

ENGSCI 700A/B

Research Compendium

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Contents

1	Website	2
1.1	Version Two	2
1.2	Version One	2
2	Programming	3
2.1	GOCPI NZ Energy Systems Example	3
2.2	GOCPI Module	18
2.2.1	Navigation	18
2.2.2	Energysystems	19
2.2.3	CreateCases	61
2.2.4	Forecasting	76
2.2.5	Optimisation	79
3	Development Scripting	84
3.1	GOCPI Data Cases	84
3.2	GOCPI Energy Balances	87
3.3	GOCPI Geographies	94
3.4	GOCPI Inputs	95
3.5	GOCPI Model Import	98
3.6	GOCPI Optimisation	99
4	OseMOSYS	105
4.1	Model File	106
4.2	Data File	115
4.3	Linear Programme File	323
5	Project Log Book	323
6	Bibliography	329

List of Figures

1	GOCPI Website V1	330
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List of Tables

1 Website

1.1 Version Two

The website was improved using Jekyll, Ruby and Markdown technologies. **You can access the website here** The following screenshots show the necessary sections of the website.

1.2 Version One

This html script was adapted from an W3 schools template to include key information about the project.

2 Programming

These section contains all programming scripts for the project.

2.1 GOCPI NZ Energy Systems Example

```

1 # GOCPI_NZ_Example.gyp is an exemplar script in how to build a
2 # data case for the Model
3 #
4 #
5 # ##########
6 # This is a major input script for creating data files.
7 #
8 # ##########
9 # Import all necessary python packages
10 import numpy as np
11 import pandas as pd
12 import matplotlib.pyplot as plt
13 import scipy as sc
14 import sklearn as skl
15 import csv as csv
16 import openpyxl
17 import pathlib
18 import os
19 from pathlib import Path
20 from openpyxl import load_workbook
21 import GOCPI as GF
22 import cplex as cp
23 import docplex as dp
24
25 # Sets sets (All must be one word)
26 # Creates a New Zealand Energy System Scenario using the CreateCases
27 # Module
28 nz_energy_system = GF.CreateCases()
29
30 # Set Definitions
31 #
32 # ##########
33 #
34 # Defines the forecast period
35 nz_energy_system.set_year(2020, 2030, 1)
36
37 # Defines the regions
38 REGION = ['NEWZEALAND', 'AUSTRALIA']
39 nz_energy_system.set_region(REGION)
40
41 # Defines the Emissions
42 EMISSION = ['CO2', 'NOX', 'CO', 'METHANE']
43 nz_energy_system.set_emission(EMISSION)
44
45 # Technology

```

```

43 #
44 #####
45 # Defines the technology set (MBIE Energy Statistics Energy Supply and
46 # Demand -
47 # Gross PJ (Higher Heating Value))
48 Production = [
49     'Indigenous_Production', 'Imports', 'Exports', 'Stock_Change',
50     'International_Transport',
51 ]
52 Conversion = [
53     'Electricity_Generation', 'Cogeneration', 'Fuel_Production',
54     'Other_Transformation', 'Losses_and_Own_Use'
55 ]
56 Non_Energy = ['Non_Energy_Use']
57 Consumption = [
58     'Agriculture', 'Forestry_and_Logging', 'Fishing', 'Mining',
59     'Food_Processing', 'Textiles', 'Wood_Pulp_Paper_and_Printing', ,
60     'Chemicals',
61     'Non_Metallic_Minerals', 'Basic_Metals',
62     'Mechanical_Electrical_Equipment', 'Building_and_Construction',
63     'Unallocated', 'Commercial', 'Transport', 'Residential'
64 ]
65 Statistical_Differences = ['Statistical_Differences']
66 TECHNOLOGY_ALL = [
67     Production, Conversion, Non_Energy, Consumption,
68     Statistical_Differences
69 ]
70 TECHNOLOGY = []
71 for tech in TECHNOLOGY_ALL:
72     for i in range(0, len(tech), 1):
73         TECHNOLOGY.append(tech[i])
74
75 # Sets the technology set
76 nz_energy_system.set_technology(TECHNOLOGY)
77
78 # Sets capacity technologies for energy production
79 CAPACITY_TECHNOLOGY = Conversion
80 CONSUMPTION_TECHNOLOGY = Consumption
81 nz_energy_system.set_capacity_technology(TECHNOLOGY)
82 nz_energy_system.set_availability_technology(TECHNOLOGY)
83 # Sets the Conversion Sets
84
85 #
86 ##########
87 # Calculates Energy Balances Base Year
88 #
89 ##########
90
91 # Sets names for the energy balance sheets
92 NZ_energy_balances = GF.Forecasting()
93 root_energy_balance = pathlib.Path(

```

```

89     '/Users/connor/Google Drive/Documents/University/Courses/2020/
90     ENGSCI 700A&B/GOCPI/data/Energy Balances'
91 )
92 IEA_World_Energy_Balances_A2K = 'IEAWorldEnergyBalances2017A-K.csv'
93 IEA_World_Energy_Balances_L2Z = 'IEAWorldEnergyBalances2017L-Z.csv'
94 create_excel_spreadsheet = True
95 output_file = "Geo EB.xlsx"
96
97 # Creates the geography dataframe
98 outputs = NZ_energy_balances.energy_balance_base(
99     root_energy_balance, IEA_World_Energy_Balances_A2K,
100    IEA_World_Energy_Balances_L2Z, create_excel_spreadsheet,
101    output_file)
102
103 #
104 ##########
105 # Calculates Fuels
106 #
107 #########
108 # Defines the fuel set (MBIE Energy Statistics Energy Supply and Demand
109 # - Gross PJ (Higher Heating Value))
110 Coal = ['Bituminous', 'Sub_Bituminous', 'Lignite']
111 Oil = [
112     'Crude_Feedstocks_NGL', 'LPG', 'Petrol', 'Diesel', 'Fuel_Oil',
113     'Aviation_Fuel_and_Kerosine', 'Oil_Other'
114 ]
115 Natural_Gas = ['Natural_Gas']
116 Renewables = [
117     'Hydro', 'Geothermal', 'Solar', 'Wind', 'Liquid_Biofuels', 'Biogas',
118     'Wood'
119 ]
119 Electricity = ['Electricity']
120 Waste_Heat = ['Waste_Heat']
121
122 FUEL_ALL = [Coal, Oil, Natural_Gas, Renewables, Electricity, Waste_Heat
123     ]
124 FUEL = []
125 for fuel_type in FUEL_ALL:
126     for i in range(0, len(fuel_type), 1):
127         FUEL.append(fuel_type[i])
128
129 # Sets Specified Fuels
130 SPECIFIED_FUEL_ALL = [
131     Coal, Oil, Natural_Gas, Renewables, Electricity, Waste_Heat
132 ]
133 SPECIFIED_FUEL = []
134 for fuel_type in SPECIFIED_FUEL_ALL:
135     for i in range(0, len(fuel_type), 1):
136         SPECIFIED_FUEL.append(fuel_type[i])
137
138 # Sets Accumulated Fuels
139 ACCUMULATED_FUEL_ALL = [
140     Coal, Oil, Natural_Gas, Renewables, Electricity, Waste_Heat
141 ]
142 ACCUMULATED_FUEL = []
143 for fuel_type in ACCUMULATED_FUEL_ALL:

```

```
138     for i in range(0, len(fuel_type), 1):
139         ACCUMULATED_FUEL.append(fuel_type[i])
140
141 # Sets the total fuels
142 nz_energy_system.set_fuel(FUEL)
143 nz_energy_system.set_specified_fuel(FUEL)
144 nz_energy_system.set_accumulated_fuel(FUEL)
145 #
146 ##########
147 # Continues defining sets
148 #
149 ##########
150 # Defines timeslices
151 TIMESLICE = [
152     'DAY_SUMMER', 'NIGHT_SUMMER', 'DAY_WINTER', 'NIGHT_WINTER',
153     'DAY_INTERMEDIATE', 'NIGHT_INTERMEDIATE'
154 ]
155 nz_energy_system.set_timeslice(TIMESLICE)
156
157 # Defines Modes of Operation
158 nz_energy_system.set_mode_of_operation(1)
159
160 # Defines the storage set
161 STORAGE = ['DAM']
162 nz_energy_system.set_storage(STORAGE)
163
164 # Defines the datatype (numbers represent different datatypes)
165 # 1 = Weekday (Mon - Fri), 2 = Weekend (Sat & Sun)
166 nz_energy_system.set_datatype(2)
167
168 # Defines the seasons
169 # (Three seasons (Summer (1), Winter (2) and Intermediate (3)))
170 nz_energy_system.set_season(3)
171
172 # Defines the dailytimebracket (Number of distinct periods in a day)
173 # 4 = Morning (6hrs), Afternoon (6hrs), Evening (6hrs), Night (6hrs)
174 nz_energy_system.set_daily_time_bracket(4)
175
176 # Defines Global Parameters
177 #
178 ##########
179 # Defines the YearSplit parameter
180 # Creates Dictionary for number of days
181 days = {
182     'January': 31,
183     'February': 28,
184     'March': 31,
185     'April': 30,
186     'May': 31,
187     'June': 30,
188     'July': 31,
189     'August': 31,
```

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188     'September': 30,
189     'October': 31,
190     'November': 30,
191     'December': 31
192 }
193
194 # Combines summer, winter and intermediate nights
195 days_summer = days['January'] + days['February'] + days['December']
196 days_winter = days['June'] + days['July'] + days['August']
197 days_intermediate = days['April'] + days['May'] + days['March'] + days[
198     'September'] + days['October'] + days['November']
199 days_total = days_summer + days_winter + days_intermediate
200
201 # Creates fractions and stores values in a dictionary
202 day_summer = (0.5 * days_summer / days_total)
203 night_summer = (0.5 * days_summer / days_total)
204 day_winter = (0.5 * days_winter / days_total)
205 night_winter = (0.5 * days_winter / days_total)
206 day_intermediate = (0.5 * days_intermediate / days_total)
207 night_intermediate = (0.5 * days_intermediate / days_total)
208
209 # Dictionaries
210 splits = {
211     'DAY_SUMMER': day_summer,
212     'NIGHT_SUMMER': night_summer,
213     'DAY_WINTER': day_winter,
214     'NIGHT_WINTER': night_winter,
215     'DAY_INTERMEDIATE': day_intermediate,
216     'NIGHT_INTERMEDIATE': night_intermediate
217 }
218 # Creates the YearSplit parameter 2D Matrix
219 nz_energy_system.set_year_split(TIMESLICE, nz_energy_system.year,
220     splits)
221
222 # Imports S&P NZX:50 and S&P ASX:200 Indices Arrays to calculate market
223 # returns
224 root = '/Users/connor/Google Drive/Documents/University/Courses/2020/
225     ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI_OseMOSYS'
226 file_root = Path(root)
227 file_spreadsheet = 'Returns.xls'
228 location = GF.Navigation(file_root, file_spreadsheet)
229 market_returns = location.Find_File()
230 nz_df = pd.read_excel(market_returns, sheet_name='NZ')
231 aus_df = pd.read_excel(market_returns, sheet_name='AUS')
232 nz_index = nz_df[['Monthly_Returns']].to_numpy()
233 aus_index = aus_df[['Monthly_Returns']].to_numpy()
234
235 # Defines the Dictionaries required for Region. All regions should have
236 # the same names
237 # Creates a dictionary of market indices
238 market_index = {'NEWZEALAND': nz_index, 'AUSTRALIA': aus_index}
239 # Treasury Equity Balances as at 2019
240 # (Australia has negative equity, New Zealand has $139746000000)
241 # However, Governments do not have market equity so should be zero for
242 # both
243 equity = {'NEWZEALAND': 0, 'AUSTRALIA': 0}
244 # Treasury Debt Balance as at 2019
245 debt = {'NEWZEALAND': 110477000000, 'AUSTRALIA': 619219000000}

```

```

241 # Treasury Finance Cost(Interest Expenses on Debt as at 2019
242 cost_of_debt_pre_tax = {'NEWZEALAND': 4059000000, 'AUSTRALIA':
243     1708800000}
244 # Preference Equity (None for governments)
245 preference_equity = {'NEWZEALAND': 0, 'AUSTRALIA': 0}
246 market_value_preference_shares = {'NEWZEALAND': 1, 'AUSTRALIA': 1}
247 # (Set to zero if none otherwise you get an error)
248 preference_dividends = {'NEWZEALAND': 0, 'AUSTRALIA': 0}
249 # Calculated from 10 Year Treasury Bonds (10 Year Average)
250 risk_free_rate = {'NEWZEALAND': 0.0360, 'AUSTRALIA': 0.0335}
251 # Company Tax Rates
252 effective_tax_rate = {'NEWZEALAND': 0.28, 'AUSTRALIA': 0.30}
253 # Beta for region modelled
254 market_risk_coefficient = {'NEWZEALAND': 0, 'AUSTRALIA': 0}
255
256 # Sets the discount rates
257 nz_energy_system.set_discount_rate(equity, debt, market_index,
258                                     cost_of_debt_pre_tax, risk_free_rate
259                                     ,
260                                     effective_tax_rate,
261                                     preference_equity,
262                                     market_value_preference_shares,
263                                     preference_dividends,
264                                     market_risk_coefficient)
265
266 # Creates Dictionary of day splits (assumes constant accross years)
267 # Preserve the order of the split.
268 hour_split = {"1": 6, "2": 6, "3": 6, "4": 6}
269 num_days = 365
270 num_hours = 24
271 nz_energy_system.set_day_split(nz_energy_system.dailytimebracket,
272                                 nz_energy_system.year, hour_split,
273                                 num_days,
274                                 num_hours)
275
276 # Sets a dictionary to match the timeslice with season
277 link_ls = {
278     "DAY_SUMMER": "1",
279     "NIGHT_SUMMER": "1",
280     "DAY_WINTER": "2",
281     "NIGHT_WINTER": "2",
282     "DAY_INTERMEDIATE": "3",
283     "NIGHT_INTERMEDIATE": "3"
284 }
285 nz_energy_system.set_conversion_ls(nz_energy_system.timeslice,
286                                     nz_energy_system.season, link_ls)
287 # Sets a dictionary to match the timeslice with daytype
288 # Daytypes: 1 = Weekday (Mon - Fri), 2 = Weekend (Sat & Sun)
289 # Order must be preserved
290 link_ld = {
291     "DAY_SUMMER": np.ones((1, 2)),
292     "NIGHT_SUMMER": np.ones((1, 2)),
293     "DAY_WINTER": np.ones((1, 2)),
294     "NIGHT_WINTER": np.ones((1, 2)),
295     "DAY_INTERMEDIATE": np.ones((1, 2)),
296     "NIGHT_INTERMEDIATE": np.ones((1, 2))
297 }
298 nz_energy_system.set_conversion_ld(nz_energy_system.timeslice,
299                                     link_ld)

```

```

295                                         nz_energy_system.daytype, link_ld)
296 # Sets a dictionary to match the timeslice with daytype
297 # 1). Morning (6hrs), 2).Afternoon (6hrs), 3).Evening (6hrs), 4).Night
298 # (6hrs)
299 # Order must be preserved in the arrays
300 link_lh = {
301     "DAY_SUMMER": np.array([1, 1, 0, 0]),
302     "NIGHT_SUMMER": np.array([0, 0, 1, 1]),
303     "DAY_WINTER": np.array([1, 1, 0, 0]),
304     "NIGHT_WINTER": np.array([0, 0, 1, 1]),
305     "DAY_INTERMEDIATE": np.array([1, 1, 0, 0]),
306     "NIGHT_INTERMEDIATE": np.array([0, 0, 1, 1])
307 }
308 override_conversionlh = None
309 # Sets the Conversionlh parameter
310
311 nz_energy_system.set_conversion_lh(nz_energy_system.timeslice,
312                                     nz_energy_system.dailytimebracket,
313                                     link_lh,
314                                     override_conversionlh)
315 # Creates season dictionary for daytypes (Assumed to be the same each
316 # year)
317 link_dtdt = {
318     "1": np.array([5, 2]),
319     "2": np.array([5, 2]),
320     "3": np.array([5, 2])
321 }
322 override_dtdt = None
323 # Sets the DaysInDayType parameter
324 nz_energy_system.set_days_in_day_type(nz_energy_system.season,
325                                         nz_energy_system.daytype,
326                                         nz_energy_system.year, link_dtdt,
327                                         override_dtdt)
328
329 # Creates trade relationships using an 2D numpy array
330 # Must [NEWZEALAND, AUSTRALIA],[NEWZEALAND, AUSTRALIA]
331 # Hypothetically, you can model any trade relationship for any fuel in
332 # any year
333 # FUELS = As above
334 # YEAR = 2020 - 2030 (11)
335 trade = np.zeros((len(nz_energy_system.region), len(nz_energy_system.
336                   region),
337                         len(nz_energy_system.fuel), len(nz_energy_system.year
338                         )))
339 trade_all_fuels = np.array([[0, 1], [1, 0]])
340 for i in range(0, len(nz_energy_system.fuel), 1):
341     for j in range(0, len(nz_energy_system.year), 1):
342         trade[:, :, i, j] = trade_all_fuels
343 nz_energy_system.set_trade_route(trade)
344
345 # Creates depreciation methods dictionary
346 depreciation_methods = {"NEWZEALAND": 2, "AUSTRALIA": 2}
347 override_depreciation = None
348 nz_energy_system.set_depreciation_method(nz_energy_system.region,
349                                         depreciation_methods,
350                                         override_depreciation)
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346 #
347 # ##### Initialisation and Definition of demand parameters (Including
348 # forecasting)
349 #
350 # Sets dictionaries to calculate CAGR for Fuels Forecasts
351 nz_cagr_fuels = {}
352 aus_cagr_fuels = {}
353 cagr_dictionaries_regions = [nz_cagr_fuels, aus_cagr_fuels]
354 # Initialises cagr parameters
355 nz_start_year_fuels = {}
356 nz_end_year_fuels = {}
357 nz_start_value_fuels = {}
358 nz_end_value_fuels = {}
359 aus_start_year_fuels = {}
360 aus_end_year_fuels = {}
361 aus_start_value_fuels = {}
362 aus_end_value_fuels = {}
363 nz_cagr_dictionaries_parameters = [
364     nz_start_year_fuels, nz_end_year_fuels, nz_start_value_fuels,
365     nz_end_value_fuels
366 ]
367 aus_cagr_dictionaries_parameters = [
368     aus_start_year_fuels, aus_end_year_fuels, aus_start_value_fuels,
369     aus_end_value_fuels
370 ]
371 # Populates regional dictionaries with new entry, all fuel types with
372 # default cagr values
373 for region_fuels in cagr_dictionaries_regions:
374     for i in range(0, len(nz_energy_system.fuel), 1):
375         region_fuels[nz_energy_system.fuel[i]] = 0.05
376 # Populates regional dictionaries with new entry, all fuel types with
377 # default values
378 for parameters in nz_cagr_dictionaries_parameters:
379     for i in range(0, len(nz_energy_system.fuel), 1):
380         region_fuels[nz_energy_system.fuel[i]] = 1
381 for parameters in nz_cagr_dictionaries_parameters:
382     for i in range(0, len(nz_energy_system.fuel), 1):
383         region_fuels[nz_energy_system.fuel[i]] = 1
384 # Loads demand data to the parameter dictionaries (Energy units are in
385 # PJ's)
386 # New Zealand
387 nz_start_years = np.zeros(len(nz_energy_system.fuel))
388 nz_start_years[:] = 2010
389 nz_end_years = np.zeros(len(nz_energy_system.fuel))
390 nz_end_years[:] = 2018
391 nz_start_values = np.array([
392     7.23, 13.24, 4.19, 0, 7.11, 110.43, 106.09, 7.11, 14.62, 0, 60.29,
393     0, 9.21,
394     0.35, 0, 0, 0.33, 55.89, 146.49, 0
395 ])

```

```

395 nz_end_values = np.zeros(len(nz_energy_system.fuel))
396 nz_end_values = np.array([
397     3.07, 16.26, 5.14, 0, 8.71, 113.22, 138.79, 5.82, 16.23, 0, 73.97,
398     0, 8.03,
399     0.36, 0, 0, 0.33, 56.61, 142.87, 0
400 ])
401 # Australia
402 aus_start_years = np.zeros(len(nz_energy_system.fuel))
403 aus_start_years[:] = 2017
404 aus_end_years = np.zeros(len(nz_energy_system.fuel))
405 aus_end_years[:] = 2018
406 aus_start_values = np.array([
407     104.9, 9.0, 0.5, 2.3, 72.4, 847.9724, 1038.76619, 42.39862,
408     190.79379, 0.0,
409     0.0, 0.0, 0, 15.7, 0.0, 8.4, 94.7, 79.2, 821.8, 0
410 ])
411 aus_end_values = np.zeros(len(nz_energy_system.fuel))
412 aus_end_values = np.array([
413     104.445, 8.737, 0.38, 2.019, 67.499, 904.7584, 1108.32904,
414     45.23792,
415     135.71376, 0.35788, 942.965, 0, 0, 16.56, 0, 8.642, 83.592, 76.81,
416     835.439,
417     0
418 ])
419 # Assign values to the dictionary
420 for i in range(0, len(nz_energy_system.fuel), 1):
421     aus_start_year_fuels[nz_energy_system.fuel[i]] = aus_start_years[i]
422     aus_end_year_fuels[nz_energy_system.fuel[i]] = aus_end_years[i]
423     aus_start_value_fuels[nz_energy_system.fuel[i]] = aus_start_values[i]
424     aus_end_value_fuels[nz_energy_system.fuel[i]] = aus_end_values[i]
425     nz_start_year_fuels[nz_energy_system.fuel[i]] = nz_start_years[i]
426     nz_end_year_fuels[nz_energy_system.fuel[i]] = nz_end_years[i]
427     nz_start_value_fuels[nz_energy_system.fuel[i]] = nz_start_values[i]
428     nz_end_value_fuels[nz_energy_system.fuel[i]] = nz_end_values[i]
429
430 print("nz_start_year_fuels", nz_start_year_fuels)
431 print("nz_end_year_fuels", nz_end_year_fuels)
432 print("nz_start_value_fuels", nz_start_value_fuels)
433 print("nz_end_value_fuels", nz_end_value_fuels)
434
435 print("aus_start_year_fuels", aus_start_year_fuels)
436 print("aus_end_year_fuels", aus_end_year_fuels)
437 print("aus_start_value_fuels", aus_start_value_fuels)
438 print("aus_end_value_fuels", aus_end_value_fuels)
439
440 # Calculates the cagr dictionary
441 forecasting_functions = GF.Forecasting()
442 for fuel in nz_cagr_fuels:
443     nz_cagr_fuels[
444         fuel] = forecasting_functions.
445         calculate_constant_average_growth_rate(
446             nz_start_year_fuels[fuel], nz_end_year_fuels[fuel],
447             nz_start_value_fuels[fuel], nz_end_value_fuels[fuel])
448
449 for fuel in aus_cagr_fuels:
450     aus_cagr_fuels[
451         fuel] = forecasting_functions.
452         calculate_constant_average_growth_rate(
453             aus_start_year_fuels[fuel], aus_end_year_fuels[fuel],
454             aus_start_value_fuels[fuel], aus_end_value_fuels[fuel]),

```

```

446             aus_start_value_fuels[fuel], aus_end_value_fuels[fuel])
447
448 # Calculates NZ CAGR forecasts
449 nz_fuel_forecast = forecasting_functions.calculate_cagr_forecasts(
450     nz_cagr_fuels, nz_end_value_fuels, nz_energy_system.fuel,
451     nz_energy_system.year)
452
453 # Calculates AUS CAGR forecasts
454 aus_fuel_forecast = forecasting_functions.calculate_cagr_forecasts(
455     aus_cagr_fuels, aus_end_value_fuels, nz_energy_system.fuel,
456     nz_energy_system.year)
457
458 fuel_forecasts = [nz_fuel_forecast, aus_fuel_forecast]
459
460 # Creates the forecast 3D array
461 forecast = np.zeros((len(nz_energy_system.region), len(nz_energy_system.
462     .fuel),
463                         len(nz_energy_system.year)))
464
465 # Sets the forecast 3D array with CAGR forecast values
466 for i in range(0, len(fuel_forecasts), 1):
467     forecast[i, :, :] = fuel_forecasts[i]
468
469 # Sets the Specified Demand Profiles
470 # nz_energy_system.set_specified_annual_demand(forecast[:, 0:-1, :])
471 nz_energy_system.set_specified_annual_demand(forecast[:, :, :])
472 # Sets the Accumulated Demand Profiles (Hack to make sure 3D Array)
473 acc_forecast = np.zeros(
474     (len(nz_energy_system.region), len(nz_energy_system.
475         accumulated_fuel),
476         len(nz_energy_system.year)))
477 acc_forecast[:, 0, :] = forecast[:, -1, :]
478
479 # Make adjustments to the accumulated fuel forecasts
480 nz_energy_system.set_accumulated_annual_demand(forecast[:, :, :])
481 # Sets linear profile for timeslices (In this example, it is assumed
482 #     the fuel is consumed uniformly in time splits)
483 linear_profile = splits
484 override = None
485
486 # Sets the Specified Demand Profiles
487 nz_energy_system.set_specified_demand_profile(
488     nz_energy_system.SpecifiedAnnualDemand, nz_energy_system.region,
489     nz_energy_system.specified_fuel, nz_energy_system.year,
490     nz_energy_system.timeslice, linear_profile, override)
491
492 # Sets the Capacity to Activity Factors (Assume conversion of GW to PJ)
493 nz_capacity_to_activity = {}
494 aus_capacity_to_activity = {}
495 for tech in nz_energy_system.capacity_technology:
496     nz_capacity_to_activity[tech] = 31.536
497     aus_capacity_to_activity[tech] = 31.536
498
499 capacity_dictionaries = [nz_capacity_to_activity,
500                           aus_capacity_to_activity]
501 # Sets the CapacityToActivity Function
502 override = None
503 nz_energy_system.set_capacity_to_activity_unit(
504     nz_energy_system.region, nz_energy_system.capacity_technology,

```

```

500     capacity_dictionaries, override)
501 print(nz_energy_system.capacity_technology)
502 print(nz_energy_system.CapacityToActivityUnit)
503
504 # Sets capacity factor matrix to operate in every timeslice (Assumes
#      operate 0.8 of the time).
505 capacity_factors = np.zeros(
506     (len(nz_energy_system.region), len(nz_energy_system.
507         capacity_technology),
508         len(nz_energy_system.timeslice), len(nz_energy_system.year)))
509 capacity_factors[:, :, :, :] = 0.8
510
511 nz_energy_system.set_capacity_factor(capacity_factors)
512
513 # Set availability factors
514 availability_factors = np.zeros((len(nz_energy_system.region),
515                                     len(nz_energy_system.
516                                         availability_technology),
517                                         len(nz_energy_system.year)))
518
519 availability_factors[:, :, :] = 1
520 nz_energy_system.set_availability_factor(availability_factors)
521
522 # Sets up operational life
523
524 # print(nz_energy_system.YearSplit)
525 # print(nz_energy_system.DiscountRate)
526 # print(nz_energy_system.DaySplit)
527 # print(nz_energy_system.ConversionId)
528 # print(nz_energy_system.Conversionls)
529 # print(nz_energy_system.Conversionlh)
530 # print(nz_energy_system.TradeRoute)
531 # print(nz_energy_system.DaysInDayType)
532 # print(nz_energy_system.DepreciationMethod)
533
534 # Initialises yet to be written parameters to check progress / load
#      Parameters (Delete later)
535 ly = len(nz_energy_system.year)
536 lr = len(nz_energy_system.region)
537 le = len(nz_energy_system.emission)
538 lt = len(nz_energy_system.technology)
539 lf = len(nz_energy_system.fuel)
540 ll = len(nz_energy_system.timeslice)
541 lm = len(nz_energy_system.mode_of_operation)
542 ls = len(nz_energy_system.storage)
543 lld = len(nz_energy_system.daytype)
544 lls = len(nz_energy_system.season)
545 llh = len(nz_energy_system.dailytimebracket)
546
547 #nz_energy_system.YearSplit = np.ones((ll, ly))
548 #nz_energy_system.DiscountRate = np.ones((lr))
549 #nz_energy_system.DaySplit = np.ones((llh, ly))
550 #nz_energy_system.Conversionls = np.ones((ll, lls))
551 #nz_energy_system.ConversionId = np.ones((ll, lld))
552 #nz_energy_system.Conversionlh = np.ones((ll, llh))
553 #nz_energy_system.DaysInDayType = np.ones((lls, lld, ly))

```

```

554 #nz_energy_system.TradeRoute = np.ones((lr, lr, lf, ly))
555 #nz_energy_system.DepreciationMethod = np.ones((lr))
556 #nz_energy_system.SpecifiedAnnualDemand = np.ones((lr, lf, ly))
557 #nz_energy_system.SpecifiedDemandProfile = np.ones((lr, lf, ll, ly))
558 #nz_energy_system.AccumulatedAnnualDemand = np.ones((lr, lf, ly))
559 #nz_energy_system.CapacityToActivityUnit = np.ones((lr, lt))
560 #nz_energy_system.CapacityFactor = np.ones((lr, lt, ll, ly))
561 #nz_energy_system.AvailabilityFactor = np.ones((lr, lt, ly))
562 nz_energy_system.OperationalLife = np.ones((lr, lt))
563 nz_energy_system.ResidualCapacity = np.ones((lr, lt, ly))
564 nz_energy_system.InputActivityRatio = np.ones((lr, lt, lf, lm, ly))
565 nz_energy_system.OutputActivityRatio = np.ones((lr, lt, lf, lm, ly))
566 nz_energy_system.CapitalCost = np.ones((lr, lt, ly))
567 nz_energy_system.VariableCost = np.ones((lr, lt, lm, ly))
568 nz_energy_system.FixedCost = np.ones((lr, lt, ly))
569 nz_energy_system.TechnologyToStorage = np.ones((lr, lt, ls, lm))
570 nz_energy_system.TechnologyFromStorage = np.ones((lr, lt, ls, lm))
571 nz_energy_system.StorageLevelStart = np.ones((lr, ls))
572 nz_energy_system.StorageMaxChargeRate = np.ones((lr, ls))
573 nz_energy_system.StorageMaxDischargeRate = np.ones((lr, ls))
574 nz_energy_system.MinStorageCharge = np.ones((lr, ls, ly))
575 nz_energy_system.OperationalLifeStorage = np.ones((lr, ls))
576 nz_energy_system.CapitalCostStorage = np.ones((lr, ls, ly))
577 nz_energy_system.ResidualStorageCapacity = np.ones((lr, ls, ly))
578 nz_energy_system.CapacityOfOneTechnologyUnit = np.ones((lr, lt, ly))
579 nz_energy_system.TotalAnnualMaxCapacity = np.ones((lr, lt, ly))
580 nz_energy_system.TotalAnnualMinCapacity = np.ones((lr, lt, ly))
581 nz_energy_system.TotalAnnualMaxCapacityInvestment = np.ones((lr, lt, ly
    ))
582 nz_energy_system.TotalAnnualMinCapacityInvestment = np.ones((lr, lt, ly
    ))
583 nz_energy_system.TotalTechnologyAnnualActivityLowerLimit = np.ones(
    (lr, lt, ly))
584 nz_energy_system.TotalTechnologyAnnualActivityUpperLimit = np.ones(
    (lr, lt, ly))
585 nz_energy_system.TotalTechnologyModelPeriodActivityUpperLimit = np.ones(
    (
    lr, lt))
586 nz_energy_system.TotalTechnologyModelPeriodActivityLowerLimit = np.ones(
    (
    lr, lt))
587 nz_energy_system.ReserveMarginTagTechnology = np.ones((lr, lt, ly))
588 nz_energy_system.ReserveMarginTagFuel = np.ones((lr, lf, ly))
589 nz_energy_system.ReserveMargin = np.ones((lr, ly))
590 nz_energy_system.RETagTechnology = np.ones((lr, lt, ly))
591 nz_energy_system.RETagFuel = np.ones((lr, lf, ly))
592 nz_energy_system.REMinProductionTarget = np.ones((lr, ly))
593 nz_energy_system.EmissionActivityRatio = np.ones((lr, lt, le, lm, ly))
594 nz_energy_system.EmissionsPenalty = np.ones((lr, le, ly))
595 nz_energy_system.AnnualExogenousEmission = np.ones((lr, le, ly))
596 nz_energy_system.AnnualEmissionLimit = np.ones((lr, le, ly))
597 nz_energy_system.ModelPeriodExogenousEmission = np.ones((lr, le))
598 nz_energy_system.ModelPeriodEmissionLimit = np.ones((lr, le))
599
600
601
602
603
604 # Sets the case (Toggle depending on the data set you choose to use)
605 case = nz_energy_system
606
607 # Initialises the energy system

```

```

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

```

```

664     'TotalAnnualMinCapacityInvestment': 0,
665     'TotalTechnologyAnnualActivityLowerLimit': 0,
666     'TotalTechnologyAnnualActivityUpperLimit': 999999,
667     'TotalTechnologyModelPeriodActivityUpperLimit': 999999,
668     'TotalTechnologyModelPeriodActivityLowerLimit': 0,
669     'ReserveMarginTagTechnology': 1,
670     'ReserveMarginTagFuel': 1,
671     'ReserveMargin': 1,
672     'RETagTechnology': 1,
673     'RETagFuel': 1,
674     'REMinProductionTarget': 1,
675     'EmissionActivityRatio': 1,
676     'EmissionsPenalty': 1,
677     'AnnualExogenousEmission': 1,
678     'AnnualEmissionLimit': 1,
679     'ModelPeriodExogenousEmission': 1,
680     'ModelPeriodEmissionLimit': 1
681 }
682
683 # Sets the default toggles (To only use defaults)
684 toggle_defaults = {
685     'YearSplit': False,
686     'DiscountRate': False,
687     'DaySplit': False,
688     'Conversionls': False,
689     'Conversionld': False,
690     'Conversionlh': False,
691     'DaysInDayType': False,
692     'TradeRoute': False,
693     'DepreciationMethod': False,
694     'SpecifiedAnnualDemand': False,
695     'SpecifiedDemandProfile': False,
696     'AccumulatedAnnualDemand': False,
697     'CapacityToActivityUnit': False,
698     'CapacityFactor': False,
699     'AvailabilityFactor': False,
700     'OperationalLife': False,
701     'ResidualCapacity': False,
702     'InputActivityRatio': False,
703     'OutputActivityRatio': False,
704     'CapitalCost': False,
705     'VariableCost': False,
706     'FixedCost': False,
707     'TechnologyToStorage': False,
708     'TechnologyFromStorage': False,
709     'StorageLevelStart': False,
710     'StorageMaxChargeRate': False,
711     'StorageMaxDischargeRate': False,
712     'MinStorageCharge': False,
713     'OperationalLifeStorage': False,
714     'CapitalCostStorage': False,
715     'ResidualStorageCapacity': False,
716     'CapacityOfOneTechnologyUnit': False,
717     'TotalAnnualMaxCapacity': False,
718     'TotalAnnualMinCapacity': False,
719     'TotalAnnualMaxCapacityInvestment': False,
720     'TotalAnnualMinCapacityInvestment': False,
721     'TotalTechnologyAnnualActivityLowerLimit': False,

```

```

722     'TotalTechnologyAnnualActivityUpperLimit': False,
723     'TotalTechnologyModelPeriodActivityUpperLimit': False,
724     'TotalTechnologyModelPeriodActivityLowerLimit': False,
725     'ReserveMarginTagTechnology': False,
726     'ReserveMarginTagFuel': False,
727     'ReserveMargin': False,
728     'RETagTechnology': False,
729     'RETagFuel': False,
730     'REMinProductionTarget': False,
731     'EmissionActivityRatio': False,
732     'EmissionsPenalty': False,
733     'AnnualExogenousEmission': False,
734     'AnnualEmissionLimit': False,
735     'ModelPeriodExogenousEmission': False,
736     'ModelPeriodEmissionLimit': False
737 }
738 # Sets the default toggles (To only use defaults)
739 # toggle_defaults = {
740 #     'YearSplit': False,
741 #     'DiscountRate': False,
742 #     'DaySplit': False,
743 #     'Conversionsls': False,
744 #     'Conversionld': True,
745 #     'Conversionlh': True,
746 #     'DaysInDayType': True,
747 #     'TradeRoute': True,
748 #     'DepreciationMethod': True,
749 #     'SpecifiedAnnualDemand': True,
750 #     'SpecifiedDemandProfile': True,
751 #     'AccumulatedAnnualDemand': True,
752 #     'CapacityToActivityUnit': True,
753 #     'CapacityFactor': True,
754 #     'AvailabilityFactor': True,
755 #     'OperationalLife': True,
756 #     'ResidualCapacity': True,
757 #     'InputActivityRatio': True,
758 #     'OutputActivityRatio': True,
759 #     'CapitalCost': True,
760 #     'VariableCost': True,
761 #     'FixedCost': True,
762 #     'TechnologyToStorage': True,
763 #     'TechnologyFromStorage': True,
764 #     'StorageLevelStart': True,
765 #     'StorageMaxChargeRate': True,
766 #     'StorageMaxDischargeRate': True,
767 #     'MinStorageCharge': True,
768 #     'OperationalLifeStorage': True,
769 #     'CapitalCostStorage': True,
770 #     'ResidualStorageCapacity': True,
771 #     'CapacityOfOneTechnologyUnit': True,
772 #     'TotalAnnualMaxCapacity': True,
773 #     'TotalAnnualMinCapacity': True,
774 #     'TotalAnnualMaxCapacityInvestment': True,
775 #     'TotalAnnualMinCapacityInvestment': True,
776 #     'TotalTechnologyAnnualActivityLowerLimit': True,
777 #     'TotalTechnologyAnnualActivityUpperLimit': True,
778 #     'TotalTechnologyModelPeriodActivityUpperLimit': True,
779 #     'TotalTechnologyModelPeriodActivityLowerLimit': True,

```

```
780 # 'ReserveMarginTagTechnology': True,
781 # 'ReserveMarginTagFuel': True,
782 # 'ReserveMargin': True,
783 # 'RETagTechnology': True,
784 # 'RETagFuel': True,
785 # 'REMinProductionTarget': True,
786 # 'EmissionActivityRatio': False,
787 # 'EmissionsPenalty': False,
788 # 'AnnualExogenousEmission': False,
789 # 'AnnualEmissionLimit': False,
790 # 'ModelPeriodExogenousEmission': False,
791 # 'ModelPeriodEmissionLimit': False
792 # }
793
794 # Create the Data File
795 system.create_data_file(data_location_1, default_parameters,
    toggle_defaults)
796
797 # Create the Model File
798 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

2.2 GOCPI Module

2.2.1 Navigation

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

```
1 import os
2
3
4 class Navigation:
5     """ Navigation is a class for navigating, manipulating and editing
6     data in the GOCPI model.
7
8     Attributes:
9         Find_File(string) representing a string to the file path
10
11    TODO: Fill out all functions below
12
13    """
14
15    def __init__(self, target_root, target_file):
16        """ Initialises the navigation functions
17
18        Args:
19            target_root (str): Base directory to search from
20            target_file (str): Name of file to search for
21
22        """
23
24        self.target_root = target_root
25        self.target_file = target_file
26
27
28    def Find_File(self):
29        """ Find_File searches for a target file, from a base directory
30        , to construct
31        a target directory.
32
```

```

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

```

2.2.2 Energysystems

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

```

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

```

```

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

```

```

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

```

```

124     self.RETagFuel = np.ones((lr, lf, ly))
125     self.REMinProductionTarget = np.ones((lr, ly))
126     self.EmissionActivityRatio = np.ones((lr, lt, le, lm, ly))
127     self.EmissionsPenalty = np.ones((lr, le, ly))
128     self.AnnualExogenousEmission = np.ones((lr, le, ly))
129     self.AnnualEmissionLimit = np.ones((lr, le, ly))
130     self.ModelPeriodExogenousEmission = np.ones((lr, le))
131     self.ModelPeriodEmissionLimit = np.ones((lr, le))
132
133     def load_datacase(self, case, system):
134         """ Loads the data case to a correct configured and intialized
135         energy system
136
137         Args:
138             case (object): Energy system datacase
139             system (object): Initialised energy system
140
141         Returns:
142             system_case (dict): Returns the updated dictionary
143         """
144
145         # Loads the sets to the energy system
146         system.year = case.year
147         system.region = case.region
148         system.emission = case.emission
149         system.capacity_technology = case.capacity_technology
150         system.availability_technology = case.availability_technology
151         system.technology = case.technology
152         system.fuel = case.fuel
153         system.specified_fuel = case.specified_fuel
154         system.accumulated_fuel = case.accumulated_fuel
155         system.timeslice = case.timeslice
156         system.mode_of_operation = case.mode_of_operation
157         system.storage = case.storage
158         system.daytype = case.daytype
159         system.season = case.season
160         system.dailytimebracket = case.dailytimebracket
161
162         # Loads the parameters to the energy system
163         system.YearSplit = case.YearSplit
164         system.DiscountRate = case.DiscountRate
165         system.DaySplit = case.DaySplit
166         system.Conversionsls = case.Conversionsls
167         system.Conversionld = case.Conversionld
168         system.Conversionlh = case.Conversionlh
169         system.DaysInDayType = case.DaysInDayType
170         system.TradeRoute = case.TradeRoute
171         system.DepreciationMethod = case.DepreciationMethod
172         system.SpecifiedAnnualDemand = case.SpecifiedAnnualDemand
173         system.SpecifiedDemandProfile = case.SpecifiedDemandProfile
174         system.AccumulatedAnnualDemand = case.AccumulatedAnnualDemand
175         system.CapacityToActivityUnit = case.CapacityToActivityUnit
176         system.CapacityFactor = case.CapacityFactor
177         system.AvailabilityFactor = case.AvailabilityFactor
178         system.OperationalLife = case.OperationalLife
179         system.ResidualCapacity = case.ResidualCapacity
180         system.InputActivityRatio = case.InputActivityRatio
181         system.OutputActivityRatio = case.OutputActivityRatio
182         system.CapitalCost = case.CapitalCost
183         system.VariableCost = case.VariableCost

```

```

181     system.FixedCost = case.FixedCost
182     system.TechnologyToStorage = case.TechnologyToStorage
183     system.TechnologyFromStorage = case.TechnologyFromStorage
184     system.StorageLevelStart = case.StorageLevelStart
185     system.StorageMaxChargeRate = case.StorageMaxChargeRate
186     system.StorageMaxDischargeRate = case.StorageMaxDischargeRate
187     system.MinStorageCharge = case.MinStorageCharge
188     system.OperationalLifeStorage = case.OperationalLifeStorage
189     system.CapitalCostStorage = case.CapitalCostStorage
190     system.ResidualStorageCapacity = case.ResidualStorageCapacity
191     system.CapacityOfOneTechnologyUnit = case.
192     CapacityOfOneTechnologyUnit
193         system.TotalAnnualMaxCapacity = case.TotalAnnualMaxCapacity
194         system.TotalAnnualMinCapacity = case.TotalAnnualMinCapacity
195         system.TotalAnnualMaxCapacityInvestment = case.
196         TotalAnnualMaxCapacityInvestment
197             system.TotalAnnualMinCapacityInvestment = case.
198         TotalAnnualMinCapacityInvestment
199             system.TotalTechnologyAnnualActivityLowerLimit = case.
200         TotalTechnologyAnnualActivityLowerLimit
201             system.TotalTechnologyAnnualActivityUpperLimit = case.
202         TotalTechnologyAnnualActivityUpperLimit
203             system.TotalTechnologyModelPeriodActivityUpperLimit = case.
204         TotalTechnologyModelPeriodActivityUpperLimit
205             system.TotalTechnologyModelPeriodActivityLowerLimit = case.
206         TotalTechnologyModelPeriodActivityLowerLimit
207             system.ReserveMarginTagTechnology = case.
208         ReserveMarginTagTechnology
209             system.ReserveMarginTagFuel = case.ReserveMarginTagFuel
210             system.ReserveMargin = case.ReserveMargin
211             system.RETagTechnology = case.RETagTechnology
212             system.RETagFuel = case.RETagFuel
213             system.REMinProductionTarget = case.REMinProductionTarget
214             system.EmissionActivityRatio = case.EmissionActivityRatio
215             system.EmissionsPenalty = case.EmissionsPenalty
216             system.AnnualExogenousEmission = case.AnnualExogenousEmission
217             system.AnnualEmissionLimit = case.AnnualEmissionLimit
218             system.ModelPeriodExogenousEmission = case.
219         ModelPeriodExogenousEmission
220             system.ModelPeriodEmissionLimit = case.ModelPeriodEmissionLimit
221
222     def create_model_file(self, root, file):
223         """ Creates the model file necessary for the project to run
224
225         Args:
226             root (str): File path of root to start the search from
227                 file ([type]): File path of model file
228             """
229
230         # Finds the file
231         # data = Find_File(data_file,model_file)
232         model_location = os.path.join(root, file)
233         df = pd.read_excel(model_location, sheet_name='Model')
234         # Creates a new dataframe based on the variables on the Include
235         column values
236         df_Include = df[df.Include == 'Yes']
237         df_model = df_Include[['Name']].copy()
238
239         # Creates a file location and write the model to a text file

```

```

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

```

```

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

```

```

339         for line in combined_list:
340             combinedflat = ''.join(str(line))
341             combinedflat = combinedflat.replace('[', ' ')
342             combinedflat = combinedflat.replace(']', ' ')
343             combinedflat = combinedflat.replace('"', ' ')
344             combinedflat = combinedflat.replace(',', ' ')
345             combinedflat = combinedflat.replace('(', ' ')
346             combinedflat = combinedflat.replace(')', ' ')
347             f.write("{}\n".format(combinedflat))
348     else:
349         f.write("param\t{}\tdefault\t{}:=\n".format(
350             param, defaults_dictionary[param]))
351     f.write(';\n')
352
353 # DaySplit = np.zeros((llh,ly))
354 param = 'DaySplit'
355 f.write('#\n')
356 columns = self.year
357 column_string = ' '.join(columns)
358 # Writes index specific parameter values to the text files
359 if toggle_defaults[param] == True:
360     f.write("param\t{}\tdefault\t{}:=\t{}:=\n".format(
361             param, defaults_dictionary[param], column_string))
362     # Converts maxtrix rows to list
363     array = np.array(self.dailytimebracket)
364     array = array.T
365     lt = array.tolist()
366     # Creates 2D matrix for this value
367     mat = self.DaySplit[:, :]
368     # Converts combined matrix to list and combines lists
369     matlist = mat.tolist()
370     #Combines the two lists
371     combined_list = list(zip(lt, matlist))
372     # Writes index specific parameter values to the text
373     files
374         f.write("param\t{}\t{}:=\n".format(param,
375             column_string))
376         for line in combined_list:
377             combinedflat = ''.join(str(line))
378             combinedflat = combinedflat.replace('[', ' ')
379             combinedflat = combinedflat.replace(']', ' ')
380             combinedflat = combinedflat.replace('"', ' ')
381             combinedflat = combinedflat.replace(',', ' ')
382             combinedflat = combinedflat.replace('(', ' ')
383             combinedflat = combinedflat.replace(')', ' ')
384             f.write("{}\n".format(combinedflat))
385     else:
386         f.write("param\t{}\tdefault\t{}:=\n".format(
387             param, defaults_dictionary[param]))
388     f.write(';\n')
389
390 # Conversionls = np.zeros((ll,ls))
391 param = 'Conversionls' # Change this line
392 f.write('#\n')
393 columns = self.season # Change this line
394 column_string = ' '.join(columns)
395 # Writes index specific parameter values to the text files
396 if toggle_defaults[param] == True:

```

```

395         f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
396             param, defaults_dictionary[param], column_string))
397     # Converts maxtrix rows to list
398     array = np.array(self.timeslice) # Change this line
399     array = array.T
400     lt = array.tolist()
401     # Creates 2D matrix for this value
402     mat = self.Conversions[:, :] # Change this line
403     # Converts combined matrix to list and combines lists
404     matlist = mat.tolist()
405     #Combines the two lists
406     combined_list = list(zip(lt, matlist))
407     for line in combined_list:
408         combinedflat = ''.join(str(line))
409         combinedflat = combinedflat.replace('[', '')
410         combinedflat = combinedflat.replace(']', '')
411         combinedflat = combinedflat.replace('"', '')
412         combinedflat = combinedflat.replace(',', '')
413         combinedflat = combinedflat.replace('(', '')
414         combinedflat = combinedflat.replace(')', '')
415         f.write("{}\n".format(combinedflat))
416     else:
417         f.write("param\t{0}\tdefault\t{1}:=\n".format(
418             param, defaults_dictionary[param]))
419     f.write(';\n')
420
421     # ConversionId = np.zeros((ll,lld))
422     param = 'ConversionId' # Change this line
423     f.write('#\n')
424     columns = self.dtype # Change this line
425     column_string = ' '.join(columns)
426     if toggle_defaults[param] == True:
427         f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
428             param, defaults_dictionary[param], column_string))
429     # Converts maxtrix rows to list
430     array = np.array(self.timeslice) # Change this line
431     array = array.T
432     lt = array.tolist()
433     # Creates 2D matrix for this value
434     mat = self.ConversionId[:, :] # Change this line
435     # Converts combined matrix to list and combines lists
436     matlist = mat.tolist()
437     #Combines the two lists
438     combined_list = list(zip(lt, matlist))
439     for line in combined_list:
440         combinedflat = ''.join(str(line))
441         combinedflat = combinedflat.replace('[', '')
442         combinedflat = combinedflat.replace(']', '')
443         combinedflat = combinedflat.replace('"', '')
444         combinedflat = combinedflat.replace(',', '')
445         combinedflat = combinedflat.replace('(', '')
446         combinedflat = combinedflat.replace(')', '')
447         f.write("{}\n".format(combinedflat))
448     else:
449         f.write("param\t{0}\tdefault\t{1}:=\n".format(
450             param, defaults_dictionary[param]))
451     f.write(';\n')
452

```

```

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

```

```

508                 combined_list = list(zip(lt, matlist))
509                 # Writes index specific parameter values to the
510                 text files
511                 f.write("\t[*,{0}]:\t{1}\t:=\n".format(y,
512                                               column_string))
513                 for line in combined_list:
514                     combinedflat = ''.join(str(line))
515                     combinedflat = combinedflat.replace('[', ' ')
516                     combinedflat = combinedflat.replace(']', ' ')
517                     combinedflat = combinedflat.replace('"', ' ')
518                     combinedflat = combinedflat.replace(',', ' ')
519                     combinedflat = combinedflat.replace('(', ' ')
520                     combinedflat = combinedflat.replace(')', ' ')
521                     f.write("{0}\n".format(combinedflat))
522                     f.write(';\n')
523
524                 # TradeRoute = np.zeros((lr,lr,lf,ly))
525                 param = 'TradeRoute' # Change this line
526                 f.write('#\n')
527                 f.write("param\t{0}\tdefault\t{1}:=\n".format(
528                           param, defaults_dictionary[param]))
529                 if toggle_defaults[param] == True:
530                     # Writes parameter values to the text files
531                     for j in range(self.lf):
532                         # Sets index value for format string
533                         fl = self.fuel[j]
534                         for k in range(self.ly):
535                             # Sets index value for format string
536                             y = self.year[k]
537                             # Converts matrix columns to strings columns to
538                             # strings
539                             columns = self.region
540                             column_string = ', '.join(columns)
541                             # Converts maxtrix rows to list
542                             array = np.array(self.region)
543                             array = array.T
544                             lt = array.tolist()
545                             # Creates 2D matrix for this value
546                             mat = self.TradeRoute[:, :, j, k]
547                             # Converts combined matrix to list and combines
548                             lists
549                             matlist = mat.tolist()
550                             #Combines the two lists
551                             combined_list = list(zip(lt, matlist))
552                             # Writes index specific parameter values to the
553                             text files
554                             f.write("\t[*,{0},{1}]:\t{2}\t:=\n".format(
555                               fl, y, column_string))
556                             for line in combined_list:
557                                 combinedflat = ''.join(str(line))
558                                 combinedflat = combinedflat.replace('[', ' ')
559                                 combinedflat = combinedflat.replace(']', ' ')
560                                 combinedflat = combinedflat.replace('"', ' ')
561                                 combinedflat = combinedflat.replace(',', ' ')
562                                 combinedflat = combinedflat.replace('(', ' ')
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557                     combinedflat = combinedflat.replace("(", " ")
558                     combinedflat = combinedflat.replace(")", " ")
559                     f.write("{0}\n".format(combinedflat))
560 f.write(';\n')
561
562 # DepreciationMethod = np.zeros((lr))
563 param = 'DepreciationMethod'
564 f.write('#\n')
565 f.write("param\t{0}\tdefault\t{1}:=\n".format(
566     param, defaults_dictionary[param]))
567 if toggle_defaults[param] == True:
568     # Converts maxtrix rows to list
569     array = np.array(self.region)
570     array = array.T
571     lt = array.tolist()
572     # Creates 2D matrix for this value
573     mat = self.DepreciationMethod[:, :]
574     # Converts combined matrix to list and combines lists
575     matlist = mat.tolist()
576     #Combines the two lists
577     combined_list = list(zip(lt, matlist))
578     # Writes index specific parameter values to the text
579 files
580     for line in combined_list:
581         combinedflat = ','.join(str(line))
582         combinedflat = combinedflat.replace('[', ' ')
583         combinedflat = combinedflat.replace(']', ' ')
584         combinedflat = combinedflat.replace('"', ' ')
585         combinedflat = combinedflat.replace(',', ' ')
586         combinedflat = combinedflat.replace('(', ' ')
587         combinedflat = combinedflat.replace(')', ' ')
588         f.write("{0}\n".format(combinedflat))
589 f.write(';\n')
590
591 # SpecifiedAnnualDemand = np.zeros((lr, lsf, ly))
592 param = 'SpecifiedAnnualDemand'
593 f.write('#\n')
594 f.write("param\t{0}\tdefault\t{1}:=\n".format(
595     param, defaults_dictionary[param]))
596 if toggle_defaults[param] == True:
597     # Writes parameter values to the text files
598     for k in range(self.ly):
599         # Sets index value for format string
600         y = self.year[k]
601         # Converts matrix columns to strings columns to
602 strings
603             columns = self.specified_fuel
604             column_string = ', '.join(columns)
605             # Converts maxtrix rows to list
606             array = np.array(self.region)
607             array = array.T
608             lt = array.tolist()
609             # Creates 2D matrix for this value
610             mat = self.SpecifiedAnnualDemand[:, :, k]
611             # Converts combined matrix to list and combines
612 lists

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610             matlist = mat.tolist()
611             #Combines the two lists
612             combined_list = list(zip(lt, matlist))
613             # Writes index specific parameter values to the
614             text files
615             f.write("\t[*,{0}]:\t{1}\t:=\n".format(y,
616             column_string))
617             for line in combined_list:
618                 combinedflat = ','.join(str(line))
619                 combinedflat = combinedflat.replace('[', '')
620                 combinedflat = combinedflat.replace(']', '')
621                 combinedflat = combinedflat.replace('"', '')
622                 combinedflat = combinedflat.replace("'", '')
623                 combinedflat = combinedflat.replace("(", '')
624                 combinedflat = combinedflat.replace(")", '')
625                 f.write("{0}\n".format(combinedflat))
626
627             f.write(';\n')
628
629             # SpecifiedDemandProfile = np.zeros((lr,lf,ll,ly))
630             param = 'SpecifiedDemandProfile' # Change this line
631             f.write('#\n')
632             f.write("param\t{0}\tdefault\t{1}:=\n".format(
633                 param, defaults_dictionary[param]))
634             if toggle_defaults[param] == True:
635                 # Writes parameter values to the text files
636                 for j in range(self.ll):
637                     # Sets index value for format string
638                     x = self.timeslice[j]
639                     for k in range(self.ly):
640                         # Sets index value for format string
641                         y = self.year[k]
642                         # Converts matrix columns to strings columns to
643                         # strings
644                         columns = self.specified_fuel
645                         column_string = ', '.join(columns)
646                         # Converts maxtrix rows to list
647                         array = np.array(self.region)
648                         array = array.T
649                         lt = array.tolist()
650                         # Creates 2D matrix for this value
651                         mat = self.SpecifiedDemandProfile[:, :, j, k]
652                         # Converts combined matrix to list and combines
653                         lists
654                         matlist = mat.tolist()
655                         #Combines the two lists
656                         combined_list = list(zip(lt, matlist))
657                         # Writes index specific parameter values to the
658                         text files
659                         f.write("\t[*,{0},{1}]:\t{2}\t:=\n".format(
660                             x, y, column_string))
661                         for line in combined_list:
662                             combinedflat = ','.join(str(line))
663                             combinedflat = combinedflat.replace('[', '')
664                             combinedflat = combinedflat.replace(']', '')
665                             combinedflat = combinedflat.replace('"', '')
666                             combinedflat = combinedflat.replace("'", '')
667
668
669

```

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

```

```

711         array = np.array(self.region) # Change this line
712         array = array.T
713         lt = array.tolist()
714         # Creates 2D matrix for this value
715         mat = self.CapacityToActivityUnit[:, :] # Change this
716
717         line
718
719         # Converts combined matrix to list and combines lists
720         matlist = mat.tolist()
721         #Combines the two lists
722         combined_list = list(zip(lt, matlist))
723         for line in combined_list:
724             combinedflat = ','.join(str(line))
725             combinedflat = combinedflat.replace('[', '')
726             combinedflat = combinedflat.replace(']', '')
727             combinedflat = combinedflat.replace('"', '')
728             combinedflat = combinedflat.replace(',', '')
729             combinedflat = combinedflat.replace('(', '')
730             combinedflat = combinedflat.replace(')', '')
731             f.write("{}\n".format(combinedflat))
732
733
734         # CapacityFactor = np.zeros((lr,lt,ll,ly))
735         param = 'CapacityFactor' # Change this line
736         f.write('#\n')
737         f.write("param\t{0}\tdefault\t{1}:=\n".format(
738             param, defaults_dictionary[param]))
739         f.write(';\n')
740
741         # CapacityFactor = np.zeros((lr,lt,ll,ly))
742         param = 'CapacityFactor' # Change this line
743         f.write('#\n')
744         f.write("param\t{0}\tdefault\t{1}:=\n".format(
745             param, defaults_dictionary[param]))
746         if toggle_defaults[param] == True:
747             # Writes parameter values to the text files
748             for j in range(self.ll):
749                 # Sets index value for format string
750                 x = self.timeslice[j]
751                 for k in range(self.ly):
752                     # Sets index value for format string
753                     y = self.year[k]
754                     # Converts matrix columns to strings columns to
755                     # strings
756
757                     columns = self.capacity_technology
758                     column_string = ', '.join(columns)
759                     # Converts maxtrix rows to list
760                     array = np.array(self.region)
761                     array = array.T
762                     lt = array.tolist()
763                     # Creates 2D matrix for this value
764                     mat = self.CapacityFactor[:, :, j, k]
765                     # Converts combined matrix to list and combines
766                     lists
767
768                     matlist = mat.tolist()
769                     #Combines the two lists
770                     combined_list = list(zip(lt, matlist))
771                     # Writes index specific parameter values to the
772                     # text files
773
774                     f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
775                         x, y, column_string))
776                     for line in combined_list:
777                         combinedflat = ', '.join(str(line))

```

```

765             combinedflat = combinedflat.replace('[', '')
766             combinedflat = combinedflat.replace(']', '')
767             combinedflat = combinedflat.replace('"', '')
768             combinedflat = combinedflat.replace(',', '')
769             combinedflat = combinedflat.replace("(", '')
770             combinedflat = combinedflat.replace(")", '')
771         )
772         f.write("{}\n".format(combinedflat))
773     f.write(';\n')
774
775     # AvailabilityFactor = np.zeros((lr,lt,ly))
776     param = 'AvailabilityFactor'
777     f.write('#\n')
778     f.write("param\t{0}\tdefault\t{1}:=\n".format(
779         param, defaults_dictionary[param]))
780     if toggle_defaults[param] == True:
781         # Writes parameter values to the text files
782         for k in range(self.ly):
783             # Sets index value for format string
784             y = self.year[k]
785             # Converts matrix columns to strings columns to
786             # strings
787             columns = self.availability_technology
788             column_string = ', '.join(columns)
789             # Converts maxtrix rows to list
790             array = np.array(self.region)
791             array = array.T
792             lt = array.tolist()
793             # Creates 2D matrix for this value
794             mat = self.AvailabilityFactor[:, :, k]
795             # Converts combined matrix to list and combines
796             # lists
797             matlist = mat.tolist()
798             #Combines the two lists
799             combined_list = list(zip(lt, matlist))
800             # Writes index specific parameter values to the
801             # text files
802             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
803                 column_string))
804             for line in combined_list:
805                 combinedflat = ''.join(str(line))
806                 combinedflat = combinedflat.replace('[', '')
807                 combinedflat = combinedflat.replace(']', '')
808                 combinedflat = combinedflat.replace('"', '')
809                 combinedflat = combinedflat.replace(',', '')
810                 combinedflat = combinedflat.replace("(", '')
811                 combinedflat = combinedflat.replace(")", '')
812             f.write("{}\n".format(combinedflat))
813         f.write(';\n')
814
815     # OperationalLife = np.zeros((lr,lt))
816     param = 'OperationalLife' # Change this line
817     f.write('#\n')

```

```

813     columns = self.technology # Change this line
814     column_string = ', '.join(columns)
815     if toggle_defaults[param] == True:
816         f.write("param\t{0}\tdefault\t{1}:=\n".format(
817             param, defaults_dictionary[param], column_string))
818     # Converts maxtrix rows to list
819     array = np.array(self.region) # Change this line
820     array = array.T
821     lt = array.tolist()
822     # Creates 2D matrix for this value
823     mat = self.OperationalLife[:, :] # Change this line
824     # Converts combined matrix to list and combines lists
825     matlist = mat.tolist()
826     #Combines the two lists
827     combined_list = list(zip(lt, matlist))
828     for line in combined_list:
829         combinedflat = ''.join(str(line))
830         combinedflat = combinedflat.replace('[', '')
831         combinedflat = combinedflat.replace(']', '')
832         combinedflat = combinedflat.replace('"', '')
833         combinedflat = combinedflat.replace("'", '')
834         combinedflat = combinedflat.replace('(', '')
835         combinedflat = combinedflat.replace(')', '')
836         f.write("{0}\n".format(combinedflat))
837     else:
838         f.write("param\t{0}\tdefault\t{1}:=\n".format(
839             param, defaults_dictionary[param]))
840     f.write(';\n')

841
842     # ResidualCapacity = np.zeros((lr,lt,ly))
843     param = 'ResidualCapacity'
844     f.write('#\n')
845     f.write("param\t{0}\tdefault\t{1}:=\n".format(
846             param, defaults_dictionary[param]))
847     if toggle_defaults[param] == True:
848         # Writes parameter values to the text files
849         for k in range(self.ly):
850             # Sets index value for format string
851             y = self.year[k]
852             # Converts matrix columns to strings columns to
853             strings
854                 columns = self.technology
855                 column_string = ', '.join(columns)
856                 # Converts maxtrix rows to list
857                 array = np.array(self.region)
858                 array = array.T
859                 lt = array.tolist()
860                 # Creates 2D matrix for this value
861                 mat = self.ResidualCapacity[:, :, k]
862                 # Converts combined matrix to list and combines
863                 lists
864                     matlist = mat.tolist()
865                     #Combines the two lists
866                     combined_list = list(zip(lt, matlist))
867                     # Writes index specific parameter values to the
868                     text files
869                         f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
870                                         column_string))

```

```

867     for line in combined_list:
868         combinedflat = ''.join(str(line))
869         combinedflat = combinedflat.replace('[', '')
870         combinedflat = combinedflat.replace(']', '')
871         combinedflat = combinedflat.replace('"', '')
872         combinedflat = combinedflat.replace("'", '')
873         combinedflat = combinedflat.replace("(", '')
874         combinedflat = combinedflat.replace(")", '')
875         f.write("{0}\n".format(combinedflat))
876     f.write(';\n')
877
878 # InputActivityRatio = np.zeros((lr,lt,lf,lm,ly))
879 param = 'InputActivityRatio' # Change this line
880 f.write('#\n')
881 f.write("param\t{0}\tdefault\t{1}:=\n".format(
882     param, defaults_dictionary[param]))
883 if toggle_defaults[param] == True:
884     # Writes parameter values to the text files
885     for i in range(self.lf): # Change loops if you need
886         # Sets index value for format string
887         x = self.fuel[i]
888         for j in range(self.lm):
889             # Sets index value for format string
890             y = self.mode_of_operation[j]
891             for k in range(self.ly):
892                 # Sets index value for format string
893                 z = self.year[k]
894                 # Converts matrix columns to strings
895                 columns = self.technology
896                 column_string = ' '.join(columns)
897                 # Converts maxtrix rows to list
898                 array = np.array(self.region)
899                 array = array.T
900                 lt = array.tolist()
901                 # Creates 2D matrix for this value
902                 mat = self.InputActivityRatio[:, :, i, j, k]
903
904                 # Converts combined matrix to list and
905                 # combines lists
906                 matlist = mat.tolist()
907                 #Combines the two lists
908                 combined_list = list(zip(lt, matlist))
909                 # Writes index specific parameter values to
910                 # the text files
911                 f.write("\t[*,*,{0},{1},{2}]:\t{3}\t:=\n".
912                     format(
913                         x, y, z, column_string))
914                 for line in combined_list:
915                     combinedflat = ''.join(str(line))
916                     combinedflat = combinedflat.replace('[',
917                         ', ')
918                     combinedflat = combinedflat.replace(']',
919                         ', ')
920                     combinedflat = combinedflat.replace('"',
921                         ', ')
922                     combinedflat = combinedflat.replace("'", '',
923                         ', ')

```

```

916             combinedflat = combinedflat.replace("(")
917             combinedflat = combinedflat.replace(")")
918             f.write("{}\n".format(combinedflat))
919             f.write(';\n')
920
921             # OutputActivityRatio = np.zeros((lr,lt,lf,lm,ly))
922             param = 'OutputActivityRatio' # Change this line
923             f.write('#\n')
924             f.write("param\t{0}\tdefault\t{1}:=\n".format(
925                 param, defaults_dictionary[param]))
926             if toggle_defaults[param] == True:
927                 # Writes parameter values to the text files
928                 for i in range(self.lf): # Change loops if you need
929                     # Sets index value for format string
930                     x = self.fuel[i]
931                     for j in range(self.lm):
932                         # Sets index value for format string
933                         y = self.mode_of_operation[j]
934                         for k in range(self.ly):
935                             # Sets index value for format string
936                             z = self.year[k]
937                             # Converts matrix columns to strings
938                             columns = self.technology
939                             column_string = ', '.join(columns)
940                             # Converts maxtrix rows to list
941                             array = np.array(self.region)
942                             array = array.T
943                             lt = array.tolist()
944                             # Creates 2D matrix for this value
945                             mat = self.OutputActivityRatio[:, :, i, j,
946                               k]
947
948                             # Converts combined matrix to list and
949                             # combines lists
950                             matlist = mat.tolist()
951                             #Combines the two lists
952                             combined_list = list(zip(lt, matlist))
953                             # Writes index specific parameter values to
954                             # the text files
955                             f.write("\t[*,*,{0},{1},{2}]:\t{3}\t:=\n".
956                               format(
957                                 x, y, z, column_string))
958                             for line in combined_list:
959                                 combinedflat = ''.join(str(line))
960                                 combinedflat = combinedflat.replace('[',
961                                     ', ')
962                                 combinedflat = combinedflat.replace(']', '')
963                                 combinedflat = combinedflat.replace(';"',
964                                     '"')
965                                 combinedflat = combinedflat.replace(",",
966                                     ", ")
967                                 combinedflat = combinedflat.replace("(",
968                                     ")")
969                                 combinedflat = combinedflat.replace(")"'
970                                     ')')

```

```

961                                     f.write("{0}\n".format(combinedflat))
962         f.write(';\n')
963
964     # CapitalCost = np.zeros((lr,lt,ly))
965     param = 'CapitalCost'
966     f.write('#\n')
967     f.write("param\t{0}\tdefault\t{1}:=\n".format(
968             param, defaults_dictionary[param]))
969     if toggle_defaults[param] == True:
970         # Writes parameter values to the text files
971         for k in range(self.ly):
972             # Sets index value for format string
973             y = self.year[k]
974             # Converts matrix columns to strings columns to
975             strings
976             columns = self.technology
977             column_string = ', '.join(columns)
978             # Converts maxtrix rows to list
979             array = np.array(self.region)
980             array = array.T
981             lt = array.tolist()
982             # Creates 2D matrix for this value
983             mat = self.CapitalCost[:, :, k]
984             # Converts combined matrix to list and combines
985             lists
986             matlist = mat.tolist()
987             #Combines the two lists
988             combined_list = list(zip(lt, matlist))
989             # Writes index specific parameter values to the
990             text files
991             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
992                 column_string))
993             for line in combined_list:
994                 combinedflat = ''.join(str(line))
995                 combinedflat = combinedflat.replace('[', '')
996                 combinedflat = combinedflat.replace(']', '')
997                 combinedflat = combinedflat.replace('"', '')
998                 combinedflat = combinedflat.replace(',', '')
999                 combinedflat = combinedflat.replace('(', '')
1000                combinedflat = combinedflat.replace(')', '')
1001                f.write("{0}\n".format(combinedflat))
1002
1003     # VariableCost = np.zeros((lr,lt,lm,ly))
1004     param = 'VariableCost' # Change this line
1005     f.write('#\n')
1006     f.write("param\t{0}\tdefault\t{1}:=\n".format(
1007             param, defaults_dictionary[param]))
1008     if toggle_defaults[param] == True:
1009         # Writes parameter values to the text files
1010         for j in range(self.lm):
1011             # Sets index value for format string
1012             x = self.mode_of_operation[j]
1013             for k in range(self.ly):
1014                 # Sets index value for format string
1015                 y = self.year[k]
1016                 # Converts matrix columns to strings columns to
1017                 strings

```

```

1014             columns = self.technology
1015             column_string = ' '.join(columns)
1016             # Converts maxtrix rows to list
1017             array = np.array(self.region)
1018             array = array.T
1019             lt = array.tolist()
1020             # Creates 2D matrix for this value
1021             mat = self.VariableCost[:, :, j, k]
1022             # Converts combined matrix to list and combines
1023             lists
1024             matlist = mat.tolist()
1025             #Combines the two lists
1026             combined_list = list(zip(lt, matlist))
1027             # Writes index specific parameter values to the
1028             # text files
1029             f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
1030                 x, y, column_string))
1031             for line in combined_list:
1032                 combinedflat = ''.join(str(line))
1033                 combinedflat = combinedflat.replace('[', '')
1034                 combinedflat = combinedflat.replace(']', '')
1035                 combinedflat = combinedflat.replace('"', '')
1036                 combinedflat = combinedflat.replace(',', '')
1037                 combinedflat = combinedflat.replace("(", '')
1038                 combinedflat = combinedflat.replace(")", '')
1039                 f.write("{0}\n".format(combinedflat))
1040             f.write(';\n')
1041
1042             # FixedCost = np.zeros((lr,lt,ly))
1043             param = 'FixedCost'
1044             f.write('#\n')
1045             f.write("param\t{0}\tdefault\t{1}:=\n".format(
1046                 param, defaults_dictionary[param]))
1047             if toggle_defaults[param] == True:
1048                 # Writes parameter values to the text files
1049                 for k in range(self.ly):
1050                     # Sets index value for format string
1051                     y = self.year[k]
1052                     # Converts matrix columns to strings columns to
1053                     strings
1054                     columns = self.technology
1055                     column_string = ' '.join(columns)
1056                     # Converts maxtrix rows to list
1057                     array = np.array(self.region)
1058                     array = array.T
1059                     lt = array.tolist()
1060                     # Creates 2D matrix for this value
1061                     mat = self.FixedCost[:, :, k]
1062                     # Converts combined matrix to list and combines
1063                     lists
1064                     matlist = mat.tolist()
1065                     #Combines the two lists

```

```

1062                     combined_list = list(zip(lt, matlist))
1063                     # Writes index specific parameter values to the
1064                     text files
1065                     f.write("\t[*,{0}]:\t{1}\t:=\n".format(y,
1066                                         column_string))
1067                     for line in combined_list:
1068                         combinedflat = ''.join(str(line))
1069                         combinedflat = combinedflat.replace('[', ' ')
1070                         combinedflat = combinedflat.replace(']', ' ')
1071                         combinedflat = combinedflat.replace('"', ' ')
1072                         combinedflat = combinedflat.replace(',', ' ')
1073                         combinedflat = combinedflat.replace('(', ' ')
1074                         combinedflat = combinedflat.replace(')', ' ')
1075                         f.write("{0}\n".format(combinedflat))
1076                     f.write(';\n')
1077
1078                     # TechnologyToStorage = np.zeros((lr,lt,ls,lm))
1079                     param = 'TechnologyToStorage' # Change this line
1080                     f.write('#\n')
1081                     f.write("param\t{0}\tdefault\t{1}:=\n".format(
1082                         param, defaults_dictionary[param]))
1083                     if toggle_defaults[param] == True:
1084                         # Writes parameter values to the text files
1085                         for j in range(self.ls):
1086                             # Sets index value for format string
1087                             x = self.storage[j]
1088                             for k in range(self.lm):
1089                                 # Sets index value for format string
1090                                 y = self.mode_of_operation[k]
1091                                 # Converts matrix columns to strings columns to
1092                                 strings
1093                                     columns = self.technology
1094                                     column_string = ', '.join(columns)
1095                                     # Converts maxtrix rows to list
1096                                     array = np.array(self.region)
1097                                     array = array.T
1098                                     lt = array.tolist()
1099                                     # Creates 2D matrix for this value
1100                                     mat = self.TechnologyToStorage[:, :, j, k]
1101                                     # Converts combined matrix to list and combines
1102                                     lists
1103                                     matlist = mat.tolist()
1104                                     #Combines the two lists
1105                                     combined_list = list(zip(lt, matlist))
1106                                     # Writes index specific parameter values to the
1107                                     text files
1108                                     f.write("\t[*,{0},{1}]:\t{2}\t:=\n".format(
1109                                         x, y, column_string))
1110                                     for line in combined_list:
1111                                         combinedflat = ''.join(str(line))
1112                                         combinedflat = combinedflat.replace('[', ' ')
1113                                         combinedflat = combinedflat.replace(']', ' ')
1114                                         combinedflat = combinedflat.replace('"', ' ')
1115                                         combinedflat = combinedflat.replace(',', ' ')
1116                                         combinedflat = combinedflat.replace('(', ' ')
1117                                         combinedflat = combinedflat.replace(')', ' ')
1118                                         combinedflat = combinedflat.replace(' ', ' ')
1119                                         combinedflat = combinedflat.replace(' ', ' ')
1120                                         combinedflat = combinedflat.replace(' ', ' ')

```

```

1111             combinedflat = combinedflat.replace("(", " "
1112         )
1113             combinedflat = combinedflat.replace(")", " "
1114     )
1115             f.write("{0}\n".format(combinedflat))
1116
1117             f.write(';\n')
1118
1119             # TechnologyFromStorage = np.zeros((lr,lt,ls,lm))
1120             param = 'TechnologyFromStorage' # Change this line
1121             f.write('#\n')
1122             f.write("param\t{0}\tdefault\t{1}:=\n".format(
1123                 param, defaults_dictionary[param]))
1124             if toggle_defaults[param] == True:
1125                 # Writes parameter values to the text files
1126                 for j in range(self.ls):
1127                     # Sets index value for format string
1128                     x = self.storage[j]
1129                     for k in range(self.lm):
1130                         # Sets index value for format string
1131                         y = self.mode_of_operation[k]
1132                         # Converts matrix columns to strings columns to
1133                         strings
1134                         columns = self.technology
1135                         column_string = ', '.join(columns)
1136                         # Converts maxtrix rows to list
1137                         array = np.array(self.region)
1138                         array = array.T
1139                         lt = array.tolist()
1140                         # Creates 2D matrix for this value
1141                         mat = self.TechnologyFromStorage[:, :, j, k]
1142                         # Converts combined matrix to list and combines
1143                         lists
1144                         matlist = mat.tolist()
1145                         #Combines the two lists
1146                         combined_list = list(zip(lt, matlist))
1147                         # Writes index specific parameter values to the
1148                         # text files
1149                         f.write("\t[*,*,{0},{1}]:\t{2}\t:=\n".format(
1150                             x, y, column_string))
1151                         for line in combined_list:
1152                             combinedflat = ', '.join(str(line))
1153                             combinedflat = combinedflat.replace('[', ' '
1154                         )
1155                             combinedflat = combinedflat.replace(']', ' ')
1156                             combinedflat = combinedflat.replace('\"', ' ')
1157                             combinedflat = combinedflat.replace('(', ' ')
1158                             combinedflat = combinedflat.replace(")", ' ')
1159             f.write("{0}\n".format(combinedflat))
1160
1161             f.write(';\n')
1162
1163             # StorageLevelStart = np.zeros((lr,ls))
1164             param = 'StorageLevelStart' # Change this line

```

```

1158     f.write('#\n')
1159     columns = self.storage # Change this line
1160     column_string = ' '.join(columns)
1161     if toggle_defaults[param] == True:
1162         f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
1163             param, defaults_dictionary[param], column_string))
1164     # Converts maxtrix rows to list
1165     array = np.array(self.region) # Change this line
1166     array = array.T
1167     lt = array.tolist()
1168     # Creates 2D matrix for this value
1169     mat = self.StorageLevelStart[:, :] # Change this line
1170     # Converts combined matrix to list and combines lists
1171     matlist = mat.tolist()
1172     #Combines the two lists
1173     combined_list = list(zip(lt, matlist))
1174     for line in combined_list:
1175         combinedflat = ''.join(str(line))
1176         combinedflat = combinedflat.replace('[', '')
1177         combinedflat = combinedflat.replace(']', '')
1178         combinedflat = combinedflat.replace('"', '')
1179         combinedflat = combinedflat.replace(',', '')
1180         combinedflat = combinedflat.replace("(", '')
1181         combinedflat = combinedflat.replace(")", '')
1182         f.write("{}\n".format(combinedflat))
1183     else:
1184         f.write("param\t{0}\tdefault\t{1}:=\n".format(
1185             param, defaults_dictionary[param]))
1186     f.write(';\n')
1187
1188     # StorageMaxChargeRate = np.zeros((lr,ls))
1189     param = 'StorageMaxChargeRate' # Change this line
1190     f.write('#\n')
1191     columns = self.storage # Change this line
1192     column_string = ' '.join(columns)
1193     if toggle_defaults[param] == True:
1194         f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
1195             param, defaults_dictionary[param], column_string))
1196     # Converts maxtrix rows to list
1197     array = np.array(self.region) # Change this line
1198     array = array.T
1199     lt = array.tolist()
1200     # Creates 2D matrix for this value
1201     mat = self.StorageMaxChargeRate[:, :] # Change this
1202     line
1203     # Converts combined matrix to list and combines lists
1204     matlist = mat.tolist()
1205     #Combines the two lists
1206     combined_list = list(zip(lt, matlist))
1207     for line in combined_list:
1208         combinedflat = ''.join(str(line))
1209         combinedflat = combinedflat.replace('[', '')
1210         combinedflat = combinedflat.replace(']', '')
1211         combinedflat = combinedflat.replace('"', '')
1212         combinedflat = combinedflat.replace(',', '')
1213         combinedflat = combinedflat.replace("(", '')
1214         combinedflat = combinedflat.replace(")", '')
1215         f.write("{}\n".format(combinedflat))

```

```

1215     else:
1216         f.write("param\t{0}\tdefault\t{1}:=\n".format(
1217             param, defaults_dictionary[param]))
1218         f.write(';\n')
1219
1220     # StorageMaxDischargeRate = np.zeros((lr,ls))
1221     param = 'StorageMaxDischargeRate' # Change this line
1222     f.write('#\n')
1223     columns = self.storage # Change this line
1224     column_string = ' '.join(columns)
1225     if toggle_defaults[param] == True:
1226         f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
1227             param, defaults_dictionary[param], column_string))
1228     # Converts maxtrix rows to list
1229     array = np.array(self.region) # Change this line
1230     array = array.T
1231     lt = array.tolist()
1232     # Creates 2D matrix for this value
1233     mat = self.StorageMaxDischargeRate[:, :] # Change this
1234     line
1235     # Converts combined matrix to list and combines lists
1236     matlist = mat.tolist()
1237     #Combines the two lists
1238     combined_list = list(zip(lt, matlist))
1239     # Writes index specific parameter values to the text
1240     files
1241         f.write("param\t{0}\t:{1}:=\n".format(param,
1242         column_string))
1243         for line in combined_list:
1244             combinedflat = ' '.join(str(line))
1245             combinedflat = combinedflat.replace('[', '')
1246             combinedflat = combinedflat.replace(']', '')
1247             combinedflat = combinedflat.replace('"', '')
1248             combinedflat = combinedflat.replace("'", '')
1249             combinedflat = combinedflat.replace("(", '')
1250             combinedflat = combinedflat.replace(")", '')
1251             f.write("{0}\n".format(combinedflat))
1252     f.write(';\n')
1253
1254     # MinStorageCharge = np.zeros((lr,ls,ly))
1255     param = 'MinStorageCharge'
1256     f.write('#\n')
1257     f.write("param\t{0}\tdefault\t{1}:=\n".format(
1258         param, defaults_dictionary[param]))
1259     if toggle_defaults[param] == True:
1260         # Writes parameter values to the text files
1261         for k in range(self.ly):
1262             # Sets index value for format string
1263             y = self.year[k]
1264             # Converts matrix columns to strings columns to
1265             strings
1266                 columns = self.storage
1267                 column_string = ' '.join(columns)
1268                 # Converts maxtrix rows to list
1269                 array = np.array(self.region)

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1269             array = array.T
1270             lt = array.tolist()
1271             # Creates 2D matrix for this value
1272             mat = self.MinStorageCharge[:, :, k]
1273             # Converts combined matrix to list and combines
1274             lists
1275             matlist = mat.tolist()
1276             # Combines the two lists
1277             combined_list = list(zip(lt, matlist))
1278             # Writes index specific parameter values to the
1279             text files
1280             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1281             column_string))
1282             for line in combined_list:
1283                 combinedflat = ''.join(str(line))
1284                 combinedflat = combinedflat.replace('[', '')
1285                 combinedflat = combinedflat.replace(']', '')
1286                 combinedflat = combinedflat.replace('"', '')
1287                 combinedflat = combinedflat.replace(',', '')
1288                 combinedflat = combinedflat.replace('(', '')
1289                 combinedflat = combinedflat.replace(')', '')
1290                 f.write("{0}\n".format(combinedflat))
1291             f.write(';\n')
1292
1293             # OperationalLifeStorage = np.zeros((lr,ls))
1294             param = 'OperationalLifeStorage' # Change this line
1295             f.write('#\n')
1296             columns = self.storage # Change this line
1297             column_string = ' '.join(columns)
1298             if toggle_defaults[param] == True:
1299                 f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
1300                     param, defaults_dictionary[param], column_string))
1301             # Converts maxtrix rows to list
1302             array = np.array(self.region) # Change this line
1303             array = array.T
1304             lt = array.tolist()
1305             # Creates 2D matrix for this value
1306             mat = self.OperationalLifeStorage[:, :] # Change this
1307             line
1308             # Converts combined matrix to list and combines lists
1309             matlist = mat.tolist()
1310             # Combines the two lists
1311             combined_list = list(zip(lt, matlist))
1312             # Writes index specific parameter values to the text
1313             files
1314             f.write("param\t{0}\t:{1}:=\n".format(param,
1315             column_string))
1316             for line in combined_list:
1317                 combinedflat = ''.join(str(line))
1318                 combinedflat = combinedflat.replace('[', '')
1319                 combinedflat = combinedflat.replace(']', '')
1320                 combinedflat = combinedflat.replace('"', '')
1321                 combinedflat = combinedflat.replace(',', '')
1322                 combinedflat = combinedflat.replace('(', '')
1323                 combinedflat = combinedflat.replace(')', '')
1324                 f.write("{0}\n".format(combinedflat))
1325             else:
1326                 f.write("param\t{0}\tdefault\t{1}:=\n".format(

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```

1321                 param, defaults_dictionary[param]))
1322             f.write(';\n')
1323
1324         # CapitalCostStorage = np.zeros((lr,ls,ly))
1325         param = 'CapitalCostStorage'
1326         f.write('#\n')
1327         f.write("param\t{0}\tdefault\t{1}:=\n".format(
1328             param, defaults_dictionary[param]))
1329     if toggle_defaults[param] == True:
1330         # Writes parameter values to the text files
1331         for k in range(self.ly):
1332             # Sets index value for format string
1333             y = self.year[k]
1334             # Converts matrix columns to strings columns to
1335             strings
1336             columns = self.storage
1337             column_string = ', '.join(columns)
1338             # Converts maxtrix rows to list
1339             array = np.array(self.region)
1340             array = array.T
1341             lt = array.tolist()
1342             # Creates 2D matrix for this value
1343             mat = self.CapitalCostStorage[:, :, k]
1344             # Converts combined matrix to list and combines
1345             lists
1346             matlist = mat.tolist()
1347             #Combines the two lists
1348             combined_list = list(zip(lt, matlist))
1349             # Writes index specific parameter values to the
1350             text files
1351             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1352                 column_string))
1353             for line in combined_list:
1354                 combinedflat = ''.join(str(line))
1355                 combinedflat = combinedflat.replace('[', '')
1356                 combinedflat = combinedflat.replace(']', '')
1357                 combinedflat = combinedflat.replace('"', '')
1358                 combinedflat = combinedflat.replace(',', '')
1359                 combinedflat = combinedflat.replace('(', '')
1360                 combinedflat = combinedflat.replace(')', '')
1361                 f.write("{0}\n".format(combinedflat))
1362             f.write(';\n')
1363
1364         # ResidualStorageCapacity = np.zeros((lr,ls,ly))
1365         param = 'ResidualStorageCapacity'
1366         f.write('#\n')
1367         f.write("param\t{0}\tdefault\t{1}:=\n".format(
1368             param, defaults_dictionary[param]))
1369     if toggle_defaults[param] == True:
1370         # Writes parameter values to the text files
1371         for k in range(self.ly):
1372             # Sets index value for format string
1373             y = self.year[k]
1374             # Converts matrix columns to strings columns to
1375             strings
1376             columns = self.storage
1377             column_string = ', '.join(columns)
1378             # Converts maxtrix rows to list

```

```

1374         array = np.array(self.region)
1375         array = array.T
1376         lt = array.tolist()
1377         # Creates 2D matrix for this value
1378         mat = self.ResidualStorageCapacity[:, :, k]
1379         # Converts combined matrix to list and combines
1380         lists
1381
1382         matlist = mat.tolist()
1383         # Combines the two lists
1384         combined_list = list(zip(lt, matlist))
1385         # Writes index specific parameter values to the
1386         # text files
1387         f.write("\t[*,{0}]:\t{1}\t:=\n".format(y,
1388
1389         column_string))
1390
1391         for line in combined_list:
1392             combinedflat = ''.join(str(line))
1393             combinedflat = combinedflat.replace('[', '')
1394             combinedflat = combinedflat.replace(']', '')
1395             combinedflat = combinedflat.replace('"', '')
1396             combinedflat = combinedflat.replace(',', '')
1397             combinedflat = combinedflat.replace('(', '')
1398             combinedflat = combinedflat.replace(')', '')
1399             f.write("{0}\n".format(combinedflat))
1400
1401             f.write(';\n')
1402
1403             # CapacityOfOneTechnologyUnit = np.zeros((lr,lt,ly))
1404             param = 'CapacityOfOneTechnologyUnit'
1405             f.write('#\n')
1406             f.write("param\t{0}\tdefault\t{1}:=\n".format(
1407                 param, defaults_dictionary[param]))
1408             if toggle_defaults[param] == True:
1409                 # Writes parameter values to the text files
1410                 for k in range(self.ly):
1411                     # Sets index value for format string
1412                     y = self.year[k]
1413                     # Converts matrix columns to strings columns to
1414                     strings
1415
1416                     columns = self.technology
1417                     column_string = ''.join(columns)
1418                     # Converts maxtrix rows to list
1419                     array = np.array(self.region)
1420                     array = array.T
1421                     lt = array.tolist()
1422                     # Creates 2D matrix for this value
1423                     mat = self.CapacityOfOneTechnologyUnit[:, :, k]
1424                     # Converts combined matrix to list and combines
1425                     lists
1426
1427                     matlist = mat.tolist()
1428                     # Combines the two lists
1429                     combined_list = list(zip(lt, matlist))
1430                     # Writes index specific parameter values to the
1431                     # text files
1432                     f.write("\t[*,{0}]:\t{1}\t:=\n".format(y,
1433
1434                     column_string))
1435                     for line in combined_list:
1436                         combinedflat = ''.join(str(line))
1437                         combinedflat = combinedflat.replace('[', '')
1438                         combinedflat = combinedflat.replace(']', '')

```

```

1425             combinedflat = combinedflat.replace(" ", ',')
1426             combinedflat = combinedflat.replace(", ", ',')
1427             combinedflat = combinedflat.replace("( ", ',')
1428             combinedflat = combinedflat.replace(") ", ',')
1429             f.write("{0}\n".format(combinedflat))
1430             f.write(';\n')
1431
1432     # TotalAnnualMaxCapacity = np.zeros((lr,lt,ly))
1433     param = 'TotalAnnualMaxCapacity'
1434     f.write('#\n')
1435     f.write("param\t{0}\tdefault\t{1}:=\n".format(
1436         param, defaults_dictionary[param]))
1437     if toggle_defaults[param] == True:
1438         # Writes parameter values to the text files
1439         for k in range(self.ly):
1440             # Sets index value for format string
1441             y = self.year[k]
1442             # Converts matrix columns to strings columns to
1443             # strings
1444             columns = self.technology
1445             column_string = ', '.join(columns)
1446             # Converts maxtrix rows to list
1447             array = np.array(self.region)
1448             array = array.T
1449             lt = array.tolist()
1450             # Creates 2D matrix for this value
1451             mat = self.TotalAnnualMaxCapacity[:, :, k]
1452             # Converts combined matrix to list and combines
1453             # lists
1454             matlist = mat.tolist()
1455             #Combines the two lists
1456             combined_list = list(zip(lt, matlist))
1457             # Writes index specific parameter values to the
1458             # text files
1459             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1460                 column_string))
1461             for line in combined_list:
1462                 combinedflat = ''.join(str(line))
1463                 combinedflat = combinedflat.replace('[', ',')
1464                 combinedflat = combinedflat.replace(']', ',')
1465                 combinedflat = combinedflat.replace('"",', ',')
1466                 combinedflat = combinedflat.replace(",\"", ',')
1467                 combinedflat = combinedflat.replace("(\"", ',')
1468                 combinedflat = combinedflat.replace(")\\"", ',')
1469                 f.write("{0}\n".format(combinedflat))
1470                 f.write(';\n')
1471
1472     # TotalAnnualMinCapacity = np.zeros((lr,lt,ly))
1473     param = 'TotalAnnualMinCapacity'
1474     f.write('#\n')
1475     f.write("param\t{0}\tdefault\t{1}:=\n".format(
1476         param, defaults_dictionary[param]))
1477     if toggle_defaults[param] == True:
1478         # Writes parameter values to the text files
1479         for k in range(self.ly):
1480             # Sets index value for format string
1481             y = self.year[k]

```

```

1478             # Converts matrix columns to strings columns to
1479             strings
1480             columns = self.technology
1481             column_string = ', '.join(columns)
1482             # Converts maxtrix rows to list
1483             array = np.array(self.region)
1484             array = array.T
1485             lt = array.tolist()
1486             # Creates 2D matrix for this value
1487             mat = self.TotalAnnualMinCapacity[:, :, k]
1488             # Converts combined matrix to list and combines
1489             lists
1490             matlist = mat.tolist()
1491             #Combines the two lists
1492             combined_list = list(zip(lt, matlist))
1493             # Writes index specific parameter values to the
1494             text files
1495             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1496             column_string))
1497             for line in combined_list:
1498                 combinedflat = ''.join(str(line))
1499                 combinedflat = combinedflat.replace('[', '')
1500                 combinedflat = combinedflat.replace(']', '')
1501                 combinedflat = combinedflat.replace('"', '')
1502                 combinedflat = combinedflat.replace(',', '')
1503                 combinedflat = combinedflat.replace('(', '')
1504                 combinedflat = combinedflat.replace(')', '')
1505                 f.write("{0}\n".format(combinedflat))
1506             f.write(';\n')
1507
1508             # TotalAnnualMaxCapacityInvestment = np.zeros((lr,lt,ly))
1509             param = 'TotalAnnualMaxCapacityInvestment'
1510             f.write('#\n')
1511             f.write("param\t{0}\tdefault\t{1}:=\n".format(
1512                 param, defaults_dictionary[param]))
1513             if toggle_defaults[param] == True:
1514                 # Writes parameter values to the text files
1515                 for k in range(self.ly):
1516                     # Sets index value for format string
1517                     y = self.year[k]
1518                     # Converts matrix columns to strings columns to
1519                     strings
1520                     columns = self.technology
1521                     column_string = ', '.join(columns)
1522                     # Converts maxtrix rows to list
1523                     array = np.array(self.region)
1524                     array = array.T
1525                     lt = array.tolist()
1526                     # Creates 2D matrix for this value
1527                     mat = self.TotalAnnualMaxCapacityInvestment[:, :, k
1528 ]
1529                     # Converts combined matrix to list and combines
1530                     lists
1531                     matlist = mat.tolist()
1532                     #Combines the two lists
1533                     combined_list = list(zip(lt, matlist))
1534                     # Writes index specific parameter values to the
1535                     text files

```

```

1528         f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1529             column_string))
1530             for line in combined_list:
1531                 combinedflat = ''.join(str(line))
1532                 combinedflat = combinedflat.replace('[', ' ')
1533                 combinedflat = combinedflat.replace(']', ' ')
1534                 combinedflat = combinedflat.replace('"', ' ')
1535                 combinedflat = combinedflat.replace(',', ' ')
1536                 combinedflat = combinedflat.replace('(', ' ')
1537                 combinedflat = combinedflat.replace(')', ' ')
1538                 f.write("{0}\n".format(combinedflat))
1539             f.write(';\n')
1540
1541     # TotalAnnualMinCapacityInvestment = np.zeros((lr,lt,ly))
1542     param = 'TotalAnnualMinCapacityInvestment'
1543     f.write('#\n')
1544     f.write("param\t{0}\tdefault\t{1}:=\n".format(
1545         param, defaults_dictionary[param]))
1546     if toggle_defaults[param] == True:
1547         # Writes parameter values to the text files
1548         for k in range(self.ly):
1549             # Sets index value for format string
1550             y = self.year[k]
1551             # Converts matrix columns to strings columns to
1552             strings
1553             columns = self.technology
1554             column_string = ' '.join(columns)
1555             # Converts maxtrix rows to list
1556             array = np.array(self.region)
1557             array = array.T
1558             lt = array.tolist()
1559             # Creates 2D matrix for this value
1560             mat = self.TotalAnnualMinCapacityInvestment[:, :, k]
1561
1562             # Converts combined matrix to list and combines
1563             lists
1564             matlist = mat.tolist()
1565             #Combines the two lists
1566             combined_list = list(zip(lt, matlist))
1567             # Writes index specific parameter values to the
1568             text files
1569             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1570                 column_string))
1571                 for line in combined_list:
1572                     combinedflat = ''.join(str(line))
1573                     combinedflat = combinedflat.replace('[', ' ')
1574                     combinedflat = combinedflat.replace(']', ' ')
1575                     combinedflat = combinedflat.replace('"', ' ')
1576                     combinedflat = combinedflat.replace(',', ' ')
1577                     combinedflat = combinedflat.replace('(', ' ')
1578                     combinedflat = combinedflat.replace(')', ' ')
1579                     f.write("{0}\n".format(combinedflat))
1580                 f.write(';\n')
1581
1582     # TotalTechnologyAnnualActivityLowerLimit= np.zeros((lr,lt,
1583     ly))
1584     param = 'TotalTechnologyAnnualActivityLowerLimit'
1585     f.write('#\n')

```

```

1579         f.write("param\t{0}\tdefault\t{1}:=\n".format(
1580             param, defaults_dictionary[param]))
1581     if toggle_defaults[param] == True:
1582         # Writes parameter values to the text files
1583         for k in range(self.ly):
1584             # Sets index value for format string
1585             y = self.year[k]
1586             # Converts matrix columns to strings columns to
1587             # strings
1588             columns = self.technology
1589             column_string = ', '.join(columns)
1590             # Converts maxtrix rows to list
1591             array = np.array(self.region)
1592             array = array.T
1593             lt = array.tolist()
1594             # Creates 2D matrix for this value
1595             mat = self.TotalTechnologyAnnualActivityLowerLimit
1596             [ :, :, k]
1597             # Converts combined matrix to list and combines
1598             lists
1599             matlist = mat.tolist()
1600             #Combines the two lists
1601             combined_list = list(zip(lt, matlist))
1602             # Writes index specific parameter values to the
1603             # text files
1604             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1605                 column_string))
1606             for line in combined_list:
1607                 combinedflat = ', '.join(str(line))
1608                 combinedflat = combinedflat.replace('[', '')
1609                 combinedflat = combinedflat.replace(']', '')
1610                 combinedflat = combinedflat.replace('"', '')
1611                 combinedflat = combinedflat.replace(',', '')
1612                 combinedflat = combinedflat.replace('(', '')
1613                 combinedflat = combinedflat.replace(')', '')
1614                 f.write("{0}\n".format(combinedflat))
1615             f.write(';\n')
1616
1617             # TotalTechnologyAnnualActivityUpperLimit = np.zeros((lr,lt
1618             ,ly))
1619             param = 'TotalTechnologyAnnualActivityUpperLimit'
1620             f.write('#\n')
1621             f.write("param\t{0}\tdefault\t{1}:=\n".format(
1622                 param, defaults_dictionary[param]))
1623             if toggle_defaults[param] == True:
1624                 # Writes parameter values to the text files
1625                 for k in range(self.ly):
1626                     # Sets index value for format string
1627                     y = self.year[k]
1628                     # Converts matrix columns to strings columns to
1629                     strings
1630                     columns = self.technology
1631                     column_string = ', '.join(columns)
1632                     # Converts maxtrix rows to list
1633                     array = np.array(self.region)
1634                     array = array.T
1635                     lt = array.tolist()
1636                     # Creates 2D matrix for this value

```

```

1630                         mat = self.TotalTechnologyAnnualActivityUpperLimit
1631                         [:, :, k]
1632                         # Converts combined matrix to list and combines
1633                         lists
1634                         matlist = mat.tolist()
1635                         #Combines the two lists
1636                         combined_list = list(zip(lt, matlist))
1637                         # Writes index specific parameter values to the
1638                         text files
1639                         f.write("\t[*,{0}]:\t{1}\t:={\n".format(y,
1640                                         column_string))
1641                         for line in combined_list:
1642                             combinedflat = ''.join(str(line))
1643                             combinedflat = combinedflat.replace('[', ' ')
1644                             combinedflat = combinedflat.replace(']', ' ')
1645                             combinedflat = combinedflat.replace('"', ' ')
1646                             combinedflat = combinedflat.replace(',', ' ')
1647                             combinedflat = combinedflat.replace('(', ' ')
1648                             combinedflat = combinedflat.replace(')', ' ')
1649                             f.write("{0}\n".format(combinedflat))
1650                         f.write(';\n')
1651
1652                         # TotalTechnologyModelPeriodActivityUpperLimit = np.zeros((
1653                         lr, lt))
1654                         param = 'TotalTechnologyModelPeriodActivityUpperLimit' ##
1655                         Change this line
1656                         f.write('#\n')
1657                         columns = self.technology # Change this line
1658                         column_string = ' '.join(columns)
1659                         if toggle_defaults[param] == True:
1660                             # Writes index specific parameter values to the text
1661                             files
1662                             f.write("param\t{0}\tdefault\t{1}:\t{2}:={\n".format(
1663                                 param, defaults_dictionary[param], column_string))
1664                             # Converts maxtrix rows to list
1665                             array = np.array(self.region) # Change this line
1666                             array = array.T
1667                             lt = array.tolist()
1668                             # Creates 2D matrix for this value
1669                             mat = self.TotalTechnologyModelPeriodActivityUpperLimit
1670                             [:, :] # Change this line
1671                             # Converts combined matrix to list and combines lists
1672                             matlist = mat.tolist()
1673                             #Combines the two lists
1674                             combined_list = list(zip(lt, matlist))
1675                             for line in combined_list:
1676                                 combinedflat = ''.join(str(line))
1677                                 combinedflat = combinedflat.replace('[', ' ')
1678                                 combinedflat = combinedflat.replace(']', ' ')
1679                                 combinedflat = combinedflat.replace('"', ' ')
1680                                 combinedflat = combinedflat.replace(',', ' ')
1681                                 combinedflat = combinedflat.replace('(', ' ')
1682                                 combinedflat = combinedflat.replace(')', ' ')
1683                                 f.write("{0}\n".format(combinedflat))
1684                         else:
1685                             f.write("param\t{0}\tdefault\t{1}:={\n".format(
1686                                 param, defaults_dictionary[param]))
1687                             f.write(';\n')

```

```

1680
1681     # TotalTechnologyModelPeriodActivityLowerLimit = np.zeros((
1682     lr,lt))
1683     param = 'TotalTechnologyModelPeriodActivityLowerLimit' # 
Change this line
1684     f.write('#\n')
1685     columns = self.technology # Change this line
1686     column_string = ' '.join(columns)
1687     if toggle_defaults[param] == True:
1688         # Writes index specific parameter values to the text
files
1689     f.write("param\t{0}\tdefault\t{1}:=\t{2}:=\n".format(
1690         param, defaults_dictionary[param], column_string))
1691     # Converts maxtrix rows to list
1692     array = np.array(self.region) # Change this line
1693     array = array.T
1694     lt = array.tolist()
1695     # Creates 2D matrix for this value
mat = self.TotalTechnologyModelPeriodActivityLowerLimit
1696     [:, :] # Change this line
1697     # Converts combined matrix to list and combines lists
1698     matlist = mat.tolist()
#Combines the two lists
1699     combined_list = list(zip(lt, matlist))
1700     for line in combined_list:
1701         combinedflat = ''.join(str(line))
1702         combinedflat = combinedflat.replace('[', '')
1703         combinedflat = combinedflat.replace(']', '')
1704         combinedflat = combinedflat.replace('"', '')
1705         combinedflat = combinedflat.replace(',', '')
1706         combinedflat = combinedflat.replace('(', '')
1707         combinedflat = combinedflat.replace(')', '')
1708         f.write("{0}\n".format(combinedflat))
1709     else:
1710         f.write("param\t{0}\tdefault\t{1}:=\t{2}:=\n".format(
1711             param, defaults_dictionary[param]))
1712     f.write(';\n')

1713
1714     # ReserveMarginTagTechnology = np.zeros((lr,lt,ly))
1715     param = 'ReserveMarginTagTechnology'
1716     f.write('#\n')
1717     f.write("param\t{0}\tdefault\t{1}:=\t{2}:=\n".format(
1718         param, defaults_dictionary[param]))
1719     if toggle_defaults[param] == True:
1720         # Writes parameter values to the text files
1721         for k in range(self.ly):
1722             # Sets index value for format string
1723             y = self.year[k]
1724             # Converts matrix columns to strings columns to
strings
1725             columns = self.technology
1726             column_string = ' '.join(columns)
1727             # Converts maxtrix rows to list
1728             array = np.array(self.region)
1729             array = array.T
1730             lt = array.tolist()
1731             # Creates 2D matrix for this value
mat = self.ReserveMarginTagTechnology[:, :, k]

```

```

1733             # Converts combined matrix to list and combines
1734             lists
1735             matlist = mat.tolist()
1736             #Combines the two lists
1737             combined_list = list(zip(lt, matlist))
1738             # Writes index specific parameter values to the
1739             text files
1740             f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1741               column_string))
1742             for line in combined_list:
1743                 combinedflat = ''.join(str(line))
1744                 combinedflat = combinedflat.replace('[', ' ')
1745                 combinedflat = combinedflat.replace(']', ' ')
1746                 combinedflat = combinedflat.replace('"', ' ')
1747                 combinedflat = combinedflat.replace(',', ' ')
1748                 combinedflat = combinedflat.replace('(', ' ')
1749                 combinedflat = combinedflat.replace(')', ' ')
1750                 f.write("{0}\n".format(combinedflat))
1751             f.write(';\n')
1752
1753             # ReserveMarginTagFuel = np.zeros((lr,lf,ly))
1754             param = 'ReserveMarginTagFuel'
1755             f.write('#\n')
1756             f.write("param\t{0}\tdefault\t{1}:=\n".format(
1757               param, defaults_dictionary[param]))
1758             if toggle_defaults[param] == True:
1759                 # Writes parameter values to the text files
1760                 for k in range(self.ly):
1761                     # Sets index value for format string
1762                     y = self.year[k]
1763                     # Converts matrix columns to strings columns to
1764                     strings
1765                     columns = self.fuel
1766                     column_string = ' '.join(columns)
1767                     # Converts maxtrix rows to list
1768                     array = np.array(self.region)
1769                     array = array.T
1770                     lt = array.tolist()
1771                     # Creates 2D matrix for this value
1772                     mat = self.ReserveMarginTagFuel[:, :, k]
1773                     # Converts combined matrix to list and combines
1774                     lists
1775                     matlist = mat.tolist()
1776                     #Combines the two lists
1777                     combined_list = list(zip(lt, matlist))
1778                     # Writes index specific parameter values to the
1779                     text files
1780                     f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1781                       column_string))
1782                     for line in combined_list:
1783                         combinedflat = ''.join(str(line))
1784                         combinedflat = combinedflat.replace('[', ' ')
1785                         combinedflat = combinedflat.replace(']', ' ')
1786                         combinedflat = combinedflat.replace('"', ' ')
1787                         combinedflat = combinedflat.replace(',', ' ')
1788                         combinedflat = combinedflat.replace('(', ' ')
1789                         combinedflat = combinedflat.replace(')', ' ')
1790                         f.write("{0}\n".format(combinedflat))

```

```

1784     f.write(';\n')
1785
1786     # ReserveMargin = np.zeros((lr,ly))
1787     param = 'ReserveMargin' # Change this line
1788     f.write('#\n')
1789     columns = self.year # Change this line
1790     column_string = ' '.join(columns)
1791     if toggle_defaults[param] == True:
1792         # Writes index specific parameter values to the text
1793         files
1794             f.write("param\t{0}\tdefault\t{1}:=\n".format(
1795                 param, defaults_dictionary[param], column_string))
1796             # Converts maxtrix rows to list
1797             array = np.array(self.region) # Change this line
1798             array = array.T
1799             lt = array.tolist()
1800             # Creates 2D matrix for this value
1801             mat = self.ReserveMargin[:, :] # Change this line
1802             # Converts combined matrix to list and combines lists
1803             matlist = mat.tolist()
1804             #Combines the two lists
1805             combined_list = list(zip(lt, matlist))
1806             for line in combined_list:
1807                 combinedflat = ''.join(str(line))
1808                 combinedflat = combinedflat.replace('[', '')
1809                 combinedflat = combinedflat.replace(']', '')
1810                 combinedflat = combinedflat.replace('"', '')
1811                 combinedflat = combinedflat.replace("'", '')
1812                 combinedflat = combinedflat.replace("(", '')
1813                 combinedflat = combinedflat.replace(")", '')
1814                 f.write("{0}\n".format(combinedflat))
1815             else:
1816                 f.write("param\t{0}\tdefault\t{1}:=\n".format(
1817                     param, defaults_dictionary[param]))
1818             f.write(';\n')
1819
1820     # RETagTechnology = np.zeros((lr,lt,ly))
1821     param = 'RETagTechnology'
1822     f.write('#\n')
1823     f.write("param\t{0}\tdefault\t{1}:=\n".format(
1824         param, defaults_dictionary[param]))
1825     if toggle_defaults[param] == True:
1826         # Writes parameter values to the text files
1827         for k in range(self.ly):
1828             # Sets index value for format string
1829             y = self.year[k]
1830             # Converts matrix columns to strings columns to
1831             strings
1832                 columns = self.technology
1833                 column_string = ' '.join(columns)
1834                 # Converts maxtrix rows to list
1835                 array = np.array(self.region)
1836                 array = array.T
1837                 lt = array.tolist()
1838                 # Creates 2D matrix for this value
1839                 mat = self.RETagTechnology[:, :, k]
1840                 # Converts combined matrix to list and combines
1841                 lists

```

```

1839         matlist = mat.tolist()
1840         #Combines the two lists
1841         combined_list = list(zip(lt, matlist))
1842         # Writes index specific parameter values to the
1843         text files
1844         f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1845             column_string))
1846         for line in combined_list:
1847             combinedflat = ''.join(str(line))
1848             combinedflat = combinedflat.replace('[', '')
1849             combinedflat = combinedflat.replace(']', '')
1850             combinedflat = combinedflat.replace('"', '')
1851             combinedflat = combinedflat.replace(',', '')
1852             combinedflat = combinedflat.replace('(', '')
1853             combinedflat = combinedflat.replace(')', '')
1854             f.write("{0}\n".format(combinedflat))
1855             f.write(';\n')
1856
1857         # RETagFuel = np.zeros((lr,lf,ly))
1858         param = 'RETagFuel'
1859         f.write('#\n')
1860         f.write("param\t{0}\tdefault\t{1}:=\n".format(
1861             param, defaults_dictionary[param]))
1862         if toggle_defaults[param] == True:
1863             # Writes parameter values to the text files
1864             for k in range(self.ly):
1865                 # Sets index value for format string
1866                 y = self.year[k]
1867                 # Converts matrix columns to strings columns to
1868                 # strings
1869                 columns = self.fuel
1870                 column_string = ', '.join(columns)
1871                 # Converts maxtrix rows to list
1872                 array = np.array(self.region)
1873                 array = array.T
1874                 lt = array.tolist()
1875                 # Creates 2D matrix for this value
1876                 mat = self.RETagFuel[:, :, k]
1877                 # Converts combined matrix to list and combines
1878                 lists
1879                 matlist = mat.tolist()
1880                 #Combines the two lists
1881                 combined_list = list(zip(lt, matlist))
1882                 # Writes index specific parameter values to the
1883                 text files
1884                 f.write("\t[*,*,{0}]:\t{1}\t:=\n".format(y,
1885                     column_string))
1886                 for line in combined_list:
1887                     combinedflat = ''.join(str(line))
1888                     combinedflat = combinedflat.replace('[', '')
1889                     combinedflat = combinedflat.replace(']', '')
1890                     combinedflat = combinedflat.replace('"', '')
1891                     combinedflat = combinedflat.replace(',', '')
1892                     combinedflat = combinedflat.replace('(', '')
1893                     combinedflat = combinedflat.replace(')', '')
1894                     f.write("{0}\n".format(combinedflat))
1895                     f.write(';\n')
1896

```

```

1891     # REMinProductionTarget = np.zeros((lr,ly))
1892     param = 'REMinProductionTarget' # Change this line
1893     f.write('#\n')
1894     columns = self.year # Change this line
1895     column_string = ' '.join(columns)
1896     if toggle_defaults[param] == True:
1897         # Writes index specific parameter values to the text
1898         files
1899             f.write("param\t{0}\tdefault\t{1}:=\t{2}:=\n".format(
1900                 param, defaults_dictionary[param], column_string))
1901             # Converts maxtrix rows to list
1902             array = np.array(self.region) # Change this line
1903             array = array.T
1904             lt = array.tolist()
1905             # Creates 2D matrix for this value
1906             mat = self.REMinProductionTarget[:, :] # Change this
1907             line
1908                 # Converts combined matrix to list and combines lists
1909                 matlist = mat.tolist()
1910                 #Combines the two lists
1911                 combined_list = list(zip(lt, matlist))
1912                 for line in combined_list:
1913                     combinedflat = ','.join(str(line))
1914                     combinedflat = combinedflat.replace('[', '')
1915                     combinedflat = combinedflat.replace(']', '')
1916                     combinedflat = combinedflat.replace('"', '')
1917                     combinedflat = combinedflat.replace("'", '')
1918                     combinedflat = combinedflat.replace("(", '')
1919                     combinedflat = combinedflat.replace(")", '')
1920                     f.write("{0}\n".format(combinedflat))
1921             else:
1922                 f.write("param\t{0}\tdefault\t{1}:=\n".format(
1923                     param, defaults_dictionary[param]))
1924             f.write(';\n')
1925
1926             # EmissionActivityRatio = np.zeros((lr,lt,le,lm,ly))
1927             #Writes new line character at parameter metadata to the
1928             text file
1929                 param = 'EmissionActivityRatio' # Change this line
1930                 f.write('#\n')
1931                 f.write("param\t{0}\tdefault\t{1}:=\n".format(
1932                     param, defaults_dictionary[param]))
1933                 if toggle_defaults[param] == True:
1934                     # Writes parameter values to the text files
1935                     for i in range(self.le): # Change loops if you need
1936                         # Sets index value for format string
1937                         emission = self.emission[i]
1938                         for j in range(self.lm):
1939                             # Sets index value for format string
1940                             MOO = self.mode_of_operation[j]
1941                             for k in range(self.ly):
1942                                 # Sets index value for format string
1943                                 y = self.year[k]
1944                                 # Converts matrix columns to strings
1945
1946             columns to strings
1947                 columns = self.technology
1948                 column_string = ' '.join(columns)
1949                 # Converts maxtrix rows to list

```

```

1945             array = np.array(self.region)
1946             array = array.T
1947             lt = array.tolist()
1948             # Creates 2D matrix for this value
1949             mat = self.EmissionActivityRatio[:, :, i, j
1950
1951             , k]
1952
1953             # Converts combined matrix to list and
1954             # combines lists
1955
1956             matlist = mat.tolist()
1957             # Combines the two lists
1958             combined_list = list(zip(lt, matlist))
1959             # Writes index specific parameter values to
1960             # the text files
1961             f.write("\t[*,{0},{1},{2}]:\t{3}\t:=\n".
1962             format(
1963                 emission, MOO, y, column_string))
1964             for line in combined_list:
1965                 combinedflat = ''.join(str(line))
1966                 combinedflat = combinedflat.replace('[',
1967                 ', ')
1968                 combinedflat = combinedflat.replace(']',
1969                 ', ')
1970                 combinedflat = combinedflat.replace('"',
1971                 ', ')
1972                 combinedflat = combinedflat.replace(',', '')
1973                 combinedflat = combinedflat.replace("((",
1974                 combinedflat = combinedflat.replace("))"
1975                 f.write("{0}\n".format(combinedflat))
1976                 f.write(';\n')
1977
1978                 # EmissionsPenalty = np.zeros((lr,le,ly))
1979                 param = 'EmissionsPenalty'
1980                 f.write('#\n')
1981                 f.write("param\t{0}\tdefault\t{1}:=\n".format(
1982                     param, defaults_dictionary[param]))
1983                 if toggle_defaults[param] == True:
1984                     # Writes parameter values to the text files
1985                     for k in range(self.ly):
1986                         # Sets index value for format string
1987                         y = self.year[k]
1988                         # Converts matrix columns to strings columns to
1989                         strings
1990                         columns = self.emission
1991                         column_string = ', '.join(columns)
1992                         # Converts maxtrix rows to list
1993                         array = np.array(self.region)
1994                         array = array.T
1995                         lt = array.tolist()
1996                         # Creates 2D matrix for this value
1997                         mat = self.EmissionsPenalty[:, :, k]
1998                         # Converts combined matrix to list and combines
1999                         lists
2000                         matlist = mat.tolist()
2001                         # Combines the two lists
2002                         combined_list = list(zip(lt, matlist))

```

```

1991             # Writes index specific parameter values to the
1992             text files
1993             f.write("\t[*,{0}]:\t{1}\t:=\n".format(y,
1994               column_string))
1995             for line in combined_list:
1996                 combinedflat = ''.join(str(line))
1997                 combinedflat = combinedflat.replace('[', ' ')
1998                 combinedflat = combinedflat.replace(']', ' ')
1999                 combinedflat = combinedflat.replace('"', ' ')
2000                 combinedflat = combinedflat.replace(',', ' ')
2001                 combinedflat = combinedflat.replace('(', ' ')
2002                 combinedflat = combinedflat.replace(')', ' ')
2003                 f.write("{0}\n".format(combinedflat))
2004             f.write(';\n')
2005
2006             # AnnualExogenousEmission = np.zeros((lr,le,ly))
2007             param = 'AnnualExogenousEmission'
2008             f.write('#\n')
2009             f.write("param\t{0}\tdefault\t{1}:=\n".format(
2010               param, defaults_dictionary[param]))
2011             if toggle_defaults[param] == True:
2012                 # Writes parameter values to the text files
2013                 for k in range(self.ly):
2014                     # Sets index value for format string
2015                     y = self.year[k]
2016                     # Converts matrix columns to strings columns to
2017                     strings
2018                     columns = self.emission
2019                     column_string = ' '.join(columns)
2020                     # Converts maxtrix rows to list
2021                     array = np.array(self.region)
2022                     array = array.T
2023                     lt = array.tolist()
2024                     # Creates 2D matrix for this value
2025                     mat = self.AnnualExogenousEmission[:, :, k]
2026                     # Converts combined matrix to list and combines
2027                     lists
2028                     matlist = mat.tolist()
2029                     #Combines the two lists
2030                     combined_list = list(zip(lt, matlist))
2031                     # Writes index specific parameter values to the
2032                     text files
2033                     f.write("\t[*,{0}]:\t{1}\t:=\n".format(y,
2034                       column_string))
2035                     for line in combined_list:
2036                         combinedflat = ''.join(str(line))
2037                         combinedflat = combinedflat.replace('[', ' ')
2038                         combinedflat = combinedflat.replace(']', ' ')
2039                         combinedflat = combinedflat.replace('"', ' ')
2040                         combinedflat = combinedflat.replace(',', ' ')
2041                         combinedflat = combinedflat.replace('(', ' ')
2042                         combinedflat = combinedflat.replace(')', ' ')
2043                         f.write("{0}\n".format(combinedflat))
2044                     f.write(';\n')
2045
2046             # AnnualEmissionLimit = np.zeros((lr,le,ly))
2047             param = 'AnnualEmissionLimit'
2048             f.write('#\n')

```

```

2043         f.write("param\t{0}\tdefault\t{1}:=\n".format(
2044             param, defaults_dictionary[param]))
2045     if toggle_defaults[param] == True:
2046         # Writes parameter values to the text files
2047         for k in range(self.ly):
2048             # Sets index value for format string
2049             y = self.year[k]
2050             # Converts matrix columns to strings columns to
2051             # strings
2052             columns = self.emission
2053             column_string = ' '.join(columns)
2054             # Converts maxtrix rows to list
2055             array = np.array(self.region)
2056             array = array.T
2057             lt = array.tolist()
2058             # Creates 2D matrix for this value
2059             mat = self.AnnualExogenousEmission[:, :, k]
2060             # Converts combined matrix to list and combines
2061             # lists
2062             matlist = mat.tolist()
2063             #Combines the two lists
2064             combined_list = list(zip(lt, matlist))
2065             # Writes index specific parameter values to the
2066             # text files
2067             f.write("\t[*,{0}]:\t{1}\t:=\n".format(y,
2068                 column_string))
2069             for line in combined_list:
2070                 combinedflat = ''.join(str(line))
2071                 combinedflat = combinedflat.replace('[', '')
2072                 combinedflat = combinedflat.replace(']', '')
2073                 combinedflat = combinedflat.replace('"', '')
2074                 combinedflat = combinedflat.replace(',', '')
2075                 combinedflat = combinedflat.replace('(', '')
2076                 combinedflat = combinedflat.replace(')', '')
2077                 f.write("{0}\n".format(combinedflat))
2078             f.write(';\n')
2079
2080             # ModelPeriodExogenousEmission = np.zeros((lr,le))
2081             param = 'ModelPeriodExogenousEmission' # Change this line
2082             f.write('#\n')
2083             columns = self.emission # Change this line
2084             column_string = ' '.join(columns)
2085             if toggle_defaults[param] == True:
2086                 # Writes index specific parameter values to the text
2087                 # files
2088                 f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
2089                     param, defaults_dictionary[param], column_string))
2090                 # Converts maxtrix rows to list
2091                 array = np.array(self.region) # Change this line
2092                 array = array.T
2093                 lt = array.tolist()
2094                 # Creates 2D matrix for this value
2095                 mat = self.ModelPeriodExogenousEmission[:, :] # Change
2096                 # this line
2097                 # Converts combined matrix to list and combines lists
2098                 matlist = mat.tolist()
2099                 #Combines the two lists
2100                 combined_list = list(zip(lt, matlist))

```

```

2095         # Writes index specific parameter values to the text
2096     files
2097         f.write("param\t{0}\t:{1}:=\n".format(param,
2098             column_string))
2099         for line in combined_list:
2100             combinedflat = ','.join(str(line))
2101             combinedflat = combinedflat.replace('[', '')
2102             combinedflat = combinedflat.replace(']', '')
2103             combinedflat = combinedflat.replace('"', '')
2104             combinedflat = combinedflat.replace("'", '')
2105             combinedflat = combinedflat.replace("(", '')
2106             combinedflat = combinedflat.replace(")", '')
2107             f.write("{0}\n".format(combinedflat))
2108     else:
2109         f.write("param\t{0}\tdefault\t{1}:=\n".format(
2110             param, defaults_dictionary[param]))
2111         f.write(';\n')
2112
2113         # ModelPeriodEmissionLimit = np.zeros((lr,le))
2114         param = 'ModelPeriodEmissionLimit' # Change this line
2115         f.write('#\n')
2116         columns = self.emission # Change this line
2117         column_string = ', '.join(columns)
2118         if toggle_defaults[param] == True:
2119             # Writes index specific parameter values to the text
2120             files
2121                 f.write("param\t{0}\tdefault\t{1}:\t{2}:=\n".format(
2122                     param, defaults_dictionary[param], column_string))
2123                 # Converts maxtrix rows to list
2124                 array = np.array(self.region) # Change this line
2125                 array = array.T
2126                 lt = array.tolist()
2127                 # Creates 2D matrix for this value
2128                 mat = self.ModelPeriodEmissionLimit[:, :] # Change
2129
2130             this line
2131                 # Converts combined matrix to list and combines lists
2132                 matlist = mat.tolist()
2133                 #Combines the two lists
2134                 combined_list = list(zip(lt, matlist))
2135                 # Writes index specific parameter values to the text
2136             files
2137                 f.write("param\t{0}\t:{1}:=\n".format(param,
2138                     column_string))
2139                 for line in combined_list:
2140                     combinedflat = ','.join(str(line))
2141                     combinedflat = combinedflat.replace('[', '')
2142                     combinedflat = combinedflat.replace(']', '')
2143                     combinedflat = combinedflat.replace('"', '')
2144                     combinedflat = combinedflat.replace("'", '')
2145                     combinedflat = combinedflat.replace("(", '')
2146                     combinedflat = combinedflat.replace(")", '')
2147                     f.write("{0}\n".format(combinedflat))
2148     else:
2149         f.write("param\t{0}\tdefault\t{1}:=\n".format(
2150             param, defaults_dictionary[param]))
2151         f.write(';\n')
2152         f.write('end;\n')
2153         f.write('#')

```

2147 return

2.2.3 CreateCases

The module to create user-defined energy systems.

```

1 import os
2 import numpy as np
3 import pandas as pd
4
5
6 class CreateCases:
7     """ A class of methods to create user-defined energy system
8     """
9     def __init__(self):
10         """ Sets the parameters and sets for the energy case
11         """
12         # Sets (placeholders for setting values)
13         self.year = None
14         self.region = None
15         self.emission = None
16         self.technology = None
17         self.capacity_technology = None
18         self.availability_technology = None
19         self.fuel = None
20         self.specified_fuel = None
21         self.accumulated_fuel = None
22         self.timeslice = None
23         self.mode_of_operation = None
24         self.storage = None
25         self.daytype = None
26         self.season = None
27         self.dailytimebracket = None
28
29         # Parameters
30         self.Conversionls = None
31         self.Conversionld = None
32         self.Conversionlh = None
33         self.DaysInDayType = None
34         self.TradeRoute = None
35         self.DepreciationMethod = None
36         self.SpecifiedAnnualDemand = None
37         self.SpecifiedDemandProfile = None
38         self.AccumulatedAnnualDemand = None
39         self.CapacityToActivityUnit = None
40         self.CapacityFactor = None
41         self.AvailabilityFactor = None
42         self.OperationalLife = None
43         self.ResidualCapacity = None
44         self.InputActivityRatio = None
45         self.OutputActivityRatio = None
46         self.CapitalCost = None
47         self.VariableCost = None
48         self.FixedCost = None
49         self.TechnologyToStorage = None
50         self.TechnologyFromStorage = None
51         self.StorageLevelStart = None
52         self.StorageMaxChargeRate = None

```

```

53         self.StorageMaxDischargeRate = None
54         self.MinStorageCharge = None
55         self.OperationalLifeStorage = None
56         self.CapitalCostStorage = None
57         self.ResidualStorageCapacity = None
58         self.CapacityOfOneTechnologyUnit = None
59         self.TotalAnnualMaxCapacity = None
60         self.TotalAnnualMinCapacity = None
61         self.TotalAnnualMaxCapacityInvestment = None
62         self.TotalAnnualMinCapacityInvestment = None
63         self.TotalTechnologyAnnualActivityLowerLimit = None
64         self.TotalTechnologyAnnualActivityUpperLimit = None
65         self.TotalTechnologyModelPeriodActivityUpperLimit = None
66         self.TotalTechnologyModelPeriodActivityLowerLimit = None
67         self.ReserveMarginTagTechnology = None
68         self.ReserveMarginTagFuel = None
69         self.ReserveMargin = None
70         self.RETagTechnology = None
71         self.RETagFuel = None
72         self.REMinProductionTarget = None
73         self.EmissionActivityRatio = None
74         self.EmissionsPenalty = None
75         self.AnnualExogenousEmission = None
76         self.AnnualEmissionLimit = None
77         self.ModelPeriodExogenousEmission = None
78         self.ModelPeriodEmissionLimit = None
79
80     def set_year(self, start_year, end_year, interval):
81         """ Sets a list of forecast years
82
83         Args:
84             start_year (int): Starting year for forecasting (Less than
85             end_year)
86             end_year (int): Ending year for forecasting (Greater than
87             start_year)
88             interval (int): Gap for forecasting period
89             """
90
91         # Sets year array for new value
92         year = []
93         count = start_year
94         while count <= end_year:
95             year.append(str(count))
96             count = count + interval
97         self.year = year
98
99     def set_region(self, regions):
100        """ Sets the datacase's regions analysis
101
102        Args:
103            regions (list): list of regions
104            """
105        self.region = regions
106
107    def set_emission(self, emissions):
108        """Sets the cases emission types
109
110        Args:
111            emissions (List): list of emission types

```

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

```

167
168     def set_mode_of_operation(self, num_modes_of_operation):
169         """ Create the number of modes of operation (n = 1, ..., num_modes_of_operation)
170
171         Args:
172             num_modes_of_operation (int): Number of modes of operation
173             """
174
175         # Create set of mode_of_operation
176         mode_of_operation = []
177         count = 1
178         while count <= num_modes_of_operation:
179             mode_of_operation.append(str(count))
180             count = count + 1
181         self.mode_of_operation = mode_of_operation
182
183     def set_storage(self, storage):
184         """ Sets storage set of the datacase
185
186         Args:
187             storage (list): list of storage types
188             """
189
190         self.storage = storage
191
192     def set_daytype(self, num_daytypes):
193         """ Sets the daytypes for the energy case
194
195         Args:
196             num_daytypes (int): Number of daytypes
197             """
198
199         # Create set of daytypes
200         daytype = []
201         count = 1
202         while count <= num_daytypes:
203             daytype.append(str(count))
204             count = count + 1
205         self.daytype = daytype
206
207     def set_season(self, num_seasons):
208         """ Creates set of seasons
209
210         Args:
211             num_seasons (int): Number of seasons
212             """
213
214         # Create set of seasons
215         season = []
216         count = 1
217         while count <= num_seasons:
218             season.append(str(count))
219             count = count + 1
220         self.season = season
221
222     def set_daily_time_bracket(self, num_dailymetimebrackets):
223         """ Creates set of daily time brackets
224
225         Args:
226             dailymetimebracket (int): Number of daily time brackets
227             """

```



```

269     Returns:
270         [int, array]: Numpy array of discount rates
271         """
272     # Creates empty dictionaries to stored values
273     annualised_returns = {}
274     cost_of_equity = {}
275     cost_of_debt = {}
276     cost_of_preference_equity = {}
277     WACC = {}
278     discount_rates = []
279     # Calculates
280     for region in market_index:
281         # Calculates annualised returns for each regions market
282         index
283         annualised_rate_of_return = (np.power(
284             (1 + ((market_index[region][-1] - market_index[region
285             ][0]) /
286                 market_index[region][0])),
287             (12 / len(market_index[region]))) - 1)
288         annualised_returns[region] = annualised_rate_of_return
289         # Calculates cost of equity
290         cost_of_equity[region] = (
291             risk_free_rate[region] + (market_risk_coefficient[
292             region]) *
293                 (annualised_returns[region] - risk_free_rate[region]))
294         # Calculates cost of debt
295         cost_of_debt[region] = (cost_of_debt_pre_tax[region] / debt
296             [region]
297                 ) * (1 - effective_tax_rate[region])
298
299         # Calculates cost of preference equity
300         cost_of_preference_equity[region] = preference_dividends[
301             region] / market_value_preference_shares[region]
302         # Calculates WACC
303         WACC[region] = (
304             cost_of_equity[region] *
305                 (equity[region] /
306                     (equity[region] + debt[region] + preference_equity[
307             region])) +
308             cost_of_debt[region] *
309                 (debt[region] /
310                     (equity[region] + debt[region] + preference_equity[
311             region])) +
312             cost_of_preference_equity[region] *
313                 (preference_equity[region] /
314                     (equity[region] + debt[region] + preference_equity[
315             region])))
316
317         # Sets discount rates for each region
318         discount_rates.append(WACC[region])
319         # Set discount array
320         self.DiscountRate = np.asarray(discount_rates)
321
322     def set_day_split(self, daily_time_bracket, years, hour_split,
323         num_days,
324             num_hours):
325         """ Sets the day split parameter
326
327         Args:

```

```

318         daily_time_bracket (list): List of daily time brackets
319         years (list): List of years
320         hour_split (dict): Dictionary of hours in a daily time
321         bracket
322             num_days (int): Number of days in a year
323             num_hours (int): Number of hours in a day
324             """
325             # Initialises the DaySplit Array
326             DaySplit = np.ones((len(daily_time_bracket), len(years)))
327             index = 0
328             for split in daily_time_bracket:
329                 DaySplit[index, :] = hour_split[split] / (num_days *
330                 num_hours)
331                 index = index + 1
332             self.DaySplit = DaySplit
333
334     def set_conversion_ls(self, timeslice, season, link):
335         """ Sets the conversions parameter
336
337         Args:
338             timeslice (list): List of timeslices
339             season (list): List of seasons
340             link (dict): Dictionary describing the connection between
341             timeslices and seasons
342             """
343             Conversionsls = np.zeros((len(timeslice), len(season)))
344             for i in range(0, len(timeslice), 1):
345                 for j in range(0, len(season), 1):
346                     if link[timeslice[i]] == season[j]:
347                         Conversionsls[i, j] = 1
348
349             self.Conversionsls = Conversionsls
350
351     def set_conversion_ld(self, timeslice, daytype, link):
352         """ Sets the Conversionld parameter
353
354         Args:
355             timeslice (list): List of timeslices
356             daytype (list): List of daytypes
357             link (dict): Dictionary describing the connection between
358             timeslices and daytypes
359             """
360             Conversionld = np.zeros((len(timeslice), len(daytype)))
361             for i in range(0, len(timeslice), 1):
362                 Conversionld[i, :] = link[timeslice[i]]
363
364             self.Conversionld = Conversionld
365
366     def set_conversion_lh(self, timeslice, dailytimebracket, link,
367     override):
368         """ Sets the Conversionlh parameter
369
370         Args:
371             timeslice (list): List of timeslices
372             dailytimebracket (list): List of dailytimebracket
373             link (dict): Dictionary describing the connection between
374             timeslices and dailytimebrackets

```

```

369         override (int, array): Override if want to manually put in
370         the array
371         """
372         if override == None:
373             Conversionlh = np.zeros((len(timeslice), len(
374             dailytimebracket)))
375             for i in range(0, len(timeslice), 1):
376                 Conversionlh[i, :] = link[timeslice[i]]
377             self.Conversionlh = Conversionlh
378         else:
379             self.Conversionlh = override
380
381     def set_days_in_day_type(self, season, daytype, year, link,
382     override):
383         """ Sets the DaysInDayType parameter
384
385         Args:
386             season (list): List of seasons
387             daytype (list): List of daytypes
388             year (list): List of years
389             link (dict): Dictionary relating seasons to daytypes
390             override (int, array): Override if want to manually put in
391             the array
392             """
393             if override == None:
394                 DaysInDayType = np.zeros((len(season), len(daytype), len(
395                 year)))
396                 for i in range(0, len(season), 1):
397                     for j in range(0, len(year), 1):
398                         DaysInDayType[i, :, j] = link[season[i]]
399                     self.DaysInDayType = DaysInDayType
400             else:
401                 self.DaysInDayType = override
402
403     def set_trade_route(self, trade):
404         """ Sets the TradeRoute parameter between regions
405             (Assume it is the same across fuels and years)
406
407         Args:
408             trade (int ,array): 4D array representing trade
409             relationships
410                                         between regions, fuels and years. You
411                                         must model this manually.
412             """
413             self.TradeRoute = trade
414
415     def set_depreciation_method(self, region, methods, override):
416         """ Sets DepreciationMethod
417             (1 = Sinking Fund Depreciation, 2 = Straightline
418             Depreciation)
419
420         Args:
421             region (list): List of regions
422             override (int, array): Manual array for setting
423             depreciation methods
424             methods (dict): Dictionary assigning methods to regions
425             """
426

```

```

419         if override == None:
420             depreciation_method = np.ones((len(region)))
421             for i in range(0, len(region), 1):
422                 depreciation_method[i] = methods[region[i]]
423             self.DepreciationMethod = depreciation_method
424         else:
425             self.DepreciationMethod = override
426
427     def set_specified_annual_demand(self, specified_forecast):
428         """ Sets the annual demand for fuels per region over the
429         forecast period (Must be accurate)
430
431         Args:
432             forecast (float, array): The forecast array of size (len(
433             region), len(fuel), len(year))
434             """
435             self.SpecifiedAnnualDemand = specified_forecast
436
437     def set_specified_demand_profile(self, specified_annual_demand,
438         region,
439                     fuel, year, timeslice, profile,
440         override):
441         """ Sets the specified annual demand profiles using the
442         specified annual demand.
443
444         Args:
445             specified_annual_demand (float, array): Specified annual
446             demand profiles
447             region (list): List of regions
448             fuel (list): List of fuels
449             year (list): List of years
450             timeslice (list): List of timeslices
451             profile (Dict): Dictionary of fuel allocations to
452             timeslices
453             override (float, array): Manual override for the specified
454             annual demand profiles.
455             """
456             # Initialises the linear array
457             demand_profile = np.zeros(
458                 (len(region), len(fuel), len(timeslice), len(year)))
459             if override == None:
460                 # Calculates the demand profile
461                 for place in region:
462                     for fuel_type in fuel:
463                         for time in timeslice:
464                             for year_num in year:
465                                 region_index = region.index(place)
466                                 fuel_index = fuel.index(fuel_type)
467                                 timeslice_index = timeslice.index(time)
468                                 year_index = year.index(year_num)
469                                 demand_profile[region_index, fuel_index,
470                                     timeslice_index,
471                                     year_index] = profile[time]
472
473             self.SpecifiedDemandProfile = demand_profile
474         else:
475             self.SpecifiedDemandProfile = override
476
477

```

```

469     def set_accumulated_annual_demand(self, accumulated_forecast):
470         """ Sets the accumulated annual demand for fuels per region
471             over the forecast period.
472             This function relies on a similar forecasting methodology
473             as set_specific_demand.
474             Fuels set in this function cannot be defined in
475             set_specific_demand.
476
477             Args:
478                 accumulated_forecast (float, array): The forecast array of
479                 size (len(region),len(fuel),len(year))
480                 """
481             self.AccumulatedAnnualDemand = accumulated_forecast
482
483     def set_capacity_to_activity_unit(self, region, technology,
484                                         capacity_dictionaries, override):
485         """ Sets the capacity to activity parameter
486
487             Args:
488                 region (list): List of regions
489                 technology (list): List of technologies
490                 capacity_dictionaries (list): List of dictionaries to
491                 assign value
492                 override (float, array) = 2D Array to assign override
493                 values
494                 """
495             if override == None:
496                 cap_to_act = np.zeros((len(region), len(technology)))
497                 for i in range(0, len(capacity_dictionaries), 1):
498                     for j in range(0, len(technology), 1):
499                         cap_to_act[i, j] = capacity_dictionaries[i][
500                             technology[j]]
501                 self.CapacityToActivityUnit = cap_to_act
502             else:
503                 self.CapacityToActivityUnit = override
504
505     def set_capacity_factor(self, factor_matrix):
506         """ Sets capacity factors for conversion technologies.
507
508             Args:
509                 factor_matrix (float, array); Capacity Factors
510                 """
511             self.CapacityFactor = factor_matrix
512
513     def set_availability_factor(self, availability_matrix):
514         """ Sets the availability factors
515
516             Args:
517                 availability_matrix (float, array): Matrix describing
518                 availability factors for given technologies
519                 """
520             self.AvailabilityFactor = availability_matrix
521
522     def set_operational_life(self, operational_lives):
523         """ Sets operational life
524
525             Args:
526                 operational_lives (list):

```

```
519     """
520     self.OperationalLife = operational_lives
521
522     def set_residual_capacity(self, residential_capacities):
523         """ Set residual capacity
524
525         Args:
526             residential_capacities (float, array): residual capacities
527             parameter
528         """
529         self.ResidualCapacity = residential_capacities
530
531     def set_input_activity_ratio(self, input_activity_ratios):
532         """ Sets input activity ratios
533
534         Args:
535             input_activity_ratios (float, array): Sets the input
536             activity ratio
537         """
538         self.InputActivityRatio = input_activity_ratios
539
540     def set_output_activity_ratio(self, output_activity_ratios):
541         """ Sets output activity ratio
542
543         Args:
544             output_activity_ratios (float, array): output activity
545             ratio parameters
546         """
547
548     def set_capital_cost(self, capital_costs):
549         """ Sets capital costs
550
551         Args:
552             capital_costs (float, array): capital cost paramters
553         """
554         self.CapitalCost = capital_costs
555
556     def set_variable_cost(self, variable_costs):
557         """ Sets variable costs
558
559         Args:
560             variable_costs (float, array): variable costs parameters
561         """
562         self.VariableCost = variable_costs
563
564     def set_fixed_cost(self, fixed_costs):
565         """ Set fixed costs
566
567         Args:
568             fixed_costs (float, array): fixed cost parameters
569         """
570         self.FixedCost = fixed_costs
571
572     def set_technology_to_storage(self, technology_to_storage):
573         """ Sets the technology to storage parameter
574
575         Args:
```

```

573         technology_to_storage (float, array): technology to storage
574     parameter
575     """
576     self.TechnologyToStorage = technology_to_storage
577
578     def set_technology_from_storage(self, technology_from_storage):
579         """ Sets technology from storage binary paramter
580
581         Args:
582             technology_from_storage (float, array): technology from
583             storage parameter
584             """
585             self.TechnologyFromStorage = technology_from_storage
586
587     def set_min_storage_charge(self, minimum_storage_charges):
588         """ Sets the minimum storage charges
589
590         Args:
591             minimum_storage_charges (float, array): minimum storage
592             parameters
593             """
594             self.MinStorageCharge = minimum_storage_charges
595
596     def set_operational_life_storage(self, operational_life_storage):
597         """ Sets the operational life storage
598
599         Args:
600             operational_life_storage (float, array): operational life
601             storage parameters
602             """
603             self.OperationalLifeStorage = operational_life_storage
604
605     def set_capital_cost_storage(self, capital_cost_storage):
606         """ Sets the capital costs of using storage technologies
607
608         Args:
609             capital_cost_storage (float, array): capital cost of
610             storage technologies
611             """
612             self.CapitalCostStorage = capital_cost_storage
613
614     def set_storage_level_start(self, storage_level_start):
615         """ Sets the storage level starting point
616
617         Args:
618             storage_level_start (float, array): storage starting level
619             """
620             self.StorageLevelStart = storage_level_start
621
622     def set_storage_max_charge_rate(self,
623         storage_max_level_charge_rates):
624         """ Sets the storgae max charge rate
625
626         Args:
627             storage_max_level_charge_rates (float, array): Storage max
628             level charge rates
629             """
630             self.StorageMaxChargeRate = storage_max_level_charge_rates

```

```

624
625     def set_storage_max_discharge_rate(self ,
626
627         storage_max_level_discharge_rates):
628             """ Sets storage technologies maximum discharge rates
629
630             Args:
631                 storage_max_level_discharge_rates (float , array): Discharge
632                 rates for storage paramters
633             """
634
635             self.StorageMaxDischargeRate =
636             storage_max_level_discharge_rates
637
638     def set_residual_storage_capacity(self , residual_storage_capacities
639     ):
640         """ Sets residual storage capacities
641
642             Args:
643                 residual_storage_capacities (float , array): residual
644                 storage capacities
645             """
646
647             self.ResidualStorageCapacity = residual_storage_capacities
648
649     def set_capacity_of_one_technology_unit(self ,
650
651         capacity_of_one_technology_unit):
652             """ Set the capacity of one technology units for all
653                 technologies
654
655             Args:
656                 capacity_of_one_technology_unit (float , array): capacities
657                 for one technology units
658             """
659
660             self.CapacityOfOneTechnologyUnit =
661             capacity_of_one_technology_unit
662
663     def set_total_annual_max_capacity(self , total_annual_max_capacities
664     ):
665         """ Sets the total annual maximum capacities
666
667             Args:
668                 total_annual_max_capacities (float , array): Total Annual
669                 Max Capacities
670             """
671
672             self.TotalAnnualMaxCapacity = total_annual_max_capacities
673
674     def set_total_annual_min_capacity(self , total_annual_min_capacities
675     ):
676         """ Sets the totoal annual minimum capacities
677
678             Args:
679                 total_annual_min_capacities (float , array): Total Annual
680                 Min Capacities
681             """
682
683             self.TotalAnnualMinCapacity = total_annual_min_capacities
684
685     def set_total_technology_annual_activity_lower_limit(
686                 self , total_technology_activity_lower_limits):

```

```

669         """ Sets the Total Technology Activity Lower Limits
670
671     Args:
672         total_technology_activity_lower_limits (float, array):
673             Technology Activity Lower Limits
674         """
675
676     self.TotalTechnologyAnnualActivityLowerLimit =
677         total_technology_activity_lower_limits
678
679
680     def set_total_technology_annual_activity_upper_limit(
681         self, total_technology_annual_activity_upper_limits):
682         """ Sets the Total Technology Activity Upper Limits
683
684         Args:
685             total_technology_annual_activity_upper_limits (float, array)
686         ): Technology Activity Upper Limits
687         """
688
689         self.TotalTechnologyAnnualActivityUpperLimit =
690         total_technology_annual_activity_upper_limits
691
692
693     def set_total_technology_period_activity_upper_limit(
694         self, total_technology_period_activity_upper_limits):
695         """ Sets Total Technology Period Activity Upper Limits
696
697         Args:
698             total_technology_period_activity_upper_limits (float, array)
699         ): Total Technology Period Activity Upper Limit
700         """
701
702         self.TotalTechnologyModelPeriodActivityUpperLimit =
703         total_technology_period_activity_upper_limits
704
705
706     def set_total_technology_period_activity_lower_limit(
707         self, total_technology_period_activity_lower_limits):
708         """Sets Total Technology Period Activity Lower Limits
709
710         Args:
711             total_technology_period_activity_lower_limits ([type]):
712             Total Technology Period Activity Lower Limit
713         """
714
715         self.TotalTechnologyModelPeriodActivityLowerLimit =
716         total_technology_period_activity_lower_limits
717
718
719     def set_reserve_margin_tag_technology(self,
720
721         reserve_margin_tag_technologies):
722             """ Sets Reserve Margin Tag Technology
723
724             Args:
725                 reserve_margin_tag_technologies (float, array): Reserve
726                 Margin Tag Technologies
727             """
728
729             self.ReserveMarginTagTechnology =
730             reserve_margin_tag_technologies
731
732
733     def set_reserve_margin_tag_fuel(self, reserve_margin_fuel_tags):
734         """ Sets the reserve margin tag fuels
735
736             Args:
737

```

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

```

771     Args:
772         annual_exogenous_emission (float, array): Annual Exogenous
773         Emissions
774         """
775         self.AnnualExogenousEmission = annual_exogenous_emission
776
777     def set_annual_emission_limit(self, annual_emission_limits):
778         """ Sets Annual Emission Limits
779
780         Args:
781             annual_emission_limits (float, array): Annual Emission
782             Limits
783             """
784             self.AnnualEmissionLimit = annual_emission_limits
785
786     def set_model_period_exogenous_emission(self,
787
788         model_period_exogenous_emissions):
789             """ Sets Model Period Exogenous Emissions
790
791         Args:
792             model_period_exogenous_emissions (float, array): Model
793             Period Exogenous Emissions
794             """
795             self.ModelPeriodExogenousEmission =
796             model_period_exogenous_emissions
797
798     def set_model_period_emission_limit(self,
799         model_period_emission_limits):
800         """ Sets Model Period Emission Limits
801
802         Args:
803             model_period_emission_limits (float, array): Model Period
804             Emission Limits
805             """
806             self.ModelPeriodEmissionLimit = model_period_emission_limits

```

2.2.4 Forecasting

The module to forecast energy and finance-related values.

```

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

```

```

18     Args:
19         root (path): Path to provide access to all the files
20             IEA_World_Energy_Balances_1 (str): File name for Energy
21             Balance A to K
22             IEA_World_Energy_Balances_2 ([type]): File name for Energy
23             Balance L to Z
24             create_excel_spreadsheet (boolean): True/false on whether
25             to create a spreadsheet
26             output_file (str): Name of output energy balance
27             spreadsheet
28
29     Returns:
30         (dict): Dictionary of energy balances and unique lists (Use
31             these key words to access: Energy Balances, Fuel, Geography,
32             Technology)
33         """
34
35         IEAWEBAK = root / IEA_World_Energy_Balances_1
36         IEAWEBLZ = root / IEA_World_Energy_Balances_2
37
38         # Creates dataframes from IEA World Energy Statistics and
39         # Balances CSVs from Stats.OECD.org in the OECDLibrary
40         # Note the data is from #https://stats.oecd.org/ and #https://
41         # www-oecd-ilibrary-org.ezproxy.auckland.ac.nz/
42         column_headers = [
43             'ID', 'Unit', 'Geo_Code', 'Geo_Description', 'Prod_Code',
44             'Prod_Description', 'Flow_Code', 'Flow_Description', 'Year',
45             ,
46             'Value(TJ)'
47         ]
48         f1 = open(IEAWEBAK, 'r')
49         df_A = pd.read_csv(f1, header=None)
50         df_A.columns = column_headers
51         df_A.info(verbose=True)
52         f2 = open(IEAWEBLZ, 'r')
53         df_B = pd.read_csv(f2, header=None)
54         df_B.columns = column_headers
55         df_B.info(verbose=True)
56         frames = [df_A, df_B]
57         df = pd.concat(frames)
58         df.info(verbose=True)
59
60         # Closes the files
61         f1.close()
62         f2.close()
63
64         # Finds the unique items in each list of the energy balance
65         sheets
66         unique_fuel = df.Prod_Description.unique()
67         unique_geography = df.Geo_Description.unique()
68         unique_technology = df.Flow_Description.unique()
69         print(unique_geography)
70
71         # Asks for a user to select a geography using the inquirer
72         function
73         selected_geo = input(
74             "Please enter the geography you wish to extract energy
75             balances: "
76         )

```

```

64
65      # Creates a pivot table to display the data in the way similar
66      # to the Energy Balance Sheet (cols = Energy Product, rows = Energy
67      # Flows)
68      energy_balance_pivot_table = pd.pivot_table(
69          df,
70          index=['Geo_Description', 'Flow_Description'],
71          # Converted values to PJ
72          values=['Value(TJ)'],
73          columns=['Prod_Description'],
74          aggfunc=[np.sum],
75          fill_value=0)
76      # Filters to the geography the user has selected
77      Input_String = 'Geo_Description == ["' + selected_geo + '"]'
78      geography_energy_balance_pivot_table =
79      energy_balance_pivot_table.query(
80          Input_String)
81
82      if create_excel_spreadsheet == True:
83          # Write the filtered pivot table to an excel file
84          writer = pd.ExcelWriter(root / output_file)
85          geography_energy_balance_pivot_table.to_excel(writer,
86          selected_geo)
87          writer.save()
88
89      # Returns the unique lists and filtered pivot table as a
90      # dataframe
91      return {
92          "Energy Balances": geography_energy_balance_pivot_table,
93          "Fuel": unique_fuel,
94          "Geography": unique_geography,
95          "Technology": unique_technology
96      }
97
98
99      def calculate_constant_average_growth_rate(self, start_year,
100                                                 end_year,
101                                                 start_value, end_value):
102
103         """ Calculates the constant average growth rate (CAGR)
104
105         Args:
106             start_year (int): Starting year
107             end_year (int): Ending year
108             start_value (int): Initial value
109             end_value (int): Final value
110
111         Returns:
112             cagr: Constant average growth rate (1+ decimal)
113
114             """
115
116         if start_value == 0 or (end_year - start_year) == 0:
117             cagr = 1
118         else:
119             cagr = np.power((end_value / start_value),
120                           (1 / (end_year - start_year)))
121
122         return cagr
123
124
125         def calculate_cagr_forecasts(self, cagr_dictionary,
126                                     base_year_dictionary,
127                                     fuel, year):
128
129
130
131
132
133
134

```

```

115     """ Forecasts base year fuels by a constant average growth rate
116     for a forecast period
117
118     Args:
119         cagr_dictionary (Dict): Dictionary of constant average
120         growth rates per fuel
121         base_year_dictionary ([type]): Dictionary of base year fuel
122         consumption in energy types
123         fuel (list): List of Fuels
124         year (list): List of forecast years
125
126     Returns:
127         [float, array]: 2D Array of demand forecasts per fuel
128     """
129
130     # Initialises the size of the array
131     forecast = np.ones((len(fuel), len(year)))
132
133     # Set the first forecast as the base year
134     for i in range(0, len(fuel), 1):
135         forecast[i, 0] = base_year_dictionary[fuel[i]]
136
137     # Calculates the forecasting
138     for i in range(0, len(fuel), 1):
139         for j in range(1, len(year), 1):
140             forecast[i, j] = forecast[i, j - 1] * cagr_dictionary[
fuel[j]]
141
142     return forecast

```

2.2.5 Optimisation

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

```

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

```

```

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

```

```

75
76     def run_ibm_wml_do(self, apikey, url, deployment_space_name,
77                         cloud_object_storage_credential,
78                         service_instance_id,
79                         deployment_space_exists, data_assets_exist,
80                         data_asset_dictionary, model_name, model_type,
81                         model_runtime_uid, model_tar_file, num_nodes,
82                         deployment_exists, payload_input_data_id,
83                         payload_input_data_file, payload_output_data_id)
84     :
85         """ This function enables the user to solve python-based
86         optimisation models. The legacy offering
87         to solve optimisation models on IBM cloud was using
88         the docplex python api to run Cplex on DOcloud.
89         As of September 2020, the DOcloud
90         was discontinued with Decision Optimisation
91         functionalities imported to IBM's Watson Machine
92         Learning Service. The new process requires the
93         energy system model to be written in python. This
94         project saw the implementation of the osemosys
95         modelling methodology in GNU Mathprog written into
96         LP Files. IBM Decision Optimisation in cannot deploy
97         models in LP File formats to get jobs. Therefore,
98         this function is for future work in converting the
99         entire energy system modelling tool to python-based only.
100        This is well-documented the report in the Future Work
101        Section. Note: You must have access to IBM Watson Studio
102        and Cloud Products through the IBM Academic Initiative or
103        Similar.
104
105        Args:
106            apikey (str): API key from user's IBM Cloud Account
107            url ([type]): URL for the server the user is using for the
108            IBM services
109            deployment_space_name (str): Name of the deployment space
110            cloud_object_storage_credential (str): Credential for the
111            cloud object storage asset
112            service_instance_id (str): Service instance id for the
113            service being used (IBM WML)
114            deployment_space_exists (boolean): True/False if the
115            deployment space already exists
116            data_assets_exist (boolean): True/False if the data assets
117            (e.g. input data stored on cloud)
118            data_asset_dictionary (dict): A dictionary of data assets
119            to stored on IBM cloud
120            model_name (str): Name of the model
121            model_type (str): Name of the model
122            model_runtime_uid (str): Runtime ID for the model
123            model_tar_file (tar): Tar file containing the python model
124            num_nodes (int): Number of nodes the model is run off.
125            deployment_exists (boolean): True/False if the deployment
126            already exists
127            payload_input_data_id (str): Name of input data
128            payload_input_data_file (dataframe): Input data file in the
129            form of a dataframe
130            payload_output_data_id (str): Name of output data file
131
132        """

```

```

123     # Creates the Watson Machine learning Credentials
124     api_wml_credentials = {
125         # IBM Cloud User Account Access Code
126         "apikey": apikey,
127         # Url to code repository
128         "url": url
129     }
130     # Initials the client credentials
131     client = APIClient(api_wml_credentials)
132
133     # Create a deployment space on the IBM Cloud Service
134     space_metadata = {
135         # Configures deployment space name
136         client.spaces.ConfigurationMetaNames.NAME:
137             deployment_space_name,
138         # Configures deployment space description
139         client.spaces.ConfigurationMetaNames.DESCRIPTION:
140             deployment_space_name + ' Deployment for energy systems
models',
141         # Configures deployment space storage location
142         client.spaces.ConfigurationMetaNames.STORAGE: {
143             "type": "bmcos_object_storage",
144             "resource_crn": cloud_object_storage_credential
145         },
146         # Configures deployment
147         client.spaces.ConfigurationMetaNames.COMPUTE: {
148             "name": "existing_instance_id",
149             "crn": service_instance_id
150         }
151     }
152     # Bypasses the creation of the deployment space if is already
exists
153     if deployment_space_exists == True:
154         client.spaces.list()
155         # Asks user to input the Space ID of the Input Space
156         space_id = input('Please input the Space ID: ')
157     else:
158         # Stores the newly created space in the repositories spaces
list
159         space = client.spaces.store(meta_props=space_metadata)
160         space_id = client.spaces.get_id(space)
161
162     # Sets the client space
163     client.set.default_space(space_id)
164
165     # Creates input and output data assets if they don't exist
166     if data_assets_exist == False:
167         # Loop through dictionary of data assets to create
168         for key in data_asset_dictionary:
169             client.data_assets.create(key, data_asset_dictionary[
key])
170
171         # Creates software mane and specification for the deployment
172         client.software_specifications.list()
173         software_name = input("Please Input Software Name: ")
174         software_spec_uid = client.software_specifications.
get_uid_by_name(
175             software_name)

```

```

176
177     # Creates the model deployment
178     model_metadata = {
179         client.repository.ModelMetaNames.NAME: model_name,
180         client.repository.ModelMetaNames.DESCRIPTION: model_name +
181         'Model',
182         client.repository.ModelMetaNames.TYPE: model_type,
183         client.repository.ModelMetaNames.RUNTIME_UID:
184         model_runtime_uid,
185         client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:
186         software_spec_uid
187     }
188     # Creates the energy model details
189     model_details = client.repository.store_model(
190         model=model_tar_file, meta_props=model_metadata)
191     # Creates model uid
192     model_uid = client.repository.get_model_uid(model_details)
193
194     # Creates a deployment
195     meta_props = {
196         client.deployments.ConfigurationMetaNames.NAME:
197             "Deployment " + str(num_nodes),
198         client.deployments.ConfigurationMetaNames.DESCRIPTION:
199             "Deployment " + str(num_nodes),
200         # client.deployments.ConfigurationMetaNames.HARDWARE_SPEC:
201         client.deployments.ConfigurationMetaNames.BATCH: {},
202         client.deployments.ConfigurationMetaNames.COMPUTE: {
203             'name': 'S',
204             'nodes': num_nodes
205         }
206     }
207
208     # Tests if deployment already exists
209     if deployment_exists == True:
210         client.deployments.list()
211         deployment_uid = input('Please input the Deployment UID: ')
212     else:
213         deployment_details = client.deployments.create(
214             model_uid, meta_props=meta_props)
215         deployment_uid = client.deployments.get_uid(
216         deployment_details)
217
218     # Creates a payload for the solver to solve (Note: Amend based
219     # on the model you are solving)
220     payload = [
221         client.deployments.DecisionOptimizationMetaNames.INPUT_DATA
222         : [
223             {
224                 "id": payload_input_data_id,
225                 "values": [
226                     payload_input_data_file
227                 ],
228                 client.deployments.DecisionOptimizationMetaNames.
229                 OUTPUT_DATA: [
230                     {
231                         "id": payload_output_data_id
232                     }
233                 ]
234             }
235         ]
236     ]

```

```

228     # Creates a new job using the deployment and payload
229     job_details = client.deployments.create_job(deployment_uid,
230     payload)
231     job_uid = client.deployments.get_job_uid(job_details)
232
233     # Print the status of the job until competition
234     while job_details['entity']['decision_optimization']['status'][
235         'state'] not in ['completed', 'failed', 'canceled']:
236         print(job_details['entity']['decision_optimization'][
237             'status'][
238                 'state'] + '...')
239         job_details = client.deployments.get_job_details(job_uid)
240         time.sleep(5)
241         print(job_details['entity']['decision_optimization'][
242             'status'][
243                 'state']))
244
245     # Reset tarfile function (Source: IBM Watson Machine Learning)
246     def reset(self, tarinfo):
247         """ Resets the tarfile information when creating tar files
248             This is to input into the filter when using tar.add()
249
250             Args:
251                 tarinfo (Object): Tar Object containing an ID of 0 and the
252                 root as the name
253
254             Returns:
255                 tarinfo (Object): Tar Object containing an ID of 0 and the
256                 root as the name
257
258         """
259         tarinfo.uid = tarinfo.gid = 0
260         tarinfo.uname = tarinfo.gname = "root"
261         return tarinfo

```

3 Development Scripting

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

3.1 GOCPI Data Cases

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

```

1 # GOCPI_Data_Cases is a methodology to import scenario data
2 # across multiple files. These are the
3 # sets and parameters for the Energy System Optimisation Model.
4 # A python script was chosen over other storage methods (e.g. excel)
5 # as values can be stored in matrices and many values are configured
6 # differently
7
8 # Import useful python packages
9 # Git repository
10 # https://github.com/CMCD1996/GOCPI.git

```

```

10 # Make more changes from the pull request
11 import numpy as np
12 import pandas as pd
13 import matplotlib.pyplot as plt
14 import scipy as sc
15 import sklearn as skl
16 import csv as csv
17 import openpyxl
18 import pathlib
19 import os
20 from pathlib import Path
21 from openpyxl import load_workbook
22 import GOCPI as GF
23 import cplex as cp
24 import docplex as dp
25
26 # Creates sets for the demo model
27 YEAR = [
28     '1990', '1991', '1992', '1993', '1994', '1995', '1996', '1997', '1998',
29     '1999', '2000', '2001', '2002', '2003', '2004', '2005', '2006', '2007',
30     '2008', '2009', '2010'
31 ]
32 REGION = ['NEWZEALAND', 'AUSTRALIA']
33 EMISSION = ['CO2', 'NOX', 'CO', 'METHANE']
34 TECHNOLOGY = [
35     'E01', 'E21', 'E31', 'E51', 'E70', 'IMPDSDL1', 'IMP GSL1', 'IMPHC01',
36     'IMPOIL1', 'IMPURN1', 'RHE', 'RHO', 'RL1', 'SRE', 'TXD', 'TXE', 'TXG',
37     'RIV', 'RHu', 'RLu', 'TXu'
38 ]
39 FUEL = [
40     'CSV', 'DSL', 'ELC', 'GSL', 'HCO', 'HYD', 'LTH', 'OIL', 'URN', 'RH',
41     'RL',
42     'TX'
43 ]
44 TIMESLICE = [
45     'INTERMEDIATE_DAY', 'INTERMEDIATE_NIGHT', 'SUMMER_DAY', 'SUMMER_NIGHT',
46     'WINTER_DAY', 'WINTER_NIGHT'
47 ]
48 MODE_OF_OPERATION = ['1', '2']
49 STORAGE = ['DAM']
50 DAYTYPE = ['1', '2', '3']
51 SEASON = [
52     '1', '2', '3', '4'
53 ] # Must be denoted in numbers to match constraints in model (1: Summer, 2: Autumn, 3: Winter, 4): Spring)
54 DAILYTIMEBRACKET = ['1', '2', '3']
55
56 # Sets
57 sets = [
58     YEAR, REGION, EMISSION, TECHNOLOGY, FUEL, TIMESLICE,
59     MODE_OF_OPERATION,
60     STORAGE, DAYTYPE, SEASON, DAILYTIMEBRACKET
61 ]

```

```

61 # Create the energy system with sets and initialised parameters. The
   parameter have the necessary parameters
62 Demo = GF.Energy_Systems(YEAR, REGION, EMISSION, TECHNOLOGY, FUEL,
   TIMESLICE,
   MODE_OF_OPERATION, STORAGE, DAYTYPE, SEASON,
   DAILYTIMEBRACKET)
63
64 # This user must now initialise the parameters as they choose to
   configure the energy system for the optimisation model.
65 # This is incredibly important. The user must understand the
   configuration of the energy system to do this! Consult the
66 # User manual to build this optimisation.
67
68 # End of user defined inputs in this script
69
70 # Sets the textfile saved locations
71 data_txt = 'GOCPI_OseMOSYS_Data.txt'
72 model_source_file = 'GOCPI_OseMOSYS_Structure.xlsx'
73 root = '/Users/connor/Google Drive/Documents/University/Courses/2020/
   ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI_OseMOSYS'
74 data_roots = Path(root)
75 data_location_1 = os.path.join(data_roots, data_txt)
76
77 # Dictionary of default parameters for creating a model file
78 default_parameters = {
79     'YearSplit': 1,
80     'DiscountRate': 1,
81     'DaySplit': 1,
82     'Conversionls': 1,
83     'Conversionld': 1,
84     'Conversionlh': 1,
85     'DaysInDayType': 1,
86     'TradeRoute': 1,
87     'DepreciationMethod': 1,
88     'SpecifiedAnnualDemand': 1,
89     'SpecifiedDemandProfile': 1,
90     'AccumulatedAnnualDemand': 1,
91     'CapacityToActivityUnit': 1,
92     'CapacityFactor': 1,
93     'AvailabilityFactor': 1,
94     'OperationalLife': 1,
95     'ResidualCapacity': 1,
96     'InputActivityRatio': 1,
97     'OutputActivityRatio': 1,
98     'CapitalCost': 1,
99     'VariableCost': 1,
100    'FixedCost': 1,
101    'TechnologyToStorage': 1,
102    'TechnologyFromStorage': 1,
103    'StorageLevelStart': 1,
104    'StorageMaxChargeRate': 1,
105    'StorageMaxDischargeRate': 1,
106    'MinStorageCharge': 1,
107    'OperationalLifeStorage': 1,
108    'CapitalCostStorage': 1,
109    'ResidualStorageCapacity': 1,
110    'CapacityOfOneTechnologyUnit': 1,
111    'TotalAnnualMaxCapacity': 1,
112
113

```

```

114     'TotalAnnualMinCapacity': 1,
115     'TotalAnnualMaxCapacityInvestment': 1,
116     'TotalAnnualMinCapacityInvestment': 1,
117     'TotalTechnologyAnnualActivityLowerLimit': 1,
118     'TotalTechnologyAnnualActivityUpperLimit': 1,
119     'TotalTechnologyModelPeriodActivityUpperLimit': 1,
120     'TotalTechnologyModelPeriodActivityLowerLimit': 1,
121     'ReserveMarginTagTechnology': 1,
122     'ReserveMarginTagFuel': 1,
123     'ReserveMargin': 1,
124     'RETagTechnology': 1,
125     'RETagFuel': 1,
126     'REMinProductionTarget': 1,
127     'EmissionActivityRatio': 1,
128     'EmissionsPenalty': 1,
129     'AnnualExogenousEmission': 1,
130     'AnnualEmissionLimit': 1,
131     'ModelPeriodExogenousEmission': 1,
132     'ModelPeriodEmissionLimit': 1
133 }
134
135 # Create the Data File
136 Demo.create_data_file(data_location_1, default_parameters)
137
138 # Cereate the Model File
139 Demo.create_model_file(root, model_source_file)
140
141 # Convert created model and data files into a Linear Problem file (lp)
142 # Test the formatting

```

3.2 GOCPI Energy Balances

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

```

1 # GOCPI_EB prepares the energy balance across time for certain
2     # geographies
3 # This script was adapted into the GOCPI Module
4
5 # Import useful python packages
6 # Git repository
7 # https://github.com/CMCD1996/GOCPI.git
8 # Make more changes from the pull request
9 import numpy as np
10 import pandas as pd
11 import matplotlib.pyplot as plt
12 import scipy as sc
13 import sklearn as skl
14 import csv as csv
15 import openpyxl as pyxl
16 import pathlib
17 import os
18 import pydrive
19
20 # Very Important Step: Sets directory root for file operations.
source_root = pathlib.Path(

```

```

21     '/Users/connor/Google Drive/Documents/University/Courses/2020/
22     ENGSCI 700A&B/GOCPI/data/Energy Balances'
23 )
24 # Load in the EnergyBalance.csv file found from the University of
# Auckland SourceOECD Database.
25 # This csv contains the energy balances around the world
26
27 # Important Step: Sets the Energy Balances Folder ID in my personal
# google drive
28 folderID = '1PCUMeT8c9dJE1ES8JDg62w2rKMAS0xSW' # Energy Balance
29
30 # Loads in appropriate pydrive functions for access
31 from pydrive.auth import GoogleAuth
32 from pydrive.drive import GoogleDrive
33
34 # # Creates the authorisation to access the google drive
35 # gauth = GoogleAuth()
36 # gauth.LocalWebserverAuth() # Gains authorisation using the
# clients_secrets.json file in the src directory
37 # # Creates a google drive object to handle files
38 # drive = GoogleDrive(gauth)
39
40 # # Tests the access to the google drive and finds all
# IEAEnergyBalances.csv File IDs in the EnergyBalances Directory
41 # file_list = []
42 # title_list = []
43 # files = drive.ListFile({'q': "'1MD5ewAKAy2McqyCfjivwavj278giRvmR' in
# parents and trashed=false"}).GetList()
44 # for filex in files:
45 #     print(filex['id'])
46 #     print(filex['title'])
47 #     file_list.append(filex['id']) # IEAEnergyBalance.csvs File IDs
48 #     title_list.append(filex['title']) # IEAEnergyBalance.csvs Titles
49
50 # Gets the links to the two files wanted
51 # Links for IEA Energy Balance for 2018 (A-K) and IEA Energy Balance
# for 2017 (L-Z)
52 IEAWEBAK = source_root / 'IEAWorldEnergyBalances2017A-K.csv'
53 IEAWEBLZ = source_root / 'IEAWorldEnergyBalances2017L-Z.csv'
54
55 # Creates dataframes from IEA World Energy Statistics and Balances CSVs
# from Stats.OECD.org in the OECDLibrary
56 # Note the data is from #https://stats.oecd.org/ and #https://www.oecd
# -library-org.ezproxy.auckland.ac.nz/
57 column_headers = [
58     'ID', 'Unit', 'Geo_Code', 'Geo_Description', 'Prod_Code',
59     'Prod_Description', 'Flow_Code', 'Flow_Description', 'Year', 'Value
# (TJ)'
60 ]
61 f1 = open(IEAWEBAK, 'r')
62 df_A = pd.read_csv(f1, header=None)
63 df_A.columns = column_headers
64 df_A.info(verbose=True)
65 f2 = open(IEAWEBLZ, 'r')
66 df_B = pd.read_csv(f2, header=None)
67 df_B.columns = column_headers
68 df_B.info(verbose=True)

```

```

69 frames = [df_A, df_B]
70 df = pd.concat(frames)
71 df.info(verbose=True)
72
73 # Closes the files
74 f1.close()
75 f2.close()
76
77 # Find the unique items in each list of the energy balance sheets
78 uv_prod = df.Prod_Description.unique()
79 uv_geo = df.Geo_Description.unique()
80 uv_flow = df.Flow_Description.unique()
81
82 # Establishes the rows and columns for the EnergyBalance.xlsx spreadsheet
83 # Note: Most likely in the calculation, Other will be a sink so Total Energy Supply - Conversion Losses = Total Energy Consumed
84 # Rows (Energy uses)
85 Primary = ['Domestic Supply', 'Imports', 'Exports', 'Total Primary Supply']
86 Conversion = [
87     'Energy Sector Consumption', 'Electricity Plants', 'Heat Plants',
88     'Petroleum Refineries', 'Total Conversion'
89 ]
90 Consumption = [
91     'Residential', 'Commercial', 'Industry', 'Agriculture', 'Transport',
92     ,
93     'Other', 'Non Energy', 'Bunkers', 'Total Final Consumption'
94 ]
95
96 # Primary (To complete)
97 DomesticSupply = ['Production']
98 Imports = ['Imports']
99 Exports = ['Exports']
100 TotalPrimarySupply = ['Total primary energy supply']
101
102 # Conversion (To complete)
103 Energy_Sector_Consumption = [',']
104 Electricity_Plants = [',']
105 Heat_Plants = [',']
106 Petroleum_Refineries = [',']
107 Total_Conversion = [',']
108
109 # Consumption (To complete)
110 Residential = [',']
111 Commercial = [',']
112 Industry = [',']
113 Agriculture = [',']
114 Transport = [',']
115 Other = ['Stock changes', 'Transfers', 'Statistical differences']
116 Non_Energy = [',']
117 Bunkers = ['International marine bunkers', 'International aviation bunkers']
118 Total_Final_Consumption = [',']
119
120 # Energy Flows
121 Energy_Flows = [
122     'Production', 'Imports', 'Exports', 'International marine bunkers',
123     'International aviation bunkers'
124 ]

```

122 'International aviation bunkers', 'Stock changes',
123 'Total primary energy supply', 'Transfers', 'Statistical
124 differences',
125 'Transformation processes', 'Main activity producer electricity
126 plants',
127 'Autoproducer electricity plants', 'Main activity producer CHP
128 plants',
129 'Autoproducer CHP plants', 'Main activity producer heat plants',
130 'Autoproducer heat plants', 'Heat pumps', 'Electric boilers',
131 'Chemical heat for electricity production', 'Blast furnaces', 'Gas
132 works',
133 'Coke ovens', 'Patent fuel plants', 'BKB/peat briquette plants',
134 'Oil refineries', 'Petrochemical plants', 'Coal liquefaction plants
135 ',
136 'Gas-to-liquids (GTL) plants', 'For blended natural gas',
137 'Charcoal production plants', 'Non-specified (transformation)',
138 'Energy industry own use', 'Coal mines', 'Oil and gas extraction',
139 'Gasification plants for biogases',
140 'Liquefaction (LNG) / regasification plants',
141 '"Own use in electricity, CHP and heat plants"', 'Pumped storage
142 plants',
143 'Nuclear industry', 'Non-specified (energy)', 'Losses',
144 'Total final consumption', 'Industry', 'Mining and quarrying',
145 'Construction', 'Manufacturing', 'Iron and steel',
146 'Chemical and petrochemical', 'Non-ferrous metals',
147 'Non-metallic minerals', 'Transport equipment', 'Machinery',
148 'Food and tobacco', '"Paper, pulp and printing"', 'Wood and wood
149 products',
150 'Textile and leather', 'Industry not elsewhere specified', 'Transport',
151 'World aviation bunkers', 'Domestic aviation', 'Road', 'Rail',
152 'Pipeline transport', 'World marine bunkers', 'Domestic navigation',
153 ',
154 'Non-specified (transport)', 'Residential',
155 'Commercial and public services', 'Agriculture/forestry', 'Fishing',
156 ',
157 'Final consumption not elsewhere specified', 'Non-energy use',
158 'Non-energy use industry/transformation/energy',
159 'Memo: Non-energy use in industry', 'Memo: Non-energy use in
160 construction',
161 'Memo: Non-energy use in mining and quarrying',
162 'Memo: Non-energy use in iron and steel',
163 'Memo: Non-energy use in chemical/petrochemical',
164 'Memo: Non-energy use in non-ferrous metals',
165 'Memo: Non-energy use in non-metallic minerals',
166 'Memo: Non-energy use in transport equipment',
167 'Memo: Non-energy use in machinery',
168 'Memo: Non-energy use in food/beverages/tobacco',
169 'Memo: Non-energy use in paper/pulp and printing',
170 'Memo: Non-energy use in wood and wood products',
171 'Memo: Non-energy use in textiles and leather',
172 'Memo: Non-energy use in industry not elsewhere specified',
173 'Non-energy use in transport', 'Non-energy use in other',
174 'Electricity output (GWh)',
175 'Electricity output (GWh)-main activity producer electricity plants
176 ',
177 'Electricity output (GWh)-autoproducer electricity plants',
178 'Electricity output (GWh)-main activity producer CHP plants',

```

168     'Electricity output (GWh)-autoproducer CHP plants',
169     'Heat output', 'Heat output-main activity producer CHP plants',
170     'Heat output-autoproducer CHP plants',
171     'Heat output-main activity producer heat plants',
172     'Heat output-autoproducer heat plants'
173 ]
174
175 # Columns (Energy Types)
176 Energy = [
177     'Solid Fuels', 'Natural Gas', 'Crude Oil', 'Diesel Oil', 'Kerosene',
178     , 'LPG',
179     'Motor Spirit', 'Naphtha', 'Heavy Fuel Oil', 'Other Petroleum
Products',
180     'Nuclear Energy', 'Biomass', 'Hydro power', 'Wind energy', 'Solar
Energy',
181     'Industrial Wastes', 'Derived Heat', 'Electricity', 'Total'
182 ]
183 Solid_Fuels = [',']
184 Natural_Gas = [',']
185 Crude_Oil = [',']
186 Diesel_Oil = [',']
187 Kerosene = [',']
188 LPG = [',']
189 Motor_Spirit = [',']
190 Naphtha = [',']
191 Heavy_Fuel_Oil = [',']
192 Other_Petroleum_Products = [',']
193 Nuclear_Energy = [',']
194 Biomass = [',']
195 Hydro_power = [',']
196 Wind_Energy = [',']
197 Solar_Energy = [',']
198 Industrial_Wastes = [',']
199 Derived_Heat = [',']
200 Electricity = [',']
201 Total = [',']

202
203 Energy_Types = [
204     'Hard coal (if no detail)', 'Brown coal (if no detail)', ,
205     'Anthracite',
206     'Coking coal', 'Other bituminous coal', 'Sub-bituminous coal', ,
207     'Lignite',
208     'Patent fuel', 'Coke oven coke', 'Gas coke', 'Coal tar'
209     'BKB', 'Gas works gas', 'Coke oven gas', 'Blast furnace gas',
210     'Other recovered gases', 'Peat', 'Peat products',
211     'Oil shale and oil sands', 'Natural gas',
212     'Crude/NGL/feedstocks (if no detail)', 'Crude oil', 'Natural gas
liquids',
213     'Refinery feedstocks', 'Additives/blending components',
214     'Other hydrocarbons', 'Refinery gas', 'Ethane',
215     'Liquefied petroleum gases (LPG)', 'Motor gasoline excl. biofuels',
216     'Aviation gasoline', 'Gasoline type jet fuel',
217     'Kerosene type jet fuel excl. biofuels', 'Other kerosene',
218     'Gas/diesel oil excl. biofuels', 'Fuel oil', 'Naphtha',
219     'White spirit & SBP', 'Lubricants', 'Bitumen', 'Paraffin waxes',
     'Petroleum coke', 'Other oil products', 'Industrial waste',
     'Municipal waste (renewable)', 'Municipal waste (non-renewable)',
```



```

270 # 'Textile and leather', 'Industry not elsewhere specified', '
271 # Transport',
272 # 'World aviation bunkers', 'Domestic aviation', 'Road', 'Rail',
273 # 'Pipeline transport', 'World marine bunkers', 'Domestic navigation',
274 # 'Non-specified (transport)', 'Residential',
275 # 'Commercial and public services', 'Agriculture/forestry', 'Fishing',
276 # 'Final consumption not elsewhere specified', 'Non-energy use',
277 # 'Non-energy use industry/transformation/energy',
278 # 'Memo: Non-energy use in industry', 'Memo: Non-energy use in
279 # construction',
280 # 'Memo: Non-energy use in mining and quarrying',
281 # 'Memo: Non-energy use in iron and steel',
282 # 'Memo: Non-energy use in chemical/petrochemical',
283 # 'Memo: Non-energy use in non-ferrous metals',
284 # 'Memo: Non-energy use in non-metallic minerals',
285 # 'Memo: Non-energy use in transport equipment',
286 # 'Memo: Non-energy use in machinery',
287 # 'Memo: Non-energy use in food/beverages/tobacco',
288 # 'Memo: Non-energy use in paper/pulp and printing',
289 # 'Memo: Non-energy use in wood and wood products',
290 # 'Memo: Non-energy use in textiles and leather',
291 # 'Memo: Non-energy use in industry not elsewhere specified',
292 # 'Non-energy use in transport', 'Non-energy use in other',
293 # 'Electricity output (GWh)',
294 # 'Electricity output (GWh)-main activity producer electricity plants
295 # ',
296 # 'Electricity output (GWh)-autoproducer electricity plants',
297 # 'Electricity output (GWh)-main activity producer CHP plants',
298 # 'Electricity output (GWh)-autoproducer CHP plants' 'Heat output',
299 # 'Heat output-main activity producer CHP plants',
300 # 'Heat output-autoproducer CHP plants',
301 # 'Heat output-main activity producer heat plants',
302 # 'Heat output-autoproducer heat plants']

303 # Energy_Types = ['Hard coal (if no detail)', 'Brown coal (if no detail
304 # )', 'Anthracite',
305 # 'Coking coal', 'Other bituminous coal', 'Sub-bituminous coal', '
306 # Lignite',
307 # 'Patent fuel', 'Coke oven coke', 'Gas coke', 'Coal tar' 'BKB',
308 # 'Gas works gas', 'Coke oven gas', 'Blast furnace gas',
309 # 'Other recovered gases', 'Peat', 'Peat products', 'Oil shale and oil
310 # sands',
311 # 'Natural gas', 'Crude/NGL/feedstocks (if no detail)', 'Crude oil',
312 # 'Natural gas liquids', 'Refinery feedstocks',
313 # 'Additives/blending components', 'Other hydrocarbons', 'Refinery gas
314 # ',
315 # 'Ethane', 'Liquefied petroleum gases (LPG)',
316 # 'Motor gasoline excl. biofuels', 'Aviation gasoline',
317 # 'Gasoline type jet fuel', 'Kerosene type jet fuel excl. biofuels',
318 # 'Other kerosene', 'Gas/diesel oil excl. biofuels', 'Fuel oil', '
319 # Naphtha',
320 # 'White spirit & SBP', 'Lubricants', 'Bitumen', 'Paraffin waxes',
321 # 'Petroleum coke', 'Other oil products', 'Industrial waste',
322 # 'Municipal waste (renewable)', 'Municipal waste (non-renewable)',
323 # 'Primary solid biofuels', 'Biogases' 'Biogasoline' 'Biodiesels',
324 # 'Bio jet kerosene', 'Other liquid biofuels',
325 # 'Non-specified primary biofuels and waste', 'Charcoal',
326 # 'Elec/heat output from non-specified manufactured gases',

```

```

320 #   'Heat output from non-specified combustible fuels', 'Nuclear', '
321 #   'Hydro',
322 #   'Geothermal', 'Solar photovoltaics', 'Solar thermal',
323 #   '"Tide, wave and ocean"', 'Wind', 'Other sources', 'Electricity', '
323 #   'Heat',
323 #   'Total', 'Memo: Renewables']

```

3.3 GOCPI Geographies

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

```

1 # GOCPI_Geographies Structures the geographies into Countries, Cities
2     and Continents
3
4 # Import useful python packages
5 # Git repository
6 # https://github.com/CMCD1996/GOCPI.git
7 # Make more changes from the pull request
8
9 import numpy as np
10 import pandas as pd
11 import matplotlib.pyplot as plt
12 import scipy as sc
13 import sklearn as skl
14 import csv as csv
15 import pathlib
16 import os
17
18 # Very Important Step: Sets directory root for file operations.
19 source_root = pathlib.Path('/Users/connor/Google Drive/Documents/
20                             University/Courses/2020/ENGSCI 700A&B/GOCPI/data/Geographies')
21
22 # Finds the relevant files needed to create csvs with the relationships
23     between cities, countries and continents
24 # Finds a file within a function
25 def Find_File(target_root,target_file):
26     for root, dirs, files in os.walk(target_root):
27         for name in files:
28             if name == target_file:
29                 f = os.path.abspath(os.path.join(root, name))
30
31     return f
32
33 # Find the necessary files for the geography conversions
34 f1 = Find_File(source_root,"Country and Continent.txt")
35 f2 = Find_File(source_root,"countries.csv")
36 f3 = Find_File(source_root,"Cities.csv")
37 f4 = Find_File(source_root,"geography_set.csv")
38
39 # Creates python list for geographies, starting with countries
40 # Creates an empty list
41 countries = []
42
43 # Creates a geography set
44 geography_set = [[ 'AFRICA' ],
45                   [ 'ASIA' ],
46                   [ 'EUROPE' ],
47                   [ 'NORTH AMERICA' ],
48                   [ 'OCEANIA' ],
49

```

```

44             [ 'SOUTH AMERICA' ] ]
45 continents = [ 'AFRICA', 'ASIA', 'EUROPE', 'NORTH AMERICA', 'OCEANIA', 'SOUTH
46   AMERICA' ]
47
47 # Sets up a for loop to append countries to the continents in the
48   geography sets
48 file = open(f1,'r')
49 for line in file:
50     string = line.split('\n')
51     string = string[0].split(',')
52     countries.append(string[1].upper())
53     for i in range(0,6,1):
54         if string[0].upper() == geography_set[i][0]:
55             geography_set[i].append(string[1].upper())
56
57 # This code block is to inform count
58 with open(f2, 'w') as file:
59     writer = csv.writer(file, delimiter = ',')
60     writer.writerow(countries)
61 file.close()
62
63 # Creates array of world cities
64 data = pd.read_csv(f3)
65 cities_df = pd.concat([data['city'],data['country'],data['population'],
66   []],axis = 1)
66 cities_df['continent'] = ""
67 cities_df.dropna(inplace = True)
68
69 # Capitalises country and city names
70 cities_df['country'] = cities_df['country'].str.upper()
71 cities_df['city'] = cities_df['city'].str.upper()
72
73 # Places the continent required in the row
74 for index, row in cities_df.iterrows():
75     for i in range(0,6,1):
76         for j in range(0,len(geography_set[i]),1):
77             if geography_set[i][j] == row['country']:
78                 cities_df.at[index,'continent'] = geography_set[i][0]
79
80 # Saves dataframe as new CSV
81 cities_df.to_csv(f4,index=False)

```

3.4 GOCPI Inputs

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

```

1 # GOCPI_Inputs is a file processing script. This script prepare the
2   spreadsheets for VEDA processing to
3   be feed into the GAMS Optimisation
4   This script was adpated into the GOCPI module
5
5 # Import useful python packages
6 # Git repository
7 # https://github.com/CMCD1996/GOCPI.git
8 # Make more changes from the pull request
9 import numpy as np

```

```

10 import pandas as pd
11 import matplotlib.pyplot as plt
12 import scipy as sc
13 import sklearn as skl
14 import csv as csv
15 import openpyxl
16 import pathlib
17 import os
18 from pathlib import Path
19 from openpyxl import load_workbook
20
21 # Very Important Step: Set directory root for file operations.
22 source_root = Path(
23     '/Users/connor/Google Drive/Documents/University/Courses/2020/
24     ENGSCI 700A&B/GOCPI/data/Inputs'
25 )
26 print(source_root)
27
28 # Finds a file within a function
29 def Find_File(target_root, target_file):
30     for root, dirs, files in os.walk(target_root):
31         for name in files:
32             if name == target_file:
33                 f = os.path.abspath(os.path.join(root, name))
34     return f
35
36
37 # Defines custom functions necessary for excel script processing
38 # Set_Values updates single cell inputs for the VEDA spreadsheet
39 def Set_Values(source_root, source_file, source_sheet, source_range,
40                 updated_value, destination_file):
41     from openpyxl import load_workbook
42     from pathlib import Path
43     # Finds the source file from the assign root directory
44     f = Find_File(source_root, source_file)
45     # Performs the workbook manipulation and updates values
46     workbook = load_workbook(filename=f)
47     sheet = workbook[source_sheet]
48     defined_range = workbook.defined_names[source_range]
49     split_string = defined_range.attr_text.split('$')
50     address = split_string[1] + split_string[2]
51     sheet[str(address)].value = updated_value
52     # Finds the destination file
53     f = Find_File(source_root, destination_file)
54     # Saves the updated file
55     workbook.save(filename=f)
56
57
58 # Initialises all variables in the System Settings. These are created
59 # in arrays and interated through via for loops.
60
61 # Book Region_Maps (Number of Regions Base Sheet Mechanics relate to,
62 # This will be expanded upon depending on the sets of geographies to be
63 # included.
64 # We will begin with two regions (Based off TIMES Demo Model 12)s
65 REG1 = 'REG1' # Ideally two selected Regions (New Zealand)
66 REG2 = 'REG2' # (Australia)

```

```

65
66 # Timeslices
67 SZN1 = "S" # Summer
68 SZN2 = "W" # Winter
69 DN1 = "D" # Day
70 DN2 = "N" # Night
71
72 # Time Periods
73 StartYear = 2030
74
75 # ActivePDef
76 # This variable defines how split up the forecast period into smaller
    time intervals
77 # Pdef-1 is a two period definition (1 Year then 2 years for a total of
        3 years)
78 # Pdef-5 is a 5 period definition of 1,2,5,5,5 year periods
        respectively.
79 # Pdef-11 is an 11 period definition of 1,2,5,5,5,5,5,5,5,5,5 year
        periods respectively.
80 # Pdef-1,5 and 11 are the only available options at the moment.
81 APDEF = "Pdef-11"
82
83 # Import Settings have been left unchanged in the SysSettings Sheet. See
    the import
84 # settings for a proper definition
85
86 # Interpolation and Extrapolation Defaults are unchanged as well. See
    details in the
87 # System settings spreadsheet if you want to make changes.
88
89 # Constants for the modelling process in the modelling sheet
90 # (TFM_INS)
91 GDY = StartYear # Discount Year
92 Discount = 0.05 # Discount Rate (This discount rate will change
    depending on the region in question
93 # Figure out how to vary dicount rates depending on financial inputs)
94
95 # Fraction of year for season and day/night level (Should change
    depending on the geography)
96 # Determine how to make these changes after you get a baseline model
    running
97 REG_Num_Sum_Days = 175
98 REG_Num_Days = 365
99 REG_Num_Win_Days = (REG_Num_Days - REG_Num_Sum_Days)
100 Frac_REG_Num_Sum_Days = REG_Num_Sum_Days / REG_Num_Days
101 Frac_REG_Num_Win_Days = REG_Num_Win_Days / REG_Num_Days
102
103 Sum_Hours_Per_Day = 12.5
104 Win_Hours_Per_Day = 11.5
105 Hours_Per_Day = 24
106
107 Frac_Sum_Hours_Per_Day = Sum_Hours_Per_Day / (Hours_Per_Day)
108 Frac_Win_Hours_Per_Day = Sum_Hours_Per_Day / (Hours_Per_Day)
109 Frac_Sum_Hours_Per_Night = (1 - Frac_Sum_Hours_Per_Day)
110 Frac_Win_Hours_Per_Night = (1 - Frac_Win_Hours_Per_Day)
111
112 SD_YRFR = Frac_REG_Num_Sum_Days * Frac_Sum_Hours_Per_Day
113 SN_YRFR = Frac_REG_Num_Sum_Days * Frac_Sum_Hours_Per_Night

```

```

114 WD_YRFR = Frac_REG_Num_Win_Days * Frac_Win_Hours_Per_Day
115 WN_YRFR = Frac_REG_Num_Win_Days * Frac_Win_Hours_Per_Night
116
117 # Currency for investment decisions underpinning the model
118 CUR = "MEuro05"
119
120 # Default Units (Review and come back to this commodity part of the
#      model)
121 # Explicitly Commodity Groups are not required in the modelling process
#      at this stage.
122
123 # Creates a function to update the spreadsheet relative to those feed
#      in to the function
124 # Inserts the various cells in python as required
125 # Imports the various functions needed for the file
126
127 source_file = "SysSettings.xlsx"
128 source_sheet = "TimePeriods"
129 source_range = "StartYear"
130 updated_value = StartYear
131 destination_file = "SysSettings.xls"
132
133 # Update the StartYear
134 Set_Values(source_root, source_file, source_sheet, source_range,
#              updated_value,
#              destination_file)
135

```

3.5 GOCPI Model Import

This script helped import OseMOSYS models.

```

1 # GOCPI_Model_Import is a file processing script. This script prepares
#      the text files from an Excel spreadsheet
2 # for the user defined energy systems model.
3 #
# ##########
4 # This script was adapted into the GOCPI module.
5 #
# ##########
6
7 # Import useful python packages
8 # Git repository
9 # https://github.com/CMCD1996/GOCPI.git
10 # Make more changes from the pull request
11 import numpy as np
12 import pandas as pd
13 import matplotlib.pyplot as plt
14 import scipy as sc
15 import sklearn as skl
16 import csv as csv
17 import openpyxl
18 import pathlib
19 import os
20 from pathlib import Path
21 from openpyxl import load_workbook

```

```

22 # Import custom functions for navigation
23 import GOCPI as GF
24 # Import data case for the model
25
26
27 # Beginning of scripting
28 # Very Important Step: Set directory root for file operations.
29 root = '/Users/connor/Google Drive/Documents/University/Courses/2020/
    ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI_OseMOSYS'
30 model_roots = Path(root)
31
32 # sets strings as excel file names for the model and parameter data.
33 model_file = 'GOCPI_OseMOSYS_Structure.xlsx'
34 data_file = 'GOCPI_OseMOSYS_Structure.xlsx'
35
36 # Finds the files necessary to create pandas dataframes.
37 # model = Find_File(model_roots, model_file)
38 Location = GF.Navigation(model_roots, model_file)
39 model = Location.Find_File()
40 print(model)
41
42 # data = Find_File(data_file, model_file)
43 df = pd.read_excel(model, sheet_name='Model')
44 # Creates a new dataframe based on the variables on the Include column
        values
45 df_Include = df[df.Include == 'Yes']
46 df_model = df_Include[['Name']].copy()
47
48 # Creates a file location and write the model to a text file
49 model_txt = 'GOCPI_OseMOSYS_Model.txt'
50 model_location = os.path.join(model_roots, model_txt)
51
52 # Saves the user defined model to a text file
53 np.savetxt(model_location, df_model.values, fmt='%s')
54
55 # Creates array of parameters from select sets and functions
56 df_Include = df[df.Include == 'Yes']
57 df_target_sets = df_Include[df.Type == "Sets"]
58 df_sets = df_target_sets[['Name']].copy()
59 df_target_parameters = df_Include[df.Type == "Parameters"]
60 df_parameters = df_target_parameters[['Name']].copy()
61
62 # Import the scenario with all sets and

```

3.6 GOCPI Optimisation

This script helped incorporate IBM optimisation technologies into the package.

```

1 #
# ##########
2 # GOCPI_Optimsation runs the optimisation through docplex
3 #
# ##########
4
5 # Imports the necessary python modules

```

```

6 import numpy as np
7 import pandas as pd
8 import matplotlib.pyplot as plt
9 import scipy as sc
10 import sklearn as skl
11 import csv as csv
12 import openpyxl
13 import pathlib
14 import os
15 from pathlib import Path
16 from openpyxl import load_workbook
17 import GOCPI as GF
18 import cplex as cp
19 import subprocess as sb
20 import docplex.mp as dmp
21 import tarfile as tf
22 from ibm_watson_machine_learning import APIClient
23
24 #
# ##########
25 # Processing
26 #
# #####
27 # Initialise Optimisation Class
28 energy_system_optimisation = GF.Optimisation()
29 # Use Cplex on the IBM Cloud to create the optimisation techniques.
30 # Create APIClient to use your cloud platform
31 # API Key: (Bxhv-kuLYXfle61GiFIBR_uM7n_LA00u4X-RrMcgtE0) - IBM Cloud
# Access
32 apikey = "Bxhv-kuLYXfle61GiFIBR_uM7n_LA00u4X-RrMcgtE0"
33 url = "https://us-south.ml.cloud.ibm.com"
34 directory = '/Users/connor/Google Drive/Documents/University/Courses
    /2020/ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI_OseMOSYS/'
35 data = 'GOCPI_Data.txt'
36 model = 'GOCPI_Model.txt'
37 output = 'GOCPI.lp'
38 payload_input = directory + output
39 payload_output = directory + "GOCPI.csv"
40 results = directory + "GOCPI_Output.txt"
41 tar_file = directory + "GOCPI.tar.gz"
42 csv = "GOCPI.csv"
43 csv_file = directory + csv
44 lp_file = directory + output
45 space_exists = True
46 deployment_exists = True
47 create_data_assets = False
48 string = 'glpsol -m ' + data + ' -d ' + model + '--wlp ' + output
49
50 api_wml_credentials = {
51     "apikey": apikey, # User Account API
52     "#instance_id": "#2dc64ea2-6be8-43d0-b217-ec2a5743e8c9", # Watson Machine Learning
53     "url": url
54 }
55
56 # Initialises client credentials
57

```

```

58 client = APIClient(api_wml_credentials)
59
60 # Create a deployment space and set it
61 space_name = 'gocpi_deployment_space'
62 cos_resource_crn = 'crn:v1:bluemix:public:cloud-object-storage:global:a
   /09d7320da1734f7e84aaedf597c37111:83e6751a-cefc-49ce-93de-4
   fbaee7e52af::'
63 instance_crn = 'crn:v1:bluemix:public:pm-20:us-south:a/09
   d7320da1734f7e84aaedf597c37111:2dc64ea2-6be8-43d0-b217-ec2a5743e8c9
   ::'
64
65 metadata = {
66     client.spaces.ConfigurationMetaNames.NAME: space_name,
67     client.spaces.ConfigurationMetaNames.DESCRIPTION:
68         space_name + ' for Deployment',
69     client.spaces.ConfigurationMetaNames.STORAGE: {
70         "type": "bmcos_object_storage",
71         "resource_crn": cos_resource_crn
72     },
73     client.spaces.ConfigurationMetaNames.COMPUTE: {
74         "name": "existing_instance_id",
75         "crn": instance_crn
76     }
77 }
78 # Set the default spaces based on the outcomes
79 if space_exists == True:
80     client.spaces.list()
81     space_id = input('Please input the Space ID: ')
82 else:
83     space = client.spaces.store(meta_props=metadata)
84     space_id = client.spaces.get_id(space)
85
86 # Set the client space
87 client.set.default_space(space_id)
88
89 # Create input and output data assets
90 if create_data_assets == True:
91     client.data_assets.create('GOCPI_Energy_System_Lp_File', lp_file)
92     client.data_assets.create('GOCPI_Energy_System_CSV_File', csv_file)
93
94
95 # Deploy model files
96 # Get location of model deployment
97 # Create tar file for model deployment
98 # Reset tarfile function (Source: IBM Watson Machine Learning)
99 def reset(tarinfo):
100     tarinfo.uid = tarinfo.gid = 0
101     tarinfo.uname = tarinfo.gname = "root"
102     return tarinfo
103
104
105 # Create the tar file
106 tar = tf.open(tar_file, "w:gz")
107 tar.add(lp_file, arcname="GOCPI.lp", filter=reset)
108 tar.close()
109
110 # List deployments using python API
111 print(client.deployments.list())

```

```

112
113 # Get the list of software available
114 client.software_specifications.list()
115 software_name = input("Please Input Software Name: ")
116 software_spec_uid = client.software_specifications.get_uid_by_name(
117     software_name)
118
119 # Create the model deployment using the created arc file
120 energy_system_model_metadata = {
121     client.repository.ModelMetaNames.NAME: "Energy System",
122     client.repository.ModelMetaNames.DESCRIPTION: "Model for Energy
System",
123     client.repository.ModelMetaNames.TYPE: "do-cplex_12.10",
124     client.repository.ModelMetaNames.RUNTIME_UID: "do_12.10",
125     client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:
software_spec_uid
126 }
127
128 energy_system_model_details = client.repository.store_model(
129     model=tar_file, meta_props=energy_system_model_metadata)
130
131 energy_system_model_uid = client.repository.get_model_uid(
132     energy_system_model_details)
133
134 # Create deployment
135 n_nodes = 1
136
137 meta_props = {
138     client.deployments.ConfigurationMetaNames.NAME:
139     "Energy System Deployment " + str(n_nodes),
140     client.deployments.ConfigurationMetaNames.DESCRIPTION:
141     "Energy System",
142     # client.deployments.ConfigurationMetaNames.HARDWARE_SPEC:
143     client.deployments.ConfigurationMetaNames.BATCH: {},
144     client.deployments.ConfigurationMetaNames.COMPUTE: {
145         'name': 'S',
146         'nodes': n_nodes
147     }
148 }
149
150 # Test if deployment already exists
151 if deployment_exists == True:
152     client.deployments.list()
153     deployment_uid = input('Please input the Deployment UID: ')
154 else:
155     deployment_details = client.deployments.create(
156         energy_system_model_uid,
157                                         meta_props=
meta_props)
158     deployment_uid = client.deployments.get_uid(deployment_details)
159
160 # Designs Payload for deployment
161 # solve_payload = {
162 #     client.deployments.DecisionOptimizationMetaNames.SOLVE_PARAMETERS
163 #     : {
164 #         'oaas.logAttachmentName': 'log.txt',
165 #         'oaas.logTailEnabled': 'true',
166 #         'oaas.resultsFormat': 'JSON'
167

```

```

165 #     },
166 #     client.deployments.DecisionOptimizationMetaNames.
167 #     INPUT_DATA_REFERENCES: [
168 #       {
169 #         'id':
170 #         'GOCPI.lp',
171 #         'type':
172 #         's3',
173 #         'connection': {
174 #           'endpoint_url':
175 #             COS_ENDPOINT,
176 #           'access_key_id':
177 #             cos_resource_crn['cos_hmac_keys']["access_key_id"],
178 #           'secret_access_key':
179 #             cos_resource_crn['cos_hmac_keys']["secret_access_key"]
180 #         },
181 #         'location': {
182 #           'bucket': COS_BUCKET,
183 #           'path': lp_file
184 #         }
185 #       },
186 #       client.deployments.DecisionOptimizationMetaNames.
187 #     OUTPUT_DATA_REFERENCES: [
188 #       {
189 #         'id':
190 #         'solution.json',
191 #         'type':
192 #         's3',
193 #         'connection': {
194 #           'endpoint_url':
195 #             url,
196 #           'access_key_id':
197 #             cos_resource_crn['cos_hmac_keys']["access_key_id"],
198 #           'secret_access_key':
199 #             cos_resource_crn['cos_hmac_keys']["secret_access_key"]
200 #         },
201 #         'location': {
202 #           'bucket': COS_BUCKET,
203 #           'path': 'solution.json'
204 #         }
205 #       },
206 #       {
207 #         'id':
208 #         'log.txt',
209 #         'type':
210 #         's3',
211 #         'connection': {
212 #           'endpoint_url':
213 #             url,
214 #           'access_key_id':
215 #             cos_credentials['cos_hmac_keys']["access_key_id"],
216 #           'secret_access_key':
217 #             cos_credentials['cos_hmac_keys']["secret_access_key"]
218 #         },
219 #         'location': {
220 #           'bucket': COS_BUCKET,
221 #           'path': 'log.txt'
222 #         }
223 #       }
224 #     }
225 #   }
226 # }
```

```

221     client.deployments.DecisionOptimizationMetaNames.SOLVE_PARAMETERS:
222     {
223         "oas.logTailEnabled": "true"
224     }
225     # client.deployments.DecisionOptimizationMetaNames.INPUT_DATA: [{{
226     #     "id": lp_file
227     # }], {
228     #     "id": csv_file
229     # }]
230 }
231 # job_details = client.deployments.create_job(deployment_uid,
232 #                                                 solve_payload)
233 # job_uid = client.deployments.get_job_uid(job_details)
234
235 # Create jobs for the deployment
236 # job_details = client.deployments.create_job(deployment_uid,
237 #                                                 energy_system_payload)
238 # job_uid = client.deployments.get_job_uid(job_details)
239
240 # Run job using deployment
241
242 # Deletes deployment
243
244 # # Find deployment pace ID
245 # def guid_from_space_name(client, space_name):
246 #     instance_details = client.service_instance.get_details()
247 #     space = client.spaces.get_details()
248 #     return (next(item for item in space['resources']
249 #                 if item['entity']['name'] == space_name) ['metadata'
250 # ] ['guid'])
251 #
252
253 # Set the default client space
254 # instance_details = client.service_instance.get_instance_id()
255 # client.set.default_space()
256 # client.set.default_project()
257 # print(instance_details)
258 # client.set.default_space()
259 # client.set.default_project()
260 # # Create a data asset to the IBM Cloud
261
262 # files = {
263 #     'Energy Balances 1':
264 #         '/Users/connor/Google Drive/Documents/University/Courses/2020/
265 #          ENGSCI 700A&B/GOCPI/data/Energy Balances/IEAWorldEnergyBalances2017A
266 #          -K.csv',
267 #     'Energy Balances 2':
268 #         '/Users/connor/Google Drive/Documents/University/Courses/2020/
269 #          ENGSCI 700A&B/GOCPI/data/Energy Balances/IEAWorldEnergyBalances2017L
270 #          -Z.csv',
271 # }
272
273 # data_assets_to_create = ['Energy Balances 1', 'Energy Balances 2']
274 # created_assets = {}
275 # for assets in data_assets_to_create:

```

```

272 #     asset_details = client.data_assets.create(name="Energy_System_Test",
273 #                                                   file_path=files[assets])
274 #     created_assets[assets] = asset_details
275
276 # Get information of assets
277
278 Optimise = GF.Optimisation()
279 directory = '/Users/connor/Google Drive/Documents/University/Courses
280             /2020/ENGSCI 700A&B/GOCPI/data/Inputs/GOCPI_OseMOSYS/'
281 data = 'GOCPI_Data.txt'
282 model = 'GOCPI_Model.txt'
283 output = 'GOCPI.lp'
284 results = directory + "GOCPI_Output.txt"
285 string = 'glpsol -m ' + data + ' -d ' + model + '--wlp ' + output
286 # os.chdir(directory)
287 # os.system('conda init bash')
288 # os.system('conda activate osemosys')
289
290 # Solve locally using Cplex
291 energy_system_cplex = cp.Cplex()
292 # Read in the model file
293 output = energy_system_cplex.set_results_stream(None)
294 output = energy_system_cplex.set_log_stream(None)
295 # Write the loaded model to the energy system
296 energy_system_cplex.read(lp_file)
297 # Solve the model
298 energy_system_cplex.solve()
299 # Returns the objective value
300 objective_value = energy_system_cplex.solution.get_objective_value()
301 values = energy_system_cplex.solution.get_values()
302 print(np.size(values))
303
304 # Creates a prints model outputs
305 with cp.Cplex() as c, open(results, "w") as f:
306     output = c.set_results_stream(f)
307     output.write("GOCPI Example")
308
309 # Creates Docplex example
310 # energy_system_docplex = docplex.cp.model.CpoModel(name="GOCPI_Docplex")
311 energy_system_docplex_lp = dpmp.model_reader.ModelReader.read(
312     lp_file, model_name='GOCPI_Docplex_Lp')
313
314 mdl = energy_system_docplex_lp.solve(url=url, api=apikey)
315 # print('mdl', mdl)
316 # return_code = sb.call("conda init bash", shell=True)
317 # return_code = sb.call("conda activate osemosys", shell=True)
318 # os.system('conda activate osemosys')
319 # Optimise.create_linear_programme_file(directory, data, model, output)

```

4 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.

4.1 Model File

```

1 set YEAR;
2 set TECHNOLOGY;
3 set TIMESLICE;
4 set FUEL;
5 set EMISSION;
6 set MODE_OF_OPERATION;
7 set REGION;
8 set SEASON;
9 set DAYTYPE;
10 set DAILYTIMEBRACKET;
11 set STORAGE;
12 param YearSplit{l in TIMESLICE,y in YEAR};
13 param DiscountRate{r in REGION};
14 param DaySplit{lh in DAILYTIMEBRACKET,y in YEAR};
15 param Conversionls{l in TIMESLICE,ls in SEASON};
16 param Conversionld{l in TIMESLICE,ld in DAYTYPE};
17 param Conversionlh{l in TIMESLICE,lh in DAILYTIMEBRACKET};
18 param DaysInDayType{ls in SEASON ,ld in DAYTYPE,y in YEAR};
19 param TradeRoute{r in REGION,rr in REGION,f in FUEL,y in YEAR};
20 param DepreciationMethod{r in REGION};
21 param SpecifiedAnnualDemand{r in REGION,f in FUEL,y in YEAR};
22 param SpecifiedDemandProfile{r in REGION,f in FUEL,l in TIMESLICE,y in
   YEAR};
23 param AccumulatedAnnualDemand{r in REGION,f in FUEL,y in YEAR};
24 param CapacityToActivityUnit{r in REGION,t in TECHNOLOGY};
25 param CapacityFactor{r in REGION,t in TECHNOLOGY,l in TIMESLICE,y in
   YEAR};
26 param AvailabilityFactor{r in REGION,t in TECHNOLOGY,y in YEAR};
27 param OperationalLife{r in REGION,t in TECHNOLOGY};
28 param ResidualCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
29 param InputActivityRatio{r in REGION,t in TECHNOLOGY,f in FUEL,m in
   MODE_OF_OPERATION,y in YEAR};
30 param OutputActivityRatio{r in REGION,t in TECHNOLOGY,f in FUEL,m in
   MODE_OF_OPERATION,y in YEAR};
31 param CapitalCost{r in REGION,t in TECHNOLOGY,y in YEAR};
32 param VariableCost{r in REGION,t in TECHNOLOGY,m in MODE_OF_OPERATION,y
   in YEAR};
33 param FixedCost{r in REGION,t in TECHNOLOGY,y in YEAR};
34 param TechnologyToStorage{r in REGION,t in TECHNOLOGY,s in STORAGE,m in
   MODE_OF_OPERATION};
35 param TechnologyFromStorage{r in REGION,t in TECHNOLOGY,s in STORAGE,m
   in MODE_OF_OPERATION};
36 param StorageLevelStart{r in REGION,s in STORAGE};
37 param StorageMaxChargeRate{r in REGION,s in STORAGE};
38 param StorageMaxDischargeRate{r in REGION,s in STORAGE};
39 param MinStorageCharge{r in REGION,s in STORAGE,y in YEAR};
40 param OperationalLifeStorage{r in REGION, s in STORAGE};
41 param CapitalCostStorage{r in REGION,s in STORAGE,y in YEAR};
42 param ResidualStorageCapacity{r in REGION,s in STORAGE,y in YEAR};
43 param CapacityOfOneTechnologyUnit{r in REGION,t in TECHNOLOGY,y in YEAR
   };
44 param TotalAnnualMaxCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
45 param TotalAnnualMinCapacity{r in REGION,t in TECHNOLOGY,y in YEAR};
46 param TotalAnnualMaxCapacityInvestment{r in REGION,t in TECHNOLOGY,y in
   YEAR};
47 param TotalAnnualMinCapacityInvestment{r in REGION,t in TECHNOLOGY,y in
   YEAR};

```

```

48 param TotalTechnologyAnnualActivityUpperLimit{r in REGION,t in
        TECHNOLOGY,y in YEAR};
49 param TotalTechnologyAnnualActivityLowerLimit{r in REGION,t in
        TECHNOLOGY,y in YEAR};
50 param TotalTechnologyModelPeriodActivityUpperLimit{r in REGION,t in
        TECHNOLOGY};
51 param TotalTechnologyModelPeriodActivityLowerLimit{r in REGION,t in
        TECHNOLOGY};
52 param ReserveMarginTagTechnology{r in REGION,t in TECHNOLOGY,y in YEAR
        };
53 param ReserveMarginTagFuel{r in REGION,f in FUEL,y in YEAR};
54 param ReserveMargin{r in REGION,y in YEAR};
55 param RETagTechnology{r in REGION,t in TECHNOLOGY,y in YEAR};
56 param RETagFuel{r in REGION,f in FUEL,y in YEAR};
57 param REMinProductionTarget{r in REGION,y in YEAR};
58 param EmissionActivityRatio{r in REGION,t in TECHNOLOGY,e in EMISSION,m
        in MODE_OF_OPERATION,y in YEAR};
59 param EmissionsPenalty{r in REGION,e in EMISSION,y in YEAR};
60 param AnnualExogenousEmission{r in REGION,e in EMISSION,y in YEAR};
61 param AnnualEmissionLimit{r in REGION,e in EMISSION,y in YEAR};
62 param ModelPeriodExogenousEmission{r in REGION,e in EMISSION};
63 param ModelPeriodEmissionLimit{r in REGION,e in EMISSION};
64 var RateOfDemand{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR} >=0;
65 var Demand{r in REGION,l in TIMESLICE,f in FUEL,y in YEAR}>=0;
66 var RateOfStorageCharge{r in REGION,s in STORAGE,ls in SEASON,ld in
        DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
67 var RateOfStorageDischarge{r in REGION,s in STORAGE,ls in SEASON,ld in
        DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
68 var NetChargeWithinYear{r in REGION,s in STORAGE,ls in SEASON,ld in
        DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
69 var NetChargeWithinDay{r in REGION,s in STORAGE,ls in SEASON,ld in
        DAYTYPE,lh in DAILYTIMEBRACKET,y in YEAR};
70 var StorageLevelYearStart{r in REGION,s in STORAGE,y in YEAR}>=0;
71 var StorageLevelYearFinish{r in REGION,s in STORAGE,y in YEAR}>=0;
72 var StorageLevelSeasonStart{r in REGION,s in STORAGE,ls in SEASON,y in
        YEAR}>=0;
73 var StorageLevelDayTypeStart{r in REGION,s in STORAGE,ls in SEASON,ld
        in DAYTYPE,y in YEAR}>=0;
74 var StorageLevelDayTypeFinish{r in REGION,s in STORAGE,ls in SEASON,ld
        in DAYTYPE,y in YEAR}>=0;
75 var StorageLowerLimit{r in REGION,s in STORAGE,y in YEAR}>=0;
76 var StorageUpperLimit{r in REGION,s in STORAGE,y in YEAR}>=0;
77 var AccumulatedNewStorageCapacity{r in REGION,s in STORAGE,y in YEAR
        }>=0;
78 var NewStorageCapacity{r in REGION,s in STORAGE,y in YEAR}>=0;
79 var CapitalInvestmentStorage{r in REGION,s in STORAGE,y in YEAR}>=0;
80 var DiscountedCapitalInvestmentStorage{r in REGION,s in STORAGE,y in
        YEAR}>=0;
81 var SalvageValueStorage{r in REGION,s in STORAGE,y in YEAR}>=0;
82 var DiscountedSalvageValueStorage{r in REGION,s in STORAGE,y in YEAR
        }>=0;
83 var TotalDiscountedStorageCost{r in REGION,s in STORAGE,y in YEAR}>=0;
84 var NumberOfNewTechnologyUnits{r in REGION,t in TECHNOLOGY,y in YEAR
        }>=0, integer;
85 var NewCapacity{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
86 var AccumulatedNewCapacity{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;
87 var TotalCapacityAnnual{r in REGION,t in TECHNOLOGY,y in YEAR}>=0;

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

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126 var AnnualTechnologyEmissionPenaltyByEmission{r in REGION,t in
    TECHNOLOGY,e in EMISSION,y in YEAR} >=0;
127 var AnnualTechnologyEmissionsPenalty{r in REGION,t in TECHNOLOGY,y in
    YEAR} >=0;
128 var DiscountedTechnologyEmissionsPenalty{r in REGION,t in TECHNOLOGY,y
    in YEAR} >=0;
129 var AnnualEmissions{r in REGION,e in EMISSION,y in YEAR} >=0;
130 var ModelPeriodEmissions{r in REGION,e in EMISSION} >=0;
131 minimize cost: sum{r in REGION, y in YEAR} TotalDiscountedCost[r,y];
132 s.t. EQ_SpecifiedDemand{r in REGION, l in TIMESLICE, f in FUEL, y in
    YEAR}: SpecifiedAnnualDemand[r,f,y]*SpecifiedDemandProfile[r,f,l,y]
    / YearSplit[l,y]=RateOfDemand[r,l,f,y];
133 s.t. CAa1_TotalNewCapacity{r in REGION, t in TECHNOLOGY, y in YEAR}:
    AccumulatedNewCapacity[r,t,y] = sum{yy in YEAR: y-yy <
    OperationalLife[r,t] && y-yy>=0} NewCapacity[r,t,yy];
134 s.t. CAa2_TotalAnnualCapacity{r in REGION, t in TECHNOLOGY, y in YEAR}:
    AccumulatedNewCapacity[r,t,y]+ ResidualCapacity[r,t,y] =
    TotalCapacityAnnual[r,t,y];
135 s.t. CAa3_TotalActivityOfEachTechnology{r in REGION, t in TECHNOLOGY, l
    in TIMESLICE, y in YEAR}: sum{m in MODE_OF_OPERATION}
    RateOfActivity[r,l,t,m,y] = RateOfTotalActivity[r,t,l,y];
136 s.t. CAa4_Constraint_Capacity{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, y in YEAR}: RateOfTotalActivity[r,t,l,y] <=
    TotalCapacityAnnual[r,t,y] * CapacityFactor[r,t,l,y]*
    CapacityToActivityUnit[r,t];
137 s.t. CAa5_TotalNewCapacity{r in REGION, t in TECHNOLOGY, y in YEAR}:
    CapacityOfOneTechnologyUnit[r,t,y]<>0: CapacityOfOneTechnologyUnit[
    r,t,y]*NumberOfNewTechnologyUnits[r,t,y] = NewCapacity[r,t,y];
138 s.t. CAB1_PlannedMaintenance{r in REGION, t in TECHNOLOGY, y in YEAR}:
    sum{l in TIMESLICE} RateOfTotalActivity[r,t,l,y]*YearSplit[l,y] <=
    sum{l in TIMESLICE} (TotalCapacityAnnual[r,t,y]*CapacityFactor[r,t,l,
    y]*YearSplit[l,y])* AvailabilityFactor[r,t,y]*
    CapacityToActivityUnit[r,t];
139 s.t. EBa1_RateOfFuelProduction1{r in REGION, l in TIMESLICE, f in FUEL,
    t in TECHNOLOGY, m in MODE_OF_OPERATION, y in YEAR}:
    OutputActivityRatio[r,t,f,m,y] <>0: RateOfActivity[r,l,t,m,y]*
    OutputActivityRatio[r,t,f,m,y] = RateOfProductionByTechnologyByMode
    [r,l,t,m,f,y];
140 s.t. EBa2_RateOfFuelProduction2{r in REGION, l in TIMESLICE, f in FUEL,
    t in TECHNOLOGY, y in YEAR}: sum{m in MODE_OF_OPERATION:
    OutputActivityRatio[r,t,f,m,y] <>0}
    RateOfProductionByTechnologyByMode[r,l,t,m,f,y] =
    RateOfProductionByTechnology[r,l,t,f,y];
141 s.t. EBa3_RateOfFuelProduction3{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: sum{t in TECHNOLOGY} RateOfProductionByTechnology[r,l,t,
    f,y] = RateOfProduction[r,l,f,y];
142 s.t. EBa4_RateOfFuelUse1{r in REGION, l in TIMESLICE, f in FUEL, t in
    TECHNOLOGY, m in MODE_OF_OPERATION, y in YEAR}: InputActivityRatio[r,
    t,f,m,y]<>0: RateOfActivity[r,l,t,m,y]*InputActivityRatio[r,t,f,m,y
    ] = RateOfUseByTechnologyByMode[r,l,t,m,f,y];
143 s.t. EBa5_RateOfFuelUse2{r in REGION, l in TIMESLICE, f in FUEL, t in
    TECHNOLOGY, y in YEAR}: sum{m in MODE_OF_OPERATION:
    InputActivityRatio[r,t,f,m,y]<>0} RateOfUseByTechnologyByMode[r,l,t,
    m,f,y] = RateOfUseByTechnology[r,l,t,f,y];
144 s.t. EBa6_RateOfFuelUse3{r in REGION, l in TIMESLICE, f in FUEL, y in
    YEAR}: sum{t in TECHNOLOGY} RateOfUseByTechnology[r,l,t,f,y] =
    RateOfUse[r,l,f,y];

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145 s.t. EBa7_EnergyBalanceEachTS1{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfProduction[r,l,f,y]*YearSplit[l,y] = Production[r,
    l,f,y];
146 s.t. EBa8_EnergyBalanceEachTS2{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfUse[r,l,f,y]*YearSplit[l,y] = Use[r,l,f,y];
147 s.t. EBa9_EnergyBalanceEachTS3{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: RateOfDemand[r,l,f,y]*YearSplit[l,y] = Demand[r,l,f,y];
148 s.t. EBa10_EnergyBalanceEachTS4{r in REGION, rr in REGION, l in
    TIMESLICE, f in FUEL, y in YEAR}: Trade[r,rr,l,f,y] = -Trade[rr,r,l,
    f,y];
149 s.t. EBa11_EnergyBalanceEachTS5{r in REGION, l in TIMESLICE, f in FUEL,
    y in YEAR}: Production[r,l,f,y] >= Demand[r,l,f,y] + Use[r,l,f,y] +
    sum{rr in REGION} Trade[r,rr,l,f,y]*TradeRoute[r,rr,f,y];
150 s.t. EBb1_EnergyBalanceEachYear1{r in REGION, f in FUEL, y in YEAR}:
    sum{l in TIMESLICE} Production[r,l,f,y] = ProductionAnnual[r,f,y];
151 s.t. EBb2_EnergyBalanceEachYear2{r in REGION, f in FUEL, y in YEAR}:
    sum{l in TIMESLICE} Use[r,l,f,y] = UseAnnual[r,f,y];
152 s.t. EBb3_EnergyBalanceEachYear3{r in REGION, rr in REGION, f in FUEL,
    y in YEAR}: sum{l in TIMESLICE} Trade[r,rr,l,f,y] = TradeAnnual[r,rr,
    f,y];
153 s.t. EBb4_EnergyBalanceEachYear4{r in REGION, f in FUEL, y in YEAR}:
    ProductionAnnual[r,f,y] >= UseAnnual[r,f,y] + sum{rr in REGION}
    TradeAnnual[r,rr,f,y]*TradeRoute[r,rr,f,y] + AccumulatedAnnualDemand
    [r,f,y];
154 s.t. Acc1_FuelProductionByTechnology{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, f in FUEL, y in YEAR}: RateOfProductionByTechnology[r,l,
    t,f,y] * YearSplit[l,y] = ProductionByTechnology[r,l,t,f,y];
155 s.t. Acc2_FuelUseByTechnology{r in REGION, l in TIMESLICE, t in
    TECHNOLOGY, f in FUEL, y in YEAR}: RateOfUseByTechnology[r,l,t,f,y]
    * YearSplit[l,y] = UseByTechnology[r,l,t,f,y];
156 s.t. Acc3_AverageAnnualRateOfActivity{r in REGION, t in TECHNOLOGY, m
    in MODE_OF_OPERATION, y in YEAR}: sum{l in TIMESLICE} RateOfActivity
    [r,l,t,m,y]*YearSplit[l,y] = TotalAnnualTechnologyActivityByMode[r,t,
    ,m,y];
157 s.t. Acc4_ModelPeriodCostByRegion{r in REGION}: sum{y in YEAR}
    TotalDiscountedCost[r,y] = ModelPeriodCostByRegion[r];
158 s.t. S1_RateOfStorageCharge{r in REGION, s in STORAGE, ls in SEASON, ld
    in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{t in TECHNOLOGY
    , m in MODE_OF_OPERATION, l in TIMESLICE: TechnologyToStorage[r,t,s,m]
    ]>0} RateOfActivity[r,l,t,m,y] * TechnologyToStorage[r,t,s,m] *
    Conversionls[l,ls] * Conversionld[l,ld] * Conversionlh[l,lh] =
    RateOfStorageCharge[r,s,ls,ld,lh,y];
159 s.t. S2_RateOfStorageDischarge{r in REGION, s in STORAGE, ls in SEASON,
    ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{t in
    TECHNOLOGY, m in MODE_OF_OPERATION, l in TIMESLICE:
    TechnologyFromStorage[r,t,s,m]>0} RateOfActivity[r,l,t,m,y] *
    TechnologyFromStorage[r,t,s,m] * Conversionls[l,ls] * Conversionld[l,
    ,ld] * Conversionlh[l,lh] = RateOfStorageDischarge[r,s,ls,ld,lh,y];
160 s.t. S3_NetChargeWithinYear{r in REGION, s in STORAGE, ls in SEASON, ld
    in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: sum{l in TIMESLICE:
    Conversionls[l,ls]>0&&Conversionld[l,ld]>0&&Conversionlh[l,lh]>0} (
    RateOfStorageCharge[r,s,ls,ld,lh,y] - RateOfStorageDischarge[r,s,ls,
    ld,lh,y]) * YearSplit[l,y] * Conversionls[l,ls] * Conversionld[l,ld]
    * Conversionlh[l,lh] = NetChargeWithinYear[r,s,ls,ld,lh,y];
161 s.t. S4_NetChargeWithinDay{r in REGION, s in STORAGE, ls in SEASON, ld
    in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: (RateOfStorageCharge
    [r,s,ls,ld,lh,y] - RateOfStorageDischarge[r,s,ls,ld,lh,y]) *
    DaySplit[lh,y] = NetChargeWithinDay[r,s,ls,ld,lh,y];

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162 s.t. S5_and_S6_StorageLevelYearStart{r in REGION, s in STORAGE, y in YEAR}: if y = min{yy in YEAR} min(yy) then StorageLevelStart[r,s] else StorageLevelYearStart[r,s,y-1] + sum{ls in SEASON, ld in DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r,s,ls,ld,lh,y-1] = StorageLevelYearStart[r,s,y];
163 s.t. S7_and_S8_StorageLevelYearFinish{r in REGION, s in STORAGE, y in YEAR}: if y < max{yy in YEAR} max(yy) then StorageLevelYearStart[r,s,y+1] else StorageLevelYearStart[r,s,y] + sum{ls in SEASON, ld in DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r,s,ls,ld,lh,y] = StorageLevelYearFinish[r,s,y];
164 s.t. S9_and_S10_StorageLevelSeasonStart{r in REGION, s in STORAGE, ls in SEASON, y in YEAR}: if ls = min{lsls in SEASON} min(lsls) then StorageLevelYearStart[r,s,y] else StorageLevelSeasonStart[r,s,ls-1,y] + sum{ld in DAYTYPE, lh in DAILYTIMEBRACKET} NetChargeWithinYear[r,s,ls-1,ld,lh,y] = StorageLevelSeasonStart[r,s,ls,y];
165 s.t. S11_and_S12_StorageLevelDayTypeStart{r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, y in YEAR}: if ld = min{lldld in DAYTYPE} min(lldld) then StorageLevelSeasonStart[r,s,ls,y] else StorageLevelDayTypeStart[r,s,ls,ld-1,y] + sum{lh in DAILYTIMEBRACKET} NetChargeWithinDay[r,s,ls,ld-1,lh,y] * DaysInDayType[ls,ld-1,y] = StorageLevelDayTypeStart[r,s,ls,ld,y];
166 s.t. S13_and_S14_and_S15_StorageLevelDayTypeFinish{r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, y in YEAR}: if ls = max{lsls in SEASON} max(lsls) && ld = max{lldld in DAYTYPE} max(lldld) then StorageLevelYearFinish[r,s,y] else if ld = max{lldld in DAYTYPE} max(lldld) then StorageLevelSeasonStart[r,s,ls+1,y] else StorageLevelDayTypeFinish[r,s,ls,ld+1,y] - sum{lh in DAILYTIMEBRACKET} NetChargeWithinDay[r,s,ls,ld+1,lh,y] * DaysInDayType[ls,ld+1,y] = StorageLevelDayTypeFinish[r,s,ls,ld,y];
167 s.t.
    SC1_LowerLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInFirstWeekConstraint{r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: 0 <= (StorageLevelDayTypeStart[r,s,ls,ld,y]+sum{lhlh in DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s,ls,ld,lhlh,y])-StorageLowerLimit[r,s,y];
168 s.t.
    SC1_UpperLimit_BeginningOfDailyTimeBracketOfFirstInstanceOfDayTypeInFirstWeekConstraint{r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: (StorageLevelDayTypeStart[r,s,ls,ld,y]+sum{lhlh in DAILYTIMEBRACKET:lh-lhlh>0} NetChargeWithinDay[r,s,ls,ld,lhlh,y])-StorageUpperLimit[r,s,y] <= 0;
169 s.t.
    SC2_LowerLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInFirstWeekConstraint{r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: 0 <= if ld > min{lldld in DAYTYPE} min(lldld) then (StorageLevelDayTypeStart[r,s,ls,ld,y]-sum{lhlh in DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[r,s,ls,ld-1,lhlh,y])-StorageLowerLimit[r,s,y];
170 s.t.
    SC2_UpperLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInFirstWeekConstraint{r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}: if ld > min{lldld in DAYTYPE} min(lldld) then (StorageLevelDayTypeStart[r,s,ls,ld,y]-sum{lhlh in DAILYTIMEBRACKET:lh-lhlh<0} NetChargeWithinDay[r,s,ls,ld-1,lhlh,y])-StorageUpperLimit[r,s,y] <= 0;
171 s.t.
    SC3_LowerLimit_EndOfDailyTimeBracketOfLastInstanceOfDayTypeInLastWeekConstraint{r in REGION, s in STORAGE, ls in SEASON, ld in DAYTYPE, lh in

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DAILYTIMEBRACKET, y in YEAR}: 0 <= (StorageLevelDayTypeFinish[r,s,ls
,ld,y] - sum{lhh in DAILYTIMEBRACKET:lh-lhh<0} NetChargeWithinDay[
r,s,ls,ld,lhh,y])-StorageLowerLimit[r,s,y];
172 s.t.
SC3_UpperLimit_EndOfDayTimeBracketOfLastInstanceOfDayTypeInLastWeekConstraint
{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{lhh in DAILYTIMEBRACKET:lh-lhh<0} NetChargeWithinDay[r,s,
ls,ld,lhh,y])-StorageUpperLimit[r,s,y] <= 0;
173 s.t.
SC4_LowerLimit_BeginningOfDayTimeBracketOfFirstInstanceOfDayTypeInLastWeekCons
{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{lhh in
DAILYTIMEBRACKET:lh-lhh>0} NetChargeWithinDay[r,s,ls,ld,lhh,y])-_
StorageLowerLimit[r,s,y];
174 s.t.
SC4_UpperLimit_BeginningOfDayTimeBracketOfFirstInstanceOfDayTypeInLastWeekCons
{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{lhh in
DAILYTIMEBRACKET:lh-lhh>0} NetChargeWithinDay[r,s,ls,ld,lhh,y])-_
StorageUpperLimit[r,s,y] <= 0;
175 s.t. SC5_MaxChargeConstraint{r in REGION, s in STORAGE, ls in SEASON,
ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}:
RateOfStorageCharge[r,s,ls,ld,lh,y] <= StorageMaxChargeRate[r,s];
176 s.t. SC6_MaxDischargeConstraint{r in REGION, s in STORAGE, ls in SEASON
, ld in DAYTYPE, lh in DAILYTIMEBRACKET, y in YEAR}:
RateOfStorageDischarge[r,s,ls,ld,lh,y] <= StorageMaxDischargeRate[r,
s];
177 s.t. SI1_StorageUpperLimit{r in REGION, s in STORAGE, y in YEAR}:
AccumulatedNewStorageCapacity[r,s,y]+ResidualStorageCapacity[r,s,y]
= StorageUpperLimit[r,s,y];
178 s.t. SI2_StorageLowerLimit{r in REGION, s in STORAGE, y in YEAR}:
MinStorageCharge[r,s,y]*StorageUpperLimit[r,s,y] = StorageLowerLimit
[r,s,y];
179 s.t. SI3_TotalNewStorage{r in REGION, s in STORAGE, y in YEAR}: sum{yy
in YEAR: y-yy < OperationalLifeStorage[r,s] && y-yy>=0}
NewStorageCapacity[r,s,yy]=AccumulatedNewStorageCapacity[r,s,y];
180 s.t. SI4_UndiscountedCapitalInvestmentStorage{r in REGION, s in STORAGE
, y in YEAR}: CapitalCostStorage[r,s,y] * NewStorageCapacity[r,s,y]
= CapitalInvestmentStorage[r,s,y];
181 s.t. SI5_DiscountingCapitalInvestmentStorage{r in REGION, s in STORAGE,
y in YEAR}: CapitalInvestmentStorage[r,s,y]/((1+DiscountRate[r])^(y
-min{yy in YEAR} min(yy))) = DiscountedCapitalInvestmentStorage[r,s,
y];
182 s.t. SI6_SalvageValueStorageAtEndOfPeriod1{r in REGION, s in STORAGE, y
in YEAR: (y+OperationalLifeStorage[r,s]-1) <= (max{yy in YEAR} max(
yy))}: 0 = SalvageValueStorage[r,s,y];
183 s.t. SI7_SalvageValueStorageAtEndOfPeriod2{r in REGION, s in STORAGE, y
in YEAR: (DepreciationMethod[r]=1 && (y+OperationalLifeStorage[r,s
]-1) > (max{yy in YEAR} max(yy)) && DiscountRate[r]=0) || (
DepreciationMethod[r]=2 && (y+OperationalLifeStorage[r,s]-1) > (max{
yy in YEAR} max(yy))}): CapitalInvestmentStorage[r,s,y]*(1-(max{yy
in YEAR} max(yy) - y+1)/OperationalLifeStorage[r,s]) =
SalvageValueStorage[r,s,y];
184 s.t. SI8_SalvageValueStorageAtEndOfPeriod3{r in REGION, s in STORAGE, y
in YEAR: DepreciationMethod[r]=1 && (y+OperationalLifeStorage[r,s
]
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] -1) > (max{yy in YEAR} max(yy)) && DiscountRate[r]>0):
    CapitalInvestmentStorage[r,s,y]*(1-(((1+DiscountRate[r]))^(max{yy in
    YEAR} max(yy) - y+1)-1)/((1+DiscountRate[r]))^OperationalLifeStorage[
    r,s]-1)) = SalvageValueStorage[r,s,y];
185 s.t. SI9_SalvageValueStorageDiscountedToStartYear{r in REGION, s in
    STORAGE, y in YEAR}: SalvageValueStorage[r,s,y]/((1+DiscountRate[r])
    ^(max{yy in YEAR} max(yy)-min{yy in YEAR} min(yy)+1)) =
    DiscountedSalvageValueStorage[r,s,y];
186 s.t. SI10_TotalDiscountedCostByStorage{r in REGION, s in STORAGE, y in
    YEAR}: DiscountedCapitalInvestmentStorage[r,s,y]-
    DiscountedSalvageValueStorage[r,s,y] = TotalDiscountedStorageCost[r,
    s,y];
187 s.t. CC1_UndiscountedCapitalInvestment{r in REGION, t in TECHNOLOGY, y
    in YEAR}: CapitalCost[r,t,y] * NewCapacity[r,t,y] =
    CapitalInvestment[r,t,y];
188 s.t. CC2_DiscountingCapitalInvestment{r in REGION, t in TECHNOLOGY, y
    in YEAR}: CapitalInvestment[r,t,y]/((1+DiscountRate[r])^(y-min{yy in
    YEAR} min(yy))) = DiscountedCapitalInvestment[r,t,y];
189 s.t. SV1_SalvageValueAtEndOfPeriod1{r in REGION, t in TECHNOLOGY, y in
    YEAR: DepreciationMethod[r]=1 && (y + OperationalLife[r,t]-1) > (max
    {yy in YEAR} max(yy)) && DiscountRate[r]>0}: SalvageValue[r,t,y] =
    CapitalCost[r,t,y]*NewCapacity[r,t,y]*(1-(((1+DiscountRate[r]))^(max{
    yy in YEAR} max(yy) - y+1)-1)/((1+DiscountRate[r]))^OperationalLife[r
    ,t]-1));
190 s.t. SV2_SalvageValueAtEndOfPeriod2{r in REGION, t in TECHNOLOGY, y in
    YEAR: (DepreciationMethod[r]=1 && (y + OperationalLife[r,t]-1) > (
    max{yy in YEAR} max(yy)) && DiscountRate[r]=0) || (
    DepreciationMethod[r]=2 && (y + OperationalLife[r,t]-1) > (max{yy in
    YEAR} max(yy))}): SalvageValue[r,t,y] = CapitalCost[r,t,y]*
    NewCapacity[r,t,y]*(1-(max{yy in YEAR} max(yy) - y+1)/
    OperationalLife[r,t]);
191 s.t. SV3_SalvageValueAtEndOfPeriod3{r in REGION, t in TECHNOLOGY, y in
    YEAR: (y + OperationalLife[r,t]-1) <= (max{yy in YEAR} max(yy))}:
    SalvageValue[r,t,y] = 0;
192 s.t. SV4_SalvageValueDiscountedToStartYear{r in REGION, t in TECHNOLOGY
    , y in YEAR}: DiscountedSalvageValue[r,t,y] = SalvageValue[r,t,y]
    /((1+DiscountRate[r])^(1+max{yy in YEAR} max(yy)-min{yy in YEAR}
    min(yy)));
193 s.t. OC1_OperatingCostsVariable{r in REGION, t in TECHNOLOGY, l in
    TIMESLICE, y in YEAR}: sum{m in MODE_OF_OPERATION}
    TotalAnnualTechnologyActivityByMode[r,t,m,y]*VariableCost[r,t,m,y] =
    AnnualVariableOperatingCost[r,t,y];
194 s.t. OC2_OperatingCostsFixedAnnual{r in REGION, t in TECHNOLOGY, y in
    YEAR}: TotalCapacityAnnual[r,t,y]*FixedCost[r,t,y] =
    AnnualFixedOperatingCost[r,t,y];
195 s.t. OC3_OperatingCostsTotalAnnual{r in REGION, t in TECHNOLOGY, y in
    YEAR}: AnnualFixedOperatingCost[r,t,y]+AnnualVariableOperatingCost[r
    ,t,y] = OperatingCost[r,t,y];
196 s.t. OC4_DiscountedOperatingCostsTotalAnnual{r in REGION, t in
    TECHNOLOGY, y in YEAR}: OperatingCost[r,t,y]/((1+DiscountRate[r])^(y
    -min{yy in YEAR} min(yy)+0.5)) = DiscountedOperatingCost[r,t,y];
197 s.t. TDC1_TotalDiscountedCostByTechnology{r in REGION, t in TECHNOLOGY,
    y in YEAR}: DiscountedOperatingCost[r,t,y]+
    DiscountedCapitalInvestment[r,t,y]+
    DiscountedTechnologyEmissionsPenalty[r,t,y]-DiscountedSalvageValue[r
    ,t,y] = TotalDiscountedCostByTechnology[r,t,y];
198 s.t. TDC2_TotalDiscountedCost{r in REGION, y in YEAR}: sum{t in
    TECHNOLOGY} TotalDiscountedCostByTechnology[r,t,y]+sum{s in STORAGE}

```

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199   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];
200 s.t. TCC2_TotalAnnualMinCapacityConstraint{r in REGION, t in TECHNOLOGY
, y in YEAR: TotalAnnualMinCapacity[r,t,y]>0}: TotalCapacityAnnual[r
,t,y] >= TotalAnnualMinCapacity[r,t,y];
201 s.t. NCC1_TotalAnnualMaxNewCapacityConstraint{r in REGION, t in
TECHNOLOGY, y in YEAR}: NewCapacity[r,t,y] <=
TotalAnnualMaxCapacityInvestment[r,t,y];
202 s.t. NCC2_TotalAnnualMinNewCapacityConstraint{r in REGION, t in
TECHNOLOGY, y in YEAR: TotalAnnualMinCapacityInvestment[r,t,y]>0}:
NewCapacity[r,t,y] >= TotalAnnualMinCapacityInvestment[r,t,y];
203 s.t. AAC1_TotalAnnualTechnologyActivity{r in REGION, t in TECHNOLOGY, y
in YEAR}: sum{l in TIMESLICE} RateOfTotalActivity[r,t,l,y]*
YearSplit[l,y] = TotalTechnologyAnnualActivity[r,t,y];
204 s.t. AAC2_TotalAnnualTechnologyActivityUpperLimit{r in REGION, t in
TECHNOLOGY, y in YEAR}: TotalTechnologyAnnualActivity[r,t,y] <=
TotalTechnologyAnnualActivityUpperLimit[r,t,y];
205 s.t. AAC3_TotalAnnualTechnologyActivityLowerLimit{r in REGION, t in
TECHNOLOGY, y in YEAR: TotalTechnologyAnnualActivityLowerLimit[r,t,y]>0}:
TotalTechnologyAnnualActivity[r,t,y] >=
TotalTechnologyAnnualActivityLowerLimit[r,t,y];
206 s.t. TAC1_TotalModelHorizonTechnologyActivity{r in REGION, t in
TECHNOLOGY}: sum{y in YEAR} TotalTechnologyAnnualActivity[r,t,y] =
TotalTechnologyModelPeriodActivity[r,t];
207 s.t. TAC2_TotalModelHorizonTechnologyActivityUpperLimit{r in REGION, t
in TECHNOLOGY: TotalTechnologyModelPeriodActivityUpperLimit[r,t]>0}:
TotalTechnologyModelPeriodActivity[r,t] <=
TotalTechnologyModelPeriodActivityUpperLimit[r,t];
208 s.t. TAC3_TotalModelHorizenTechnologyActivityLowerLimit{r in REGION, t
in TECHNOLOGY: TotalTechnologyModelPeriodActivityLowerLimit[r,t]>0}:
TotalTechnologyModelPeriodActivity[r,t] >=
TotalTechnologyModelPeriodActivityLowerLimit[r,t];
209 s.t. RM1_ReserveMargin_TechnologiesIncluded_In_Activity_Units{r in
REGION, l in TIMESLICE, y in YEAR}: sum {t in TECHNOLOGY}
TotalCapacityAnnual[r,t,y] * ReserveMarginTagTechnology[r,t,y] *
CapacityToActivityUnit[r,t] =
TotalCapacityInReserveMargin[r,y];
210 s.t. RM2_ReserveMargin_FuelsIncluded{r in REGION, l in TIMESLICE, y in
YEAR}: sum {f in FUEL} RateOfProduction[r,l,f,y] *
ReserveMarginTagFuel[r,f,y] = DemandNeedingReserveMargin[r,l,y];
211 s.t. RM3_ReserveMargin_Constraint{r in REGION, l in TIMESLICE, y in
YEAR}: DemandNeedingReserveMargin[r,l,y] * ReserveMargin[r,y]<=
TotalCapacityInReserveMargin[r,y];
212 s.t. RE1_FuelProductionByTechnologyAnnual{r in REGION, t in TECHNOLOGY,
f in FUEL, y in YEAR}: sum{l in TIMESLICE} ProductionByTechnology[r
,l,t,f,y] = ProductionByTechnologyAnnual[r,t,f,y];
213 s.t. RE2_TechIncluded{r in REGION, y in YEAR}: sum{t in TECHNOLOGY, f
in FUEL} ProductionByTechnologyAnnual[r,t,f,y]*RETagTechnology[r,t,y
] = TotalREProductionAnnual[r,y];
214 s.t. RE3_FuelIncluded{r in REGION, y in YEAR}: sum{l in TIMESLICE, f in
FUEL} RateOfProduction[r,l,f,y]*YearSplit[l,y]*RETagFuel[r,f,y] =
RETotalProductionOfTargetFuelAnnual[r,y];
215 s.t. RE4_EnergyConstraint{r in REGION, y in YEAR}:
REMInProductionTarget[r,y]*RETotalProductionOfTargetFuelAnnual[r,y]
<= TotalREProductionAnnual[r,y];

```

```

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

```

4.2 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.

```

1 # GOCPI Energy System Data File
2 # Insert instructions when the file is running properly
3 #
4 # Sets
5 #
6 set YEAR := 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
     2001 2002 2003 2004 2005 2006 2007 2008 2009 2010;
7 set REGION := NEWZEALAND AUSTRALIA;
8 set EMISSION := CO2 NOX CO METHANE;
9 set TECHNOLOGY := E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu;
10 set FUEL := CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX;
11 set TIMESLICE := INTERMEDIATE_DAY INTERMEDIATE_NIGHT SUMMER_DAY
     SUMMER_NIGHT WINTER_DAY WINTER_NIGHT;
12 set MODE_OF_OPERATION := 1 2;
13 set STORAGE := DAM;

```

```

14 set DAYTYPE := 1 2 3;
15 set SEASON := 1 2 3 4;
16 set DAILYTIMEBRACKET := 1 2 3;
17 #
18 #
19 param YearSplit :1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
20   2001 2002 2003 2004 2005 2006 2007 2008 2009 2010:=
21 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
22   1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
23 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
24   1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
25 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
26   1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
27 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
28   1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
29 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
30   1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
31 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
32   1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
33 ;
34 #
35 param DiscountRate default 1:-
36 NEWZEALAND 1.0
37 AUSTRALIA 1.0
38 ;
39 #
40 param DaySplit :1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
41   2001 2002 2003 2004 2005 2006 2007 2008 2009 2010:=
42 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
43   1.0 1.0 1.0 1.0
44 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
45   1.0 1.0 1.0 1.0
46 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
47   1.0 1.0 1.0 1.0
48 ;
49 #
50 param Conversionls :1 2 3 4:-
51 INTERMEDIATE_DAY 1.0 1.0 1.0 1.0
52 INTERMEDIATE_NIGHT 1.0 1.0 1.0 1.0
53 SUMMER_DAY 1.0 1.0 1.0 1.0
54 SUMMER_NIGHT 1.0 1.0 1.0 1.0
55 WINTER_DAY 1.0 1.0 1.0 1.0
56 WINTER_NIGHT 1.0 1.0 1.0 1.0
57 ;
58 #
59 param Conversionld :1 2 3:-
60 INTERMEDIATE_DAY 1.0 1.0 1.0
61 INTERMEDIATE_NIGHT 1.0 1.0 1.0
62 SUMMER_DAY 1.0 1.0 1.0
63 SUMMER_NIGHT 1.0 1.0 1.0
64 WINTER_DAY 1.0 1.0 1.0
65 WINTER_NIGHT 1.0 1.0 1.0
66 ;
67 #
68 param Conversionlh :1 2 3:-
69 INTERMEDIATE_DAY 1.0 1.0 1.0
70 INTERMEDIATE_NIGHT 1.0 1.0 1.0
71 SUMMER_DAY 1.0 1.0 1.0

```

```

61 SUMMER_NIGHT 1.0 1.0 1.0
62 WINTER_DAY 1.0 1.0 1.0
63 WINTER_NIGHT 1.0 1.0 1.0
64 ;
65 #
66 param DaysInDayType default 1:-
67   [*,* ,1990]: 1 2 3 := 
68   1 1.0 1.0 1.0
69   2 1.0 1.0 1.0
70   3 1.0 1.0 1.0
71   4 1.0 1.0 1.0
72   [*,* ,1991]: 1 2 3 :=
73   1 1.0 1.0 1.0
74   2 1.0 1.0 1.0
75   3 1.0 1.0 1.0
76   4 1.0 1.0 1.0
77   [*,* ,1992]: 1 2 3 :=
78   1 1.0 1.0 1.0
79   2 1.0 1.0 1.0
80   3 1.0 1.0 1.0
81   4 1.0 1.0 1.0
82   [*,* ,1993]: 1 2 3 :=
83   1 1.0 1.0 1.0
84   2 1.0 1.0 1.0
85   3 1.0 1.0 1.0
86   4 1.0 1.0 1.0
87   [*,* ,1994]: 1 2 3 :=
88   1 1.0 1.0 1.0
89   2 1.0 1.0 1.0
90   3 1.0 1.0 1.0
91   4 1.0 1.0 1.0
92   [*,* ,1995]: 1 2 3 :=
93   1 1.0 1.0 1.0
94   2 1.0 1.0 1.0
95   3 1.0 1.0 1.0
96   4 1.0 1.0 1.0
97   [*,* ,1996]: 1 2 3 :=
98   1 1.0 1.0 1.0
99   2 1.0 1.0 1.0
100  3 1.0 1.0 1.0
101  4 1.0 1.0 1.0
102  [*,* ,1997]: 1 2 3 :=
103  1 1.0 1.0 1.0
104  2 1.0 1.0 1.0
105  3 1.0 1.0 1.0
106  4 1.0 1.0 1.0
107  [*,* ,1998]: 1 2 3 :=
108  1 1.0 1.0 1.0
109  2 1.0 1.0 1.0
110  3 1.0 1.0 1.0
111  4 1.0 1.0 1.0
112  [*,* ,1999]: 1 2 3 :=
113  1 1.0 1.0 1.0
114  2 1.0 1.0 1.0
115  3 1.0 1.0 1.0
116  4 1.0 1.0 1.0
117  [*,* ,2000]: 1 2 3 :=
118  1 1.0 1.0 1.0

```

```

119 2 1.0 1.0 1.0
120 3 1.0 1.0 1.0
121 4 1.0 1.0 1.0
122 [*,* ,2001]: 1 2 3 := 
123 1 1.0 1.0 1.0
124 2 1.0 1.0 1.0
125 3 1.0 1.0 1.0
126 4 1.0 1.0 1.0
127 [*,* ,2002]: 1 2 3 := 
128 1 1.0 1.0 1.0
129 2 1.0 1.0 1.0
130 3 1.0 1.0 1.0
131 4 1.0 1.0 1.0
132 [*,* ,2003]: 1 2 3 := 
133 1 1.0 1.0 1.0
134 2 1.0 1.0 1.0
135 3 1.0 1.0 1.0
136 4 1.0 1.0 1.0
137 [*,* ,2004]: 1 2 3 := 
138 1 1.0 1.0 1.0
139 2 1.0 1.0 1.0
140 3 1.0 1.0 1.0
141 4 1.0 1.0 1.0
142 [*,* ,2005]: 1 2 3 := 
143 1 1.0 1.0 1.0
144 2 1.0 1.0 1.0
145 3 1.0 1.0 1.0
146 4 1.0 1.0 1.0
147 [*,* ,2006]: 1 2 3 := 
148 1 1.0 1.0 1.0
149 2 1.0 1.0 1.0
150 3 1.0 1.0 1.0
151 4 1.0 1.0 1.0
152 [*,* ,2007]: 1 2 3 := 
153 1 1.0 1.0 1.0
154 2 1.0 1.0 1.0
155 3 1.0 1.0 1.0
156 4 1.0 1.0 1.0
157 [*,* ,2008]: 1 2 3 := 
158 1 1.0 1.0 1.0
159 2 1.0 1.0 1.0
160 3 1.0 1.0 1.0
161 4 1.0 1.0 1.0
162 [*,* ,2009]: 1 2 3 := 
163 1 1.0 1.0 1.0
164 2 1.0 1.0 1.0
165 3 1.0 1.0 1.0
166 4 1.0 1.0 1.0
167 [*,* ,2010]: 1 2 3 := 
168 1 1.0 1.0 1.0
169 2 1.0 1.0 1.0
170 3 1.0 1.0 1.0
171 4 1.0 1.0 1.0
172 ;
173 #
174 param TradeRoute default 1:=
175 [*,* ,CSV ,1990]: NEWZEALAND AUSTRALIA :=
176 NEWZEALAND 1.0 1.0

```

```
177 AUSTRALIA 1.0 1.0
178 [*,* ,CSV ,1991]: NEWZEALAND AUSTRALIA := 
179 NEWZEALAND 1.0 1.0
180 AUSTRALIA 1.0 1.0
181 [*,* ,CSV ,1992]: NEWZEALAND AUSTRALIA := 
182 NEWZEALAND 1.0 1.0
183 AUSTRALIA 1.0 1.0
184 [*,* ,CSV ,1993]: NEWZEALAND AUSTRALIA := 
185 NEWZEALAND 1.0 1.0
186 AUSTRALIA 1.0 1.0
187 [*,* ,CSV ,1994]: NEWZEALAND AUSTRALIA := 
188 NEWZEALAND 1.0 1.0
189 AUSTRALIA 1.0 1.0
190 [*,* ,CSV ,1995]: NEWZEALAND AUSTRALIA := 
191 NEWZEALAND 1.0 1.0
192 AUSTRALIA 1.0 1.0
193 [*,* ,CSV ,1996]: NEWZEALAND AUSTRALIA := 
194 NEWZEALAND 1.0 1.0
195 AUSTRALIA 1.0 1.0
196 [*,* ,CSV ,1997]: NEWZEALAND AUSTRALIA := 
197 NEWZEALAND 1.0 1.0
198 AUSTRALIA 1.0 1.0
199 [*,* ,CSV ,1998]: NEWZEALAND AUSTRALIA := 
200 NEWZEALAND 1.0 1.0
201 AUSTRALIA 1.0 1.0
202 [*,* ,CSV ,1999]: NEWZEALAND AUSTRALIA := 
203 NEWZEALAND 1.0 1.0
204 AUSTRALIA 1.0 1.0
205 [*,* ,CSV ,2000]: NEWZEALAND AUSTRALIA := 
206 NEWZEALAND 1.0 1.0
207 AUSTRALIA 1.0 1.0
208 [*,* ,CSV ,2001]: NEWZEALAND AUSTRALIA := 
209 NEWZEALAND 1.0 1.0
210 AUSTRALIA 1.0 1.0
211 [*,* ,CSV ,2002]: NEWZEALAND AUSTRALIA := 
212 NEWZEALAND 1.0 1.0
213 AUSTRALIA 1.0 1.0
214 [*,* ,CSV ,2003]: NEWZEALAND AUSTRALIA := 
215 NEWZEALAND 1.0 1.0
216 AUSTRALIA 1.0 1.0
217 [*,* ,CSV ,2004]: NEWZEALAND AUSTRALIA := 
218 NEWZEALAND 1.0 1.0
219 AUSTRALIA 1.0 1.0
220 [*,* ,CSV ,2005]: NEWZEALAND AUSTRALIA := 
221 NEWZEALAND 1.0 1.0
222 AUSTRALIA 1.0 1.0
223 [*,* ,CSV ,2006]: NEWZEALAND AUSTRALIA := 
224 NEWZEALAND 1.0 1.0
225 AUSTRALIA 1.0 1.0
226 [*,* ,CSV ,2007]: NEWZEALAND AUSTRALIA := 
227 NEWZEALAND 1.0 1.0
228 AUSTRALIA 1.0 1.0
229 [*,* ,CSV ,2008]: NEWZEALAND AUSTRALIA := 
230 NEWZEALAND 1.0 1.0
231 AUSTRALIA 1.0 1.0
232 [*,* ,CSV ,2009]: NEWZEALAND AUSTRALIA := 
233 NEWZEALAND 1.0 1.0
234 AUSTRALIA 1.0 1.0
```

```
235  [*,* ,CSV ,2010]: NEWZEALAND AUSTRALIA  :=  
236  NEWZEALAND 1.0 1.0  
237  AUSTRALIA 1.0 1.0  
238  [*,* ,DSL ,1990]: NEWZEALAND AUSTRALIA  :=  
239  NEWZEALAND 1.0 1.0  
240  AUSTRALIA 1.0 1.0  
241  [*,* ,DSL ,1991]: NEWZEALAND AUSTRALIA  :=  
242  NEWZEALAND 1.0 1.0  
243  AUSTRALIA 1.0 1.0  
244  [*,* ,DSL ,1992]: NEWZEALAND AUSTRALIA  :=  
245  NEWZEALAND 1.0 1.0  
246  AUSTRALIA 1.0 1.0  
247  [*,* ,DSL ,1993]: NEWZEALAND AUSTRALIA  :=  
248  NEWZEALAND 1.0 1.0  
249  AUSTRALIA 1.0 1.0  
250  [*,* ,DSL ,1994]: NEWZEALAND AUSTRALIA  :=  
251  NEWZEALAND 1.0 1.0  
252  AUSTRALIA 1.0 1.0  
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762 AUSTRALIA 1.0 1.0  
763 [*,* ,RH ,1997]: NEWZEALAND AUSTRALIA :=  
764 NEWZEALAND 1.0 1.0  
765 AUSTRALIA 1.0 1.0  
766 [*,* ,RH ,1998]: NEWZEALAND AUSTRALIA :=  
767 NEWZEALAND 1.0 1.0  
768 AUSTRALIA 1.0 1.0  
769 [*,* ,RH ,1999]: NEWZEALAND AUSTRALIA :=  
770 NEWZEALAND 1.0 1.0  
771 AUSTRALIA 1.0 1.0  
772 [*,* ,RH ,2000]: NEWZEALAND AUSTRALIA :=  
773 NEWZEALAND 1.0 1.0  
774 AUSTRALIA 1.0 1.0  
775 [*,* ,RH ,2001]: NEWZEALAND AUSTRALIA :=  
776 NEWZEALAND 1.0 1.0  
777 AUSTRALIA 1.0 1.0  
778 [*,* ,RH ,2002]: NEWZEALAND AUSTRALIA :=  
779 NEWZEALAND 1.0 1.0  
780 AUSTRALIA 1.0 1.0  
781 [*,* ,RH ,2003]: NEWZEALAND AUSTRALIA :=  
782 NEWZEALAND 1.0 1.0  
783 AUSTRALIA 1.0 1.0  
784 [*,* ,RH ,2004]: NEWZEALAND AUSTRALIA :=  
785 NEWZEALAND 1.0 1.0  
786 AUSTRALIA 1.0 1.0  
787 [*,* ,RH ,2005]: NEWZEALAND AUSTRALIA :=  
788 NEWZEALAND 1.0 1.0  
789 AUSTRALIA 1.0 1.0  
790 [*,* ,RH ,2006]: NEWZEALAND AUSTRALIA :=  
791 NEWZEALAND 1.0 1.0  
792 AUSTRALIA 1.0 1.0  
793 [*,* ,RH ,2007]: NEWZEALAND AUSTRALIA :=  
794 NEWZEALAND 1.0 1.0  
795 AUSTRALIA 1.0 1.0  
796 [*,* ,RH ,2008]: NEWZEALAND AUSTRALIA :=  
797 NEWZEALAND 1.0 1.0  
798 AUSTRALIA 1.0 1.0  
799 [*,* ,RH ,2009]: NEWZEALAND AUSTRALIA :=  
800 NEWZEALAND 1.0 1.0  
801 AUSTRALIA 1.0 1.0  
802 [*,* ,RH ,2010]: NEWZEALAND AUSTRALIA :=  
803 NEWZEALAND 1.0 1.0  
804 AUSTRALIA 1.0 1.0  
805 [*,* ,RL ,1990]: NEWZEALAND AUSTRALIA :=  
806 NEWZEALAND 1.0 1.0  
807 AUSTRALIA 1.0 1.0  
808 [*,* ,RL ,1991]: NEWZEALAND AUSTRALIA :=  
809 NEWZEALAND 1.0 1.0  
810 AUSTRALIA 1.0 1.0  
811 [*,* ,RL ,1992]: NEWZEALAND AUSTRALIA :=  
812 NEWZEALAND 1.0 1.0  
813 AUSTRALIA 1.0 1.0  
814 [*,* ,RL ,1993]: NEWZEALAND AUSTRALIA :=
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815 NEWZEALAND 1.0 1.0
816 AUSTRALIA 1.0 1.0
817 [*,* ,RL ,1994]: NEWZEALAND AUSTRALIA := 
818 NEWZEALAND 1.0 1.0
819 AUSTRALIA 1.0 1.0
820 [*,* ,RL ,1995]: NEWZEALAND AUSTRALIA := 
821 NEWZEALAND 1.0 1.0
822 AUSTRALIA 1.0 1.0
823 [*,* ,RL ,1996]: NEWZEALAND AUSTRALIA := 
824 NEWZEALAND 1.0 1.0
825 AUSTRALIA 1.0 1.0
826 [*,* ,RL ,1997]: NEWZEALAND AUSTRALIA := 
827 NEWZEALAND 1.0 1.0
828 AUSTRALIA 1.0 1.0
829 [*,* ,RL ,1998]: NEWZEALAND AUSTRALIA := 
830 NEWZEALAND 1.0 1.0
831 AUSTRALIA 1.0 1.0
832 [*,* ,RL ,1999]: NEWZEALAND AUSTRALIA := 
833 NEWZEALAND 1.0 1.0
834 AUSTRALIA 1.0 1.0
835 [*,* ,RL ,2000]: NEWZEALAND AUSTRALIA := 
836 NEWZEALAND 1.0 1.0
837 AUSTRALIA 1.0 1.0
838 [*,* ,RL ,2001]: NEWZEALAND AUSTRALIA := 
839 NEWZEALAND 1.0 1.0
840 AUSTRALIA 1.0 1.0
841 [*,* ,RL ,2002]: NEWZEALAND AUSTRALIA := 
842 NEWZEALAND 1.0 1.0
843 AUSTRALIA 1.0 1.0
844 [*,* ,RL ,2003]: NEWZEALAND AUSTRALIA := 
845 NEWZEALAND 1.0 1.0
846 AUSTRALIA 1.0 1.0
847 [*,* ,RL ,2004]: NEWZEALAND AUSTRALIA := 
848 NEWZEALAND 1.0 1.0
849 AUSTRALIA 1.0 1.0
850 [*,* ,RL ,2005]: NEWZEALAND AUSTRALIA := 
851 NEWZEALAND 1.0 1.0
852 AUSTRALIA 1.0 1.0
853 [*,* ,RL ,2006]: NEWZEALAND AUSTRALIA := 
854 NEWZEALAND 1.0 1.0
855 AUSTRALIA 1.0 1.0
856 [*,* ,RL ,2007]: NEWZEALAND AUSTRALIA := 
857 NEWZEALAND 1.0 1.0
858 AUSTRALIA 1.0 1.0
859 [*,* ,RL ,2008]: NEWZEALAND AUSTRALIA := 
860 NEWZEALAND 1.0 1.0
861 AUSTRALIA 1.0 1.0
862 [*,* ,RL ,2009]: NEWZEALAND AUSTRALIA := 
863 NEWZEALAND 1.0 1.0
864 AUSTRALIA 1.0 1.0
865 [*,* ,RL ,2010]: NEWZEALAND AUSTRALIA := 
866 NEWZEALAND 1.0 1.0
867 AUSTRALIA 1.0 1.0
868 [*,* ,TX ,1990]: NEWZEALAND AUSTRALIA := 
869 NEWZEALAND 1.0 1.0
870 AUSTRALIA 1.0 1.0
871 [*,* ,TX ,1991]: NEWZEALAND AUSTRALIA := 
872 NEWZEALAND 1.0 1.0
```

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873 AUSTRALIA 1.0 1.0
874 [*,* ,TX,1992]: NEWZEALAND AUSTRALIA := 
875 NEWZEALAND 1.0 1.0
876 AUSTRALIA 1.0 1.0
877 [*,* ,TX,1993]: NEWZEALAND AUSTRALIA := 
878 NEWZEALAND 1.0 1.0
879 AUSTRALIA 1.0 1.0
880 [*,* ,TX,1994]: NEWZEALAND AUSTRALIA := 
881 NEWZEALAND 1.0 1.0
882 AUSTRALIA 1.0 1.0
883 [*,* ,TX,1995]: NEWZEALAND AUSTRALIA := 
884 NEWZEALAND 1.0 1.0
885 AUSTRALIA 1.0 1.0
886 [*,* ,TX,1996]: NEWZEALAND AUSTRALIA := 
887 NEWZEALAND 1.0 1.0
888 AUSTRALIA 1.0 1.0
889 [*,* ,TX,1997]: NEWZEALAND AUSTRALIA := 
890 NEWZEALAND 1.0 1.0
891 AUSTRALIA 1.0 1.0
892 [*,* ,TX,1998]: NEWZEALAND AUSTRALIA := 
893 NEWZEALAND 1.0 1.0
894 AUSTRALIA 1.0 1.0
895 [*,* ,TX,1999]: NEWZEALAND AUSTRALIA := 
896 NEWZEALAND 1.0 1.0
897 AUSTRALIA 1.0 1.0
898 [*,* ,TX,2000]: NEWZEALAND AUSTRALIA := 
899 NEWZEALAND 1.0 1.0
900 AUSTRALIA 1.0 1.0
901 [*,* ,TX,2001]: NEWZEALAND AUSTRALIA := 
902 NEWZEALAND 1.0 1.0
903 AUSTRALIA 1.0 1.0
904 [*,* ,TX,2002]: NEWZEALAND AUSTRALIA := 
905 NEWZEALAND 1.0 1.0
906 AUSTRALIA 1.0 1.0
907 [*,* ,TX,2003]: NEWZEALAND AUSTRALIA := 
908 NEWZEALAND 1.0 1.0
909 AUSTRALIA 1.0 1.0
910 [*,* ,TX,2004]: NEWZEALAND AUSTRALIA := 
911 NEWZEALAND 1.0 1.0
912 AUSTRALIA 1.0 1.0
913 [*,* ,TX,2005]: NEWZEALAND AUSTRALIA := 
914 NEWZEALAND 1.0 1.0
915 AUSTRALIA 1.0 1.0
916 [*,* ,TX,2006]: NEWZEALAND AUSTRALIA := 
917 NEWZEALAND 1.0 1.0
918 AUSTRALIA 1.0 1.0
919 [*,* ,TX,2007]: NEWZEALAND AUSTRALIA := 
920 NEWZEALAND 1.0 1.0
921 AUSTRALIA 1.0 1.0
922 [*,* ,TX,2008]: NEWZEALAND AUSTRALIA := 
923 NEWZEALAND 1.0 1.0
924 AUSTRALIA 1.0 1.0
925 [*,* ,TX,2009]: NEWZEALAND AUSTRALIA := 
926 NEWZEALAND 1.0 1.0
927 AUSTRALIA 1.0 1.0
928 [*,* ,TX,2010]: NEWZEALAND AUSTRALIA := 
929 NEWZEALAND 1.0 1.0
930 AUSTRALIA 1.0 1.0
```

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931 ;
932 #
933 param DepreciationMethod default 1:=
934 NEWZEALAND 1.0
935 AUSTRALIA 1.0
936 ;
937 #
938 param SpecifiedAnnualDemand default 1:=
939 [*,* ,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
940 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
941 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
942 [*,* ,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
943 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
944 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
945 [*,* ,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
946 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
947 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
948 [*,* ,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
949 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
950 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
951 [*,* ,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
952 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
953 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
954 [*,* ,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
955 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
956 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
957 [*,* ,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
958 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
959 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
960 [*,* ,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
961 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
962 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
963 [*,* ,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
964 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
965 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
966 [*,* ,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
967 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
968 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
969 [*,* ,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
970 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
971 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
972 [*,* ,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
973 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
974 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
975 [*,* ,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
976 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
977 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
978 [*,* ,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
979 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
980 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
981 [*,* ,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
982 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
983 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
984 [*,* ,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
985 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
986 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
987 [*,* ,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
988 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

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989 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
990 [*,* ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
991 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
992 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
993 [*,* ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
994 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
995 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
996 [*,* ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
997 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
998 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
999 [*,* ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
1000 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1001 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1002 ;
1003 #
1004 param SpecifiedDemandProfile default 1:=
1005 [*,* ,INTERMEDIATE_DAY ,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1006 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1007 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1008 [*,* ,INTERMEDIATE_DAY ,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1009 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1010 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1011 [*,* ,INTERMEDIATE_DAY ,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1012 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1013 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1014 [*,* ,INTERMEDIATE_DAY ,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1015 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1016 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1017 [*,* ,INTERMEDIATE_DAY ,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1018 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1019 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1020 [*,* ,INTERMEDIATE_DAY ,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1021 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1022 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1023 [*,* ,INTERMEDIATE_DAY ,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1024 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1025 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1026 [*,* ,INTERMEDIATE_DAY ,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1027 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1028 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1029 [*,* ,INTERMEDIATE_DAY ,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1030 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1031 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1032 [*,* ,INTERMEDIATE_DAY ,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1033 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1034 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1035 [*,* ,INTERMEDIATE_DAY ,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=

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1036 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1037 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1038 [*,* ,INTERMEDIATE_DAY ,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1039 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1040 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1041 [*,* ,INTERMEDIATE_DAY ,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1042 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1043 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1044 [*,* ,INTERMEDIATE_DAY ,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1045 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1046 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1047 [*,* ,INTERMEDIATE_DAY ,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1048 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1049 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1050 [*,* ,INTERMEDIATE_DAY ,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1051 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1052 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1053 [*,* ,INTERMEDIATE_DAY ,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1054 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1055 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1056 [*,* ,INTERMEDIATE_DAY ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1057 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1058 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1059 [*,* ,INTERMEDIATE_DAY ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1060 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1061 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1062 [*,* ,INTERMEDIATE_DAY ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1063 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1064 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1065 [*,* ,INTERMEDIATE_DAY ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH
    RL TX :=
1066 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1067 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1068 [*,* ,INTERMEDIATE_NIGHT ,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1069 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1070 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1071 [*,* ,INTERMEDIATE_NIGHT ,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1072 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1073 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1074 [*,* ,INTERMEDIATE_NIGHT ,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1075 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1076 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1077 [*,* ,INTERMEDIATE_NIGHT ,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1078 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1079 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

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1080 [*,* ,INTERMEDIATE_NIGHT ,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1081 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1082 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1083 [*,* ,INTERMEDIATE_NIGHT ,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1084 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1085 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1086 [*,* ,INTERMEDIATE_NIGHT ,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1087 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1088 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1089 [*,* ,INTERMEDIATE_NIGHT ,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1090 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1091 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1092 [*,* ,INTERMEDIATE_NIGHT ,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1093 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1094 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1095 [*,* ,INTERMEDIATE_NIGHT ,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1096 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1097 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1098 [*,* ,INTERMEDIATE_NIGHT ,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1099 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1100 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1101 [*,* ,INTERMEDIATE_NIGHT ,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1102 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1103 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1104 [*,* ,INTERMEDIATE_NIGHT ,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1105 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1106 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1107 [*,* ,INTERMEDIATE_NIGHT ,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1108 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1109 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1110 [*,* ,INTERMEDIATE_NIGHT ,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1111 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1112 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1113 [*,* ,INTERMEDIATE_NIGHT ,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1114 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1115 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1116 [*,* ,INTERMEDIATE_NIGHT ,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1117 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1118 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1119 [*,* ,INTERMEDIATE_NIGHT ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=
1120 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1121 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1122 [*,* ,INTERMEDIATE_NIGHT ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN
    RH RL TX :=

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1123 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1124 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1125 [*,* ,INTERMEDIATE_NIGHT ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN
      RH RL TX :=
1126 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1127 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1128 [*,* ,INTERMEDIATE_NIGHT ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN
      RH RL TX :=
1129 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1130 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1131 [*,* ,SUMMER_DAY ,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1132 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1133 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1134 [*,* ,SUMMER_DAY ,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1135 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1136 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1137 [*,* ,SUMMER_DAY ,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1138 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1139 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1140 [*,* ,SUMMER_DAY ,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1141 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1142 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1143 [*,* ,SUMMER_DAY ,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1144 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1145 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1146 [*,* ,SUMMER_DAY ,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1147 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1148 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1149 [*,* ,SUMMER_DAY ,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1150 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1151 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1152 [*,* ,SUMMER_DAY ,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1153 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1154 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1155 [*,* ,SUMMER_DAY ,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1156 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1157 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1158 [*,* ,SUMMER_DAY ,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1159 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1160 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1161 [*,* ,SUMMER_DAY ,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1162 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1163 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1164 [*,* ,SUMMER_DAY ,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1165 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1166 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

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1167 [*,* ,SUMMER_DAY ,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1168   :=
1169 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1170 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1171 [*,* ,SUMMER_DAY ,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1172   :=
1173 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1174 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1175 [*,* ,SUMMER_DAY ,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1176   :=
1177 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1178 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1179 [*,* ,SUMMER_DAY ,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1180   :=
1181 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1182 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1183 [*,* ,SUMMER_DAY ,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1184   :=
1185 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1186 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1187 [*,* ,SUMMER_DAY ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1188   :=
1189 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1190 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1191 [*,* ,SUMMER_DAY ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1192   :=
1193 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1194 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1195 [*,* ,SUMMER_NIGHT ,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1196   TX :=
1197 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1198 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1199 [*,* ,SUMMER_NIGHT ,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1200   TX :=
1201 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1202 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1203 [*,* ,SUMMER_NIGHT ,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1204   TX :=
1205 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1206 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1207 [*,* ,SUMMER_NIGHT ,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1208   TX :=
1209 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1210 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1211 [*,* ,SUMMER_NIGHT ,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1212   TX :=
1213 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1214 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1215 [*,* ,SUMMER_NIGHT ,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1216   TX :=

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1210 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1211 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1212 [*,* ,SUMMER_NIGHT ,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1213 TX :=  

1214 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1215 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1216 [*,* ,SUMMER_NIGHT ,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1217 TX :=  

1218 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1219 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1220 [*,* ,SUMMER_NIGHT ,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1221 TX :=  

1222 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1223 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1224 [*,* ,SUMMER_NIGHT ,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1225 TX :=  

1226 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1227 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1228 [*,* ,SUMMER_NIGHT ,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1229 TX :=  

1230 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1231 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1232 [*,* ,SUMMER_NIGHT ,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1233 TX :=  

1234 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1235 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1236 [*,* ,SUMMER_NIGHT ,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1237 TX :=  

1238 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1239 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1240 [*,* ,SUMMER_NIGHT ,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1241 TX :=  

1242 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1243 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1244 [*,* ,SUMMER_NIGHT ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1245 TX :=  

1246 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1247 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1248 [*,* ,SUMMER_NIGHT ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1249 TX :=  

1250 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1251 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1252 [*,* ,SUMMER_NIGHT ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1253 TX :=  

1254 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1255 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

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1254 [*,* ,SUMMER_NIGHT ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1255 TX :=
1255 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1256 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1257 [*,* ,WINTER_DAY ,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1257 :=
1258 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1259 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1260 [*,* ,WINTER_DAY ,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1260 :=
1261 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1262 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1263 [*,* ,WINTER_DAY ,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1263 :=
1264 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1265 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1266 [*,* ,WINTER_DAY ,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1266 :=
1267 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1268 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1269 [*,* ,WINTER_DAY ,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1269 :=
1270 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1271 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1272 [*,* ,WINTER_DAY ,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1272 :=
1273 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1274 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1275 [*,* ,WINTER_DAY ,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1275 :=
1276 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1277 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1278 [*,* ,WINTER_DAY ,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1278 :=
1279 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1280 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1281 [*,* ,WINTER_DAY ,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1281 :=
1282 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1283 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1284 [*,* ,WINTER_DAY ,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1284 :=
1285 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1286 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1287 [*,* ,WINTER_DAY ,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1287 :=
1288 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1289 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1290 [*,* ,WINTER_DAY ,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1290 :=
1291 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1292 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1293 [*,* ,WINTER_DAY ,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1293 :=
1294 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1295 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1296 [*,* ,WINTER_DAY ,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
1296 :=

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1297 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1298 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1299 [*,* ,WINTER_DAY ,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1300 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1301 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1302 [*,* ,WINTER_DAY ,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1303 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1304 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1305 [*,* ,WINTER_DAY ,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1306 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1307 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1308 [*,* ,WINTER_DAY ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1309 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1310 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1311 [*,* ,WINTER_DAY ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1312 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1313 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1314 [*,* ,WINTER_DAY ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1315 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1316 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1317 [*,* ,WINTER_DAY ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX
      :=
1318 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1319 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1320 [*,* ,WINTER_NIGHT ,1990]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
      TX  :=
1321 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1322 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1323 [*,* ,WINTER_NIGHT ,1991]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
      TX  :=
1324 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1325 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1326 [*,* ,WINTER_NIGHT ,1992]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
      TX  :=
1327 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1328 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1329 [*,* ,WINTER_NIGHT ,1993]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
      TX  :=
1330 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1331 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1332 [*,* ,WINTER_NIGHT ,1994]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
      TX  :=
1333 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1334 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1335 [*,* ,WINTER_NIGHT ,1995]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
      TX  :=
1336 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1337 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1338 [*,* ,WINTER_NIGHT ,1996]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
      TX  :=
1339 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1340 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

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1341 [*,* ,WINTER_NIGHT ,1997]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1342 TX :=
1342 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1343 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1344 [*,* ,WINTER_NIGHT ,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1344 TX :=
1345 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1346 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1347 [*,* ,WINTER_NIGHT ,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1347 TX :=
1348 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1349 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1350 [*,* ,WINTER_NIGHT ,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1350 TX :=
1351 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1352 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1353 [*,* ,WINTER_NIGHT ,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1353 TX :=
1354 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1355 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1356 [*,* ,WINTER_NIGHT ,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1356 TX :=
1357 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1358 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1359 [*,* ,WINTER_NIGHT ,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1359 TX :=
1360 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1361 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1362 [*,* ,WINTER_NIGHT ,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1362 TX :=
1363 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1364 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1365 [*,* ,WINTER_NIGHT ,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1365 TX :=
1366 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1367 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1368 [*,* ,WINTER_NIGHT ,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1368 TX :=
1369 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1370 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1371 [*,* ,WINTER_NIGHT ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1371 TX :=
1372 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1373 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1374 [*,* ,WINTER_NIGHT ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1374 TX :=
1375 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1376 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1377 [*,* ,WINTER_NIGHT ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1377 TX :=
1378 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1379 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1380 [*,* ,WINTER_NIGHT ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL
1380 TX :=
1381 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1382 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1383 ;
1384 #

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1443 [*,* ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX :=  

1444 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

1445 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

1446 [*,* ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX :=  

1447 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

1448 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

1449 ;  

1450 #  

1451 param CapacityToActivityUnit :E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1  

    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu  

    :=  

1452 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1453 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1454 ;  

1455 #  

1456 param CapacityFactor default 1:=  

1457 [*,* ,INTERMEDIATE_DAY ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1  

    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu  

    :=  

1458 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1459 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1460 [*,* ,INTERMEDIATE_DAY ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1  

    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu  

    :=  

1461 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1462 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1463 [*,* ,INTERMEDIATE_DAY ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1  

    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu  

    :=  

1464 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1465 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1466 [*,* ,INTERMEDIATE_DAY ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1  

    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu  

    :=  

1467 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1468 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1469 [*,* ,INTERMEDIATE_DAY ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1  

    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu  

    :=  

1470 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1471 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0  

1472 [*,* ,INTERMEDIATE_DAY ,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1  

    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu  

    :=  

1473 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

    1.0 1.0 1.0 1.0 1.0

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1499 [*,* ,INTERMEDIATE_DAY ,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
1500 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1501 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1502 [*,* ,INTERMEDIATE_DAY ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
1503 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1504 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1505 [*,* ,INTERMEDIATE_DAY ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
1506 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1507 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1508 [*,* ,INTERMEDIATE_DAY ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
1509 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1510 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1511 [*,* ,INTERMEDIATE_DAY ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
1512 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1513 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1514 [*,* ,INTERMEDIATE_DAY ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
1515 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1516 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1517 [*,* ,INTERMEDIATE_DAY ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
1518 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1519 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1520 [*,* ,INTERMEDIATE_NIGHT ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu
    :=
1521 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1522 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1523 [*,* ,INTERMEDIATE_NIGHT ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1
    IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu

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1745 [*,* ,WINTER_DAY ,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1746 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1747 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1748 [*,* ,WINTER_DAY ,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1749 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1750 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1751 [*,* ,WINTER_DAY ,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1752 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1753 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1754 [*,* ,WINTER_DAY ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1755 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1756 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1757 [*,* ,WINTER_DAY ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1758 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1759 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1760 [*,* ,WINTER_DAY ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1761 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1762 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1763 [*,* ,WINTER_DAY ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1764 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1765 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1766 [*,* ,WINTER_DAY ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1767 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1768 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1769 [*,* ,WINTER_DAY ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1770 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1771 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1772 [*,* ,WINTER_NIGHT ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1773 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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1832 [*,* ,WINTER_NIGHT ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
1833     IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1833 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1833     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1834 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1834     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1835 ;
1836 #
1837 param AvailabilityFactor default 1:=
1838 [*,* ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
1838     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1839 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1839     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1840 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1840     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1841 [*,* ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
1841     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1842 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1842     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1843 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1843     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1844 [*,* ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
1844     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1845 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1845     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1846 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1846     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1847 [*,* ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
1847     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1848 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1848     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1849 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1849     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1850 [*,* ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
1850     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1851 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1851     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1852 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1852     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1853 [*,* ,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
1853     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1854 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1854     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1855 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1855     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1856 [*,* ,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
1856     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1857 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1857     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1858 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1858     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1859 [*,* ,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
1859     IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1860 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1860     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1861 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1861     1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

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1862 [*,* ,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1863 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1864 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1865 [*,* ,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1866 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1867 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1868 [*,* ,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1869 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1870 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1871 [*,* ,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1872 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1873 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1874 [*,* ,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1875 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1876 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1877 [*,* ,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1878 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1879 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1880 [*,* ,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1881 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1882 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1883 [*,* ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1884 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1885 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1886 [*,* ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1887 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1888 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1889 [*,* ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1890 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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1951 [*,* ,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1952 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1953 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1954 [*,* ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1955 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1956 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1957 [*,* ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1958 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1959 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1960 [*,* ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1961 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1962 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1963 [*,* ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1964 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1965 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1966 [*,* ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1967 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1968 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1969 [*,* ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1970 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1971 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1972 ;
1973 #
1974 param InputActivityRatio default 1:=
1975 [*,* ,CSV ,1,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1976 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1977 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1978 [*,* ,CSV ,1,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
1979 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
1980 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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2590 [*,* ,HCO ,2 ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2591 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2592 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2593 [*,* ,HCO ,2 ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2594 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2595 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2596 [*,* ,HCO ,2 ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2597 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2598 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2599 [*,* ,HCO ,2 ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2600 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2601 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2602 [*,* ,HCO ,2 ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2603 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2604 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2605 [*,* ,HYD ,1 ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2606 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2607 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2608 [*,* ,HYD ,1 ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2609 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2610 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2611 [*,* ,HYD ,1 ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2612 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2613 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2614 [*,* ,HYD ,1 ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2615 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2616 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
2617 [*,* ,HYD ,1 ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
2618 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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3460 [*,* ,TX ,2 ,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3461 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3462 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3463 [*,* ,TX ,2 ,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3464 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3465 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3466 [*,* ,TX ,2 ,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3467 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3468 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3469 [*,* ,TX ,2 ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3470 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3471 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3472 [*,* ,TX ,2 ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3473 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3474 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3475 [*,* ,TX ,2 ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3476 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3477 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3478 [*,* ,TX ,2 ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3479 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3480 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3481 [*,* ,TX ,2 ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3482 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3483 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3484 [*,* ,TX ,2 ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
3485 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3486 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
3487 ;
3488 #
3489 param OutputActivityRatio default 1:=

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5116 [*,* ,1,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5117 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5118 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5119 [*,* ,1,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5120 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5121 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5122 [*,* ,1,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5123 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5124 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5125 [*,* ,1,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5126 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5127 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5128 [*,* ,1,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5129 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5130 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5131 [*,* ,1,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5132 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5133 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5134 [*,* ,2,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5135 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5136 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5137 [*,* ,2,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5138 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5139 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5140 [*,* ,2,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5141 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5142 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5143 [*,* ,2,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5144 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0

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5262 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5263 ;
5264 #
5265 param TechnologyToStorage default 1:=
5266   [*,* ,DAM,1]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5267 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5268 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5269 [*,* ,DAM,2]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5270 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5271 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5272 ;
5273 #
5274 param TechnologyFromStorage default 1:=
5275   [*,* ,DAM,1]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5276 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5277 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5278 [*,* ,DAM,2]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5279 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5280 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5281 ;
5282 #
5283 param StorageLevelStart :DAM:=
5284 NEWZEALAND 1.0
5285 AUSTRALIA 1.0
5286 ;
5287 #
5288 param StorageMaxChargeRate :DAM:=
5289 NEWZEALAND 1.0
5290 AUSTRALIA 1.0
5291 ;
5292 #
5293 param StorageMaxDischargeRate :DAM:=
5294 NEWZEALAND 1.0
5295 AUSTRALIA 1.0
5296 ;
5297 #
5298 param MinStorageCharge default 1:=
5299   [*,* ,1990]: DAM :=
5300 NEWZEALAND 1.0
5301 AUSTRALIA 1.0
5302   [*,* ,1991]: DAM :=
5303 NEWZEALAND 1.0
5304 AUSTRALIA 1.0
5305   [*,* ,1992]: DAM :=
5306 NEWZEALAND 1.0

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5307 AUSTRALIA 1.0
5308 [*,* ,1993]: DAM :=
5309 NEWZEALAND 1.0
5310 AUSTRALIA 1.0
5311 [*,* ,1994]: DAM :=
5312 NEWZEALAND 1.0
5313 AUSTRALIA 1.0
5314 [*,* ,1995]: DAM :=
5315 NEWZEALAND 1.0
5316 AUSTRALIA 1.0
5317 [*,* ,1996]: DAM :=
5318 NEWZEALAND 1.0
5319 AUSTRALIA 1.0
5320 [*,* ,1997]: DAM :=
5321 NEWZEALAND 1.0
5322 AUSTRALIA 1.0
5323 [*,* ,1998]: DAM :=
5324 NEWZEALAND 1.0
5325 AUSTRALIA 1.0
5326 [*,* ,1999]: DAM :=
5327 NEWZEALAND 1.0
5328 AUSTRALIA 1.0
5329 [*,* ,2000]: DAM :=
5330 NEWZEALAND 1.0
5331 AUSTRALIA 1.0
5332 [*,* ,2001]: DAM :=
5333 NEWZEALAND 1.0
5334 AUSTRALIA 1.0
5335 [*,* ,2002]: DAM :=
5336 NEWZEALAND 1.0
5337 AUSTRALIA 1.0
5338 [*,* ,2003]: DAM :=
5339 NEWZEALAND 1.0
5340 AUSTRALIA 1.0
5341 [*,* ,2004]: DAM :=
5342 NEWZEALAND 1.0
5343 AUSTRALIA 1.0
5344 [*,* ,2005]: DAM :=
5345 NEWZEALAND 1.0
5346 AUSTRALIA 1.0
5347 [*,* ,2006]: DAM :=
5348 NEWZEALAND 1.0
5349 AUSTRALIA 1.0
5350 [*,* ,2007]: DAM :=
5351 NEWZEALAND 1.0
5352 AUSTRALIA 1.0
5353 [*,* ,2008]: DAM :=
5354 NEWZEALAND 1.0
5355 AUSTRALIA 1.0
5356 [*,* ,2009]: DAM :=
5357 NEWZEALAND 1.0
5358 AUSTRALIA 1.0
5359 [*,* ,2010]: DAM :=
5360 NEWZEALAND 1.0
5361 AUSTRALIA 1.0
5362 ;
5363 #
5364 param OperationalLifeStorage :DAM :=

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5365 NEWZEALAND 1.0
5366 AUSTRALIA 1.0
5367 ;
5368 #
5369 param CapitalCostStorage default 1:=
5370 [*,* ,1990]: DAM :=
5371 NEWZEALAND 1.0
5372 AUSTRALIA 1.0
5373 [*,* ,1991]: DAM :=
5374 NEWZEALAND 1.0
5375 AUSTRALIA 1.0
5376 [*,* ,1992]: DAM :=
5377 NEWZEALAND 1.0
5378 AUSTRALIA 1.0
5379 [*,* ,1993]: DAM :=
5380 NEWZEALAND 1.0
5381 AUSTRALIA 1.0
5382 [*,* ,1994]: DAM :=
5383 NEWZEALAND 1.0
5384 AUSTRALIA 1.0
5385 [*,* ,1995]: DAM :=
5386 NEWZEALAND 1.0
5387 AUSTRALIA 1.0
5388 [*,* ,1996]: DAM :=
5389 NEWZEALAND 1.0
5390 AUSTRALIA 1.0
5391 [*,* ,1997]: DAM :=
5392 NEWZEALAND 1.0
5393 AUSTRALIA 1.0
5394 [*,* ,1998]: DAM :=
5395 NEWZEALAND 1.0
5396 AUSTRALIA 1.0
5397 [*,* ,1999]: DAM :=
5398 NEWZEALAND 1.0
5399 AUSTRALIA 1.0
5400 [*,* ,2000]: DAM :=
5401 NEWZEALAND 1.0
5402 AUSTRALIA 1.0
5403 [*,* ,2001]: DAM :=
5404 NEWZEALAND 1.0
5405 AUSTRALIA 1.0
5406 [*,* ,2002]: DAM :=
5407 NEWZEALAND 1.0
5408 AUSTRALIA 1.0
5409 [*,* ,2003]: DAM :=
5410 NEWZEALAND 1.0
5411 AUSTRALIA 1.0
5412 [*,* ,2004]: DAM :=
5413 NEWZEALAND 1.0
5414 AUSTRALIA 1.0
5415 [*,* ,2005]: DAM :=
5416 NEWZEALAND 1.0
5417 AUSTRALIA 1.0
5418 [*,* ,2006]: DAM :=
5419 NEWZEALAND 1.0
5420 AUSTRALIA 1.0
5421 [*,* ,2007]: DAM :=
5422 NEWZEALAND 1.0
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5423 AUSTRALIA 1.0
5424 [*,* ,2008]: DAM :=
5425 NEWZEALAND 1.0
5426 AUSTRALIA 1.0
5427 [*,* ,2009]: DAM :=
5428 NEWZEALAND 1.0
5429 AUSTRALIA 1.0
5430 [*,* ,2010]: DAM :=
5431 NEWZEALAND 1.0
5432 AUSTRALIA 1.0
5433 ;
5434 #
5435 param ResidualStorageCapacity default 1: =
5436 [*,* ,1990]: DAM :=
5437 NEWZEALAND 1.0
5438 AUSTRALIA 1.0
5439 [*,* ,1991]: DAM :=
5440 NEWZEALAND 1.0
5441 AUSTRALIA 1.0
5442 [*,* ,1992]: DAM :=
5443 NEWZEALAND 1.0
5444 AUSTRALIA 1.0
5445 [*,* ,1993]: DAM :=
5446 NEWZEALAND 1.0
5447 AUSTRALIA 1.0
5448 [*,* ,1994]: DAM :=
5449 NEWZEALAND 1.0
5450 AUSTRALIA 1.0
5451 [*,* ,1995]: DAM :=
5452 NEWZEALAND 1.0
5453 AUSTRALIA 1.0
5454 [*,* ,1996]: DAM :=
5455 NEWZEALAND 1.0
5456 AUSTRALIA 1.0
5457 [*,* ,1997]: DAM :=
5458 NEWZEALAND 1.0
5459 AUSTRALIA 1.0
5460 [*,* ,1998]: DAM :=
5461 NEWZEALAND 1.0
5462 AUSTRALIA 1.0
5463 [*,* ,1999]: DAM :=
5464 NEWZEALAND 1.0
5465 AUSTRALIA 1.0
5466 [*,* ,2000]: DAM :=
5467 NEWZEALAND 1.0
5468 AUSTRALIA 1.0
5469 [*,* ,2001]: DAM :=
5470 NEWZEALAND 1.0
5471 AUSTRALIA 1.0
5472 [*,* ,2002]: DAM :=
5473 NEWZEALAND 1.0
5474 AUSTRALIA 1.0
5475 [*,* ,2003]: DAM :=
5476 NEWZEALAND 1.0
5477 AUSTRALIA 1.0
5478 [*,* ,2004]: DAM :=
5479 NEWZEALAND 1.0
5480 AUSTRALIA 1.0
```

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5481 [*,* ,2005]: DAM :=  

5482 NEWZEALAND 1.0  

5483 AUSTRALIA 1.0  

5484 [*,* ,2006]: DAM :=  

5485 NEWZEALAND 1.0  

5486 AUSTRALIA 1.0  

5487 [*,* ,2007]: DAM :=  

5488 NEWZEALAND 1.0  

5489 AUSTRALIA 1.0  

5490 [*,* ,2008]: DAM :=  

5491 NEWZEALAND 1.0  

5492 AUSTRALIA 1.0  

5493 [*,* ,2009]: DAM :=  

5494 NEWZEALAND 1.0  

5495 AUSTRALIA 1.0  

5496 [*,* ,2010]: DAM :=  

5497 NEWZEALAND 1.0  

5498 AUSTRALIA 1.0  

5499 ;  

5500 #  

5501 param CapacityOfOneTechnologyUnit default 1:=  

5502 [*,* ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

   IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

5503 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5504 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5505 [*,* ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

   IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

5506 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5507 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5508 [*,* ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

   IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

5509 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5510 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5511 [*,* ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

   IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

5512 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5513 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5514 [*,* ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

   IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

5515 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5516 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5517 [*,* ,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

   IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

5518 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0  

5519 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

   1.0 1.0 1.0 1.0 1.0

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5667 [*,* ,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5668 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5669 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5670 [*,* ,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5671 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5672 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5673 [*,* ,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5674 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5675 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5676 [*,* ,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5677 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5678 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5679 [*,* ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5680 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5681 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5682 [*,* ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5683 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5684 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5685 [*,* ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5686 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5687 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5688 [*,* ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5689 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5690 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5691 [*,* ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5692 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5693 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0
5694 [*,* ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5695 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0 1.0

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5814 [*,* ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5815 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5816 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5817 [*,* ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5818 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5819 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5820 [*,* ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5821 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5822 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5823 [*,* ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5824 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5825 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5826 [*,* ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5827 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5828 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5829 ;
5830 #
5831 param TotalTechnologyAnnualActivityLowerLimit default 1:=
5832 [*,* ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5833 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5834 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5835 [*,* ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5836 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5837 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5838 [*,* ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5839 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5840 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5841 [*,* ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5842 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5843 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0

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5844 [*,* ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5845 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5846 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5847 [*,* ,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5848 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5849 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5850 [*,* ,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5851 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5852 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5853 [*,* ,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5854 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5855 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5856 [*,* ,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5857 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5858 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5859 [*,* ,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5860 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5861 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5862 [*,* ,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5863 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5864 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5865 [*,* ,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5866 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5867 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5868 [*,* ,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5869 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5870 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5871 [*,* ,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5872 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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5961 ;
5962 #
5963 param TotalTechnologyModelPeriodActivityUpperLimit :E01 E21 E31 E51
      E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE
      TXG RIV RHu RLu TXu :=
5964 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5965 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5966 ;
5967 #
5968 param TotalTechnologyModelPeriodActivityLowerLimit :E01 E21 E31 E51
      E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE
      TXG RIV RHu RLu TXu :=
5969 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5970 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5971 ;
5972 #
5973 param ReserveMarginTagTechnology default 1:-
5974 [*,* ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5975 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5976 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5977 [*,* ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5978 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5979 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5980 [*,* ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5981 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5982 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5983 [*,* ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5984 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5985 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5986 [*,* ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5987 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5988 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5989 [*,* ,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
      IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5990 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0
5991 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
      1.0 1.0 1.0 1.0 1.0

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5992 [*,* ,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5993 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5994 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5995 [*,* ,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5996 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5997 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
5998 [*,* ,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
5999 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6000 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6001 [*,* ,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6002 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6003 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6004 [*,* ,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6005 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6006 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6007 [*,* ,2001]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6008 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6009 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6010 [*,* ,2002]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6011 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6012 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6013 [*,* ,2003]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6014 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6015 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6016 [*,* ,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6017 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6018 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6019 [*,* ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6020 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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6063 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6064 [*,* ,1998]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6065 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6066 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6067 [*,* ,1999]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6068 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6069 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6070 [*,* ,2000]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6071 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6072 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6073 [*,* ,2001]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6074 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6075 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6076 [*,* ,2002]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6077 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6078 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6079 [*,* ,2003]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6080 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6081 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6082 [*,* ,2004]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6083 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6084 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6085 [*,* ,2005]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6086 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6087 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6088 [*,* ,2006]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6089 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6090 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6091 [*,* ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6092 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6093 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6094 [*,* ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6095 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6096 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6097 [*,* ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6098 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6099 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6100 [*,* ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX := 
6101 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6102 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
6103 ;
6104 #
6105 param ReserveMargin :1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
       2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010:=
6106 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6107 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6108 ;
6109 #
6110 param RETagTechnology default 1:=
6111 [*,* ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHCO1 IMPOIL1
       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6112 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6113 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0

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6114 [*,* ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6115 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6116 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6117 [*,* ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6118 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6119 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6120 [*,* ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6121 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6122 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6123 [*,* ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6124 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6125 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6126 [*,* ,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6127 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6128 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6129 [*,* ,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6130 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6131 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6132 [*,* ,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6133 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6134 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6135 [*,* ,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6136 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6137 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6138 [*,* ,1999]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6139 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6140 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6141 [*,* ,2000]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6142 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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6228 [*,* ,2007]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX :=  

6229 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

6230 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

6231 [*,* ,2008]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX :=  

6232 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

6233 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

6234 [*,* ,2009]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX :=  

6235 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

6236 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

6237 [*,* ,2010]: CSV DSL ELC GSL HCO HYD LTH OIL URN RH RL TX :=  

6238 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

6239 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

6240 ;  

6241 #  

6242 param REMinProductionTarget :1990 1991 1992 1993 1994 1995 1996 1997  

       1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010:=  

6243 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6244 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6245 ;  

6246 #  

6247 param EmissionActivityRatio default 1:=  

6248 [*,* ,C02 ,1 ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

6249 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6250 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6251 [*,* ,C02 ,1 ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

6252 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6253 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6254 [*,* ,C02 ,1 ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

6255 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6256 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6257 [*,* ,C02 ,1 ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

6258 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6259 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6260 [*,* ,C02 ,1 ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

6261 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6262 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0  

6263 [*,* ,C02 ,1 ,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1  

       IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=  

6264 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0  

       1.0 1.0 1.0 1.0 1.0

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6497 [*,* ,NOX ,2 ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6498 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6499 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6500 [*,* ,CO ,1 ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6501 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6502 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6503 [*,* ,CO ,1 ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6504 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6505 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6506 [*,* ,CO ,1 ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6507 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6508 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6509 [*,* ,CO ,1 ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6510 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6511 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6512 [*,* ,CO ,1 ,1994]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6513 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6514 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6515 [*,* ,CO ,1 ,1995]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6516 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6517 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6518 [*,* ,CO ,1 ,1996]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6519 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6520 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6521 [*,* ,CO ,1 ,1997]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6522 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6523 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6524 [*,* ,CO ,1 ,1998]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01 IMPOIL1
    IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6525 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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6671 [*,* ,METHANE ,1 ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6672 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6673 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6674 [*,* ,METHANE ,1 ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6675 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6676 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6677 [*,* ,METHANE ,1 ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6678 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6679 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6680 [*,* ,METHANE ,1 ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6681 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6682 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6683 [*,* ,METHANE ,1 ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6684 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6685 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6686 [*,* ,METHANE ,1 ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6687 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6688 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6689 [*,* ,METHANE ,2 ,1990]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6690 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6691 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6692 [*,* ,METHANE ,2 ,1991]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6693 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6694 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6695 [*,* ,METHANE ,2 ,1992]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6696 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6697 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0
6698 [*,* ,METHANE ,2 ,1993]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
    IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6699 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
    1.0 1.0 1.0 1.0 1.0 1.0

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6729 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6730 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6731 [*,* ,METHANE ,2 ,2004]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
      IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6732 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6733 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6734 [*,* ,METHANE ,2 ,2005]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
      IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6735 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6736 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6737 [*,* ,METHANE ,2 ,2006]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
      IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6738 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6739 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6740 [*,* ,METHANE ,2 ,2007]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
      IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6741 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6742 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6743 [*,* ,METHANE ,2 ,2008]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
      IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6744 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6745 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6746 [*,* ,METHANE ,2 ,2009]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
      IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6747 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6748 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6749 [*,* ,METHANE ,2 ,2010]: E01 E21 E31 E51 E70 IMPDSL1 IMPGSL1 IMPHC01
      IMPOIL1 IMPURN1 RHE RHO RL1 SRE TXD TXE TXG RIV RHu RLu TXu :=
6750 NEWZEALAND 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6751 AUSTRALIA 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
       1.0 1.0 1.0 1.0 1.0 1.0
6752 ;
6753 #
6754 param EmissionsPenalty default 1:-
6755 [*,* ,1990]: CO2 NOX CO METHANE  :=
6756 NEWZEALAND 1.0 1.0 1.0 1.0
6757 AUSTRALIA 1.0 1.0 1.0 1.0
6758 [*,* ,1991]: CO2 NOX CO METHANE  :=
6759 NEWZEALAND 1.0 1.0 1.0 1.0
6760 AUSTRALIA 1.0 1.0 1.0 1.0
6761 [*,* ,1992]: CO2 NOX CO METHANE  :=
6762 NEWZEALAND 1.0 1.0 1.0 1.0
6763 AUSTRALIA 1.0 1.0 1.0 1.0

```

```

6764 [*,* ,1993]: CO2 NOX CO METHANE :=  

6765 NEWZEALAND 1.0 1.0 1.0 1.0  

6766 AUSTRALIA 1.0 1.0 1.0 1.0  

6767 [*,* ,1994]: CO2 NOX CO METHANE :=  

6768 NEWZEALAND 1.0 1.0 1.0 1.0  

6769 AUSTRALIA 1.0 1.0 1.0 1.0  

6770 [*,* ,1995]: CO2 NOX CO METHANE :=  

6771 NEWZEALAND 1.0 1.0 1.0 1.0  

6772 AUSTRALIA 1.0 1.0 1.0 1.0  

6773 [*,* ,1996]: CO2 NOX CO METHANE :=  

6774 NEWZEALAND 1.0 1.0 1.0 1.0  

6775 AUSTRALIA 1.0 1.0 1.0 1.0  

6776 [*,* ,1997]: CO2 NOX CO METHANE :=  

6777 NEWZEALAND 1.0 1.0 1.0 1.0  

6778 AUSTRALIA 1.0 1.0 1.0 1.0  

6779 [*,* ,1998]: CO2 NOX CO METHANE :=  

6780 NEWZEALAND 1.0 1.0 1.0 1.0  

6781 AUSTRALIA 1.0 1.0 1.0 1.0  

6782 [*,* ,1999]: CO2 NOX CO METHANE :=  

6783 NEWZEALAND 1.0 1.0 1.0 1.0  

6784 AUSTRALIA 1.0 1.0 1.0 1.0  

6785 [*,* ,2000]: CO2 NOX CO METHANE :=  

6786 NEWZEALAND 1.0 1.0 1.0 1.0  

6787 AUSTRALIA 1.0 1.0 1.0 1.0  

6788 [*,* ,2001]: CO2 NOX CO METHANE :=  

6789 NEWZEALAND 1.0 1.0 1.0 1.0  

6790 AUSTRALIA 1.0 1.0 1.0 1.0  

6791 [*,* ,2002]: CO2 NOX CO METHANE :=  

6792 NEWZEALAND 1.0 1.0 1.0 1.0  

6793 AUSTRALIA 1.0 1.0 1.0 1.0  

6794 [*,* ,2003]: CO2 NOX CO METHANE :=  

6795 NEWZEALAND 1.0 1.0 1.0 1.0  

6796 AUSTRALIA 1.0 1.0 1.0 1.0  

6797 [*,* ,2004]: CO2 NOX CO METHANE :=  

6798 NEWZEALAND 1.0 1.0 1.0 1.0  

6799 AUSTRALIA 1.0 1.0 1.0 1.0  

6800 [*,* ,2005]: CO2 NOX CO METHANE :=  

6801 NEWZEALAND 1.0 1.0 1.0 1.0  

6802 AUSTRALIA 1.0 1.0 1.0 1.0  

6803 [*,* ,2006]: CO2 NOX CO METHANE :=  

6804 NEWZEALAND 1.0 1.0 1.0 1.0  

6805 AUSTRALIA 1.0 1.0 1.0 1.0  

6806 [*,* ,2007]: CO2 NOX CO METHANE :=  

6807 NEWZEALAND 1.0 1.0 1.0 1.0  

6808 AUSTRALIA 1.0 1.0 1.0 1.0  

6809 [*,* ,2008]: CO2 NOX CO METHANE :=  

6810 NEWZEALAND 1.0 1.0 1.0 1.0  

6811 AUSTRALIA 1.0 1.0 1.0 1.0  

6812 [*,* ,2009]: CO2 NOX CO METHANE :=  

6813 NEWZEALAND 1.0 1.0 1.0 1.0  

6814 AUSTRALIA 1.0 1.0 1.0 1.0  

6815 [*,* ,2010]: CO2 NOX CO METHANE :=  

6816 NEWZEALAND 1.0 1.0 1.0 1.0  

6817 AUSTRALIA 1.0 1.0 1.0 1.0  

6818 ;  

6819 #  

6820 param AnnualExogenousEmission default 1:=  

6821 [*,* ,1990]: CO2 NOX CO METHANE :=

```

```
6822 NEWZEALAND 1.0 1.0 1.0 1.0
6823 AUSTRALIA 1.0 1.0 1.0 1.0
6824 [*,* ,1991]: CO2 NOX CO METHANE := 
6825 NEWZEALAND 1.0 1.0 1.0 1.0
6826 AUSTRALIA 1.0 1.0 1.0 1.0
6827 [*,* ,1992]: CO2 NOX CO METHANE := 
6828 NEWZEALAND 1.0 1.0 1.0 1.0
6829 AUSTRALIA 1.0 1.0 1.0 1.0
6830 [*,* ,1993]: CO2 NOX CO METHANE := 
6831 NEWZEALAND 1.0 1.0 1.0 1.0
6832 AUSTRALIA 1.0 1.0 1.0 1.0
6833 [*,* ,1994]: CO2 NOX CO METHANE := 
6834 NEWZEALAND 1.0 1.0 1.0 1.0
6835 AUSTRALIA 1.0 1.0 1.0 1.0
6836 [*,* ,1995]: CO2 NOX CO METHANE := 
6837 NEWZEALAND 1.0 1.0 1.0 1.0
6838 AUSTRALIA 1.0 1.0 1.0 1.0
6839 [*,* ,1996]: CO2 NOX CO METHANE := 
6840 NEWZEALAND 1.0 1.0 1.0 1.0
6841 AUSTRALIA 1.0 1.0 1.0 1.0
6842 [*,* ,1997]: CO2 NOX CO METHANE := 
6843 NEWZEALAND 1.0 1.0 1.0 1.0
6844 AUSTRALIA 1.0 1.0 1.0 1.0
6845 [*,* ,1998]: CO2 NOX CO METHANE := 
6846 NEWZEALAND 1.0 1.0 1.0 1.0
6847 AUSTRALIA 1.0 1.0 1.0 1.0
6848 [*,* ,1999]: CO2 NOX CO METHANE := 
6849 NEWZEALAND 1.0 1.0 1.0 1.0
6850 AUSTRALIA 1.0 1.0 1.0 1.0
6851 [*,* ,2000]: CO2 NOX CO METHANE := 
6852 NEWZEALAND 1.0 1.0 1.0 1.0
6853 AUSTRALIA 1.0 1.0 1.0 1.0
6854 [*,* ,2001]: CO2 NOX CO METHANE := 
6855 NEWZEALAND 1.0 1.0 1.0 1.0
6856 AUSTRALIA 1.0 1.0 1.0 1.0
6857 [*,* ,2002]: CO2 NOX CO METHANE := 
6858 NEWZEALAND 1.0 1.0 1.0 1.0
6859 AUSTRALIA 1.0 1.0 1.0 1.0
6860 [*,* ,2003]: CO2 NOX CO METHANE := 
6861 NEWZEALAND 1.0 1.0 1.0 1.0
6862 AUSTRALIA 1.0 1.0 1.0 1.0
6863 [*,* ,2004]: CO2 NOX CO METHANE := 
6864 NEWZEALAND 1.0 1.0 1.0 1.0
6865 AUSTRALIA 1.0 1.0 1.0 1.0
6866 [*,* ,2005]: CO2 NOX CO METHANE := 
6867 NEWZEALAND 1.0 1.0 1.0 1.0
6868 AUSTRALIA 1.0 1.0 1.0 1.0
6869 [*,* ,2006]: CO2 NOX CO METHANE := 
6870 NEWZEALAND 1.0 1.0 1.0 1.0
6871 AUSTRALIA 1.0 1.0 1.0 1.0
6872 [*,* ,2007]: CO2 NOX CO METHANE := 
6873 NEWZEALAND 1.0 1.0 1.0 1.0
6874 AUSTRALIA 1.0 1.0 1.0 1.0
6875 [*,* ,2008]: CO2 NOX CO METHANE := 
6876 NEWZEALAND 1.0 1.0 1.0 1.0
6877 AUSTRALIA 1.0 1.0 1.0 1.0
6878 [*,* ,2009]: CO2 NOX CO METHANE := 
6879 NEWZEALAND 1.0 1.0 1.0 1.0
```

```
6880 AUSTRALIA 1.0 1.0 1.0 1.0
6881 [*,* ,2010]: CO2 NOX CO METHANE := 
6882 NEWZEALAND 1.0 1.0 1.0 1.0
6883 AUSTRALIA 1.0 1.0 1.0 1.0
6884 ;
6885 #
6886 param AnnualEmissionLimit default 1:=
6887 [*,* ,1990]: CO2 NOX CO METHANE := 
6888 NEWZEALAND 1.0 1.0 1.0 1.0
6889 AUSTRALIA 1.0 1.0 1.0 1.0
6890 [*,* ,1991]: CO2 NOX CO METHANE := 
6891 NEWZEALAND 1.0 1.0 1.0 1.0
6892 AUSTRALIA 1.0 1.0 1.0 1.0
6893 [*,* ,1992]: CO2 NOX CO METHANE := 
6894 NEWZEALAND 1.0 1.0 1.0 1.0
6895 AUSTRALIA 1.0 1.0 1.0 1.0
6896 [*,* ,1993]: CO2 NOX CO METHANE := 
6897 NEWZEALAND 1.0 1.0 1.0 1.0
6898 AUSTRALIA 1.0 1.0 1.0 1.0
6899 [*,* ,1994]: CO2 NOX CO METHANE := 
6900 NEWZEALAND 1.0 1.0 1.0 1.0
6901 AUSTRALIA 1.0 1.0 1.0 1.0
6902 [*,* ,1995]: CO2 NOX CO METHANE := 
6903 NEWZEALAND 1.0 1.0 1.0 1.0
6904 AUSTRALIA 1.0 1.0 1.0 1.0
6905 [*,* ,1996]: CO2 NOX CO METHANE := 
6906 NEWZEALAND 1.0 1.0 1.0 1.0
6907 AUSTRALIA 1.0 1.0 1.0 1.0
6908 [*,* ,1997]: CO2 NOX CO METHANE := 
6909 NEWZEALAND 1.0 1.0 1.0 1.0
6910 AUSTRALIA 1.0 1.0 1.0 1.0
6911 [*,* ,1998]: CO2 NOX CO METHANE := 
6912 NEWZEALAND 1.0 1.0 1.0 1.0
6913 AUSTRALIA 1.0 1.0 1.0 1.0
6914 [*,* ,1999]: CO2 NOX CO METHANE := 
6915 NEWZEALAND 1.0 1.0 1.0 1.0
6916 AUSTRALIA 1.0 1.0 1.0 1.0
6917 [*,* ,2000]: CO2 NOX CO METHANE := 
6918 NEWZEALAND 1.0 1.0 1.0 1.0
6919 AUSTRALIA 1.0 1.0 1.0 1.0
6920 [*,* ,2001]: CO2 NOX CO METHANE := 
6921 NEWZEALAND 1.0 1.0 1.0 1.0
6922 AUSTRALIA 1.0 1.0 1.0 1.0
6923 [*,* ,2002]: CO2 NOX CO METHANE := 
6924 NEWZEALAND 1.0 1.0 1.0 1.0
6925 AUSTRALIA 1.0 1.0 1.0 1.0
6926 [*,* ,2003]: CO2 NOX CO METHANE := 
6927 NEWZEALAND 1.0 1.0 1.0 1.0
6928 AUSTRALIA 1.0 1.0 1.0 1.0
6929 [*,* ,2004]: CO2 NOX CO METHANE := 
6930 NEWZEALAND 1.0 1.0 1.0 1.0
6931 AUSTRALIA 1.0 1.0 1.0 1.0
6932 [*,* ,2005]: CO2 NOX CO METHANE := 
6933 NEWZEALAND 1.0 1.0 1.0 1.0
6934 AUSTRALIA 1.0 1.0 1.0 1.0
6935 [*,* ,2006]: CO2 NOX CO METHANE := 
6936 NEWZEALAND 1.0 1.0 1.0 1.0
6937 AUSTRALIA 1.0 1.0 1.0 1.0
```

```

6938 [*,* ,2007]: CO2 NOX CO METHANE :=  

6939 NEWZEALAND 1.0 1.0 1.0 1.0  

6940 AUSTRALIA 1.0 1.0 1.0 1.0  

6941 [*,* ,2008]: CO2 NOX CO METHANE :=  

6942 NEWZEALAND 1.0 1.0 1.0 1.0  

6943 AUSTRALIA 1.0 1.0 1.0 1.0  

6944 [*,* ,2009]: CO2 NOX CO METHANE :=  

6945 NEWZEALAND 1.0 1.0 1.0 1.0  

6946 AUSTRALIA 1.0 1.0 1.0 1.0  

6947 [*,* ,2010]: CO2 NOX CO METHANE :=  

6948 NEWZEALAND 1.0 1.0 1.0 1.0  

6949 AUSTRALIA 1.0 1.0 1.0 1.0  

6950 ;  

6951 #  

6952 param ModelPeriodExogenousEmission :CO2 NOX CO METHANE :=  

6953 NEWZEALAND 1.0 1.0 1.0 1.0  

6954 AUSTRALIA 1.0 1.0 1.0 1.0  

6955 ;  

6956 #  

6957 param ModelPeriodEmissionLimit :CO2 NOX CO METHANE :=  

6958 NEWZEALAND 1.0 1.0 1.0 1.0  

6959 AUSTRALIA 1.0 1.0 1.0 1.0  

6960 ;  

6961 end;  

6962 #

```

4.3 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.

5 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 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 combine 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 BE 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 EN-GSCI 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

6 Bibliography

GOCPI

ABOUT PROJECT TEAM WORK CONTACT

Global Optimisation Carbon Pricing Initiatives

Discover what's instore for the project

[View Our Works](#)

Discover what's instore for the project

ABOUT PROJECT TEAM WORK CONTACT

ABOUT THE PROJECT

Model	Purpose	Output	System
The model adopts The Integrated Market EFORM System (TIMES) Model to model the entire energy system for a given geography	Communicate the urgency of addressing climate change while informing carbon pricing policy and sustainable investment strategies	Geography specific services demand profiles and energy system recommendations	The model is written in GAMS with supporting functionality provided by Python, HTML, CSS and JavaScript

GOCPI

ABOUT PROJECT TEAM WORK CONTACT

Experience

Connor is a Part IV Engineering Science Student. He has experience building mathematical and optimisation models. Connor has worked in several industries. These include Industrials, Professional Services, and Energy.

[View Our Works](#)

```
document.getElementById('div').innerHTML = '';
else if (i==2)
{
    var atpos=inputs[i].indexOf('@');
    var dotpos=inputs[i].lastIndexOf('.');
    if (atpos<1 || dotpos<atpos+2 || dotpos>inputs[i].length-2)
        document.getElementById('errEmail').innerHTML = 'Email address is invalid';
    else
        document.getElementById('div').innerHTML = '';
}
else if (i==5)
    document.getElementById('errEmail').innerHTML = 'Email address is invalid';
else
    document.getElementById('div').innerHTML = '';
}
```