private cloud using Decision Optimisation on Cloud service through the provision of a service url and personal API key. The CPLEX Python APIs were most attractive as provided the user with a powerful commercial solver in an accessible format.

There is a caveat to the use of the CPLEX solver. The IBM ILOG CPLEX Optimization Studio is commercial by nature and requires a license to use. Fortunately IBM have the IBM Academic Initiative [34], granting students access to commercial software for free. This commercial nature creates accessibility issues for users who are not enrolled at an academic institution or can afford to pay for the software. Accessibility issues caused by the need for commercial solvers must be addressed to enable the distribution of the GOCPI product.

4.1.7 IBM Watson Machine Learning Service

The IBM CPLEX Optimisation Cplex python API is suitable for smaller models that can be solved locally. As the model increases in complexity, the docplex Python API did enable the ability to solve larger linear programmes. Unfortunately, IBM phased out the docplex Python API by incorporating the Decision Optimisation on Cloud services into the IBM Watson Machine Learning cloud services [35]. This change occurred during September 2020. This service uses IBM Cloud to access assets through credentials, create model deployments in IBM's servers and execute jobs to solve models. The model deployments must be Python-based models with jobs specifying a payloads containing input data and output formats.

4.1.8 PyPI

PyPI[1] is the Python Package Index, a repository of software for the python programming language. This repository helps you find and install software developed by the Python community who have decided to share their work. The GOCPI package is distributed from this platform to enable as many as possible the ability to model their own energy systems to inform and question energy policy and investment. Enter command: **pip install GOCPI** in the terminal to install the package using pip package management software.

4.1.9 Code Style

The GOCPI project was developed as the GOCPI package. All development code is organised within this package. The PEP8 style for Python Code was the formatting style for development code [32]. All code was formatted with **yapf**, a formatter maintained by Google to format Python files. Standardised formatting is important as makes the code easy to read, helps optimise the code and promotes consistency. Docstrings and commenting were most important in documentation. A docstring is a Python inline comment. Each class and function has an unique docstring, a one sentence description of the function, inputs with data types and types of outputs. The Google style docstring was most appropriate because of it's readability, ease to write and consistency with the Google Style Guide. Additionally, automated documentation generators (**pdoc3, Sphinx** etc.) can parse this format to create documentation. This self-consistent code style facilitated best practise maintenance and enabled reproducibility.

4.1.10 Infrastructure

GOCPI creates scalable energy system optimisation models with complexity size dependent. Computations either took place locally on a 128 GB, four core Apple MacBook Pro or remotely using a cloud service.

4.2 Documentation

The GOCPI project is well documented to keep an accurate record of key design decisions. The commit history described in 4.1.1 was the most important form of document. Other explicit documentation methods were applied to supplement this commit history. These methods, in addition to in-code documentation, include project updates and meeting minutes nested within a project logbook.

4.2.1 Project updates

Project updates were recorded as itemized lists. Each item is a brief description of the work completed during that day, week or month. Items include, but are not limited to, completing GOCPI submodules, researching energy system statistics, building websites or writing sections of this research report. These updates were pivotal to exploring new options, monitoring progress and making decisions to drive forward development. For example, the decision to adopt the OseMOSYS methodology in favour of the TIMES

[1] https://pypi.org/

modelling methodology. Project updates were transcribed to the project logbook held in this project's research compendium.

4.2.2 Meeting minutes

Project meetings took place for half an hour once a week. These meetings included discussions on energy markets, modelling methodologies, project progress and key design decisions. The minutes from these meetings accompanies project updates in the project logbook nested within the research compendium.

4.3 Geographical Partitioning

The first stage of the GOCPI project was to come up with an exhaustive list of geographies. The user has the choice to either model the energy systems of these geographies individually or model a network of geographies connected by trade relationships. Geographies are grouped into three distinct sets. There is a continental set with six continents: Africa, North America, South America, Oceania, Asia and Africa. Antarctica was excluded from this set. The country set includes 194 United Nations member states. The elements in the city set number approximately 13800 unique cities from the 194 member states. The **GOCPI Geographies.gyp** script processes these unique sets to create a csv file detailing an aggregate geography set. This file contains 13800 geography combinations. Each combination includes a city's name, population, country and continent e.g. VANCOUVER,CANADA,2313328.0,NORTH AMERICA. A user may use this information to design energy systems for cities with similar populations, countries and/or continents. The user may also create combinations using cities or countries. The user may also build energy systems on a continent level. After the formation of an exhaustive list of geographies, the exploration and adaptation of energy system modelling methods began.

4.4 Energy Modelling: TIMES

The World Energy Council devised three energy scenarios to inform energy policy and investment. These are Hard Rock, Unfinished Symphony and Modern Jazz [47]. New Zealand devised two energy scenarios to inform national energy policy and investment. These are Tui and Kea [21]. TIMES modelling underpins the construction of these scenarios. Subsequently, I began the standardisation of a TIMES implementation to develop a method for building scalable energy systems.

4.4.1 TIMES: The Integrated Markel-Eform System

An implementation of TIMES is divided into a five stages as displayed in Figure 1:

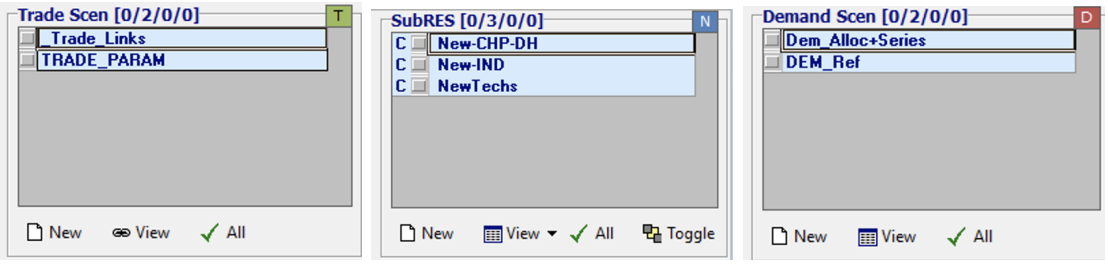
Figure 1: TIMES Implementation Process

The VErsatile data analyst (VEDA) [24] is a software package required for TIMES modelling. VEDA is an interface to design energy systems from Excel-based inputs and create the TIMES data and model text files for optimisation using GAMS. The installation of VEDA FE and VEDA BE required a windows operating system. A virtual private network (VPN) and Microsoft Remote Desktop was used to access a windows operating system via a virtual machine. GAMS Studio was installed on both the local Macintosh operating system and remote Windows operating system to perform the optimisation formulated in GAMS. VEDA is proprietary and requires a commercial license to use. Fortunately, there is a 60 day trial version available for download and use. After installing VEDA, GAMS and Microsoft Excel, I began following a TIMES user manual written by the IEA to build a standardised TIMES model. The user manual started with a very basic energy system, incrementing on the energy model using twelve demo models. I downloaded these twelve demo models to edit their associated Excel files.

The first stage was to adapt the existing Excel files so the user could design their own reference energy systems and sets of energy scenarios. Data and assumptions for reference energy systems and scenarios are primarily recorded in several tables across separate excel sheets and files. I made copies of these excel files and began writing functions to change the data stored in these sheets for a user to create new energy systems.

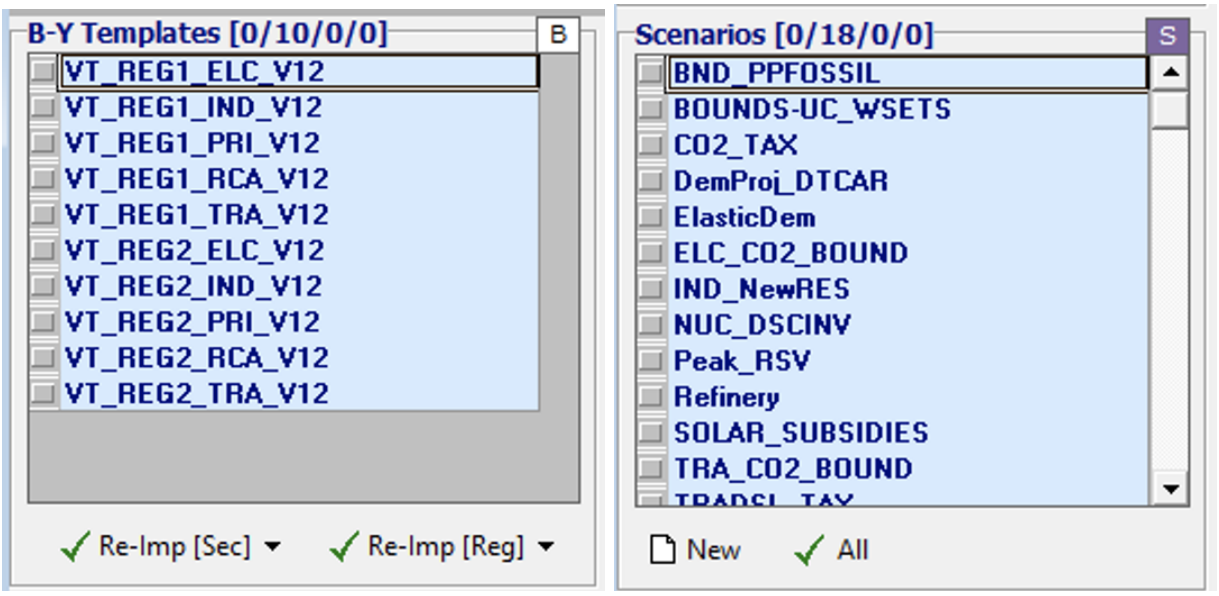
The second stage was to design energy systems using the VEDA interface. Figures 4 and 3 show the VEDA interface. I used the VEDA interface to combine the Excel files I adapted from the VEDA demo models. Initially, I built the base year scenario as shown in figure 4a. The inclusion of different energy scenarios (figure 4b) led to a more robust energy system. Examples include introducing the price elasticity of demand, solar technology subsidies and carbon dioxide taxes. New resources, technologies, trade relationships and demand profiles were added as shown in subfigures 3c, 3b and 3a. VEDA informs the user if the energy system is consistent with all data and assumptions correctly defined by the key shown in figure 2.

Figure 2: VEDA Energy System Consistency Key



(a) Trade Relationships (b) New Resources (c) Demand Proliles

Figure 3: VEDA Technology, Demand and Trade Scenarios



(a) Energy System Base Year (b) Energy Scenarios

Figure 4: VEDA Energy System Base Year and Scenarios

After designing the energy system using the VEDA interface, a case manager was used to generate a TIMES text file and run the optimisation. The model file is written in GAMS and integrated into the VEDA interface. The case manager allows you to select different scenarios and produce new model files.

The third stage was to execute the GAMS optimisation and produce outputs to be fed into VEDA BE. The forth stage is for VEDA BE to convert the GAMS output into Excel-based data files. In the fifth stage, data visualisation would enable the user to take the Excel outputs and make informed decisions related to energy policy and investment.

Unfortunately, I faced severe limitations at stage 3 of the TIMES implementation. Several factors made the TIMES implementation difficult:

1. The remote nature of the project made software integration between Flex IT, local hardware and remote servers difficult.
2. VEDA and GAMS Studio's commercial nature creates accessibility and equity issues for those who don't have the resources or connections to access the software. This contradicts the project's purpose.
3. The complexity of TIMES inhibits reproducibility and creates technical barriers for users not too familiar with energy modelling.

These reasons led to the abandonment of the TIMES implementation in favour of an alternative method. An alternative methodology would trade the complexity and sophistication of TIMES modelling for usability and accessibility. After consultation with my project supervisor and one of New Zealand's Energy Council modelers, the OseMOSYS methodology was recommended. Subsequently, I began developing a scalable open source energy system using the OseMOSYS methodology.

4.5 Energy Modelling: OseMOSYS

4.5.1 Overview

The OseMOSYS methodology was the next best alternative to TIMES for modelling large scale energy systems. TIMES can model useful complexities such as stochastic processes where OseMOSYS cannot. However, OseMOSYS proved to be the better of the two methods as more closely aligned with the overall scope and purpose of the project. The aforementioned tradeoffs are justified given the usability and availability of OseMOSYS.

There is an online community who make contributions to the development of OseMOSYS. Their mission is to make energy modelling more transparent and accessible. This online community is developing three versions of OseMOSYS accompanied with exemplar energy systems. The resources created by this online community can be found on Github [53]. A version of OseMOSYS was available in GAMS, GNU Mathprog or Python (Pyomo). Each version was at different stages of development. The GNU Mathprog version was chosen as was most complete of the three versions and included two energy system examples. The model and data files were downloaded as text files and stored in the project's working directory.

4.5.2 Implementation

It is not practical to explain the entire model given the scale of OseMOSYS. Therefore, the provision of a high level outline follows. Please refer to section 9.2 to view the complete model. The OseMOSYS model contains 11 sets, 52 parameters, 67 variables, 1 objective function and 94 constraints. A summary of the model's components follow:

Component	Factors
Sets	Year, Technology, Timeslice, Fuel, Emission, Mode of Operation, Region, Season, Day Type, Daily Time Bracket, Storage
Parameters	Trade, Activities, Demand Profiles, Costs, Storage Rates, Conversion Rates, Emission Limits etc.
Variables	Demand, Storage Rates, Production, Emission Penalties, Operating Costs, Technology Use etc.
Constraints	Energy Balances, Production, Charging Discharging, Storage Costs, Capacities, Investments Renewable Energy Requirements, Emissions Accounting etc.

Table 1: OseMOSYS Components

The sets are the primary components to the model. It is important they are explained to provide greater context.

1. **Year**: Represents the timeframe of the model containing all years to be considered.
2. **Technology**: Represents any element in the energy system that changes a commodity from one form to another, uses it or supplies it. The modeler is free to

interpret the technology. It may be a single technology e.g. a power plant or an aggregation of many technologies e.g. millions of solar panels.

3. **Timeslice**: Represents the times resolution of the model through time splits.
4. **Fuel**: Represents any energy vector, proxies or energy service flowing through technologies. Depending on the required analysis, fuels may be individual groups, aggregate groups or artificially separated.
5. **Emission**: Represents emissions potentially derived from operating technologies.
6. **Mode of Operation**: Represents the number of modes a technology may have. If a technology can have various input and output fuels, and can choose any linear combination of the inputs and outputs, this may be expressed as a mode of operation. E.g. a CHP plant may produce heat in one mode and electricity in another.
7. **Region**: Represents the regions to model as explained in section 4.3. Supply-demand energy balances for all energy vectors, including trade with other regions, are ensured.
8. **Season**: Represents the number of seasons accounted for e.g. Summer, Autumn , Winter and Spring. These are expressed as successive integers e.g. Summer = 1, Autumn = 2.
9. **Day Type**: Represents the number of days types accounted for e.g. Weekend, Weekday. These are expressed as successive integers e.g. Weekend = 1, Weekday = 2.
10. **Daily Time Bracket**: Represents the number of splits for a day e.g. night, morning, afternoon, evening. These are expressed as successive integers e.g. night = 1, morning = 2, afternoon = 3, evening = 4.
11. **Storage**: Represents storage facilities/capabilities used in the model.

$$\textbf{Min:} \sum_{r} \sum_{y} \text{TotalDiscountedCost}_{r,y}$$

Figure 5: OseMOSYS Objective Function

Combinations of sets are used to define the parameters and variables. These parameters and variables are used to set constraints. The objective function uses the constraints to find the optimal variables. The objective function is the minimisation of total discounted cost in each region across all years specified in the forecast horizon (Figure 5). Total discounted cost is the sum of the total discounted costs by technology over all the technologies.

4.5.3 Integration

An lp-format file was required to solve OseMOSYS implementations with a solver. These files are written in GNU Mathprog, a language intended for describing linear mathematical programming models [50]. GNU Mathprog is a subset of the Algebraic Mathematical Programming Language (AMPL) [5] and consists of user-defined sets of statements and data blocks. The custom anaconda environment (**osemosys**) was created to facilitate

this model formulation. This environment contains the libcxx package which provides a standard library of C++ functionalities. The GNU Linear Programming Kit (GLPK) sits within this library. GLPK uses GNU Mathprog to solve large scale linear programming (LP), mixed integer programming (MIP), and other related problems. GLPK is called using the **glpsol** command in the osemosys conda environment:

glpsol -m model.txt -d data.txt –wlp GOCPI.lp

The aforementioned glpsol command converts a data and model text file to an lp-file. The command also solves the problem if the energy system is a reasonable size. It is likely glpsol would not be able to solve larger scale energy system. Therefore, a commercial solver would be needed. The installation of the GLPK was tested using the Utopian example data and model files with the aforementioned glpsol function. The necessary lp-format file was generated for the users chosen solver. This was paramount before disembarking on developing a standardised energy systems development method to generate both text and data files from user-defined energy systems.

4.5.4 Storage

Energy modelling and OseMOSYS can be quite complex. It is important this complexity is conveyed to the user so they understand how to build their own energy systems. Subsequently, an Excel-based template was created to describe and store all model components. The **GOCPI_OseMOSYS_Structure.xlsx** contains all the sets, parameters, variables and constraints needed for an OseMOSYS model. The spreadsheet also includes descriptions of all model components and the ability to toggle their inclusion in the user defined model. The user may customise the structure of their energy model by making adjustments to the model's components in the GOCPI_OseMOSYS_Structure Excel sheet. Constraints may be added or removed and the objective function changed to consider other factors e.g. the minimise emissions penalties or maximise the uptake of renewable technologies. The base model came from the model text file, written in GNU Mathprog, stored in the OseMOSYS Github Repository. The template was adjusted to ensure constraint, variable and parameter indices were consistent with the demo data files.

4.6 Building Energy Systems

After the correct installation and initialisation of the OseMOSYS structure, it was appropriate to begin developing a methodology for building energy systems. The first step in this process was to understand the components and structure of the Utopia.txt example available from the OseMOSYS Github repository.

4.6.1 Utopia Example

The Utopia example models a 'Utopian' energy system. The system is developed by the OseMOSYS community to function as a baseline model and inform the construction of user-defined energy systems. The deconstruction of this system was paramount to understanding how to produce a standardised approach to building energy systems described in section 4.9.3. The Utopian example is a self sufficient energy system with no trade relationships. The system models twelve fuels processed in 21 technologies over a 21 year

forecast period. The model tracks two types of emissions, two modes of operation for some technologies and one storage technology. The utopian data file benchmarked the structure needed to generate compatible energy system data files.

4.6.2 NZ Example

The construction of a NZ energy system was undertaken after understanding the structure of the Utopian example. The purpose of the NZ energy system example was to demonstrate the practicality and usability of this model. The NZ energy system models the energy systems of New Zealand, Australia and a bi-directional trade relationship between the two nations. After disembarking on the development of a user-defined energy system, the limitations inhibiting the formation of a complete system were made apparent. These are briefly described as follows:

1. **Data Availability**: Publicly available and accurate data is hard to find when creating energy systems. This project was able to access publicly available from government agencies and global reporting entities. However, data is recorded differently depending on the region. This creates issues with building consistency between modeled regions. Many underlying assumptions must be made to build energy systems. These assumptions may change depending on the region. It is recommended there is access to consistent data source for all regions the user intends to model.
2. **Time Constraints**: The construction of an energy system is very time consuming. The NZ Energy system between Australia and New Zealand required the collection and scripting of a lot of data. This example was only between two regions. The model can support the maximum number of region combinations the IBM Watson Machine Learning Decision Optimisation service is capable of solving. The construction of a feasible and realistic energy system could be a Part IV project in itself.

These limitations led to the abandonment of developing a complete energy system. The NZ example is partially complete to show proof of concept. Section 6.2.2 explains next steps in finishing this example.

4.6.3 Energy System Concepts

The construction of energy systems requires a firm grasp on several concepts. These concepts are either related to general financial and energy theory, or specific to the OseMOSYS methodology. Each parameter in the model formulation relates to an important financial or energy concept in the energy system. The scope of this report prevents the inclusion of detailed descriptions for all integral components. Subsequently, the most important concepts are addressed in this section.

4.6.4 Reference Energy System

The **Reference Energy System (RES)** describes the network flows amongst the energy production, conversion and consumption of different fuels from different technologies. Essentially, it maps all relevant technologies to be involved in the energy system. Each region in the aggregate energy system has it's own energy system.

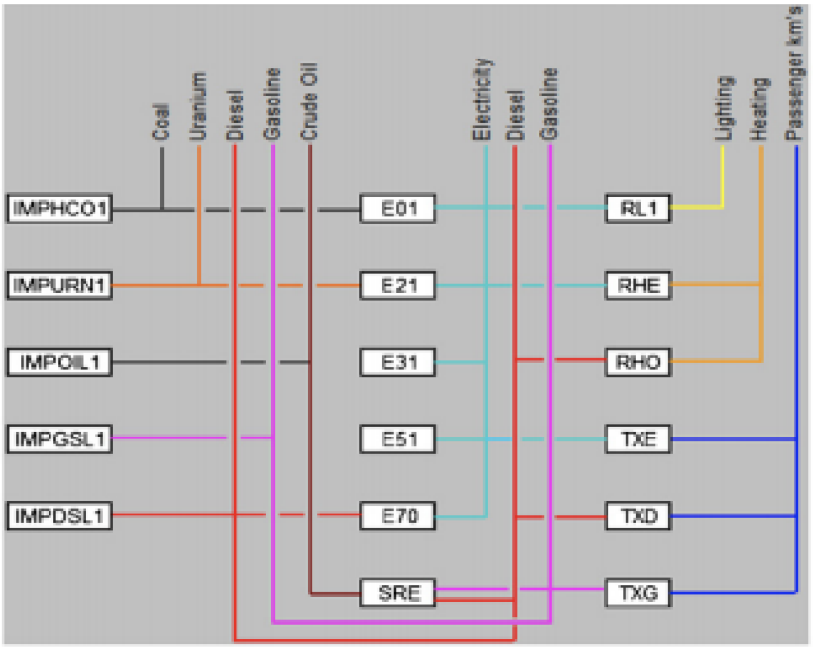


Figure 6: Utopian Reference Energy System

The Utopian energy example shown in figure 6 is the a very simple mapping of technologies. A realistic example is more complex. The NZ Reference Energy System was designed using energy balance data available from the Ministry of Business, Innovation and Employment (MBIE) ([16]). Table 2 describes the technologies mapped in the New Zealand RES. The fuels within the RES are described in table 3. The Australian RES was derived from the Department of Industry, Science, Energy and Resources (ISER) energy data set ([22]). The Australian dataset was adapted to match the NZ RES as RES between regions must follow the same format. Simplifying assumptions were required to ensure RES consistency. Subsequently, these assumptions create limitations in building large energy systems as it may be difficult to create consistent systems with the available data. Figure 7 shows the RES mapping of the NZ energy system for this project. In comparison to the Utopian RES, the mapping of technologies for the NZ RES is more complex.

Categories	Technologies
Production	Indigenous Production, Imports, Exports, Stock Change, International Transport
Conversion	Electricity Generation, Cogeneration, Fuel Production, Other Transformation, Losses and Own Use
Non Energy Uses	Non Energy
Consumption	Agriculture, Forestry and Logging, Fishing, Mining, Food Processing, Textiles, Wood Pulp Paper and Printing, Chemicals, Non Metallic Minerals, Basic Metals, Mechanical Electrical Equippment, Building and Construction, Unallocated, Commercial, Transport, Residential

Table 2: NZ Reference Energy System Technologies

Fuel Type	Fuels
Coal	Bituminous, Sub Bitumious, Lignite,
Oil	Crude Feedstocks NGL, LPG, Petrol, Diesel, Fuel Oil, Aviation Fuel and Kerosine, Oil Other
Natural Gas	Natural Gas
Renewables	Hydro, Geothermal, Solar, Wind, Liquid Biofuels, Biogas, Wood
Electricity	Electricity
Waste Heat	Waste Heat

Table 3: NZ Reference Energy System Fuels

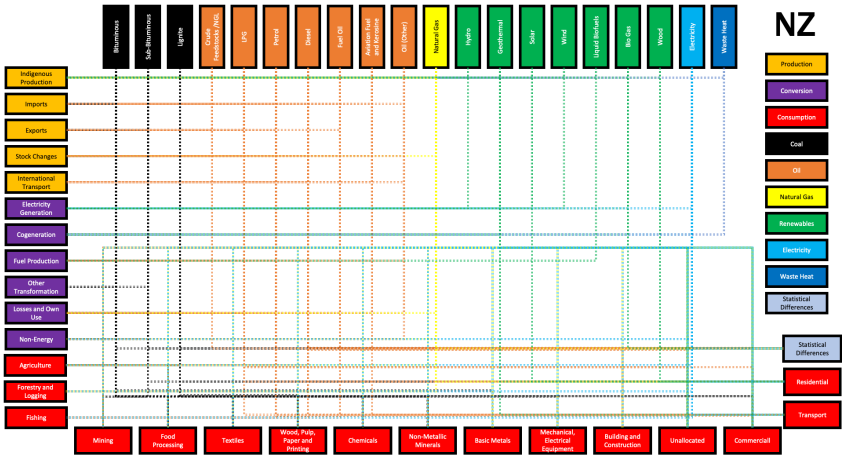


Figure 7: NZ Reference Energy System Mapping

4.6.5 Energy Balances

Energy balances are the base year energy production, conversion and consumption for a reference energy system. The energy balance is forecast for each interval in the energy system's time horizon. The NZ and Australia energy balances for the NZ example RES are derived from MBIE and ISER data respectively. Additionally, GOCPI includes a functionality to create energy balances from a large dataset published by International Energy Agency (IEA) ([2]). A constant average growth rate (CAGR) forecasting methodology was the baseline forecasting methodology for this project. This is a simple forecasting method. The energy balances between 2010 and 2018 were used to derive the CAGR using the formula as shown in figure 8.

$$\text{CAGR} = \frac{\text{Value}_{\text{Final}}}{\text{Value}_{\text{Initial}}}^{\frac{1}{(\text{Number of Years})}} - 1$$

Figure 8: CAGR Formula

The number of parameters to estimate made forecasting difficult. The use of CAGR to forecast values is not very realistic as you cannot assume values will grow or fall at a constant rate. Stochasticity is a large factor in energy production, conversion and consumption. OseMOSYS does not account for stochasticity. Therefore, randomness is not addressed. There are no degrees of freedom

for estimated parameters. For example, renewable energy production is stochastic. Weather patterns are increasing volatile so energy production will need to address this volatility for accuracy. It is recommended future developments include Machine Learning (ML) and Autoregressive Integrated Moving Average Models (ARIMA) forecasting methods. An ARIMA model is a times series forecasting method aiming to describe autocorrelations in the data to account for stochasticity ([33]). ML methods train models to make energy balance predictions using factors not obviously considered.

4.6.6 Trade Relationships

The trade relationships describe the exchange of energy-related resources between the modeled regions in the energy system.

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

Figure 9: NZ/AUS Trade Matrix

These relationships are modeled using a four dimensional matrix. The matrix is indexed as follows: [region, region, fuel, year]. The first position corresponds to the regions where trade originates from. The second position corresponds to the regions which receive trade from the region indexed in the first position. The third position is the fuel being traded. The fourth position is the year the trade takes place. Values are binary to set trade between two regions for fuels and regions (1 = Trade, 0 = No Trade). The NZ energy system example assumes free trade exist between both NZ and Australia for all fuel types every year.

4.6.7 Discount Rate

The **discount rate** for a region is one of the most important concepts as informs for discounted costs and therefore the objective function. The function **def set_discount_rate** calculates the discount rate for each region. This function is most important as the discount rate underpins the total value of discounted cash flows and the objective function. The discount rate is calculated using the weighted average cost of capital (WACC) method. The WACC, cost of equity, cost of preference equity and pre-tax cost of debt are calculated as follows:

$$WACC = \frac{D}{E+D+K} \times r_d \times (1-t) + \frac{E}{D+E+K} \times r_e + \frac{K}{D+E+K} \times r_k \quad (1)$$

$$r_e = r_f + \beta \times (r_m - r_f) \quad (2)$$

$$r_d = \frac{i}{D} \quad (3)$$

$$r_k = \frac{Div}{MV_{ps}} \quad (4)$$

D = Book value of debt ($m)
r_f = Risk free rates (%)
K = Market value of preferred equity ($m)
r_d = Pre-tax cost of debt (%)
r_e = Cost of ordinary equity (%)
Div = Preference Dividends ($)
MV_{ps} = Market value of preference shares ($)
r_k = Cost of preferred equity (%)
t = Effective tax rate (%)
i = Cost of borrowings (%)
β = Market risk co-efficient (%)
r_m = Market return (%)
E = Market value of equity ($m)

The regions used in the energy system example are New Zealand and Australia. Both are public entities in this case. The model may be used for both private and public entities. It is assumed the financial performance and position for each region, reported in the the New Zealand and Australian Government's financial reports, are suitable for providing the financials necessary for calculating discount rates. Cost of borrowings (i), Equity (E), Debt (D) and Preference Equity (K) are reported in each region's annual financial reports (New Zealand [55] and Australia [29]). It is assumed both have no preference shareholders, do not distribute preference dividends (Div), list preference shares (MV_{ps}) or have preference equity (K). The effective tax rates (t) are each region's company tax rate. This example assumes New Zealand's market value of equity (E) is zero as not publically traded and Australia's negative net work implies market equity (E) is zero. Risk free rates (r_f) were derived from average 10 Year Government bond yields using data from each region's respective Reserve Bank (Reserve Bank of New Zealand [42] and Reserve Bank of Australia [8]). The monthly market returns for each region are annualised to calculate the market return (r_m). Each region has a market index which serves as a proxy for the market. New Zealand has the NZX 50 and Australia has the ASX 200. Historical returns related to these proxies were downloaded from yahoo finance [26]. Monthly returns are annualised as follows:

$$\text{Annualised Monthly Return} = ((1 + \frac{\text{Index}_{\text{Ending}} - \text{Index}_{\text{Beginning}}}{\text{Index}_{\text{Beginning}}})^{(\frac{12}{\text{Number of Months}})}) - 1 \tag{5}$$

The cost of ordinary equity is calculated using the Capital Assets Pricing Model (CAPM), a model to describe the relationship between systematic risk and expected return for assets. Both New Zealand and Australia are assumed to have market risk co-efficients (β) of zero as their fiscal policy is market independent. This methodology is appropriate for both public and private entities.

The RES, energy balances, trade relationships and discount rate are a small subset of the energy systems concepts required to build a model. Please refer to the model sets and parameters in the **GOCPI_OseMOSYS_Structure** for the complete list of required energy system concepts required to build an energy system.

4.7 Optimisation

OseMOSYS is expressed as a linear programme requiring a commercial solver to solve the system. A few commercial solvers were considered.

4.7.1 IBM CPLEX

IBM has a suite of optimisation and analytics services accessible on IBM Cloud. There is an Academic Initiative to grant access to the suite of service's for free. The IBM ILOG CPLEX Optimisation Studio allows the user to build and solve problems locally. There are a number of Python APIs to access the IBM Cloud or the Optimisation Studio.

4.7.2 Gurobi

The Gurobi suite of optimisation products was considered as the default commercial solver. The Gurobi Optimizer can solve linear programmes and has the capability to use Python APIs to solve energy systems locally. Gurobi also offers the Gurobi Computer Server and Gurobi Cloud, suppported by Microsoft Azure and Amazon Web Services, to solve large optimisation problems remotely.

4.7.3 Optimisation Implementation

IBM's suite of services offered greater opportunities to develop the product further by setting up a pipeline to take advantage of IBM Cloud's full range of services.

Firstly, the IBM Academic Initiative grants the user access to a subset of the full sweet of IBM products. The user must represent, or be a member of, an academic institution to gain access to the initiative. The academic initiative allocates a IBMid linked to an academic email address. This IBMid enables access to IBM's services.

The CPLEX Optimisation Studio IDE was installed locally to enable the installation of both cplex and docplex Python APIs. The cplex API connects with the CPLEX Optimisation Studio IDE (10)to solve small scale optimisation problems locally. Alternatively, you can build your models in the IDE instead of using the Python API. The docplex API uses an api key to connect to a remote server to run the IBM Decision Optimisation service and solve larger optimisation problems in the cloud. Unfortunately, the IBM Decision Optimisation in Cloud service the docplex API connects to was discontinued in September 2020. The IBM Decision Optimisation in Cloud service was imported into the IBM Watson Machine Learning service in IBM Cloud. Subsequently, the project had to pivot to using the IBM Cloud services to solve larger energy systems.

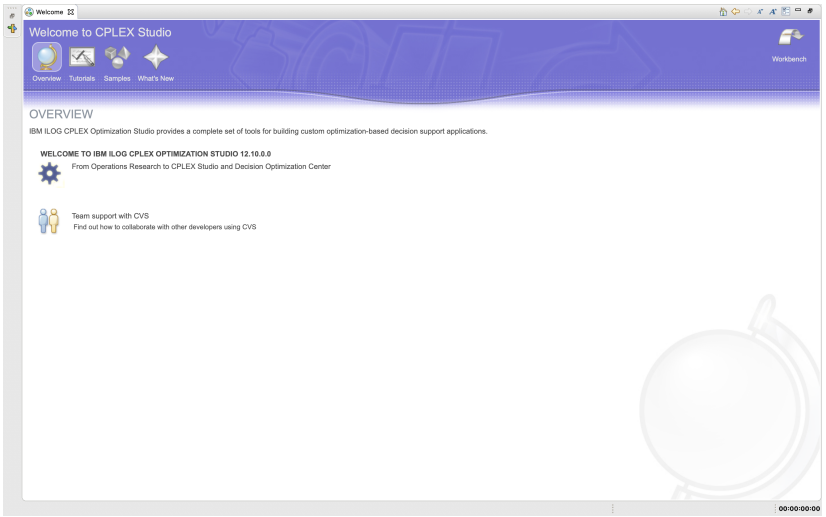


Figure 10: CPLEX Optimisation Studio IDE

An API key is required to use IBM Cloud services. This key grants access to your account and use of all licensed services. IBM Cloud has approximately 173 services to analyse

data and inform decisions. A subset of these services are displayed in figure 11.

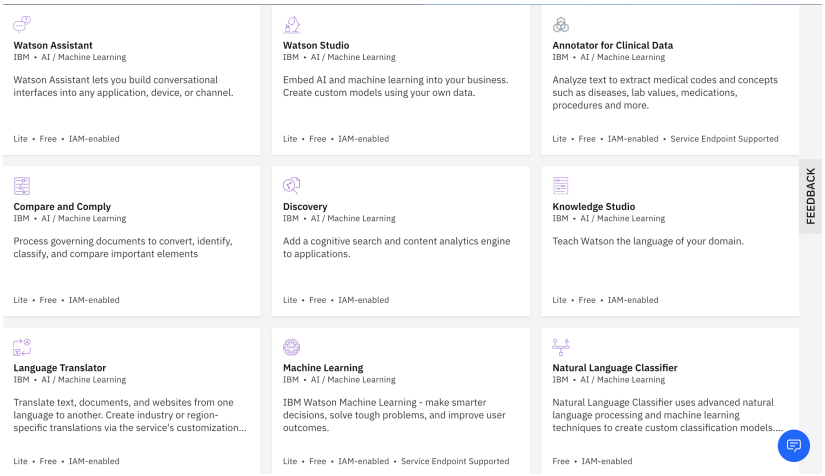


Figure 11: IBM Cloud Services

Services include AI/Machine Learning, Blockchain, Security, Database and Optimisation functionalities. The IBM Decision Optimisation service sits within the IBM Watson Machine Learning Service which is apart of IBM Watson Studio resource. A service or storage object sits within a resource. A new IBM Watson Studio resource was created to access the required services. After initialising the resource, the GOCPI project was created. This project contains two additional services and one deployment space. The services are the IBM Watson Machine Learning service to use the IBM Decision Optimisation service and a Cloud Storage Object (COS). The COS stores content related to the project. The deployment space is the location to evaluate, configure, deploy and monitor deployable assets. A deployment asset includes the input data and model formulation related to the project. Each component of a resource (service, storage object etc.) has a CRN and GUID tag. These identify the services when accessing them remotely using API's. Services are executed using the **ibm_watson_machine_learning** module and IBM Developer Tools VS Code extension.

The process to solve energy systems, using the IBM Decision Optimisation service, is as follows:

1. Create the IBM Watson Machine Learning, COS and Deployment Space on IBM Watson Studio.
2. Formulate the OseMOSYS model, in Python, for model deployment.
3. Create a model deployment to fill the deployment space (if one does not already exist).
4. Design a payload (input data and output structure).
5. Create a new job to solve the payload using the model deployment.
6. Push the job in the deployment space until the energy system either solved or deemed infeasible.

The docplex API enabled IBM Decision Optimisation to solve energy systems in a lp format. Therefore, the GNU Mathprog OseMOSYS formulation was acceptable using the docplex API. Unfortunately, the IBM Watson Machine Learning Decision Optimisation service required Python-based OseMOSYS model formulations. This limitation lead to the inability to solve large scale energy systems. A pipeline was created to solve Python-

based OseMOSYS formulations for subsequent iterations detailed in section 6.2. This pipeline is detailed in section 4.9.6.

4.8 Interface

It was important to make the tool accessible for those proficient in python. The model needed to easy way to access and distribute the GOCPI product. A website was the best tool to achieve this desired outcome. The website has one page dedicated to the project interface. The remaining pages relate to content out of project scope.

4.8.1 Jekyll, GitHub pages and Google Domain

Jekyll is a static site generator, simple in nature and written in Ruby. GitHub enables the free hosting of websites through GitHub pages. GitHub pages is powered by Jekyll, enabling the ability to build websites. The directory structure for the project website is shown in figure 12.

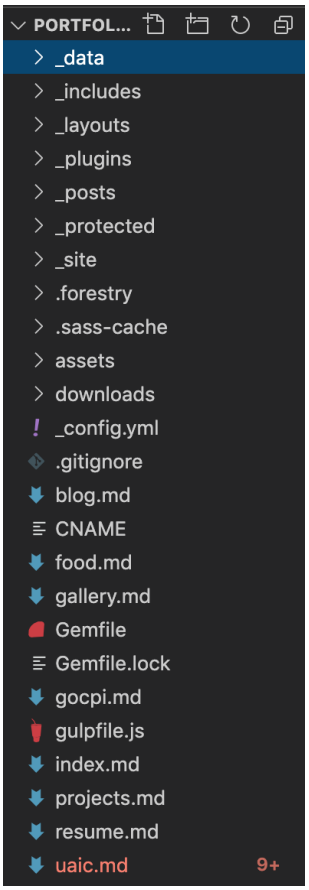


Figure 12: Website Directory

Jekyll is unique in terms of site generation. Ruby gems are used for package management. Ruby and bundler was installed on the local device to enable website development. Firstly, the GitHub pages functionality and a custom domain name were initialised for the GitHub repository. In the Gemfile shown in figure 12, ruby gem commands were added to control the website's theme, markdown parsing and GitHub pages adaptation. Content was transcribed in markdown files using text. These markdown files were converted into html scripts stored in the _site sub directory. An outline of the project was conveyed through an embedded video presentation and a hyperlinked powerpoint. Hyperlinked images take the user to this project report and the research compendium. At the base of the site, there are hyperlinks to download and install the software required to use the product. The images used for hyperlinking were stored in the assets sub directory. The hyperlinked reports are stored in the downloads sub directory. The structure of the html scripts generated from markdown files were stored in the _layouts sub directory. A custom css file to enable video embedding was added to a video embedding html script in the _includes folder to enable responsive sizing when switching between mobile and desktop displays. The minima theme, github pages and kramdown-parser-gfm gems were added to the Gemfile and implemented using the terminal command **bundle exec jekyll serve**. This command uses the bundler package and Gemfile to generate the html and css files required to build the website. The command also creates a local server to display the website. Committing and pushing changes to the GitHub repository generates updates for website content. Additionally, a google

domain name (https://connormcdowall.com) was purchased for the project. The chosen domain name was purchased as will be used for additional uses outside the scope of the project. Custom resource records (IP) were generated to create a new Domain Name System (DNS) record. This record translates the purchased domain to the newly set IP addresses in order to load the website on any internet browser.

4.9 Standardised Forecasting Methodology: GOCPI Package Development

4.9.1 PyPI and Directory Structure

The aforementioned distribution method PyPI (section 4.1.8) was most appropriate. The GOCPI project is listed as an active project. The package required a specific directory structure to publish new distributions. The **GOCPI** stores several files required for the package: A sub directory of the same name containing an initialisation file (**init.py**) and package modules. A distributions sub directory (**dist**) for new package versions. A Python file for setup information (**setup.py**) and a setup file for package configuration (**setup.cfg**). Lastly, there is a sub directory storing text files related to dependencies, package information and source links.

New distributions are stored in the **dist** displayed in figure 13. **Twine** is a package to upload new setup descriptions, configurations and code changes via the local terminal. PyPI enables the immediate release and availability of the GOCPI package. Users can continue to use the product as new versions are released.

The development of the GOCPI package used the following process:

1. Make additions, deletions or increments to package modules.
2. Update the initialisation file to reflect additions, deletions or increments.
3. Update package information in the **setup.py** file and increment package version number.
4. Create a new distribution (tar.gz file) using the following command: **python setup.py sdist**.
5. Upload the new distribution using the following command: **twine upload dist/GOCPI-X.tar.gz'** where X is the version number.
6. Download the new distribution using the following command: **pip install –upgrade GOCPI'**.

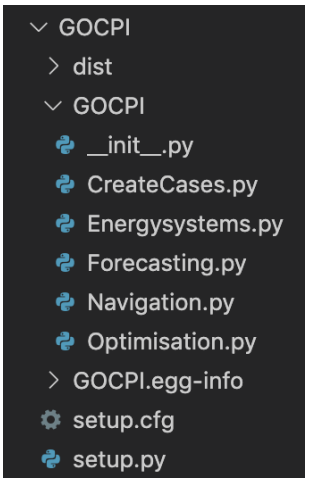


Figure 13: GOCPI File Structure

Over 80 distributions were released during this prototype's development. Five classes were developed to support the construction, forecasting and optimisation of user defined energy systems. These will be addressed in turn as contribute to the key functionalities of

the package. The docstrings related to all written functions may be found in the section 9.3.

4.9.2 Navigation Module

The navigation module is a class to help the user navigate their local directory. The most important function in this class is the **Find_File** function. The purpose of Find_File() is to enable the user to seek and find designated files in their modelling directory from a directory root. This root may be any node in the directory structure. The FindFile function is important for the other functions in this package.

4.9.3 EnergySystems Module

The EnergySystems module is a class to load, create model text files and create data text files from input user defined energy systems. There are three core modules to this class. **load_datacase()**, **create_model_file()** and **create_data_file()**. The EnergySystems class is initialized by taking the 11 sets, defined as lists, outlined in section 4.5.2 as inputs. The lengths of these sets are calculated using python's numpy module and used to initialise all 52 parameters related to an OseMOSYS energy model.

The load_datacase() function will load a user built energy system as outlined in section 4.6. The function simply replaces the EnergySystems initial sets and parameters with the ones defined by the user. The create_model_file() reads the GOCPI_OseMOSYS_Structure.xlsx explained in section 4.5.4 using the pandas module and writes the generated dataframe to a text file in the correct structure.

The create_data_file() function is the most extensive of the three functions in this class. Simplistically, the function write the python arrays and matrices for each set and parameter to one text file. Each set and parameter must have the correct syntax and structure to create a compatible data file written as a text file. Effectively, user-defined python-based multi-dimensional lists/arrays had to be converted into GNU Mathprog-structure data blocks. This GNU Mathprog conversion had to occur for all 11 sets and 52 parameters. Sets and parameters varied in size, ranging from one dimensional arrays/lists to five dimensional matrices. The variability of size and need for correct naming conventions created a considerable design challenge. This solution had to change based on the users inputs while still generating the correct GNU Mathprog structure. The solution was to design a conversion block for each set and parameter. Examples of set and conversion block are shown in listings 1 and 2 in the appendix section 9.1. Please refer to the Research Compendium for the complete set of 63 Python to GNU Mathprog Conversion Blocks in the create_data_file() function. The create_data_file() is approximately 2000 lines including commenting and formatting described in section 4.1.9.

4.9.4 CreateCases Module

The create cases module is the most comprehensive of the GOCPI package. This module sets the user-defined sets and parameters to an energy systems class. The class is initialised with an empty set of energy system sets and parameters. Each set and parameter has it's own function to set the correct values. The construction of an energy system occurs in a processing script. The development of the NZ energy system was facilitated in the (**GOCPI_NZ_Example.gyp**) script as explained in section 4.6.2. Please refer to

the **Research Compendium** for a complete set of the functions in **CreateCases** class and the **GOCPI_NZ_Example.gyp** Processing Script.

4.9.5 Forecasting Class

The forecasting class contains three modules. The **energy_balance_base()**, **calculate_constant_average_growth_rate()** and **calculate_cagr_forecast()**. A major issue in designing energy systems is the inconsistency of energy data across different regions. An energy system requires consistent reference energy systems across regions. The structure is the same with the flows and values different.

The energy_balance_base() module solves this issue. The International Energy Agency publishes a comprehensive dataset for energy balances in OECD countries. A process was developed to extract IEA's Energy balance for a target region. The 2017 IEA world energy balances were downloaded and stored in two csv files, approximately $1.35 million data points. The files are processed to extract a unique list of fuels, technologies and regions. These lists are stored as data frames. The user is prompted to select a target region to extract energy balances. The energy balances for the target region is stored as a pivot table and returns a dictionary with the unique list and pivot table. The NZ energy system example uses different data for proof of concept. Further developments should prioritise the International Energy Agency dataset to standardise the structure of energy balances for reference energy systems.

The calculate_constant_average_growth_rate() is a simple function to calculate the constant average growth rate (CAGR) for a time period. The formula is expressed in figure 8.

The calculate_cagr_forecast() uses the calculate_constant_average_growth_rate() function to forecast energy balances. Several dictionaries are passed into the function to forecast the energy balance for each interval in the time horizon.

4.9.6 Optimisation Class

The optimisation class has two core functions: **run_cplex_local()** and **run_ibm_wml_do()**. These two modules run IBM's commercial solvers, either locally or remotely, to minimise the total discounted cost for the energy system.

The run_cplex_local() module initialises a model, loads the energy system model file, solves the problem and returns the objective function value.

The run_ibm_wml_do() is more complex. Firstly, the function initialises IBM credentials to grant the user remote access to IBM Cloud services. After initialising credentials, a deployment space is created on the IBM Cloud service. If needed, data assets are created. After the creation of a deployment space, a deployment is either created or loaded from an existing set. Lastly, a model payload is sent as a new job request to the deployment to solve the problem using the IBM Watson Machine Learning Decision Optimisation service. This function is written to accommodate future developments of a Python-based OseMOSYS methodology.

The remaining functions are in development at this stage of the project.

5 Results

5.1 Outline

The intention of this project was to develop a global carbon pricing optimisation model. The project changed in scope slightly as limitations were discovered, leading to the need to pivot in new directions. Carbon taxes are imposed as constraints in the OseMOSYS methodology. This project successfully sets the foundation for building a Python-based open source energy modelling tool. The TIMES methodology explored was not suitable for building a scalable solution. OseMOSYS was a better alternative as the methodology is more intuitive while still capturing the complexity required for energy modelling. An energy modeller can access the OseMOSYS model in Excel to customise the model formulation to meet their needs. Geographies are partitioned to use regions and IEA world energy balances in order to construct reference energy systems. The user can devise processing scripts to design and formulate their own energy systems with Python dictionaries and matrices. The GOCPI package provides a suite of classes to build, solve and interpret energy systems. A user can design energy systems, navigate directories to access files, formulate energy systems, make forecasts and solve energy systems with IBM optimisation technologies using the package. The package is distributed using PyPI and can be installed using pip, Python's package management software. All project related information is accessible on a website which acts as an interface for the user. A pipeline was created to build a Python-based OseMOSYS model, continue to build the user-defined energy systems and use IBM Cloud technologies to inform analysis. The project set the foundation to create an accessible, scalable energy modelling tool in order to make informed decisions about energy investment and policy.

5.2 Deliverables

This project does not have a traditional set of results from experimentation. The project has set of deliverables informing a minimal viable product (MVP) and the process for further development. The following list describes the deliverables achieved in this project:

1. An adaptation of the OseMOSYS Methodology a user can customise to meet modelling needs.
2. A method to generate energy balances for regions from IEA world energy balances.
3. A processing script to build user defined energy systems.
4. A partially complete energy system, with a bi-lateral trade relationship between Australia and New Zealand, to show proof of concept.
5. The ability to solve energy system models locally using the IBM ILOG CPLEX Optimisation Studio and associated Python APIs.
6. A pipeline to use IBM Cloud services to solve energy system models using the IBM Decision Optimisation service.
7. A Python-based open source energy modelling package (GOCPI) distributable using PyPI. Use the following command to access: **pip install GOCPI**.
    (a) Navigation: Navigate directory structures to access key resources and data.

(b) EnergySystems: Convert energy systems into the necessary formats needed to solve the system.

(c) CreateCases: Build energy systems from Python arrays and dictionaries.

(d) Forecasting: Generate energy balances and forecast energy/financial information.

(e) Optimisation: Utilize IBM technologies to solve energy systems. These models may be solved locally or remotely.

8. A website to access key project resources and communicate information related to the project. **Visit the website here to view content.**

6 Discussion

6.1 Outcome

Here, we summarise the key findings from the project. Section 6.1.1 outlines the inaccessibility of the legacy approach to energy modelling. Section 6.1.2 identifies OseMOSYS is the best alternative to the legacy offering. Section 6.1.3 explains the GOCPI package developed as the main project deliverable. Section 6.1.4 identifies the construction of a process to correctly design energy systems. Section 6.2 outlines the improvements to make to the modelling approach and GOCPI package.

6.1.1 TIMES

TIMES is the legacy energy modelling approach for energy systems. After attempting to set up the structure required to create a scalable energy system, the approach was deemed not fit for purpose considering the scope of the project. Ultimately, reproducibility, integration and complexity issues led to the abandonment of this method.

6.1.2 OseMOSYS

The alternative energy modelling methodology OseMOSYS replaced TIMES. The OseMOSYS structure is similar to most linear programmes with sets, parameters, an objective function, constraints and variables defining an energy system. These models are easy to interpret with constraints and objective function customisable to meet modelling needs. The GNU Mathprog version of OseMOSYS was adapted to build energy systems from reference energy systems.

6.1.3 GOCPI: An open source, scalable energy modelling solution

The main objective of the project was to build a scalable modelling tool. This was achieved in the GOCPI python package. The code repository is version controlled and accessible using GitHub. The package is distributed on PyPI and downloadable using the pip package management software. There are five classes in the package to build and solve energy systems. All classes and modules are well documented for interpretability and inform future developments. The package interfaces with IBM Cloud technologies to solve energy systems.

6.1.4 Methodology

The project establishes a structure for generating energy systems in GNU Mathprog from Python dictionaries, matrices, Numpy arrays and lists. Energy system sets and parameters must be structured consistently to correctly design a system. The process converts one to five dimensional Python matrices into combinations of text blocks need to create lp formatted text files. This structure enables the user to model N combinations of regions in one energy system.

6.2 Outlook

6.2.1 Python Development

The OseMOSYS methodology must be adapted into a Python implementation to take advantage of IBM technologies and solve larger energy systems using the IBM Decision Optimisation service. There is a Python version available for distribution from the OseMOSYS GitHub repository. This version uses Pyomo, a Python-based, open-source optimisation modelling language. Pyomo was not originally chosen as larger energy systems could not be solved remotely on powerful commercial solvers e.g. IBM Cloud of Gurobi. A Python adaptation will be required moving forward.

6.2.2 NZ Example Completion

The energy system with a bi-lateral relationship between New Zealand and Australia is partially complete. Data inconsistency and inaccessibility made it difficult to construct an accurate representation of this energy system. Building this example could be a project in itself. It is important for proof of concept an example system is finished.

6.2.3 Develop Simulation Processes

Energy systems are stochastic in nature with production, conversion and consumption prone to variation e.g. renewable energy production. These uncertainties must be addressed by incorporating stochastic processes in energy modelling. This could be in the form of Autoregressive Integrated Moving Average models or Stochastic Dual Dynamic Programming (SDDP).

6.2.4 Develop Forecasting Methodologies

IBM Cloud has a range of forecasting services using machine learning techniques. These may be used to forecast financial and energy-relate information. Forecasts are currently estimated using constant average growth rates which are unrealistic. There may be unexplained factors to consider in estimating forecasts which more complex methodologies consider.

6.2.5 Develop Investment Strategies

The energy transition will require different investments depending on different stakeholders. A range of investment strategies need to be considered to drive equitable outcomes for the energy transition.

6.2.6 Develop Interactive Interface

It is important to be able to interpret the outputs from an energy system. The objective function, variables and constraints are to be displayed on the web-based user interface.

7 Summary and Conclusion

Energy modelling is inherently quite complex under existing methodologies. It doesn't have to be. The OseMOSYS methodology is a simple alternative that still captures many of the complexities underpinning energy modelling. The GNU Mathprog version of OseMOSYS was adapted to build a scalable method for building energy systems. Reference energy systems for OECD regions are easy to generate. A Python-based open-source energy modelling package gives the modeler the necessary tools to construct energy systems. A pipeline of optimisation and forecasting functionalities is set to further develop the product for functional use. The interface with IBM Cloud technologies enables powerful predictive possibilities. The energy modelers have access to project resources from the web-based interface. This project takes a big leap forward in making energy accessible and removing many of the technical barriers. Continuing to adopt the OseMOSYS methodology and develop the GOCPI package will help inform energy investment and policy. Overall, this initiative will drive equitable outcomes for the energy transition.

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9 Appendices

9.1 Set and Parameter Conversion Blocks

```
# year
set_string = ' '.join(self.year)
f.write('set YEAR\t:=\t{0};\n'.format(set_string))
```

Listing 1: One Dimensional Set Python to GNU Mathprog Conversion Block

```

# DaySplit = np.zeros((llh,ly))
param = 'DaySplit'
f.write('#\n')
columns = self.year
column_string = ' '.join(columns)
# Writes index specific parameter values to the text files
if toggle_defaults[param] == True:
  f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
    param, defaults_dictionary[param], column_string))
  # Converts maxtrix rows to list
  array = np.array(self.dailytimebracket)
  array = array.T
  lt = array.tolist()
  # Creates 2D matrix for this value
  mat = self.DaySplit[:, :]
  # Converts combined matrix to list and combines lists
  matlist = mat.tolist()
  #Combines the two lists
  combined_list = list(zip(lt, matlist))
  # Writes index specific parameter values to the text files
  f.write("param\t{0}\t:{1}:=\n".format(param, column_string))
  for line in combined_list:
    combinedflat = ''.join(str(line))
    combinedflat = combinedflat.replace('[', '')
    combinedflat = combinedflat.replace(']', '')
    combinedflat = combinedflat.replace("'", '')
    combinedflat = combinedflat.replace(",", '')
    combinedflat = combinedflat.replace("(", '')
    combinedflat = combinedflat.replace(")", '')
    f.write("{0}\n".format(combinedflat))
else:
  f.write("param\t{0}\tdefault\t{1}:=\n".format(
    param, defaults_dictionary[param]))
f.write(';\n')
```

Listing 2: Two Dimensional Parameter Python to GNU Mathprog Conversion Block

9.2 OseMOSYS Model

The Open Source Energy Modelling System is a linear programme with sets, parameters, an objective function and constraints related to energy systems. The model is described below. Please refer to GOCPI OseMOSYS Structure.xlsx in the GitHub Repository for full descriptions of the sets, parameters and constraints.

```
set YEAR;
set TECHNOLOGY;
set TIMESLICE;
set FUEL;
set EMISSION;
set MODE_OF_OPERATION;
set REGION;
set SEASON;
set DAYTYPE;
set DAILYTIMEBRACKET;
set STORAGE;
param YearSplit{l in TIMESLICE,y in YEAR};
param DiscountRate{r in REGION};
param DaySplit{lh in DAILYTIMEBRACKET,y in YEAR};
param Conversionls{l in TIMESLICE,ls in SEASON};
param Conversionld{l in TIMESLICE,ld in DAYTYPE};
param Conversionlh{l in TIMESLICE,lh in DAILYTIMEBRACKET};
param DaysInDayType{ls in SEASON ,ld in DAYTYPE,y in YEAR};
param TradeRoute{r in REGION,rr in REGION,f in FUEL,y in YEAR};
param DepreciationMethod{r in REGION};
param SpecifiedAnnualDemand{r in REGION,f in FUEL,y in YEAR};
param SpecifiedDemandProfile{r in REGION,f in FUEL,l in TIMESLICE,y in
    YEAR};
param AccumulatedAnnualDemand{r in REGION,f in FUEL,y in YEAR};
param CapacityToActivityUnit{r in REGION,t in TECHNOLOGY};
param CapacityFactor{r in REGION,t in TECHNOLOGY,l in TIMESLICE,y in
    YEAR};
param AvailabilityFactor{r in REGION,t in TECHNOLOGY,y in YEAR};
param OperationalLife{r in REGION,t in TECHNOLOGY};
param ResidualCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
param InputActivityRatio{r in REGION,t in TECHNOLOGY,f in FUEL,m in
    MODE_OF_OPERATION,y in YEAR};
param OutputActivityRatio{r in REGION,t in TECHNOLOGY,f in FUEL,m in
    MODE_OF_OPERATION,y in YEAR};
param CapitalCost{r in REGION,t in TECHNOLOGY,y in YEAR};
param VariableCost{r in REGION,t in TECHNOLOGY,m in MODE_OF_OPERATION,y
     in YEAR};
param FixedCost{r in REGION,t in TECHNOLOGY,y in YEAR};
param TechnologyToStorage{r in REGION,t in TECHNOLOGY,s in STORAGE,m in
     MODE_OF_OPERATION};
param TechnologyFromStorage{r in REGION,t in TECHNOLOGY,s in STORAGE,m
    in MODE_OF_OPERATION};
param StorageLevelStart{r in REGION,s in STORAGE};
param StorageMaxChargeRate{r in REGION,s in STORAGE};
param StorageMaxDischargeRate{r in REGION,s in STORAGE};
param MinStorageCharge{r in REGION,s in STORAGE,y in YEAR};
param OperationalLifeStorage{r in REGION, s in STORAGE};
param CapitalCostStorage{r in REGION,s in STORAGE,y in YEAR};
param ResidualStorageCapacity{r in REGION,s in STORAGE,y in YEAR};
param CapacityOfOneTechnologyUnit{r in REGION,t in TECHNOLOGY,y in YEAR
    };
```

```
param TotalAnnualMaxCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalAnnualMinCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
param TotalAnnualMaxCapacityInvestment{r in REGION,t in TECHNOLOGY,y in
    YEAR};
param TotalAnnualMinCapacityInvestment{r in REGION,t in TECHNOLOGY,y in
    YEAR};
param TotalTechnologyAnnualActivityUpperLimit{r in REGION,t in
   TECHNOLOGY,y in YEAR};
param TotalTechnologyAnnualActivityLowerLimit{r in REGION,t in
   TECHNOLOGY,y in YEAR};
param TotalTechnologyModelPeriodActivityUpperLimit{r in REGION,t in
   TECHNOLOGY};
param TotalTechnologyModelPeriodActivityLowerLimit{r in REGION,t in
   TECHNOLOGY};
param ReserveMarginTagTechnology{r in REGION,t in TECHNOLOGY,y in YEAR
   };
param ReserveMarginTagFuel{r in REGION,f in FUEL,y in YEAR};
param ReserveMargin{r in REGION,y in YEAR};
param RETagTechnology{r in REGION,t in TECHNOLOGY,y in YEAR};
param RETagFuel{r in REGION,f in FUEL,y in YEAR};
param REMinProductionTarget{r in REGION,y in YEAR};
param EmissionActivityRatio{r in REGION,t in TECHNOLOGY,e in EMISSION,m
    in MODE_OF_OPERATION,y in YEAR};
param EmissionsPenalty{r in REGION,e in EMISSION,y in YEAR};
param AnnualExogenousEmission{r in REGION,e in EMISSION,y in YEAR};
param AnnualEmissionLimit{r in REGION,e in EMISSION,y in YEAR};
param ModelPeriodExogenousEmission{r in REGION,e in EMISSION};
param ModelPeriodEmissionLimit{r in REGION,e in EMISSION};
var RateOfDemand{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
var Demand{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR}>=0;
var RateOfStorageCharge{r in REGION,s in STORAGE,ls in SEASON,ld in
   DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
var RateOfStorageDischarge{r in REGION,s in STORAGE,ls in SEASON,ld in
   DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
var NetChargeWithinYear{r in REGION,s in STORAGE,ls in SEASON,ld in
   DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
var NetChargeWithinDay{r in REGION,s in STORAGE,ls in SEASON,ld in
   DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
var StorageLevelYearStart{r in REGION,s in STORAGE,y in YEAR}>=0;
var StorageLevelYearFinish{r in REGION,s in STORAGE,y in YEAR}>=0;
var StorageLevelSeasonStart{r in REGION,s in STORAGE,ls in SEASON,y in
   YEAR}>=0;
var StorageLevelDayTypeStart{r in REGION,s in STORAGE,ls in SEASON,ld
   in DAYTYPE,y in YEAR}>=0;
var StorageLevelDayTypeFinish{r in REGION,s in STORAGE,ls in SEASON,ld
   in DAYTYPE,y in YEAR}>=0;
var StorageLowerLimit{r in REGION,s in STORAGE,y in YEAR}>=0;
var StorageUpperLimit{r in REGION,s in STORAGE,y in YEAR}>=0;
var AccumulatedNewStorageCapacity{r in REGION,s in STORAGE,y in YEAR
   }>=0;
var NewStorageCapacity{r in REGION,s in STORAGE,y in YEAR}>=0;
var CapitalInvestmentStorage{r in REGION,s in STORAGE,y in YEAR}>=0;
var DiscountedCapitalInvestmentStorage{r in REGION,s in STORAGE,y in
   YEAR}>=0;
var SalvageValueStorage{r in REGION,s in STORAGE,y in YEAR}>=0;
var DiscountedSalvageValueStorage{r in REGION,s in STORAGE,y in YEAR
   }>=0;
var TotalDiscountedStorageCost{r in REGION,s in STORAGE,y in YEAR}>=0;
```

```
84 var NumberOfNewTechnologyUnits{r in REGION,t in TECHNOLOGY,y in YEAR
   }>=0, integer;
85 var NewCapacity{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
86 var AccumulatedNewCapacity{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
87 var TotalCapacityAnnual{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
88 var RateOfActivity{r in REGION,l in TIMESLICE,t in TECHNOLOGY,m in
   MODE_OF_OPERATION,y in YEAR} >=0;
89 var RateOfTotalActivity{r in REGION,t in TECHNOLOGY,l in TIMESLICE,y in
    YEAR} >=0;
90 var TotalTechnologyAnnualActivity{r in REGION,t in TECHNOLOGY,y in YEAR
   } >=0;
91 var TotalAnnualTechnologyActivityByMode{r in REGION,t in TECHNOLOGY,m
   in MODE_OF_OPERATION,y in YEAR} >=0;
92 var TotalTechnologyModelPeriodActivity{r in REGION,t in TECHNOLOGY};
93 var RateOfProductionByTechnologyByMode{r in REGION,l in TIMESLICE,t in
   TECHNOLOGY,m in MODE_OF_OPERATION,f in FUEL,y in YEAR}>=0;
94 var RateOfProductionByTechnology{r in REGION,l in TIMESLICE,t in
   TECHNOLOGY,f in FUEL,y in YEAR} >=0;
95 var ProductionByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f
    in FUEL,y in YEAR} >=0;
96 var ProductionByTechnologyAnnual{r in REGION,t in TECHNOLOGY,f in FUEL,
   y in YEAR} >=0;
97 var RateOfProduction{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR
   }>=0;
98 var Production{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
99 var RateOfUseByTechnologyByMode{r in REGION,l in TIMESLICE,t in
   TECHNOLOGY,m in MODE_OF_OPERATION,f in FUEL,y in YEAR} >=0;
100 var RateOfUseByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f
   in FUEL,y in YEAR} >=0;
101 var UseByTechnologyAnnual{r in REGION,t in TECHNOLOGY,f in FUEL,y in
   YEAR} >=0;
102 var UseByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f in
   FUEL,y in YEAR} >=0;
103 var RateOfUse{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR}>=0;
104 var Use{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
105 var Trade{r in REGION,rr in REGION,l in TIMESLICE,f in FUEL,y in YEAR};
106 var TradeAnnual{r in REGION,rr in REGION,f in FUEL,y in YEAR};
107 var ProductionAnnual{r in REGION,f in FUEL,y in YEAR} >=0;
108 var UseAnnual{r in REGION,f in FUEL,y in YEAR}>=0;
109 var CapitalInvestment{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
110 var DiscountedCapitalInvestment{r in REGION,t in TECHNOLOGY,y in YEAR}
   >=0;
111 var SalvageValue{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
112 var DiscountedSalvageValue{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
113 var OperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
114 var DiscountedOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
115 var AnnualVariableOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR}
   >=0;
116 var AnnualFixedOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR}
   >=0;
117 var TotalDiscountedCostByTechnology{r in REGION,t in TECHNOLOGY,y in
   YEAR} >=0;
118 var TotalDiscountedCost{r in REGION,y in YEAR} >=0;
119 var ModelPeriodCostByRegion{r in REGION}>=0;
120 var TotalCapacityInReserveMargin{r in REGION,y in YEAR} >=0;
121 var DemandNeedingReserveMargin{r in REGION,l in TIMESLICE,y in YEAR}
   >=0;
122 var TotalREProductionAnnual{r in REGION,y in YEAR};
```

```
123 var RETotalProductionOfTargetFuelAnnual{r in REGION,y in YEAR};
124 var AnnualTechnologyEmissionByMode{r in REGION,t in TECHNOLOGY,e in
    EMISSION,m in MODE_OF_OPERATION,y in YEAR} >=0;
125 var AnnualTechnologyEmission{r in REGION,t in TECHNOLOGY,e in EMISSION,
    y in YEAR} >=0;
126 var AnnualTechnologyEmissionPenaltyByEmission{r in REGION,t in
    TECHNOLOGY,e in EMISSION,y in YEAR} >=0;
127 var AnnualTechnologyEmissionsPenalty{r in REGION,t in TECHNOLOGY,y in
    YEAR} >=0;
128 var DiscountedTechnologyEmissionsPenalty{r in REGION,t in TECHNOLOGY,y
    in YEAR} >=0;
129 var AnnualEmissions{r in REGION,e in EMISSION,y in YEAR} >=0;
130 var ModelPeriodEmissions{r in REGION,e in EMISSION} >=0;
131 minimize cost: sum{r in REGION, y in YEAR} TotalDiscountedCost[r,y];
132 s.t. EQ_SpecifiedDemand{r in REGION, l in TIMESLICE, f in FUEL, y in
    YEAR}: SpecifiedAnnualDemand[r,f,y]*SpecifiedDemandProfile[r,f,l,y]
    / YearSplit[l,y]=RateOfDemand[r,l,f,y];
133 s.t. CAa1_TotalNewCapacity{r in REGION, t in TECHNOLOGY, y in YEAR}:
    AccumulatedNewCapacity[r,t,y] = sum{yy in YEAR: y-yy <
    OperationalLife[r,t] && y-yy>=0} NewCapacity[r,t,yy];
134 s.t. CAa2_TotalAnnualCapacity{r in REGION, t in TECHNOLOGY, y in YEAR}:
     AccumulatedNewCapacity[r,t,y]+ ResidualCapacity[r,t,y] =
    TotalCapacityAnnual[r,t,y];
135 s.t. CAa3_TotalActivityOfEachTechnology{r in REGION, t in TECHNOLOGY, l
     in TIMESLICE, y in YEAR}: sum{m in MODE_OF_OPERATION}
    RateOfActivity[r,l,t,m,y] = RateOfTotalActivity[r,t,l,y];
136 s.t. CAa4_Constraint_Capacity{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, y in YEAR}: RateOfTotalActivity[r,t,l,y] <=
    TotalCapacityAnnual[r,t,y] * CapacityFactor[r,t,l,y]*
    CapacityToActivityUnit[r,t];
137 s.t. CAa5_TotalNewCapacity{r in REGION, t in TECHNOLOGY, y in YEAR:
    CapacityOfOneTechnologyUnit[r,t,y]<>0}: CapacityOfOneTechnologyUnit[
    r,t,y]*NumberOfNewTechnologyUnits[r,t,y] = NewCapacity[r,t,y];
138 s.t. CAb1_PlannedMaintenance{r in REGION, t in TECHNOLOGY, y in YEAR}:
    sum{l in TIMESLICE} RateOfTotalActivity[r,t,l,y]*YearSplit[l,y] <=
    sum{l in TIMESLICE} (TotalCapacityAnnual[r,t,y]*CapacityFactor[r,t,l
    ,y]*YearSplit[l,y])* AvailabilityFactor[r,t,y]*
    CapacityToActivityUnit[r,t];
139 s.t. EBa1_RateOfFuelProduction1{r in REGION, l in TIMESLICE, f in FUEL,
     t in TECHNOLOGY, m in MODE_OF_OPERATION, y in YEAR:
    OutputActivityRatio[r,t,f,m,y] <>0}: RateOfActivity[r,l,t,m,y]*
    OutputActivityRatio[r,t,f,m,y]  = RateOfProductionByTechnologyByMode
    [r,l,t,m,f,y];
140 s.t. EBa2_RateOfFuelProduction2{r in REGION, l in TIMESLICE, f in FUEL,
     t in TECHNOLOGY, y in YEAR}: sum{m in MODE_OF_OPERATION:
    OutputActivityRatio[r,t,f,m,y] <>0}
    RateOfProductionByTechnologyByMode[r,l,t,m,f,y] =
    RateOfProductionByTechnology[r,l,t,f,y];
141 s.t. EBa3_RateOfFuelProduction3{r in REGION, l in TIMESLICE, f in FUEL,
     y in YEAR}: sum{t in TECHNOLOGY} RateOfProductionByTechnology[r,l,t
    ,f,y]  =  RateOfProduction[r,l,f,y];
142 s.t. EBa4_RateOfFuelUse1{r in REGION, l in TIMESLICE, f in FUEL, t in
    TECHNOLOGY, m in MODE_OF_OPERATION, y in YEAR: InputActivityRatio[r,
    t,f,m,y]<>0}: RateOfActivity[r,l,t,m,y]*InputActivityRatio[r,t,f,m,y
    ]  = RateOfUseByTechnologyByMode[r,l,t,m,f,y];
143 s.t. EBa5_RateOfFuelUse2{r in REGION, l in TIMESLICE, f in FUEL, t in
    TECHNOLOGY, y in YEAR}: sum{m in MODE_OF_OPERATION:
    InputActivityRatio[r,t,f,m,y]<>0} RateOfUseByTechnologyByMode[r,l,t,
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    m,f,y] = RateOfUseByTechnology[r,l,t,f,y];
144 s.t. EBa6_RateOfFuelUse3{r in REGION, l in TIMESLICE, f in FUEL, y in
    YEAR}: sum{t in TECHNOLOGY} RateOfUseByTechnology[r,l,t,f,y]  =
    RateOfUse[r,l,f,y];
145 s.t. EBa7_EnergyBalanceEachTS1{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfProduction[r,l,f,y]*YearSplit[l,y] = Production[r,
    l,f,y];
146 s.t. EBa8_EnergyBalanceEachTS2{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfUse[r,l,f,y]*YearSplit[l,y] = Use[r,l,f,y];
147 s.t. EBa9_EnergyBalanceEachTS3{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfDemand[r,l,f,y]*YearSplit[l,y] = Demand[r,l,f,y];
148 s.t. EBa10_EnergyBalanceEachTS4{r in REGION, rr in REGION, l in
    TIMESLICE, f in FUEL, y in YEAR}: Trade[r,rr,l,f,y] = -Trade[rr,r,l,
    f,y];
149 s.t. EBa11_EnergyBalanceEachTS5{r in REGION, l in TIMESLICE, f in FUEL,
     y in YEAR}: Production[r,l,f,y] >= Demand[r,l,f,y] + Use[r,l,f,y] +
     sum{rr in REGION} Trade[r,rr,l,f,y]*TradeRoute[r,rr,f,y];
150 s.t. EBb1_EnergyBalanceEachYear1{r in REGION, f in FUEL, y in YEAR}:
    sum{l in TIMESLICE} Production[r,l,f,y] = ProductionAnnual[r,f,y];
151 s.t. EBb2_EnergyBalanceEachYear2{r in REGION, f in FUEL, y in YEAR}:
    sum{l in TIMESLICE} Use[r,l,f,y] = UseAnnual[r,f,y];
152 s.t. EBb3_EnergyBalanceEachYear3{r in REGION, rr in REGION, f in FUEL,
    y in YEAR}: sum{l in TIMESLICE} Trade[r,rr,l,f,y] = TradeAnnual[r,rr
    ,f,y];
153 s.t. EBb4_EnergyBalanceEachYear4{r in REGION, f in FUEL, y in YEAR}:
    ProductionAnnual[r,f,y] >= UseAnnual[r,f,y] + sum{rr in REGION}
    TradeAnnual[r,rr,f,y]*TradeRoute[r,rr,f,y] + AccumulatedAnnualDemand
    [r,f,y];
154 s.t. Acc1_FuelProductionByTechnology{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, f in FUEL, y in YEAR}: RateOfProductionByTechnology[r,l,
    t,f,y] * YearSplit[l,y] = ProductionByTechnology[r,l,t,f,y];
155 s.t. Acc2_FuelUseByTechnology{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, f in FUEL, y in YEAR}: RateOfUseByTechnology[r,l,t,f,y]
    * YearSplit[l,y] = UseByTechnology[r,l,t,f,y];
156 s.t. Acc3_AverageAnnualRateOfActivity{r in REGION, t in TECHNOLOGY, m
    in MODE_OF_OPERATION, y in YEAR}: sum{l in TIMESLICE} RateOfActivity
    [r,l,t,m,y]*YearSplit[l,y] = TotalAnnualTechnologyActivityByMode[r,t
    ,m,y];
157 s.t. Acc4_ModelPeriodCostByRegion{r in REGION}: sum{y in YEAR}
    TotalDiscountedCost[r,y] = ModelPeriodCostByRegion[r];
158 s.t. S1_RateOfStorageCharge{r in REGION, s in STORAGE, ls in SEASON, ld
     in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{t in TECHNOLOGY
    , m in MODE_OF_OPERATION, l in TIMESLICE:TechnologyToStorage[r,t,s,m
    ]>0} RateOfActivity[r,l,t,m,y] * TechnologyToStorage[r,t,s,m] *
    Conversionls[l,ls] * Conversionld[l,ld] * Conversionlh[l,lh] =
    RateOfStorageCharge[r,s,ls,ld,lh,y];
159 s.t. S2_RateOfStorageDischarge{r in REGION, s in STORAGE, ls in SEASON,
     ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{t in
    TECHNOLOGY, m in MODE_OF_OPERATION, l in TIMESLICE:
    TechnologyFromStorage[r,t,s,m]>0} RateOfActivity[r,l,t,m,y] *
    TechnologyFromStorage[r,t,s,m] * Conversionls[l,ls] * Conversionld[l
    ,ld] * Conversionlh[l,lh] = RateOfStorageDischarge[r,s,ls,ld,lh,y];
160 s.t. S3_NetChargeWithinYear{r in REGION, s in STORAGE, ls in SEASON, ld
     in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{l in TIMESLICE:
    Conversionls[l,ls]>0&&Conversionld[l,ld]>0&&Conversionlh[l,lh]>0}  (
    RateOfStorageCharge[r,s,ls,ld,lh,y] - RateOfStorageDischarge[r,s,ls,
    ld,lh,y]) * YearSplit[l,y] * Conversionls[l,ls] * Conversionld[l,ld]
     * Conversionlh[l,lh] = NetChargeWithinYear[r,s,ls,ld,lh,y];
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161 s.t. S4_NetChargeWithinDay{r in REGION, s in STORAGE, ls in SEASON, ld
    in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: (RateOfStorageCharge
    [r,s,ls,ld,lh,y] - RateOfStorageDischarge[r,s,ls,ld,lh,y]) *
    DaySplit[lh,y] = NetChargeWithinDay[r,s,ls,ld,lh,y];
162 s.t. S5_and_S6_StorageLevelYearStart{r in REGION, s in STORAGE, y in
    YEAR}: if y = min{yy in YEAR} min(yy) then StorageLevelStart[r,s]
    else StorageLevelYearStart[r,s,y-1] + sum{ls in SEASON, ld in
    DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r,s,ls,ld,lh,y
    -1] = StorageLevelYearStart[r,s,y];
163 s.t. S7_and_S8_StorageLevelYearFinish{r in REGION, s in STORAGE, y in
    YEAR}: if y < max{yy in YEAR} max(yy) then StorageLevelYearStart[r,s
    ,y+1] else StorageLevelYearStart[r,s,y] + sum{ls in SEASON, ld in
    DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r,s,ls,ld,lh,y]
     = StorageLevelYearFinish[r,s,y];
164 s.t. S9_and_S10_StorageLevelSeasonStart{r in REGION, s in STORAGE, ls
    in SEASON, y in YEAR}: if ls = min{lsls in SEASON} min(lsls) then
    StorageLevelYearStart[r,s,y] else StorageLevelSeasonStart[r,s,ls-1,y
    ] + sum{ld in DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r
    ,s,ls-1,ld,lh,y] = StorageLevelSeasonStart[r,s,ls,y];
165 s.t. S11_and_S12_StorageLevelDayTypeStart{r in REGION, s in STORAGE, ls
     in SEASON, ld in DAYTYPE, y in YEAR}: if ld = min{ldld in DAYTYPE}
    min(ldld) then StorageLevelSeasonStart[r,s,ls,y] else
    StorageLevelDayTypeStart[r,s,ls,ld-1,y] + sum{lh in DAILYTIMEBRACKET
    } NetChargeWithinDay[r,s,ls,ld-1,lh,y] * DaysInDayType[ls,ld-1,y] =
    StorageLevelDayTypeStart[r,s,ls,ld,y];
166 s.t. S13_and_S14_and_S15_StorageLevelDayTypeFinish{r in REGION, s in
    STORAGE, ls in SEASON, ld in DAYTYPE, y in YEAR}:  if ls = max{lsls
    in SEASON} max(lsls) && ld = max{ldld in DAYTYPE} max(ldld) then
    StorageLevelYearFinish[r,s,y] else if ld = max{ldld in DAYTYPE} max(
    ldld) then StorageLevelSeasonStart[r,s,ls+1,y] else
    StorageLevelDayTypeFinish[r,s,ls,ld+1,y] - sum{lh in
    DAILYTIMEBRACKET} NetChargeWithinDay[r,s,ls,ld+1,lh,y] *
    DaysInDayType[ls,ld+1,y] = StorageLevelDayTypeFinish[r,s,ls,ld,y];
167 s.t.
    SC1_LowerLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInFirstWeekCon
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: 0 <= (StorageLevelDayTypeStart[r,s,ls,
    ld,y]+sum{lhlh in DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s
    ,ls,ld,lhlh,y])-StorageLowerLimit[r,s,y];
168 s.t.
    SC1_UpperLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInFirstWeekCon
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: (StorageLevelDayTypeStart[r,s,ls,ld,y
    ]+sum{lhlh in DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s,ls,
    ld,lhlh,y])-StorageUpperLimit[r,s,y] <= 0;
169 s.t.
    SC2_LowerLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInFirstWeekConstraint
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: 0 <= if ld > min{ldld in DAYTYPE} min(
    ldld) then (StorageLevelDayTypeStart[r,s,ls,ld,y]-sum{lhlh in
    DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[r,s,ls,ld-1,lhlh,y])-
    StorageLowerLimit[r,s,y];
170 s.t.
    SC2_UpperLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInFirstWeekConstraint
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: if ld > min{ldld in DAYTYPE} min(ldld)
     then (StorageLevelDayTypeStart[r,s,ls,ld,y]-sum{lhlh in
    DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[r,s,ls,ld-1,lhlh,y])-
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    StorageUpperLimit[r,s,y] <= 0;
s.t.
    SC3_LowerLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInLastWeekConstraint
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: 0 <= (StorageLevelDayTypeFinish[r,s,ls
    ,ld,y] - sum{lhlh in DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[
    r,s,ls,ld,lhlh,y])-StorageLowerLimit[r,s,y];
s.t.
    SC3_UpperLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInLastWeekConstraint
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: (StorageLevelDayTypeFinish[r,s,ls,ld,y
    ] - sum{lhlh in DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[r,s,
    ls,ld,lhlh,y])-StorageUpperLimit[r,s,y] <= 0;
s.t.
    SC4_LowerLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInLastWeekCons
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: 0 <= if ld > min{ldld in DAYTYPE} min(
    ldld) then (StorageLevelDayTypeFinish[r,s,ls,ld-1,y]+sum{lhlh in
    DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s,ls,ld,lhlh,y])-
    StorageLowerLimit[r,s,y];
s.t.
    SC4_UpperLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInLastWeekCons
    {r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in
    DAILYTIMEBRACKET, y in YEAR}: if ld > min{ldld in DAYTYPE} min(ldld)
     then (StorageLevelDayTypeFinish[r,s,ls,ld-1,y]+sum{lhlh in
    DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s,ls,ld,lhlh,y])-
    StorageUpperLimit[r,s,y] <= 0;
s.t. SC5_MaxChargeConstraint{r in REGION, s in STORAGE, ls in SEASON,
    ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}:
    RateOfStorageCharge[r,s,ls,ld,lh,y] <= StorageMaxChargeRate[r,s];
s.t. SC6_MaxDischargeConstraint{r in REGION, s in STORAGE, ls in SEASON
    , ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}:
    RateOfStorageDischarge[r,s,ls,ld,lh,y] <= StorageMaxDischargeRate[r,
    s];
s.t. SI1_StorageUpperLimit{r in REGION, s in STORAGE, y in YEAR}:
    AccumulatedNewStorageCapacity[r,s,y]+ResidualStorageCapacity[r,s,y]
    = StorageUpperLimit[r,s,y];
s.t. SI2_StorageLowerLimit{r in REGION, s in STORAGE, y in YEAR}:
    MinStorageCharge[r,s,y]*StorageUpperLimit[r,s,y] = StorageLowerLimit
    [r,s,y];
s.t. SI3_TotalNewStorage{r in REGION, s in STORAGE, y in YEAR}: sum{yy
    in YEAR: y-yy < OperationalLifeStorage[r,s] && y-yy>=0}
    NewStorageCapacity[r,s,yy]=AccumulatedNewStorageCapacity[r,s,y];
s.t. SI4_UndiscountedCapitalInvestmentStorage{r in REGION, s in STORAGE
    , y in YEAR}: CapitalCostStorage[r,s,y] * NewStorageCapacity[r,s,y]
    = CapitalInvestmentStorage[r,s,y];
s.t. SI5_DiscountingCapitalInvestmentStorage{r in REGION, s in STORAGE,
     y in YEAR}: CapitalInvestmentStorage[r,s,y]/((1+DiscountRate[r])^(y
    -min{yy in YEAR} min(yy))) = DiscountedCapitalInvestmentStorage[r,s,
    y];
s.t. SI6_SalvageValueStorageAtEndOfPeriod1{r in REGION, s in STORAGE, y
     in YEAR: (y+OperationalLifeStorage[r,s]-1) <= (max{yy in YEAR} max(
    yy))}: 0 = SalvageValueStorage[r,s,y];
s.t. SI7_SalvageValueStorageAtEndOfPeriod2{r in REGION, s in STORAGE, y
     in YEAR: (DepreciationMethod[r]=1 && (y+OperationalLifeStorage[r,s
    ]-1) > (max{yy in YEAR} max(yy)) && DiscountRate[r]=0) || (
    DepreciationMethod[r]=2 && (y+OperationalLifeStorage[r,s]-1) > (max{
    yy in YEAR} max(yy)))}: CapitalInvestmentStorage[r,s,y]*(1-(max{yy
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    in YEAR} max(yy) - y+1)/OperationalLifeStorage[r,s]) =
    SalvageValueStorage[r,s,y];
184 s.t. SI8_SalvageValueStorageAtEndOfPeriod3{r in REGION, s in STORAGE, y
     in YEAR: DepreciationMethod[r]=1 && (y+OperationalLifeStorage[r,s
    ]-1) > (max{yy in YEAR} max(yy)) && DiscountRate[r]>0}:
    CapitalInvestmentStorage[r,s,y]*(1-(((1+DiscountRate[r])^(max{yy in
    YEAR} max(yy) - y+1)-1)/((1+DiscountRate[r])^OperationalLifeStorage[
    r,s]-1))) = SalvageValueStorage[r,s,y];
185 s.t. SI9_SalvageValueStorageDiscountedToStartYear{r in REGION, s in
    STORAGE, y in YEAR}: SalvageValueStorage[r,s,y]/((1+DiscountRate[r])
    ^(max{yy in YEAR} max(yy)-min{yy in YEAR} min(yy)+1)) =
    DiscountedSalvageValueStorage[r,s,y];
186 s.t. SI10_TotalDiscountedCostByStorage{r in REGION, s in STORAGE, y in
    YEAR}: DiscountedCapitalInvestmentStorage[r,s,y]-
    DiscountedSalvageValueStorage[r,s,y] = TotalDiscountedStorageCost[r,
    s,y];
187 s.t. CC1_UndiscountedCapitalInvestment{r in REGION, t in TECHNOLOGY, y
    in YEAR}: CapitalCost[r,t,y] * NewCapacity[r,t,y] =
    CapitalInvestment[r,t,y];
188 s.t. CC2_DiscountingCapitalInvestment{r in REGION, t in TECHNOLOGY, y
    in YEAR}: CapitalInvestment[r,t,y]/((1+DiscountRate[r])^(y-min{yy in
     YEAR} min(yy))) = DiscountedCapitalInvestment[r,t,y];
189 s.t. SV1_SalvageValueAtEndOfPeriod1{r in REGION, t in TECHNOLOGY, y in
    YEAR: DepreciationMethod[r]=1 && (y + OperationalLife[r,t]-1) > (max
    {yy in YEAR} max(yy)) && DiscountRate[r]>0}: SalvageValue[r,t,y] =
    CapitalCost[r,t,y]*NewCapacity[r,t,y]*(1-(((1+DiscountRate[r])^(max{
    yy in YEAR} max(yy) - y+1)-1)/((1+DiscountRate[r])^OperationalLife[r
    ,t]-1)));
190 s.t. SV2_SalvageValueAtEndOfPeriod2{r in REGION, t in TECHNOLOGY, y in
    YEAR: (DepreciationMethod[r]=1 && (y + OperationalLife[r,t]-1) > (
    max{yy in YEAR} max(yy)) && DiscountRate[r]=0) || (
    DepreciationMethod[r]=2 && (y + OperationalLife[r,t]-1) > (max{yy in
     YEAR} max(yy)))}: SalvageValue[r,t,y] = CapitalCost[r,t,y]*
    NewCapacity[r,t,y]*(1-(max{yy in YEAR} max(yy) - y+1)/
    OperationalLife[r,t]);
191 s.t. SV3_SalvageValueAtEndOfPeriod3{r in REGION, t in TECHNOLOGY, y in
    YEAR: (y + OperationalLife[r,t]-1) <= (max{yy in YEAR} max(yy))}:
    SalvageValue[r,t,y] = 0;
192 s.t. SV4_SalvageValueDiscountedToStartYear{r in REGION, t in TECHNOLOGY
    , y in YEAR}: DiscountedSalvageValue[r,t,y] = SalvageValue[r,t,y
    ]/((1+DiscountRate[r])^(1+max{yy in YEAR} max(yy)-min{yy in YEAR}
    min(yy)));
193 s.t. OC1_OperatingCostsVariable{r in REGION, t in TECHNOLOGY, l in
    TIMESLICE, y in YEAR}: sum{m in MODE_OF_OPERATION}
    TotalAnnualTechnologyActivityByMode[r,t,m,y]*VariableCost[r,t,m,y] =
     AnnualVariableOperatingCost[r,t,y];
194 s.t. OC2_OperatingCostsFixedAnnual{r in REGION, t in TECHNOLOGY, y in
    YEAR}: TotalCapacityAnnual[r,t,y]*FixedCost[r,t,y] =
    AnnualFixedOperatingCost[r,t,y];
195 s.t. OC3_OperatingCostsTotalAnnual{r in REGION, t in TECHNOLOGY, y in
    YEAR}: AnnualFixedOperatingCost[r,t,y]+AnnualVariableOperatingCost[r
    ,t,y] = OperatingCost[r,t,y];
196 s.t. OC4_DiscountedOperatingCostsTotalAnnual{r in REGION, t in
    TECHNOLOGY, y in YEAR}: OperatingCost[r,t,y]/((1+DiscountRate[r])^(y
    -min{yy in YEAR} min(yy)+0.5)) = DiscountedOperatingCost[r,t,y];
197 s.t. TDC1_TotalDiscountedCostByTechnology{r in REGION, t in TECHNOLOGY,
     y in YEAR}: DiscountedOperatingCost[r,t,y]+
    DiscountedCapitalInvestment[r,t,y]+
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    DiscountedTechnologyEmissionsPenalty[r,t,y]-DiscountedSalvageValue[r
    ,t,y] = TotalDiscountedCostByTechnology[r,t,y];
198 s.t. TDC2_TotalDiscountedCost{r in REGION, y in YEAR}: sum{t in
    TECHNOLOGY} TotalDiscountedCostByTechnology[r,t,y]+sum{s in STORAGE}
     TotalDiscountedStorageCost[r,s,y] = TotalDiscountedCost[r,y];
199 s.t. TCC1_TotalAnnualMaxCapacityConstraint{r in REGION, t in TECHNOLOGY
    , y in YEAR}: TotalCapacityAnnual[r,t,y] <= TotalAnnualMaxCapacity[r
    ,t,y];
200 s.t. TCC2_TotalAnnualMinCapacityConstraint{r in REGION, t in TECHNOLOGY
    , y in YEAR: TotalAnnualMinCapacity[r,t,y]>0}: TotalCapacityAnnual[r
    ,t,y] >= TotalAnnualMinCapacity[r,t,y];
201 s.t. NCC1_TotalAnnualMaxNewCapacityConstraint{r in REGION, t in
    TECHNOLOGY, y in YEAR}: NewCapacity[r,t,y] <=
    TotalAnnualMaxCapacityInvestment[r,t,y];
202 s.t. NCC2_TotalAnnualMinNewCapacityConstraint{r in REGION, t in
    TECHNOLOGY, y in YEAR: TotalAnnualMinCapacityInvestment[r,t,y]>0}:
    NewCapacity[r,t,y] >= TotalAnnualMinCapacityInvestment[r,t,y];
203 s.t. AAC1_TotalAnnualTechnologyActivity{r in REGION, t in TECHNOLOGY, y
     in YEAR}: sum{l in TIMESLICE} RateOfTotalActivity[r,t,l,y]*
    YearSplit[l,y] = TotalTechnologyAnnualActivity[r,t,y];
204 s.t. AAC2_TotalAnnualTechnologyActivityUpperLimit{r in REGION, t in
    TECHNOLOGY, y in YEAR}: TotalTechnologyAnnualActivity[r,t,y] <=
    TotalTechnologyAnnualActivityUpperLimit[r,t,y] ;
205 s.t. AAC3_TotalAnnualTechnologyActivityLowerLimit{r in REGION, t in
    TECHNOLOGY, y in YEAR: TotalTechnologyAnnualActivityLowerLimit[r,t,y
    ]>0}: TotalTechnologyAnnualActivity[r,t,y] >=
    TotalTechnologyAnnualActivityLowerLimit[r,t,y];
206 s.t. TAC1_TotalModelHorizonTechnologyActivity{r in REGION, t in
    TECHNOLOGY}: sum{y in YEAR} TotalTechnologyAnnualActivity[r,t,y] =
    TotalTechnologyModelPeriodActivity[r,t];
207 s.t. TAC2_TotalModelHorizonTechnologyActivityUpperLimit{r in REGION, t
    in TECHNOLOGY: TotalTechnologyModelPeriodActivityUpperLimit[r,t]>0}:
     TotalTechnologyModelPeriodActivity[r,t] <=
    TotalTechnologyModelPeriodActivityUpperLimit[r,t] ;
208 s.t. TAC3_TotalModelHorizenTechnologyActivityLowerLimit{r in REGION, t
    in TECHNOLOGY: TotalTechnologyModelPeriodActivityLowerLimit[r,t]>0}:
     TotalTechnologyModelPeriodActivity[r,t] >=
    TotalTechnologyModelPeriodActivityLowerLimit[r,t] ;
209 s.t. RM1_ReserveMargin_TechnologiesIncluded_In_Activity_Units{r in
    REGION, l in TIMESLICE, y in YEAR}: sum {t in TECHNOLOGY}
    TotalCapacityAnnual[r,t,y] * ReserveMarginTagTechnology[r,t,y] *
    CapacityToActivityUnit[r,t]       =
    TotalCapacityInReserveMargin[r,y];
210 s.t. RM2_ReserveMargin_FuelsIncluded{r in REGION, l in TIMESLICE, y in
    YEAR}: sum {f in FUEL} RateOfProduction[r,l,f,y] *
    ReserveMarginTagFuel[r,f,y] = DemandNeedingReserveMargin[r,l,y];
211 s.t. RM3_ReserveMargin_Constraint{r in REGION, l in TIMESLICE, y in
    YEAR}: DemandNeedingReserveMargin[r,l,y] * ReserveMargin[r,y]<=
    TotalCapacityInReserveMargin[r,y];
212 s.t. RE1_FuelProductionByTechnologyAnnual{r in REGION, t in TECHNOLOGY,
     f in FUEL, y in YEAR}: sum{l in TIMESLICE} ProductionByTechnology[r
    ,l,t,f,y] = ProductionByTechnologyAnnual[r,t,f,y];
213 s.t. RE2_TechIncluded{r in REGION, y in YEAR}: sum{t in TECHNOLOGY, f
    in FUEL} ProductionByTechnologyAnnual[r,t,f,y]*RETagTechnology[r,t,y
    ] = TotalREProductionAnnual[r,y];
214 s.t. RE3_FuelIncluded{r in REGION, y in YEAR}: sum{l in TIMESLICE, f in
     FUEL} RateOfProduction[r,l,f,y]*YearSplit[l,y]*RETagFuel[r,f,y] =
    RETotalProductionOfTargetFuelAnnual[r,y];
```

```
215 s.t. RE4_EnergyConstraint{r in REGION, y in YEAR}:
    REMinProductionTarget[r,y]*RETotalProductionOfTargetFuelAnnual[r,y]
    <= TotalREProductionAnnual[r,y];
216 s.t. RE5_FuelUseByTechnologyAnnual{r in REGION, t in TECHNOLOGY, f in
    FUEL, y in YEAR}: sum{l in TIMESLICE} RateOfUseByTechnology[r,l,t,f,
    y]*YearSplit[l,y] = UseByTechnologyAnnual[r,t,f,y];
217 s.t. E1_AnnualEmissionProductionByMode{r in REGION, t in TECHNOLOGY, e
    in EMISSION, m in MODE_OF_OPERATION, y in YEAR}:
    EmissionActivityRatio[r,t,e,m,y]*TotalAnnualTechnologyActivityByMode
    [r,t,m,y]=AnnualTechnologyEmissionByMode[r,t,e,m,y];
218 s.t. E2_AnnualEmissionProduction{r in REGION, t in TECHNOLOGY, e in
    EMISSION, y in YEAR}: sum{m in MODE_OF_OPERATION}
    AnnualTechnologyEmissionByMode[r,t,e,m,y] = AnnualTechnologyEmission
    [r,t,e,y];
219 s.t. E3_EmissionsPenaltyByTechAndEmission{r in REGION, t in TECHNOLOGY,
     e in EMISSION, y in YEAR}: AnnualTechnologyEmission[r,t,e,y]*
    EmissionsPenalty[r,e,y] = AnnualTechnologyEmissionPenaltyByEmission[
    r,t,e,y];
220 s.t. E4_EmissionsPenaltyByTechnology{r in REGION, t in TECHNOLOGY, y in
     YEAR}: sum{e in EMISSION} AnnualTechnologyEmissionPenaltyByEmission
    [r,t,e,y] = AnnualTechnologyEmissionsPenalty[r,t,y];
221 s.t. E5_DiscountedEmissionsPenaltyByTechnology{r in REGION, t in
    TECHNOLOGY, y in YEAR}: AnnualTechnologyEmissionsPenalty[r,t,y]/((1+
    DiscountRate[r])^(y-min{yy in YEAR} min(yy)+0.5)) =
    DiscountedTechnologyEmissionsPenalty[r,t,y];
222 s.t. E6_EmissionsAccounting1{r in REGION, e in EMISSION, y in YEAR}:
    sum{t in TECHNOLOGY} AnnualTechnologyEmission[r,t,e,y] =
    AnnualEmissions[r,e,y];
223 s.t. E7_EmissionsAccounting2{r in REGION, e in EMISSION}: sum{y in YEAR
    } AnnualEmissions[r,e,y] = ModelPeriodEmissions[r,e]-
    ModelPeriodExogenousEmission[r,e];
224 s.t. E8_AnnualEmissionsLimit{r in REGION, e in EMISSION, y in YEAR}:
    AnnualEmissions[r,e,y]+AnnualExogenousEmission[r,e,y] <=
    AnnualEmissionLimit[r,e,y];
225 s.t. E9_ModelPeriodEmissionsLimit{r in REGION, e in EMISSION}:
    ModelPeriodEmissions[r,e] <= ModelPeriodEmissionLimit[r,e];
226 solve;
227 end;
```

9.3 Project Modules

The classes and modules developed for this project are detailed in the documentation starting on the next page.

University of Auckland
Department of Engineering Science

Global Optimisation Carbon Pricing Initiative (GOCPI) Modules

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Supervisor: Rosalind Archer

Monday 26th October, 2020

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1 GOCPI package

1.1 Submodules

1.2 GOCPI.CreateCases module

class GOCPI.CreateCases.CreateCases
Bases: object

A class of methods to create user-defined data cases

set_accumulated_annual_demand(*accumulated_forecast*)

Sets the accumulated annual demand for fuels per region over the forecast period.
This function relies on a similar forecasting methodology as set_specific_demand.
Fuels set in this function cannot be defined in set_specific_demand.

Parameters accumulated_forecast (*float , array*) – The forecast array of size (len(region),len(fuel),len(year))

set_accumulated_fuel(*accumulated_fuel*)
Sets the case's accumulated fuel types

Parameters specified_fuel (*list*) – list of specified fuels

set_annual_emission_limit(*annual_emission_limits*)
Sets Annual Emission Limits

Parameters annual_emission_limits (*float , array*) – Annual Emission Limits

set_annual_exogenous_emission(*annual_exogenous_emission*)
Sets Annual Exogneous Emissions

Parameters annual_exogenous_emission (*float , array*) – Annual Exogenous Emissions

set_availability_factor(*availablility_matrix*)
Sets the availability factors

Parameters availablility_matrix (*float , array*) – Matrix describing availability factors for given technologies

set_availability_technology(*availability_technology*)
Sets the cases availability_technology type

Parameters availability_technology (*list*) – List of technologies

set_capacity_factor(*factor_matrix*)
Sets capacity factors for conversion technologies.

Parameters `factor_matrix` (*float , array*) –

`set_capacity_of_one_technology_unit`(*capacity_ of_ one_ technology_ unit*)
Set the capacity of one technology units for all technologies

Parameters `capacity_of_one_technology_unit` (*float , array*) – capacities for one technology units

`set_capacity_technology`(*capacity_ technology*)
Sets the cases capacity_technology type

Parameters `capacity_technology` (*list*) – List of technologies

`set_capacity_to_activity_unit`(*region*, *technology*, *capacity_ dictionaries*, *override*)
Sets the capacity to activity parameter

Parameters
- `region` (*list*) – List of regions
- `technology` (*list*) – List of technologies
- `capacity_dictionaries` (*list*) – List of dictionaries to assign value
- `override` (*float , array*) –

`set_capital_cost`(*capital_ costs*)
Sets capital costs

Parameters `capital_costs` (*float , array*) – capital cost paramters

`set_capital_cost_storage`(*capital_ cost_ storage*)
Sets the capital costs of using storage technologies

Parameters `capital_cost_storage` (*float , array*) – capital cost of storage technologies

`set_conversion_ld`(*timeslice*, *daytype*, *link*)
Sets the Conversionld parameter

Parameters
- `timeslice` (*list*) – List of timeslices
- `daytype` (*list*) – List of daytypes
- `link` (*dict*) – Dictionary describing the connection between timeslices and daytypes

`set_conversion_lh`(*timeslice*, *dailytimebracket*, *link*, *override*)
Sets the Conversionlh parameter

Parameters
- `timeslice` (*list*) – List of timeslices
- `dailytimebracket` (*list*) – List of dailytimebracket
- `link` (*dict*) – Dictionary describing the connection between timeslices and dailytimebrackets
- `override` (*int , array*) – Override if want to manually put in the array

`set_conversion_ls`(*timeslice*, *season*, *link*)
Sets the Conversionls parameter

Parameters

- `timeslice` (*list*) – List of timeslices
- `season` (*list*) – List of seasons
- `link` (*dict*) – Dictionary describing the connection between timeslices and seasons

`set_daily_time_bracket(`*num_dailytimebrackets*`)`

Creates set of daily time brackets

Parameters `dailytimebracket` (*int*) – [description]

`set_day_split(`*daily_time_bracket*, *years*, *hour_split*, *num_days*, *num_hours*`)`

Sets the day split parameter

Parameters

- `daily_time_bracket` (*list*) – List of daily time brackets
- `years` (*list*) – List of year
- `hour_split` (*dict*) – Dictonary of hours in a daily time bracket
- `num_days` (*int*) – Number of days in a year
- `num_hours` (*int*) – Number of hours in a day

`set_days_in_day_type(`*season*, *daytype*, *year*, *link*, *override*`)`

Sets the DaysInDayType parameter

Parameters

- `season` (*list*) – List of seasons
- `daytype` (*list*) – List of daytypes
- `year` (*list*) – List of years
- `link` (*dict*) – Dictionary relating seasons to daytypes
- `override` (*int , array*) – Override if want to manually put in the array

`set_daytype(`*num_daytypes*`)`

[summary]

Parameters `num_daytypes` (*int*) – Number of daytypes

`set_depreciation_method(`*region*, *methods*, *override*`)`

Sets DepreciationMethod (1 = Sinking Fund Depreciation, 2 = Straightline Depreciation)

Parameters

- `region` (*list*) – List of regions
- `override` (*int , array*) – Manual array for setting depreciation methods
- `methods` (*dict*) – Dictionary assigning methods to regions

`set_discount_rate(`*equity*, *debt*, *market_index*, *cost_of_debt_pre_tax*, *risk_free_rate*, *effective_tax_rate*, *preference_equity*, *market_value_preference_shares*, *preference_dividends*, *market_risk_coefficient*`)`

[summary]

Parameters

- `equity` (*dict*) – Dictionary of equity totals from treasury balance sheets
- `debt` (*dict*) – Dictionary of equity totals from treasury balance sheets
- `market_index` (*int , array*) – Regional monthly index returns (Arrays)
- `cost_of_debt_pre_tax` (*dict*) – Dictionary of pre-tax cost of debts calculated from treasury balance sheets
- `risk_free_rate` (*dict*) – Dictionary of risk free rates from 10 year swap rates for each region
- `effective_tax_rate` (*dict*) – Dictionary of company tax rates for each region
- `preference_equity` (*dict*) – Dictionary of preference equity for each region
- `market_value_preference_shares` (*dict*) – Dictionary of the market value of prefence shares for each region
- `preference_dividends` (*dict*) – Dictionary of prefence dividends for each region
- `market_risk_coefficient` (*dict*) – Dictionary of markey risk coefficients

Returns Numpy array of discount rates

Return type [int, array]

`set_emission(`*emissions*`)`

Sets the cases emission types

Parameters `emissions` (*List*) – list of emission types

`set_emission_activity_ratio(`*emission_activity_ratios*`)`

Sets Emission Activity Ratios

Parameters `emission_activity_ratios` (*[float , array*) – Emission Activity Ratios

`set_emissions_penalty(`*emissions_penalties*`)`

Sets Emissions Penalties

Parameters `emissions_penalties` (*float , penalties*) – Emissions Penalties

`set_fixed_cost(`*fixed_costs*`)`

Set fixed costs

Parameters `fixed_costs` (*float , array*) – fixed cost parameters

`set_fuel(`*fuel*`)`

Sets the case's fuel types

Parameters `fuel` (*list*) – list of fuels

`set_input_activity_ratio(`*input_activity_ratios*`)`

Sets input activity ratios

Parameters `input_activity_ratios` (*float , array*) – Sets the input activity ratio

`set_min_storage_charge(`*minimum_storage_charges*`)`
Sets the minimum storage charges

Parameters `minimum_storage_charges` (*float , array*) – minimum storage parameters

`set_mode_of_operation(`*num_modes_of_operation*`)`
Create the number of modes of operation (n = 1,. . . ,num_modes_of_operation)

Parameters `num_modes_of_operation` (*int*) –

`set_model_period_emission_limit(`*model_period_emission_limits*`)`
Sets Model Period Emission Limits

Parameters `model_period_emission_limits` (*float , array*) – Model Period Emission Limits

`set_model_period_exogenous_emission(`*model_period_exogenous_emissions*`)`
Sets Model Period Exogenous Emissions

Parameters `model_period_exogenous_emissions` (*float , array*) – Model Period Exogenous Emissions

`set_operational_life(`*operational_lives*`)`
Sets operational life

Parameters `operational_lives` (*list*) –

`set_operational_life_storage(`*operational_life_storage*`)`
Sets the operational life storage

Parameters `operational_life_storage` (*float , array*) – operational life storage parameters

`set_output_activity_ratio(`*output_activity_ratios*`)`
Sets output activity ratio

Parameters `output_activity_ratios` (*float , array*) – output activity ratio parameters

`set_re_min_production_target(`*re_min_production_targets*`)`
Sets Renewable Energy Minimum Production Targets

Parameters `re_min_production_targets` (*float , array*) – Renewable Energy Minimum Production Targets

`set_re_tag_fuel(`*re_tag_fuels*`)`
Sets RE Tag Fuels

Parameters `re_tag_fuels` (*float , array*) – RE Tag Fuels

`set_re_tag_technology(`*re_tag_technologies*`)`
Sets RE Tag Technology

Parameters `re_tag_technologies` (*float , array*) – RE Tag Technologies

`set_region(`*regions*`)`
Sets the datacase's regions analysis

Parameters `regions` (*list*) – list of regions

`set_reserve_margin(`*reserve_ margins*`)`
Sets reserve margins

Parameters `reserve_margins` (*float , array*) – Reserve Margins

`set_reserve_margin_tag_fuel(`*reserve_ margin_ fuel_ tags*`)`
Sets the reserve margin tag fuels

Parameters `reserve_margin_fuel_tags` (*float , array*) – Sets the reserve margin tag fuel parameters

`set_reserve_margin_tag_technology(`*reserve_ margin_ tag_ technologies*`)`
Sets Reserve Margin Tag Technology

Parameters `reserve_margin_tag_technologies` (*float , array*) – Reserve Margin Tag Technologies

`set_residual_capacity(`*residential_ capacities*`)`
Set residual capacity

Parameters `residential_capacities` (*float , array*) – residual capacities parameter

`set_residual_storage_capacity(`*residual_ storage_ capacities*`)`
Sets residual storage capacities

Parameters `residual_storage_capacities` (*float , array*) – residual storage capacities

`set_season(`*num_ seasons*`)`
Creates set of seasons

Parameters `num_seasons` (*int*) – Number of seasons

`set_specified_annual_demand(`*specified_ forecast*`)`
Sets the annual demand for fuels per region over the forecast period (Must be accurate)

Parameters `forecast` (*float , array*) – The forecast array of size (len(region),len(fuel),len(year))

`set_specified_demand_profile(`*specified_ annual_ demand*, *region*, *fuel*, *year*, *timeslice*, *profile*, *override*`)`
Sets the specified annual demand profiles using the specified annual demand.

Parameters

- `specified_annual_demand` (*float , array*) – Specified annual demand profiles
- `region` (*list*) – List of regions
- `fuel` (*list*) – List of fuels
- `year` (*list*) – List of years
- `timeslice` (*list*) – List of timeslices
- `profile` (*Dict*) – Dictionary of fuel allocations to timeslices

- `override` (*float , array*) – Manual override for the specified annual demand profiles.

`set_specified_fuel(`*specified_fuel*`)`
Sets the case's specified fuel types

Parameters `specified_fuel` (*list*) – list of specified fuels

`set_storage(`*storage*`)`
Sets storage set of the datacase

Parameters `storage` (*list*) – list of storage types

`set_storage_level_start(`*storage_level_start*`)`
Sets the storage level starting point

Parameters `storage_level_start` (*float , array*) – storage starting level

`set_storage_max_charge_rate(`*storage_max_level_charge_rates*`)`
Sets the storgae max charge rate

Parameters `storage_max_level_charge_rates` (*float , array*) – Storage max level charge rates

`set_storage_max_discharge_rate(`*storage_max_level_discharge_rates*`)`
Sets storage technologies maximum discharge rates

Parameters `storage_max_level_discharge_rates` (*float , array*) – Discharge rates for storage paramters

`set_technology(`*technology*`)`
Sets the cases technology type

Parameters `technology` (*list*) – List of technologies

`set_technology_from_storage(`*technology_from_storage*`)`
Sets technology from storage binary paramter

Parameters `technology_from_storage` (*float , array*) – technology from storage parameter

`set_technology_to_storage(`*technology_to_storage*`)`
Sets the technology to storage parameter

Parameters `technology_to_storage` (*float , array*) – technology to storage parameter

`set_timeslice(`*timeslice*`)`
Set of timeslices

Parameters `timeslice` (*list*) – list of timeslices

`set_total_annual_max_capacity(`*total_annual_max_capacities*`)`
Sets the total annual maximum capacities

Parameters `total_annual_max_capacities` (*float , array*) – Total Annual Max Capacities

set_total_annual_min_capacity(*total_annual_min_capacities*)
Sets the totoal annual minimum capacities

Parameters total_annual_min_capacities (*float , array*) – Total Annual Min Capacities

set_total_technology_annual_activity_lower_limit(*total_technology_activity_lower_limits*)
Sets the Total Technology Activity Lower Limits

Parameters total_technology_activity_lower_limits (*float , array*) – Technology Activity Lower Limits

set_total_technology_annual_activity_upper_limit(*total_technology_annual_activity_upper_*
Sets the Total Technology Activity Upper Limits

Parameters total_technology_annual_activity_upper_limits (*float , array*) – Technology Activity Upper Limits

set_total_technology_period_activity_lower_limit(*total_technology_period_activity_lower_*
Sets Total Technology Period Activity Lower Limits

Parameters total_technology_period_activity_lower_limits (*[type]*) – Total Technology Period Activity Lower Limit

set_total_technology_period_activity_upper_limit(*total_technology_period_activity_upper_*
Sets Total Technology Period Activity Upper Limits

Parameters total_technology_period_activity_upper_limits (*float , array*) – Total Technology Period Activity Upper Limit

set_trade_route(*trade*)

Sets the TradeRoute parameter between regions (Assume it is the same across fuels and years)

Parameters trade (*int , array*) – 4D array representing trade relationships between regions, fuels and years. You must model this manually.

set_variable_cost(*variable_costs*)
Sets variable costs

Parameters variable_costs (*float , array*) – variable costs parameters

set_year(*start_year*, *end_year*, *interval*)
Sets a list of forecast years

Parameters

- start_year (*int*) – Starting year for forecasting (Less than end_year)
- end_year (*int*) – Ending year for forecasting (Greater than start_year)
- interval (*int*) – Gap for forecasting period

set_year_split(*timeslices*, *years*, *splits*)

Creates 2D Numpy Array Parameter Splits. (Note: The index positions of timelices and splits must match)

Parameters

- `timeslices` (*list*) – List of timeslices
- `years` (*list*) – List of years
- `splits` (*dict*) – A dictionary linking yearsplits to timeslices

1.3 GOCPI.Energysystems module

`class GOCPI.Energysystems.Energy_Systems(`*year*, *region*, *emission*, *technology*, *capacity_technology*, *availability_technology*, *fuel*, *specified_fuel*, *accumulated_fuel*, *timeslice*, *mode_of_operation*, *storage*, *daytype*, *season*, *dailytimebracket*`)`

Bases: `object`

A class of methods to initialise energy sytems and create the data/model files needed for optimisation.

`create_data_file(`*file_location*, *defaults_dictionary*, *toggle_defaults*`)`

Creates the osemosys datafile

Parameters

- `file_location` (*str*) – String of directory to save data file
- `defaults_dictionary` (*dict*) – Dictionary setting the default values for parameters
- `toggle_defaults` (*Bool*) – Boolean (True/False to only print the default functions

`create_model_file(`*root*, *file*`)`

Creates the model file necessary for the project to run

Parameters `for the basic problem` (*Parameters*) –
Returns The loaded in parameters and sets

`load_datacase(`*case*, *system*`)`

Loads the data case to a correct configured and intialised energy system

(The load status dictionary must be compatible with the data_case and system_case)

Parameters

- `case` (*object*) – Energy system datacase
- `system` (*object*) – Initialised energy system
- `load_status` (*dict*) – Dictionary setting the required sets and parameters to load

Returns Returns the updated dictionary
Return type system_case (dict)

1.4 GOCPI.Forecasting module

class GOCPI.Forecasting.Forecasting

Bases: object

calculate_cagr_forecasts(*cagr_dictionary*, *base_year_dictionary*, *fuel*, *year*)

Forecasts base year fuels by a constant average growth rate for a forecast period

Parameters

- cagr_dictionary (*Dict*) – Dictionary of constant average growth rates per fuel
- base_year_dictionary (*[type]*) – Dictionary of base year fuel consumption in energy types
- fuel (*list*) – List of Fuels
- year (*list*) – List of forecast years

Returns 2D Array of demand forecasts per fuel

Return type [float, array]

calculate_constant_average_growth_rate(*start_year*, *end_year*, *start_value*, *end_value*)

Calculates the constant average growth rate (CAGR)

Parameters

- start_year (*int*) – Starting year
- end_year (*int*) – Ending year
- start_value (*int*) – Initial value
- end_value (*int*) – Final value

Returns Constant average growth rate (1+ decimal)

Return type cagr

energy_balance_base(*root*, *IEA_World_Energy_Balances_1*, *IEA_World_Energy_Balances_2*, *create_excel_spreadsheet*, *output_file*)

Creates the baseline energy balance for forecasting

Parameters

- root (*path*) – Path to provide access to all the files
- IEA_World_Energy_Balances_1 (*str*) – File name for Energy Balance A to K
- IEA_World_Energy_Balances_2 (*[type]*) – File name for Energy Balance L to Z
- create_excel_spreadsheet (*boolean*) – True/false on whether to create a spreadsheet
- output_file (*str*) – Name of output energy balance spreadsheet

Returns Dictionary of energy balances and unique lists (Use these key words to access: Energy Balances, Fuel, Geography, Technology)

Return type (dict)

1.5 GOCPI.Navigation module

class GOCPI.Navigation.Navigation(*target_root*, *target_file*)

Bases: object

Navigation is a class for navigating, manipulating and editing data in the GOCPI model.

Find_File

Type string

TODO: Fill out all functions below

Find_File()

Find_File searches for a target file, from a base directory, to construct a target directory.

Inputs: target_root = The base directory to search from (string). target_file = The name of the target file (string).

Outputs: f = Combinated target file location (string).

create_linear_programme_file(*directory*, *data_file*, *model_file*, *output_file*)

Creates the model file through executing model system commands

Parameters

- **directory** (*str*) – Name of directory to put data into
- **data_file** (*str*) – Name of energy system data file
- **model_file** (*str*) – Name of energy system model file
- **output_file** (*str*) – Name of output linear programme

1.6 GOCPI.Optimisation module

class GOCPI.Optimisation.Optimisation

Bases: object

Prepare and runs optimisation with IBM ILOG CPLEX Optimisation Studio

create_linear_programme_file(*directory*, *data_file*, *model_file*, *output_file*)

Creates the model file through executing model system commands

Parameters

- **directory** (*str*) – Name of directory to put data into
- **data_file** (*str*) – Name of energy system data file
- **model_file** (*str*) – Name of energy system model file
- **output_file** (*str*) – Name of output linear programme

reset(*tarinfo*)

Resets the tarfile information when creating tar files This is to input into the filter when using tar.add()

Parameters **tarinfo** (*Object*) – Tar Object containing an ID of 0 and the root as the name

Returns Tar Object containing an ID of 0 and the root as the name
Return type tarinfo (Object)

`run_cplex_local(`*model_file*`)`
This function runs cplex on the local device if the energy system is of a small enough complexity

`run_ibm_wml_do(`*apikey*, *url*, *deployment_space_name*, *cloud_object_storage_credential*, *service_instance_id*, *deployment_space_exists*, *data_assets_exist*, *data_asset_dictionary*, *model_name*, *model_type*, *model_runtime_uid*, *model_tar_file*, *num_nodes*, *deployment_exists*, *payload_input_data_id*, *payload_input_data_file*, *payload_output_data_id*`)`

This function enables the user to solve python-based optimisation models. The legacy offering to solve optimisation models on IBM cloud was using the docplex python api to run Cplex on DOcloud. As of September 2020, the DOcloud was discontinued with Decision Optimisation functionalities imported to IBM's Watson Machine Learning Service. The new process requires the energy system model to be written in python. This project saw the implementation of the osemosys modelling methodology in GNU Mathprog written into LP Files. IBM Decision Optimisation in cannot deploy models in LP File formats to get jobs. Therefore, this function is for future work in converting the entire energy system modelling tool to python-based only. This is well-documented the report in the Future Work Section. Note: You must have access to IBM Watson Studio and Cloud Products through the IBM Academic Initiative or Similar.

Parameters

- `apikey` (*str*) – API key from user's IBM Cloud Account
- `url` (*[type]*) – URL for the server the user is using for the IBM services
- `deployment_space_name` (*str*) – Name of the deployment space
- `cloud_object_storage_credential` (*str*) – Credential for the cloud object storage asset
- `service_instance_id` (*str*) – Service instance id for the service being used (IBM WML)
- `deployment_space_exists` (*boolean*) – True/False if the deployment space already exists
- `data_assets_exist` (*boolean*) – True/False if the data assets (e.g. input data stored on cloud)
- `data_asset_dictionary` (*dict*) – A dictionary of data assets to stored on IBM cloud
- `model_name` (*str*) – Name of the model
- `model_type` (*str*) – Name of the model
- `model_runtime_uid` (*str*) – Runtime ID for the model
- `model_tar_file` (*tar*) – Tar file containing the python model
- `num_nodes` (*int*) – Number of nodes the model is run off.
- `deployment_exists` (*boolean*) – True/False if the deployment already exists
- `payload_input_data_id` (*str*) – Name of input data

- `payload_input_data_file` (*dataframe*) – Input data file in the form of a dataframe
- `payload_output_data_id` (*str*) – Name of output data file

`use_bash_shell(`*command*`)`

Execute bash commands in python scripts

Parameters `command` (*str*) – Command to execute

1.7 Module contents

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