ENGSCI 700A/B

Research Compendium

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Declaration of Contribution

I proposed this project. I am the sole contributor.

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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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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

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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:
```

```
    for i in range(0, len(fuel_type), 1):
        ACCUMULATED_FUEL.append(fuel_type[i])

# Sets the total fuels
nz_energy_system.set_fuel(FUEL)
nz_energy_system.set_specified_fuel(FUEL)
nz_energy_system.set_accumulated_fuel(FUEL)
# ##########################################################################
# Continues defining sets
# ##########################################################################
# Defines timeslices
TIMESLICE = [
    'DAY_SUMMER', 'NIGHT_SUMMER', 'DAY_WINTER', 'NIGHT_WINTER',
    'DAY_INTERMEDIATE', 'NIGHT_INTERMEDIATE'
]
nz_energy_system.set_timeslice(TIMESLICE)

# Defines Modes of Operation
nz_energy_system.set_mode_of_operation(1)

# Defines the storage set
STORAGE = ['DAM']
nz_energy_system.set_storage(STORAGE)

# Defines the daytype (numbers represent different daytypes)
# 1 = Weekday (Mon - Fri), 2 = Weekend (Sat & Sun)
nz_energy_system.set_daytype(2)

# Defines the seasons
# (Three seasons (Summer (1), Winter (2) and Intermediate (3)))
nz_energy_system.set_season(3)

# Defines the dailytimebracket (Number of distinct periods in a day)
# 4 = Morning (6hrs), Afternoon (6hrs), Evening (6hrs), Night (6hrs)
nz_energy_system.set_daily_time_bracket(4)

# ##########################################################################
# Defines Global Parameters
# ##########################################################################
# Defines the YearSplit parameter
# Creates Dictionary for number of days
days = {
    'January': 31,
    'February': 28,
    'March': 31,
    'April': 30,
    'May': 31,
    'June': 30,
    'July': 31,
    '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)

```

```
#
    ##############################################################################
# Initialisation and Definition of demand parameters (Including
    forecasting)
#
    ##############################################################################
# Sets dictionaries to calculate CAGR for Fuels Forecasts
nz_cagr_fuels = {}
aus_cagr_fuels = {}
cagr_dictionaries_regions = [nz_cagr_fuels, aus_cagr_fuels]
# Initialises cagr parameters
nz_start_year_fuels = {}
nz_end_year_fuels = {}
nz_start_value_fuels = {}
nz_end_value_fuels = {}
aus_start_year_fuels = {}
aus_end_year_fuels = {}
aus_start_value_fuels = {}
aus_end_value_fuels = {}
nz_cagr_dictionaries_parameters = [
    nz_start_year_fuels, nz_end_year_fuels, nz_start_value_fuels,
    nz_end_value_fuels
]
aus_cagr_dictionaries_parameters = [
    aus_start_year_fuels, aus_end_year_fuels, aus_start_value_fuels,
    aus_end_value_fuels
]

# Populates regional dictionaries with new entry, all fuel types with
    default cagr values
for region_fuels in cagr_dictionaries_regions:
    for i in range(0, len(nz_energy_system.fuel), 1):
        region_fuels[nz_energy_system.fuel[i]] = 0.05

# Populates regional dictionaries with new entry, all fuel types with
    default values
for parameters in nz_cagr_dictionaries_parameters:
    for i in range(0, len(nz_energy_system.fuel), 1):
        region_fuels[nz_energy_system.fuel[i]] = 1

for parameters in nz_cagr_dictionaries_parameters:
    for i in range(0, len(nz_energy_system.fuel), 1):
        region_fuels[nz_energy_system.fuel[i]] = 1
# Loads demand data to the parameter dictionaries (Energy units are in
    PJs)
# New Zealand

nz_start_years = np.zeros(len(nz_energy_system.fuel))
nz_start_years[:] = 2010
nz_end_years = np.zeros(len(nz_energy_system.fuel))
nz_end_years[:] = 2018
nz_start_values = np.array([
    7.23, 13.24, 4.19, 0, 7.11, 110.43, 106.09, 7.11, 14.62, 0, 60.29,
    0, 9.21,
    0.35, 0, 0, 0.33, 55.89, 146.49, 0
])
```

```
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
```

```
system = GF.Energy_Systems(
    nz_energy_system.year, nz_energy_system.region, nz_energy_system.
   emission,
    nz_energy_system.technology, nz_energy_system.capacity_technology,
    nz_energy_system.availability_technology, nz_energy_system.fuel,
    nz_energy_system.specified_fuel, nz_energy_system.accumulated_fuel,
    nz_energy_system.timeslice, nz_energy_system.mode_of_operation,
    nz_energy_system.storage, nz_energy_system.daytype,
    nz_energy_system.season, nz_energy_system.dailytimebracket)

# Loads the datacase to the system
system.load_datacase(case, system)

# Sets up location information
data_txt = 'GOCPI_NZ_Example_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)

# Sets the default parameters
default_parameters = {
    'YearSplit': 1,
    'DiscountRate': 0.05,
    'DaySplit': 1,
    'Conversionls': 1,
    'Conversionld': 1,
    'Conversionlh': 1,
    'DaysInDayType': 1,
    'TradeRoute': 1,
    'DepreciationMethod': 2,
    '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': 99999,
    'TotalAnnualMinCapacity': 1,
    '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,
#     'ConversionIs': False,
#     'ConversionId': True,
#     'ConversionIh': 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.
```

```

        Returns:
            str: File path for file
        """

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

    def create_linear_programme_file(self, directory, data_file, model_file,
                                     output_file):
        """ Creates the model file through executing model system commands
            (Work in Progress)

        Args:
            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
        """
        # Change the working directory
        os.chdir(directory)
        # Load the custom anaconda environment
        # This assumes the conda environment has already been initialised.
        os.system('conda activate osemosys')
        # Execute the file structure to create the linear programming file
        # (glpsol -m GOCPI_OSeMOSYS_Model.txt -d GOCPI_NZ_Example_Data.txt --wlp GOCPI_NZ_Example.lp)
        command = 'glpsol -m ' + data_file + ' -d ' + model_file + '--wlp ' + output_file
        os.system(command)
```

5.2.2 Energysystems

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

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


class Energy_Systems:
    """ A class of methods to initialise energy sytems and create the data/model files needed for optimisation.
    """
    def __init__(self, year, region, emission, technology, capacity_technology,
                 availability_technology, fuel, specified_fuel,
                 accumulated_fuel, timeslice, mode_of_operation, storage,
                 daytype, season, dailytimebracket):
```

```
        """ Function to create complete energy system set to prepare datafile, as per the established model.

        Args:
            year (list): List of years
            region (list): List of regions
            emission (list): List of emissions
            technology (list): List of technologies
            capacity_technology (list): List of technologies
            availability_technology (list): List of technologies
            fuel (list): List of fuels
            specified_fuel (list): List of fuels
            accumulated_fuel (list): List of fuels
            timeslice (list): List of timeslices
            mode_of_operation (list): List of modes of operation
            storage (list): List of storage
            daytype (list): List of daytypes
            season (list): List of seasons
            dailytimebracket (list): List of dailytimebrackets
        """
        self.year = year
        self.region = region
        self.emission = emission
        self.technology = technology
        self.capacity_technology = capacity_technology
        self.availability_technology = availability_technology
        self.fuel = fuel
        self.specified_fuel = specified_fuel
        self.accumulated_fuel = accumulated_fuel
        self.timeslice = timeslice
        self.mode_of_operation = mode_of_operation
        self.storage = storage
        self.daytype = daytype
        self.season = season
        self.dailytimebracket = dailytimebracket

        ly = len(self.year)
        lr = len(self.region)
        le = len(self.emission)
        lt = len(self.technology)
        lct = len(self.capacity_technology)
        lat = len(self.availability_technology)
        lf = len(self.fuel)
        lsf = len(self.specified_fuel)
        laf = len(self.accumulated_fuel)
        ll = len(self.timeslice)
        lm = len(self.mode_of_operation)
        ls = len(self.storage)
        lld = len(self.daytype)
        lls = len(self.season)
        llh = len(self.dailytimebracket)

        self.ly = ly
        self.lr = lr
        self.le = le
        self.lt = lt
        self.lct = lct
        self.lat = lat
```

```
        self.lf = lf
        self.lsf = lsf
        self.laf = laf
        self.ll = ll
        self.lm = lm
        self.ls = ls
        self.lld = lld
        self.lls = lls
        self.llh = llh

        self.YearSplit = np.ones((ll, ly))
        self.DiscountRate = np.ones((lr))
        self.DaySplit = np.ones((llh, ly))
        self.Conversionls = np.ones((ll, lls))
        self.Conversionld = np.ones((ll, lld))
        self.Conversionlh = np.ones((ll, llh))
        self.DaysInDayType = np.ones((lls, lld, ly))
        self.TradeRoute = np.ones((lr, lr, lf, ly))
        self.DepreciationMethod = np.ones((lr))
        self.SpecifiedAnnualDemand = np.ones((lr, lsf, ly))
        self.SpecifiedDemandProfile = np.ones((lr, lsf, ll, ly))
        self.AccumulatedAnnualDemand = np.ones((lr, laf, ly))
        self.CapacityToActivityUnit = np.ones((lr, lct))
        self.CapacityFactor = np.ones((lr, lct, ll, ly))
        self.AvailabilityFactor = np.ones((lr, lat, ly))
        self.OperationalLife = np.ones((lr, lct))
        self.ResidualCapacity = np.ones((lr, lt, ly))
        self.InputActivityRatio = np.ones((lr, lt, lf, lm, ly))
        self.OutputActivityRatio = np.ones((lr, lt, lf, lm, ly))
        self.CapitalCost = np.ones((lr, lt, ly))
        self.VariableCost = np.ones((lr, lt, lm, ly))
        self.FixedCost = np.ones((lr, lt, ly))
        self.TechnologyToStorage = np.ones((lr, lt, ls, lm))
        self.TechnologyFromStorage = np.ones((lr, lt, ls, lm))
        self.StorageLevelStart = np.ones((lr, ls))
        self.StorageMaxChargeRate = np.ones((lr, ls))
        self.StorageMaxDischargeRate = np.ones((lr, ls))
        self.MinStorageCharge = np.ones((lr, ls, ly))
        self.OperationalLifeStorage = np.ones((lr, ls))
        self.CapitalCostStorage = np.ones((lr, ls, ly))
        self.ResidualStorageCapacity = np.ones((lr, ls, ly))
        self.CapacityOfOneTechnologyUnit = np.ones((lr, lt, ly))
        self.TotalAnnualMaxCapacity = np.ones((lr, lt, ly))
        self.TotalAnnualMinCapacity = np.ones((lr, lt, ly))
        self.TotalAnnualMaxCapacityInvestment = np.ones((lr, lt, ly))
        self.TotalAnnualMinCapacityInvestment = np.ones((lr, lt, ly))
        self.TotalTechnologyAnnualActivityLowerLimit = np.ones((lr, lt, ly))
        self.TotalTechnologyAnnualActivityUpperLimit = np.ones((lr, lt, ly))
        self.TotalTechnologyModelPeriodActivityUpperLimit = np.ones((lr, lt))
        self.TotalTechnologyModelPeriodActivityLowerLimit = np.ones((lr, lt))
        self.ReserveMarginTagTechnology = np.ones((lr, lt, ly))
        self.ReserveMarginTagFuel = np.ones((lr, lf, ly))
        self.ReserveMargin = np.ones((lr, ly))
        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
```

```
        model_txt = 'GOCPI_OseMOSYS_Model.txt'
        model_location = os.path.join(root, model_txt)

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

    def create_data_file(self, file_location, defaults_dictionary,
                         toggle_defaults):
        """ Creates the osemosys datafile

        Args:
            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
        """
        # Opens the file for write the data
        with open(file_location, 'w') as f:
            # Sets up the preamble for the data file
            f.write('# GOCPI Energy System Data File\n')
            f.write(
                '# Insert instructions when the file is running properly\n')
            f.write('#\n')
            # Sets
            f.write('# Sets\n#\n')
            # year
            set_string = ' '.join(self.year)
            f.write('set YEAR\t:=\t{0};\n'.format(set_string))
            # region
            set_string = ' '.join(self.region)
            f.write('set REGION\t:=\t{0};\n'.format(set_string))
            # emission
            set_string = ' '.join(self.emission)
            f.write('set EMISSION\t:=\t{0};\n'.format(set_string))
            # technology
            set_string = ' '.join(self.technology)
            f.write('set TECHNOLOGY\t:=\t{0};\n'.format(set_string))
            # fuel
            set_string = ' '.join(self.fuel)
            f.write('set FUEL\t:=\t{0};\n'.format(set_string))
            # timeslice
            set_string = ' '.join(self.timeslice)
            f.write('set TIMESLICE\t:=\t{0};\n'.format(set_string))
            # mode_of_operation
            set_string = ' '.join(self.mode_of_operation)
            f.write('set MODE_OF_OPERATION\t:=\t{0};\n'.format(set_string))
            # storage
            set_string = ' '.join(self.storage)
            f.write('set STORAGE\t:=\t{0};\n'.format(set_string))
            # daytype
            set_string = ' '.join(self.daytype)
            f.write('set DAYTYPE\t:=\t{0};\n'.format(set_string))
            # season
            set_string = ' '.join(self.season)
            f.write('set SEASON\t:=\t{0};\n'.format(set_string))
```

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

            # YearSplit = np.zeros((ll,ly))
            param = 'YearSplit'
            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.timeslice)
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.YearSplit[:, :]
                # 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')

            # DiscountRate = np.zeros((lr))
            param = 'DiscountRate'
            f.write('#\n')
            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)
                array = array.T
                lt = array.tolist()
                # Creates 2D matrix for this value
                mat = self.DiscountRate[:]
                # 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))
            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')

```

```
            # Conversionlh = np.zeros((ll,llh))
            param = 'Conversionlh'  # Change this line
            f.write('#\n')
            columns = self.dailytimebracket  # 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.Conversionlh[:, :]  # 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')

            # DaysInDayType = np.zeros((lls,lld,ly))
            #Writes new line character at parameter metadata to the text file
            param = 'DaysInDayType'
            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.daytype
                    column_string = ' '.join(columns)
                    # Converts maxtrix rows to list
                    array = np.array(self.season)
                    array = array.T
                    lt = array.tolist()
                    # Creates 2D matrix for this value
                    mat = self.DaysInDayType[:, :, 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')

            # 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
```

```
                    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')

            # SpecifiedDemandProfile = np.zeros((lr,lf,ll,ly))
            param = 'SpecifiedDemandProfile'  # 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.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.SpecifiedDemandProfile[:, :, 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')

            # AccumulatedAnnualDemand = np.zeros((lr,lf,ly))
            param = 'AccumulatedAnnualDemand'
            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.accumulated_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.AccumulatedAnnualDemand[:, :, 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')

            # CapacityToActivityUnit = np.zeros((lr,lt))
            param = 'CapacityToActivityUnit'  # Change this line
            f.write('#\n')
            columns = self.capacity_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.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))
```

```
                                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')

            # AvailabilityFactor = np.zeros((lr,lt,ly))
            param = 'AvailabilityFactor'
            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.availability_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.AvailabilityFactor[:, :, 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')

            # OperationalLife = np.zeros((lr,lt))
            param = 'OperationalLife'  # Change this line
            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(
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                    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
```

```
                    mat = self.TotalTechnologyAnnualActivityUpperLimit[:, :, 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')

            # TotalTechnologyModelPeriodActivityUpperLimit = np.zeros((lr,lt))
            param = 'TotalTechnologyModelPeriodActivityUpperLimit'  # Change this line
            f.write('#\n')
            columns = self.technology  # 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.TotalTechnologyModelPeriodActivityUpperLimit[:, :]  # 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')
```

```
            # TotalTechnologyModelPeriodActivityLowerLimit = np.zeros((lr,lt))
            param = 'TotalTechnologyModelPeriodActivityLowerLimit'  # Change this line
            f.write('#\n')
            columns = self.technology  # 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.TotalTechnologyModelPeriodActivityLowerLimit[:, :]  # 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')

            # ReserveMarginTagTechnology = np.zeros((lr,lt,ly))
            param = 'ReserveMarginTagTechnology'
            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.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('#')
```

```
        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
```

```
        self.StorageMaxDischargeRate = None
        self.MinStorageCharge = None
        self.OperationalLifeStorage = None
        self.CapitalCostStorage = None
        self.ResidualStorageCapacity = None
        self.CapacityOfOneTechnologyUnit = None
        self.TotalAnnualMaxCapacity = None
        self.TotalAnnualMinCapacity = None
        self.TotalAnnualMaxCapacityInvestment = None
        self.TotalAnnualMinCapacityInvestment = None
        self.TotalTechnologyAnnualActivityLowerLimit = None
        self.TotalTechnologyAnnualActivityUpperLimit = None
        self.TotalTechnologyModelPeriodActivityUpperLimit = None
        self.TotalTechnologyModelPeriodActivityLowerLimit = None
        self.ReserveMarginTagTechnology = None
        self.ReserveMarginTagFuel = None
        self.ReserveMargin = None
        self.RETagTechnology = None
        self.RETagFuel = None
        self.REMinProductionTarget = None
        self.EmissionActivityRatio = None
        self.EmissionsPenalty = None
        self.AnnualExogenousEmission = None
        self.AnnualEmissionLimit = None
        self.ModelPeriodExogenousEmission = None
        self.ModelPeriodEmissionLimit = None

    def set_year(self, start_year, end_year, interval):
        """ Sets a list of forecast years

        Args:
            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
        """
        # Sets year array for new value
        year = []
        count = start_year
        while count <= end_year:
            year.append(str(count))
            count = count + interval
        self.year = year

    def set_region(self, regions):
        """ Sets the datacase's regions analysis

        Args:
            regions (list): list of regions
        """
        self.region = regions

    def set_emission(self, emissions):
        """Sets the cases emission types

        Args:
            emissions (List): list of emission types
```

```
        """
        self.emission = emissions

    def set_technology(self, technology):
        """ Sets the cases technology type

        Args:
            technology (list): List of technologies
        """
        self.technology = technology

    def set_capacity_technology(self, capacity_technology):
        """ Sets the cases capacity_technology type

        Args:
            capacity_technology (list): List of technologies
        """
        self.capacity_technology = capacity_technology

    def set_availability_technology(self, availability_technology):
        """ Sets the cases availability_technology type

        Args:
            availability_technology (list): List of technologies
        """
        self.availability_technology = availability_technology

    def set_fuel(self, fuel):
        """ Sets the case's fuel types

        Args:
            fuel (list): list of fuels
        """
        self.fuel = fuel

    def set_specified_fuel(self, specified_fuel):
        """ Sets the case's specified fuel types

        Args:
            specified_fuel (list): list of specified fuels
        """
        self.specified_fuel = specified_fuel

    def set_accumulated_fuel(self, accumulated_fuel):
        """ Sets the case's accumulated fuel types

        Args:
            specified_fuel (list): list of specified fuels
        """
        self.accumulated_fuel = accumulated_fuel

    def set_timeslice(self, timeslice):
        """ Set of timeslices

        Args:
            timeslice (list): list of timeslices
        """
        self.timeslice = timeslice
```

```python

    def set_mode_of_operation(self, num_modes_of_operation):
        """ Create the number of modes of operation (n = 1,..., num_modes_of_operation)

        Args:
            num_modes_of_operation (int): Number of modes of operation
        """
        # Create set of mode_of_operation
        mode_of_operation = []
        count = 1
        while count <= num_modes_of_operation:
            mode_of_operation.append(str(count))
            count = count + 1
        self.mode_of_operation = mode_of_operation

    def set_storage(self, storage):
        """ Sets storage set of the datacase

        Args:
            storage (list): list of storage types
        """
        self.storage = storage

    def set_daytype(self, num_daytypes):
        """ Sets the daytypes for the energy case

        Args:
            num_daytypes (int): Number of daytypes
        """
        # Create set of daytypes
        daytype = []
        count = 1
        while count <= num_daytypes:
            daytype.append(str(count))
            count = count + 1
        self.daytype = daytype

    def set_season(self, num_seasons):
        """ Creates set of seasons

        Args:
            num_seasons (int): Number of seasons
        """
        # Create set of seasons
        season = []
        count = 1
        while count <= num_seasons:
            season.append(str(count))
            count = count + 1
        self.season = season

    def set_daily_time_bracket(self, num_dailytimebrackets):
        """ Creates set of daily time brackets

        Args:
            dailytimebracket (int): Number of daily time brackets
        """
```

```
        # Create set of dailytimebrackets
        dailytimebracket = []
        count = 1
        while count <= num_dailytimebrackets:
            dailytimebracket.append(str(count))
            count = count + 1
        self.dailytimebracket = dailytimebracket

    # Functions to define the parameters moving forward.
    def set_year_split(self, timeslices, years, splits):
        """ Creates 2D Numpy Array Parameter Splits.
            (Note: The index positions of timelices and splits must match)

        Args:
            timeslices (list): List of timeslices
            years (list): List of years
            splits (dict): A dictionary linking yearsplits to timeslices
        """
        # Creates a 2D YearSplit parameter
        YearSplit = np.ones((len(timeslices), len(years)))
        index = 0
        for time in timeslices:
            YearSplit[index, :] = splits[time]
            index = index + 1
        self.YearSplit = YearSplit

    def set_discount_rate(self, 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]

        Args:
            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 co-efficients

```

```
        Returns:
            [int, array]: Numpy array of discount rates
        """
        # Creates empty dictionaries to stored values
        annualised_returns = {}
        cost_of_equity = {}
        cost_of_debt = {}
        cost_of_preference_equity = {}
        WACC = {}
        discount_rates = []
        # Calculates
        for region in market_index:
            # Calculates annualised returns for each regions market index
            annualised_rate_of_return = (np.power(
                (1 + ((market_index[region][-1] - market_index[region][0]) /
                      market_index[region][0])),
                (12 / len(market_index[region]))) - 1)
            annualised_returns[region] = annualised_rate_of_return
            # Calculates cost of equity
            cost_of_equity[region] = (
                risk_free_rate[region] + (market_risk_coefficient[region]) *
                (annualised_returns[region] - risk_free_rate[region]))
            # Calculates cost of debt
            cost_of_debt[region] = (cost_of_debt_pre_tax[region] / debt[region]
                                    ) * (1 - effective_tax_rate[region])
            # Calculates cost of preference equity
            cost_of_preference_equity[region] = preference_dividends[
                region] / market_value_preference_shares[region]
            # Calculates WACC
            WACC[region] = (
                cost_of_equity[region] *
                (equity[region] /
                 (equity[region] + debt[region] + preference_equity[region])) +
                cost_of_debt[region] *
                (debt[region] /
                 (equity[region] + debt[region] + preference_equity[region])) +
                cost_of_preference_equity[region] *
                (preference_equity[region] /
                 (equity[region] + debt[region] + preference_equity[region])))
            # Sets discount rates for each region
            discount_rates.append(WACC[region])
        # Set discount array
        self.DiscountRate = np.asarray(discount_rates)

    def set_day_split(self, daily_time_bracket, years, hour_split, num_days,
                      num_hours):
        """ Sets the day split parameter

        Args:
```

```
            daily_time_bracket (list): List of daily time brackets
            years (list): List of years
            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
        """
        # Initilises the DaySplit Array
        DaySplit = np.ones((len(daily_time_bracket), len(years)))
        index = 0
        for split in daily_time_bracket:
            DaySplit[index, :] = hour_split[split] / (num_days * num_hours)
            index = index + 1
        self.DaySplit = DaySplit

    def set_conversion_ls(self, timeslice, season, link):
        """ Sets the conversionls parameter

        Args:
            timeslice (list): List of timeslices
            season (list): List of seasons
            link (dict): Dictionary describing the connection between timeslices and seasons
        """
        Conversionls = np.zeros((len(timeslice), len(season)))
        for i in range(0, len(timeslice), 1):
            for j in range(0, len(season), 1):
                if link[timeslice[i]] == season[j]:
                    Conversionls[i, j] = 1

        self.Conversionls = Conversionls

    def set_conversion_ld(self, timeslice, daytype, link):
        """ Sets the Conversionld parameter

        Args:
            timeslice (list): List of timeslices
            daytype (list): List of daytypes
            link (dict): Dictionary describing the connection between timeslices and daytypes
        """
        Conversionld = np.zeros((len(timeslice), len(daytype)))
        for i in range(0, len(timeslice), 1):
            Conversionld[i, :] = link[timeslice[i]]

        self.Conversionld = Conversionld

    def set_conversion_lh(self, timeslice, dailytimebracket, link, override):
        """ Sets the Conversionlh parameter

        Args:
            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
        """
        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
        """

```

```
        if override == None:
            depreciation_method = np.ones((len(region)))
            for i in range(0, len(region), 1):
                depreciation_method[i] = methods[region[i]]
            self.DepreciationMethod = depreciation_method
        else:
            self.DepreciationMethod = override

    def set_specified_annual_demand(self, specified_forecast):
        """ Sets the annual demand for fuels per region over the forecast period (Must be accurate)

        Args:
            forecast (float, array): The forecast array of size (len(region),len(fuel),len(year))
        """
        self.SpecifiedAnnualDemand = specified_forecast

    def set_specified_demand_profile(self, specified_annual_demand, region,
                                     fuel, year, timeslice, profile, override):
        """ Sets the specified annual demand profiles using the specified annual demand.

        Args:
            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.
        """
        # Initialises the linear array
        demand_profile = np.zeros(
            (len(region), len(fuel), len(timeslice), len(year)))
        if override == None:
            # Calculates the demand profile
            for place in region:
                for fuel_type in fuel:
                    for time in timeslice:
                        for year_num in year:
                            region_index = region.index(place)
                            fuel_index = fuel.index(fuel_type)
                            timeslice_index = timeslice.index(time)
                            year_index = year.index(year_num)
                            demand_profile[region_index, fuel_index,
                                           timeslice_index,
                                           year_index] = profile[time]

            self.SpecifiedDemandProfile = demand_profile
        else:
            self.SpecifiedDemandProfile = override

```

```
    def set_accumulated_annual_demand(self, 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.

        Args:
            accumulated_forecast (float, array): The forecast array of size (len(region),len(fuel),len(year))
        """
        self.AccumulatedAnnualDemand = accumulated_forecast

    def set_capacity_to_activity_unit(self, region, technology,
                                      capacity_dictionaries, override):
        """ Sets the capacity to activity parameter

        Args:
            region (list): List of regions
            technology (list): List of technologies
            capacity_dictionaries (list): List of dictionaries to assign value
            override (float, array) = 2D Array to assign override values
        """
        if override == None:
            cap_to_act = np.zeros((len(region), len(technology)))
            for i in range(0, len(capacity_dictionaries), 1):
                for j in range(0, len(technology), 1):
                    cap_to_act[i, j] = capacity_dictionaries[i][technology[j]]
            self.CapacityToActivityUnit = cap_to_act
        else:
            self.CapacityToActivityUnit = override

    def set_capacity_factor(self, factor_matrix):
        """ Sets capacity factors for conversion technologies.

        Args:
            factor_matrix (float, array); Capacity Factors
        """
        self.CapacityFactor = factor_matrix

    def set_availability_factor(self, availablility_matrix):
        """ Sets the availability factors

        Args:
            availablility_matrix (float, array): Matrix describing availability factors for given technologies
        """
        self.AvailabilityFactor = availablility_matrix

    def set_operational_life(self, operational_lives):
        """ Sets operational life

        Args:
            operational_lives (list):
```

```
        """
        self.OperationalLife = operational_lives

    def set_residual_capacity(self, residential_capacities):
        """ Set residual capacity

        Args:
            residential_capacities (float, array): residual capacities
parameter
        """
        self.ResidualCapacity = residential_capacities

    def set_input_activity_ratio(self, input_activity_ratios):
        """ Sets input activity ratios

        Args:
            input_activity_ratios (float, array): Sets the input
activity ratio
        """
        self.InputActivityRatio = input_activity_ratios

    def set_output_activity_ratio(self, output_activity_ratios):
        """ Sets output activity ratio

        Args:
            output_activity_ratios (float, array): output activity
ratio parameters
        """

    def set_capital_cost(self, capital_costs):
        """ Sets capital costs

        Args:
            capital_costs (float, array): capital cost paramters
        """
        self.CapitalCost = capital_costs

    def set_variable_cost(self, variable_costs):
        """ Sets variable costs

        Args:
            variable_costs (float, array): variable costs parameters
        """
        self.VariableCost = variable_costs

    def set_fixed_cost(self, fixed_costs):
        """ Set fixed costs

        Args:
            fixed_costs (float, array): fixed cost parameters
        """
        self.FixedCost = fixed_costs

    def set_technology_to_storage(self, technology_to_storage):
        """ Sets the technology to storage parameter

        Args:
```

```
            technology_to_storage (float, array): technology to storage parameter
        """
        self.TechnologyToStorage = technology_to_storage

    def set_technology_from_storage(self, technology_from_storage):
        """ Sets technology from storage binary paramter

        Args:
            technology_from_storage (float, array): technology from storage parameter
        """
        self.TechnologyFromStorage = technology_from_storage

    def set_min_storage_charge(self, minimum_storage_charges):
        """ Sets the minimum storage charges

        Args:
            minimum_storage_charges (float, array): minimum storage parameters
        """
        self.MinStorageCharge = minimum_storage_charges

    def set_operational_life_storage(self, operational_life_storage):
        """ Sets the operational life storage

        Args:
            operational_life_storage (float, array): operational life storage parameters
        """
        self.OperationalLifeStorage = operational_life_storage

    def set_capital_cost_storage(self, capital_cost_storage):
        """ Sets the capital costs of using storage technologies

        Args:
            capital_cost_storage (float, array): capital cost of storage technologies
        """
        self.CapitalCostStorage = capital_cost_storage

    def set_storage_level_start(self, storage_level_start):
        """ Sets the storage level starting point

        Args:
            storage_level_start (float, array): storage starting level
        """
        self.StorageLevelStart = storage_level_start

    def set_storage_max_charge_rate(self, storage_max_level_charge_rates):
        """ Sets the storgae max charge rate

        Args:
            storage_max_level_charge_rates (float, array): Storage max level charge rates
        """
        self.StorageMaxChargeRate = storage_max_level_charge_rates
```

```
    def set_storage_max_discharge_rate(self,
    storage_max_level_discharge_rates):
        """ Sets storage technologies maximum discharge rates

        Args:
            storage_max_level_discharge_rates (float, array): Discharge
     rates for storage paramters
        """
        self.StorageMaxDischargeRate =
    storage_max_level_discharge_rates

    def set_residual_storage_capacity(self, residual_storage_capacities
    ):
        """ Sets residual storage capacities

        Args:
            residual_storage_capacities (float, array): residual
    storage capacities
        """
        self.ResidualStorageCapacity = residual_storage_capacities

    def set_capacity_of_one_technology_unit(self,
    capacity_of_one_technology_unit):
        """ Set the capacity of one technology units for all
    technologies

        Args:
            capacity_of_one_technology_unit (float, array): capacities
    for one technology units
        """
        self.CapacityOfOneTechnologyUnit =
    capacity_of_one_technology_unit

    def set_total_annual_max_capacity(self, total_annual_max_capacities
    ):
        """ Sets the total annual maximum capacities

        Args:
            total_annual_max_capacities (float, array): Total Annual
    Max Capacities
        """
        self.TotalAnnualMaxCapacity = total_annual_max_capacities

    def set_total_annual_min_capacity(self, total_annual_min_capacities
    ):
        """ Sets the totoal annual minimum capacities

        Args:
            total_annual_min_capacities (float, array): Total Annual
    Min Capacities
        """
        self.TotalAnnualMinCapacity = total_annual_min_capacities

    def set_total_technology_annual_activity_lower_limit(
            self, total_technology_activity_lower_limits):
```

```
        """ Sets the Total Technology Activity Lower Limits

        Args:
            total_technology_activity_lower_limits (float, array): Technology Activity Lower Limits
        """
        self.TotalTechnologyAnnualActivityLowerLimit = total_technology_activity_lower_limits

    def set_total_technology_annual_activity_upper_limit(
            self, total_technology_annual_activity_upper_limits):
        """ Sets the Total Technology Activity Upper Limits

        Args:
            total_technology_annual_activity_upper_limits (float, array): Technology Activity Upper Limits
        """
        self.TotalTechnologyAnnualActivityUpperLimit = total_technology_annual_activity_upper_limits

    def set_total_technology_period_activity_upper_limit(
            self, total_technology_period_activity_upper_limits):
        """ Sets Total Technology Period Activity Upper Limits

        Args:
            total_technology_period_activity_upper_limits (float, array): Total Technology Period Activity Upper Limit
        """
        self.TotalTechnologyModelPeriodActivityUpperLimit = total_technology_period_activity_upper_limits

    def set_total_technology_period_activity_lower_limit(
            self, total_technology_period_activity_lower_limits):
        """Sets Total Technology Period Activity Lower Limits

        Args:
            total_technology_period_activity_lower_limits ([type]): Total Technology Period Activity Lower Limit
        """
        self.TotalTechnologyModelPeriodActivityLowerLimit = total_technology_period_activity_lower_limits

    def set_reserve_margin_tag_technology(self, reserve_margin_tag_technologies):
        """ Sets Reserve Margin Tag Technology

        Args:
            reserve_margin_tag_technologies (float, array): Reserve Margin Tag Technologies
        """
        self.ReserveMarginTagTechnology = reserve_margin_tag_technologies

    def set_reserve_margin_tag_fuel(self, reserve_margin_fuel_tags):
        """ Sets the reserve margin tag fuels

        Args:
```

```
            reserve_margin_fuel_tags (float, array): Sets the reserve margin tag fuel parameters
        """
        self.ReserveMarginTagFuel = reserve_margin_fuel_tags

    def set_reserve_margin(self, reserve_margins):
        """ Sets reserve margins

        Args:
            reserve_margins (float, array): Reserve Margins
        """
        self.ReserveMargin = reserve_margins

    def set_re_tag_technology(self, re_tag_technologies):
        """ Sets RE Tag Technology

        Args:
            re_tag_technologies (float, array): RE Tag Technologies
        """
        self.RETagTechnology = re_tag_technologies

    def set_re_tag_fuel(self, re_tag_fuels):
        """ Sets RE Tag Fuels

        Args:
            re_tag_fuels (float, array): RE Tag Fuels
        """
        self.RETagFuel = re_tag_fuels

    def set_re_min_production_target(self, re_min_production_targets):
        """ Sets Renewable Energy Minimum Production Targets

        Args:
            re_min_production_targets (float, array): Renewable Energy Minimum Production Targets
        """
        self.REMinProductionTarget = re_min_production_targets

    def set_emission_activity_ratio(self, emission_activity_ratios):
        """ Sets Emission Activity Ratios

        Args:
            emission_activity_ratios ([float, array): Emission Activity Ratios
        """
        self.EmissionActivityRatio = emission_activity_ratios

    def set_emissions_penalty(self, emissions_penalties):
        """ Sets Emissions Penalties

        Args:
            emissions_penalties (float, penalties): Emissions Penalties
        """
        self.EmissionsPenalty = emissions_penalties

    def set_annual_exogenous_emission(self, annual_exogenous_emission):
        """ Sets Annual Exogneous Emissions

```

```
        Args:
            annual_exogenous_emission (float, array): Annual Exogenous Emissions
        """
        self.AnnualExogenousEmission = annual_exogenous_emission

    def set_annual_emission_limit(self, annual_emission_limits):
        """ Sets Annual Emission Limits

        Args:
            annual_emission_limits (float, array): Annual Emission Limits
        """
        self.AnnualEmissionLimit = annual_emission_limits

    def set_model_period_exogenous_emission(self, model_period_exogenous_emissions):
        """ Sets Model Period Exogenous Emissions

        Args:
            model_period_exogenous_emissions (float, array): Model Period Exogenous Emissions
        """
        self.ModelPeriodExogenousEmission = model_period_exogenous_emissions

    def set_model_period_emission_limit(self, model_period_emission_limits):
        """ Sets Model Period Emission Limits

        Args:
            model_period_emission_limits (float, array): Model Period Emission Limits
        """
        self.ModelPeriodEmissionLimit = model_period_emission_limits
```

5.2.4 Forecasting

The module to forecast energy and finance-related values.

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


class Forecasting:
    def __unit__(self):
        """Initialises the forecasting class
        """
        self.forecasts = None

    def energy_balance_base(self, root, IEA_World_Energy_Balances_1,
                            IEA_World_Energy_Balances_2,
                            create_excel_spreadsheet, output_file):
        """ Creates the baseline energy balance for forecasting

```

```
    Args:
        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:
        (dict): Dictionary of energy balances and unique lists (Use these key words to access: Energy Balances, Fuel, Geography, Technology)
    """
    IEAWEBAK = root / IEA_World_Energy_Balances_1
    IEAWEBLZ = root / IEA_World_Energy_Balances_2

    # 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()

    # Finds the unique items in each list of the energy balance sheets
    unique_fuel = df.Prod_Description.unique()
    unique_geography = df.Geo_Description.unique()
    unique_technology = df.Flow_Description.unique()
    print(unique_geography)

    # Asks for a user to select a geography using the inquirer function
    selected_geo = input(
        "Please enter the geography you wish to extract energy balances:  "
    )
```

```
        # Creates a pivot table to display the data in the way similar to the Energy Balance Sheet (cols = Energy Product, rows = Energy Flows)
        energy_balance_pivot_table = pd.pivot_table(
            df,
            index=['Geo_Description', 'Flow_Description'],
            # Converted values to PJ
            values=['Value(TJ)'],
            columns=['Prod_Description'],
            aggfunc=[np.sum],
            fill_value=0)
        # Filters to the geography the user has selected
        Input_String = 'Geo_Description == ["' + selected_geo + '"]'
        geography_energy_balance_pivot_table = energy_balance_pivot_table.query(
            Input_String)

        if create_excel_spreadsheet == True:
            # Write the filtered pivot table to an excel file
            writer = pd.ExcelWriter(root / output_file)
            geography_energy_balance_pivot_table.to_excel(writer, selected_geo)
            writer.save()

        # Returns the unique lists and filtered pivot table as a dataframe
        return {
            "Energy Balances": geography_energy_balance_pivot_table,
            "Fuel": unique_fuel,
            "Geography": unique_geography,
            "Technology": unique_technology
        }

    def calculate_constant_average_growth_rate(self, start_year, end_year,
                                               start_value, end_value):
        """ Calculates the constant average growth rate (CAGR)

        Args:
            start_year (int): Starting year
            end_year (int): Ending year
            start_value (int): Initial value
            end_value (int): Final value

        Returns:
            cagr: Constant average growth rate (1+ decimal)
        """
        if start_value == 0 or (end_year - start_year) == 0:
            cagr = 1
        else:
            cagr = np.power((end_value / start_value),
                            (1 / (end_year - start_year)))
        return cagr

    def calculate_cagr_forecasts(self, cagr_dictionary, base_year_dictionary,
                                 fuel, year):
```

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

        Args:
            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:
            [float, array]: 2D Array of demand forecasts per fuel
        """
        # Initialises the size of the array
        forecast = np.ones((len(fuel), len(year)))

        # Set the first forecast as the base year
        for i in range(0, len(fuel), 1):
            forecast[i, 0] = base_year_dictionary[fuel[i]]

        # Calculates the forecasting
        for i in range(0, len(fuel), 1):
            for j in range(1, len(year), 1):
                forecast[i, j] = forecast[i, j - 1] * cagr_dictionary[fuel[j]]

        return forecast
```

5.2.5 Optimisation

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

```
#################################################################
# Optimisation contains the Optimisation Class to use CPLEX
#################################################################

# Import python modules
import os
import cplex as cp
import docplex as dp
import subprocess as sp
from ibm_watson_machine_learning import APIClient
import tarfile as tf
import time


# Begin class breakdown
class Optimisation:
    """ Prepares and runs optimisation with IBM ILOG CPLEX Optimisation Studio
    """
    def __init__(self):
        """ Initialise the optimisation class
        """

    def use_bash_shell(self, command):
```

```
        """ Execute bash commands in python scripts

        Args:
            command (str): Command to execute
        """
        # Execute the demand
        sp.Popen([['/bin/bash', '-c', command]])

    def create_linear_programme_file(self, directory, data_file, model_file,
                                     output_file):
        """ Creates the model file through executing model system commands

            Args:
                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
            """
        # Change the working directory
        os.chdir(directory)
        # Load the custom anaconda environment
        # This assumes the conda environment has already been initialised.
        os.system('conda activate osemosys')
        # Execute the file structure to create the linear programming file
        # (glpsol -m GOCPI_Model.txt -d GOCPI_Data.txt --wlp GOCPI.lp)
        command = 'glpsol -m ' + data_file + ' -d ' + model_file + '--wlp ' + output_file
        os.system(command)

    def run_cplex_local(self, model_file):
        """ This function runs cplex on the local device if the energy system
            is of a small enough scale

        Args:
            model_file (str): Path of model file

        Returns:
            [int]: Objective value
        """
        # Creates the model structure
        model = cp.Cplex()
        # Produces the results stream and log streams
        output = model.set_results_stream(None)
        output = model.set_log_stream(None)
        # Write the energy system model to Cplex
        model.read(model_file)
        # Solve the model using the version of Cplex installed on the local
        # device (IBM ILOG CPLEX Optimisation Studio)
        model.solve()
        # Return the value of the objective function
        objective_value = model.solution.get_objective_value()
        return objective_value
```

```python

    def run_ibm_wml_do(self, 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.

        Args:
            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
        """

```

```
        # 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)
```

```

        # Creates the model deployment
        model_metadata = {
            client.repository.ModelMetaNames.NAME: model_name,
            client.repository.ModelMetaNames.DESCRIPTION: model_name + 'Model',
            client.repository.ModelMetaNames.TYPE: model_type,
            client.repository.ModelMetaNames.RUNTIME_UID: model_runtime_uid,
            client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:
            software_spec_uid
        }
        # Creates the energy model details
        model_details = client.repository.store_model(
            model=model_tar_file, meta_props=model_metadata)
        # Creates model uid
        model_uid = client.repository.get_model_uid(model_details)

        # Creates a deployment
        meta_props = {
            client.deployments.ConfigurationMetaNames.NAME:
            "Deployment " + str(num_nodes),
            client.deployments.ConfigurationMetaNames.DESCRIPTION:
            "Deployment " + str(num_nodes),
            # client.deployments.ConfigurationMetaNames.HARDWARE_SPEC:
            client.deployments.ConfigurationMetaNames.BATCH: {},
            client.deployments.ConfigurationMetaNames.COMPUTE: {
                'name': 'S',
                'nodes': num_nodes
            }
        }

        # Tests 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(
                model_uid, meta_props=meta_props)
            deployment_uid = client.deployments.get_uid(deployment_details)

        # Creates a payload for the solver to solve (Note: Ammend based on the model you are solving)
        payload = {
            client.deployments.DecisionOptimizationMetaNames.INPUT_DATA: [{
                "id":
                payload_input_data_id,
                "values":
                payload_input_data_file
            }],
            client.deployments.DecisionOptimizationMetaNames.OUTPUT_DATA: [{
                "id":
                payload_output_data_id
            }]
        }
```

```
        # Creates a new job using the deployment and payload
        job_details = client.deployments.create_job(deployment_uid, payload)
        job_uid = client.deployments.get_job_uid(job_details)

        # Print the status of the job until competition
        while job_details['entity']['decision_optimization']['status']['state'] not in ['completed', 'failed', 'canceled']:
            print(job_details['entity']['decision_optimization']['status']['state'] + '...')
            job_details = client.deployments.get_job_details(job_uid)
            time.sleep(5)
            print(job_details['entity']['decision_optimization']['status']['state'])

    # Reset tarfile function (Source: IBM Watson Machine Learning)
    def reset(self, tarinfo):
        """ Resets the tarfile information when creating tar files
            This is to input into the filter when using tar.add()

        Args:
            tarinfo (Object): Tar Object containing an ID of 0 and the root as the name

        Returns:
            tarinfo (Object): Tar Object containing an ID of 0 and the root as the name
        """
        tarinfo.uid = tarinfo.gid = 0
        tarinfo.uname = tarinfo.gname = "root"
        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.

```python
# 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)
```

```

# Fraction of year for season and day/night level (Should change depending on the geography)
# Determine how to make these changes after you get a baseline model running
REG_Num_Sum_Days = 175
REG_Num_Days = 365
REG_Num_Win_Days = (REG_Num_Days - REG_Num_Sum_Days)
Frac_REG_Num_Sum_Days = REG_Num_Sum_Days / REG_Num_Days
Frac_REG_Num_Win_Days = REG_Num_Win_Days / REG_Num_Days

Sum_Hours_Per_Day = 12.5
Win_Hours_Per_Day = 11.5
Hours_Per_Day = 24

Frac_Sum_Hours_Per_Day = Sum_Hours_Per_Day / (Hours_Per_Day)
Frac_Win_Hours_Per_Day = Sum_Hours_Per_Day / (Hours_Per_Day)
Frac_Sum_Hours_Per_Night = (1 - Frac_Sum_Hours_Per_Day)
Frac_Win_Hours_Per_Night = (1 - Frac_Win_Hours_Per_Day)

SD_YRFR = Frac_REG_Num_Sum_Days * Frac_Sum_Hours_Per_Day
SN_YRFR = Frac_REG_Num_Sum_Days * Frac_Sum_Hours_Per_Night
WD_YRFR = Frac_REG_Num_Win_Days * Frac_Win_Hours_Per_Day
WN_YRFR = Frac_REG_Num_Win_Days * Frac_Win_Hours_Per_Night

# Currency for investment decisions underpinning the model
CUR = "MEuro05"

# Default Units (Review and come back to this commodity part of the model)
# Explicitly Commodity Groups are not required in the modelling process at this stage.

# Creates a function to update the spreadsheet relative to those feed in to the function
# Inserts the various cells in python as required
# Imports the various functions needed for the file

source_file = "SysSettings.xlsm"
source_sheet = "TimePeriods"
source_range = "StartYear"
updated_value = StartYear
destination_file = "SysSettings.xls"

# Update the StartYear
Set_Values(source_root, source_file, source_sheet, source_range, updated_value,
           destination_file)
```

6.5 GOCPI Model Import

This script helped import OseMOSYS models.

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

```
# 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)
```

```
    output.write("GOCPI Example")

# Creates Docplex example
# energy_system_docplex = docplex.cp.model.CpoModel(name="GOCPI_Docplex
    ")
energy_system_docplex_lp = dpmp.model_reader.ModelReader.read(
    lp_file, model_name='GOCPI_Docplex_Lp')

mdl = energy_system_docplex_lp.solve(url=url, api=apikey)
# print('mdl', mdl)
# return_code = sb.call("conda init bash", shell=True)
# return_code = sb.call("conda activate osemosys", shell=True)
# os.system('conda activate osemosys')
# 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};
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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;
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var DiscountedSalvageValueStorage{r in REGION,s in STORAGE,y in YEAR}>=0;
var TotalDiscountedStorageCost{r in REGION,s in STORAGE,y in YEAR}>=0;
var NumberOfNewTechnologyUnits{r in REGION,t in TECHNOLOGY,y in YEAR}>=0, integer;
var NewCapacity{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
var AccumulatedNewCapacity{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
var TotalCapacityAnnual{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
var RateOfActivity{r in REGION,l in TIMESLICE,t in TECHNOLOGY,m in MODE_OF_OPERATION,y in YEAR} >=0;
var RateOfTotalActivity{r in REGION,t in TECHNOLOGY,l in TIMESLICE,y in YEAR} >=0;
var TotalTechnologyAnnualActivity{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
var TotalAnnualTechnologyActivityByMode{r in REGION,t in TECHNOLOGY,m in MODE_OF_OPERATION,y in YEAR} >=0;
var TotalTechnologyModelPeriodActivity{r in REGION,t in TECHNOLOGY};
var RateOfProductionByTechnologyByMode{r in REGION,l in TIMESLICE,t in TECHNOLOGY,m in MODE_OF_OPERATION,f in FUEL,y in YEAR}>=0;
var RateOfProductionByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f in FUEL,y in YEAR} >=0;
var ProductionByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f in FUEL,y in YEAR} >=0;
var ProductionByTechnologyAnnual{r in REGION,t in TECHNOLOGY,f in FUEL,y in YEAR} >=0;
var RateOfProduction{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR}>=0;
var Production{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
var RateOfUseByTechnologyByMode{r in REGION,l in TIMESLICE,t in TECHNOLOGY,m in MODE_OF_OPERATION,f in FUEL,y in YEAR} >=0;
var RateOfUseByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f in FUEL,y in YEAR} >=0;
var UseByTechnologyAnnual{r in REGION,t in TECHNOLOGY,f in FUEL,y in YEAR} >=0;
var UseByTechnology{r in REGION,l in TIMESLICE,t in TECHNOLOGY,f in FUEL,y in YEAR} >=0;
var RateOfUse{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR}>=0;
var Use{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
var Trade{r in REGION,rr in REGION,l in TIMESLICE,f in FUEL,y in YEAR};
var TradeAnnual{r in REGION,rr in REGION,f in FUEL,y in YEAR};
var ProductionAnnual{r in REGION,f in FUEL,y in YEAR} >=0;
var UseAnnual{r in REGION,f in FUEL,y in YEAR}>=0;
var CapitalInvestment{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
var DiscountedCapitalInvestment{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
var SalvageValue{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
var DiscountedSalvageValue{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
var OperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
var DiscountedOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
var AnnualVariableOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
var AnnualFixedOperatingCost{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
var TotalDiscountedCostByTechnology{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
var TotalDiscountedCost{r in REGION,y in YEAR} >=0;
var ModelPeriodCostByRegion{r in REGION}>=0;
var TotalCapacityInReserveMargin{r in REGION,y in YEAR} >=0;
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var DemandNeedingReserveMargin{r in REGION,l in TIMESLICE,y in YEAR} >=0;
var TotalREProductionAnnual{r in REGION,y in YEAR};
var RETotalProductionOfTargetFuelAnnual{r in REGION,y in YEAR};
var AnnualTechnologyEmissionByMode{r in REGION,t in TECHNOLOGY,e in EMISSION,m in MODE_OF_OPERATION,y in YEAR} >=0;
var AnnualTechnologyEmission{r in REGION,t in TECHNOLOGY,e in EMISSION,y in YEAR} >=0;
var AnnualTechnologyEmissionPenaltyByEmission{r in REGION,t in TECHNOLOGY,e in EMISSION,y in YEAR} >=0;
var AnnualTechnologyEmissionsPenalty{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
var DiscountedTechnologyEmissionsPenalty{r in REGION,t in TECHNOLOGY,y in YEAR} >=0;
var AnnualEmissions{r in REGION,e in EMISSION,y in YEAR} >=0;
var ModelPeriodEmissions{r in REGION,e in EMISSION} >=0;
minimize cost: sum{r in REGION, y in YEAR} TotalDiscountedCost[r,y];
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];
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];
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];
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];
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];
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];
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];
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];
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];
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];
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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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];
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];
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];
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];
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];
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];
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];
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];
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];
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];
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];
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];
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];
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];
s.t. Acc4_ModelPeriodCostByRegion{r in REGION}: sum{y in YEAR} TotalDiscountedCost[r,y] = ModelPeriodCostByRegion[r];
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];
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];
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];
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];
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];
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];
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];
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];
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];
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];
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;
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];
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;
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
in YEAR} max(yy) - y+1)/OperationalLifeStorage[r,s]) =
SalvageValueStorage[r,s,y];
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];
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];
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];
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];
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];
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)));
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]);
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;
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)));
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];
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];
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];
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];
```

```
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];
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];
s.t. TCC1_TotalAnnualMaxCapacityConstraint{r in REGION, t in TECHNOLOGY, y in YEAR}: TotalCapacityAnnual[r,t,y] <= TotalAnnualMaxCapacity[r,t,y];
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];
s.t. NCC1_TotalAnnualMaxNewCapacityConstraint{r in REGION, t in TECHNOLOGY, y in YEAR}: NewCapacity[r,t,y] <= TotalAnnualMaxCapacityInvestment[r,t,y];
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];
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];
s.t. AAC2_TotalAnnualTechnologyActivityUpperLimit{r in REGION, t in TECHNOLOGY, y in YEAR}: TotalTechnologyAnnualActivity[r,t,y] <= TotalTechnologyAnnualActivityUpperLimit[r,t,y] ;
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];
s.t. TAC1_TotalModelHorizonTechnologyActivity{r in REGION, t in TECHNOLOGY}: sum{y in YEAR} TotalTechnologyAnnualActivity[r,t,y] = TotalTechnologyModelPeriodActivity[r,t];
s.t. TAC2_TotalModelHorizonTechnologyActivityUpperLimit{r in REGION, t in TECHNOLOGY: TotalTechnologyModelPeriodActivityUpperLimit[r,t]>0}: TotalTechnologyModelPeriodActivity[r,t] <= TotalTechnologyModelPeriodActivityUpperLimit[r,t] ;
s.t. TAC3_TotalModelHorizenTechnologyActivityLowerLimit{r in REGION, t in TECHNOLOGY: TotalTechnologyModelPeriodActivityLowerLimit[r,t]>0}: TotalTechnologyModelPeriodActivity[r,t] >= TotalTechnologyModelPeriodActivityLowerLimit[r,t] ;
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];
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];
s.t. RM3_ReserveMargin_Constraint{r in REGION, l in TIMESLICE, y in YEAR}: DemandNeedingReserveMargin[r,l,y] * ReserveMargin[r,y]<= TotalCapacityInReserveMargin[r,y];
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];
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
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AUSTRALIA 1.0 1.0
  [*,*,RH,2000]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2001]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2002]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2003]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2004]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2005]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2006]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2007]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2008]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2009]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RH,2010]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1990]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
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  [*,*,RL,1991]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1992]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1993]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1994]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1995]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1996]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1997]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1998]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,1999]:  NEWZEALAND AUSTRALIA  :=
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AUSTRALIA 1.0 1.0
  [*,*,RL,2000]:  NEWZEALAND AUSTRALIA  :=
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  [*,*,RL,2001]:  NEWZEALAND AUSTRALIA  :=
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  [*,*,RL,2002]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
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  [*,*,RL,2003]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,2004]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,2005]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,2006]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,2007]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,2008]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,2009]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,RL,2010]:  NEWZEALAND AUSTRALIA  :=
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NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1990]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1991]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1992]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1993]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1994]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1995]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1996]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1997]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1998]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,1999]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2000]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2001]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2002]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2003]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2004]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2005]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2006]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2007]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
AUSTRALIA 1.0 1.0
  [*,*,TX,2008]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
```

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AUSTRALIA 1.0 1.0
  [*,*,TX,2009]:  NEWZEALAND AUSTRALIA  :=
NEWZEALAND 1.0 1.0
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  :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 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 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  :=
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  [*,*,INTERMEDIATE_NIGHT,1996]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,1997]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,1998]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,1999]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,2000]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
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  [*,*,INTERMEDIATE_NIGHT,2001]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,2002]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
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  [*,*,INTERMEDIATE_NIGHT,2003]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
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  [*,*,INTERMEDIATE_NIGHT,2004]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
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  [*,*,INTERMEDIATE_NIGHT,2005]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,2006]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,2007]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,2008]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,2009]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX  :=
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  [*,*,INTERMEDIATE_NIGHT,2010]:  CSV DSL ELC GSL HCO HYD LTH OIL URN
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  [*,*,SUMMER_DAY,2009]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
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  [*,*,SUMMER_NIGHT,1993]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
    TX  :=
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    TX  :=
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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
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  [*,*,SUMMER_NIGHT,2008]:  CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
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  [*,*,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
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 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
      :=
```

```
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 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
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 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
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 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
      :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 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]:  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,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_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
```

```
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,WINTER_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
  [*,*,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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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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  [*,*,INTERMEDIATE_NIGHT,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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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_DAY,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
  [*,*,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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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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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  [*,*,SUMMER_DAY,2000]:  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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  [*,*,SUMMER_DAY,2001]:  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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  [*,*,SUMMER_DAY,2002]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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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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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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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  [*,*,SUMMER_NIGHT,1990]:  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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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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,1992]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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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
  [*,*,SUMMER_NIGHT,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
  [*,*,SUMMER_NIGHT,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
  [*,*,SUMMER_NIGHT,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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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,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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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]:  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,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_NIGHT,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_NIGHT,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
```

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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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]:  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,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 AvailabilityFactor  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 :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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 :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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 :=
```

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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
  [*,*,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 OperationalLife :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 ResidualCapacity  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
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  [*,*,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
    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
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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
  [*,*,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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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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
    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
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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
    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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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
;
#
param OutputActivityRatio 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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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,1,1993]: 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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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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   1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,RH,2,2001]:  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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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,2,2003]:  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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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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  [*,*,RL,1,1993]:  E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
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  [*,*,RL,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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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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,2,2001]:  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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  [*,*,RL,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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  [*,*,RL,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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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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,2,2006]:  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
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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,2,2007]:  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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  [*,*,RL,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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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,2,2000]: 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
  [*,*,2,2001]: 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
```

```
  [*,*,2,2002]: 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
  [*,*,2,2003]: 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
  [*,*,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
  [*,*,2,2005]: 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
  [*,*,2,2006]: 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
  [*,*,2,2007]: 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
  [*,*,2,2008]: 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
  [*,*,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
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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
  [*,*,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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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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
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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
  [*,*,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
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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
    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
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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
  [*,*,2005]: 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
  [*,*,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
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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 TechnologyToStorage default 1:=
  [*,*,DAM,1]:  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
  [*,*,DAM,2]:  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 TechnologyFromStorage default 1:=
  [*,*,DAM,1]:  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
  [*,*,DAM,2]:  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 StorageLevelStart :DAM:=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
param StorageMaxChargeRate  :DAM:=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
param StorageMaxDischargeRate :DAM:=
NEWZEALAND 1.0
AUSTRALIA 1.0
;
#
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 :=
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AUSTRALIA 1.0
  [*,*,1998]: DAM :=
NEWZEALAND 1.0
AUSTRALIA 1.0
  [*,*,1999]: DAM :=
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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 :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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 :=
NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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 TotalAnnualMaxCapacity  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
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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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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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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;
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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 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
  [*,*,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
  [*,*,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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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
  [*,*,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
  [*,*,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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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 :=
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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 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
  [*,*,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
  [*,*,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
  [*,*,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
  [*,*,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
;
#
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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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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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  [*,*,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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  [*,*,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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  [*,*,1996]: 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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  [*,*,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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  [*,*,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
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  [*,*,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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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
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  [*,*,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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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 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 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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  [*,*,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
  [*,*,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
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AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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
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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
  [*,*,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
    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
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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
  [*,*,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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    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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
    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 :=
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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
  [*,*,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 ReserveMarginTagFuel  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
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  [*,*,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
;
#
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```
param RETagTechnology default 1:=
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    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
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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
    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
  [*,*,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
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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
  [*,*,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
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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
  [*,*,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
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 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
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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:=
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     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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NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,1995]: 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
  [*,*,CO2,1,1996]: 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
AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,CO2,1,1997]: 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
  [*,*,CO2,1,1998]: 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
  [*,*,CO2,1,1999]: 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
  [*,*,CO2,1,2000]: 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
  [*,*,CO2,1,2001]: 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
  [*,*,CO2,1,2002]: 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
  [*,*,CO2,1,2003]: 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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    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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  [*,*,METHANE,1,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,1,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,1,1995]: 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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  [*,*,METHANE,1,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,1,2002]: 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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  [*,*,METHANE,1,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,1,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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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
  [*,*,METHANE,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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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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  [*,*,METHANE,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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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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  [*,*,METHANE,1,2010]: 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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  [*,*,METHANE,2,1990]: 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
    1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,2,1991]: 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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  [*,*,METHANE,2,1992]: 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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  [*,*,METHANE,2,1994]: 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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  [*,*,METHANE,2,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,2,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,2,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,2,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,2,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,2,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1
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  [*,*,METHANE,2,2001]: 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 1.0 1.0 1.0 1.0 1.0 1.0
  [*,*,METHANE,2,2003]: 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
  [*,*,METHANE,2,2004]: 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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  [*,*,METHANE,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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  [*,*,METHANE,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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  [*,*,METHANE,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
  [*,*,METHANE,2,2008]: 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,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
  [*,*,METHANE,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 EmissionsPenalty  default 1:=
  [*,*,1990]: CO2 NOX CO METHANE  :=
```

```
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  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1998]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1999]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2000]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2001]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2002]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2003]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2004]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2005]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2006]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2007]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2008]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2009]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
```

```
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2010]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
;
#
param AnnualExogenousEmission default 1:=
  [*,*,1990]: CO2 NOX CO METHANE  :=
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  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1998]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1999]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2000]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2001]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2002]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2003]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2004]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2005]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2006]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
```

```
  [*,*,2007]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2008]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2009]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2010]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
;
#
param AnnualEmissionLimit default 1:=
  [*,*,1990]: CO2 NOX CO METHANE  :=
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  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1998]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,1999]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2000]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2001]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2002]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2003]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2004]: CO2 NOX CO METHANE  :=
```

```
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2005]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2006]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2007]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2008]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2009]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
  [*,*,2010]: CO2 NOX CO METHANE  :=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
;
#
param ModelPeriodExogenousEmission  :CO2 NOX CO METHANE:=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
;
#
param ModelPeriodEmissionLimit  :CO2 NOX CO METHANE:=
NEWZEALAND 1.0 1.0 1.0 1.0
AUSTRALIA 1.0 1.0 1.0 1.0
;
end;
#
```

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.

8 Bibliography