Energy and Flexibility Modelling

Hands-on 4 (macOS)

Please use the following citation for:

- **This exercise**

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- **clicSANDMac Software**

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- **OSeMOSYS Google Forum**

Please sign up to the help Google forum here. If you are stuck, please ask questions here. If you get ahead, please answer questions in the same forum. Please state that you are using the 'clicSAND' Interface.

Learning outcomes

By the end of this exercise, you will be able to:

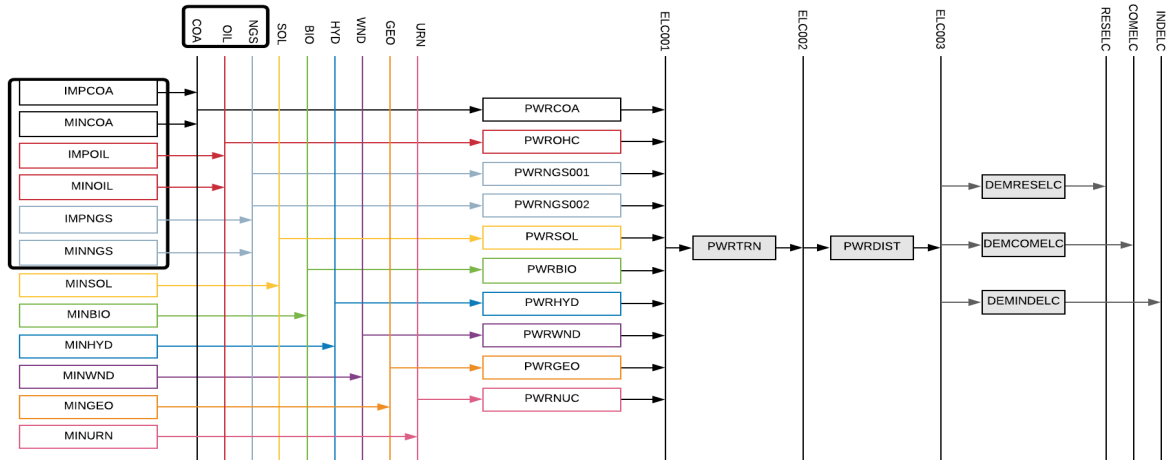
1) Define technologies representing the domestic production of energy commodities

2) Define technologies representing the import of energy commodities

We will not run the model at the end of this exercise.

Define technologies representing the domestic production of energy commodities

In Lecture 4 we learnt how to represent a technology in OSeMOSYS and which parameters characterize the primary energy supply technologies. These technologies can represent domestic production/extraction or importation of fuels such as coal, natural gas, and oil. In this Hands-On, we will add 6 technologies in total – 3 for imports and 3 for the domestic production of coal, natural gas, and oil. We will build the highlighted part of the RES:



In order to represent a primary supply technology, remember that the following **parameters** must be considered:

- **OutputActivityRatio**: defines the fuel provided (in this first example Coal)
- **Variable Cost**: defines the cost of coal extraction
- **TotatTechnologyModelPeriodUpperLimit**: defines the level of proven coal reserves that are available for extraction throughout the entire model period (we will express it in PJ)
- **TotalAnnualMaxCapacity**: defines the maximum annual rate of production of Coal
- **CapacityToAcitivityUnit**: used to convert data related to the Capacity of technology into the Activity it can generate. For primary supply technology, this value should be set to 1.

Let's add **MINCOA** - the technology representing the domestic extraction of coal.

1. Go to SETS and in cell B4 change the name from "TEC001" to "**MINCOA**" and the description to "**Coal Domestic Production**". In this way, we add the technology which will be providing Coal (**COA**) to the model.
2. Now let's add the **coal fuel** in Cell E4 following the same procedure.

Technologies			Commodities	
Code	*Description*		*Code*	*Description*
BACKSTOP	Backstop Technology		ELC003	Electricity after distribution
MINCOA	Coal domestic production		COA	Coal
TEC002	Additional Technology		COM003	Additional Fuel

3. Next, go to Parameters Sheet and filter out in Column C for **MINCOA** (as done in Hands-on 3 for the Backstop).
4. Add the data for **MINCOA** like the tables below and as given in the DataPrep file.
    a. **OutputActivityRatio**: choose the Coal Fuel row (Cell K31373) and paste 1 from 2015 to 2070

	Parameter	REGION	TECHNOLOGY	EMISSION	FUEL	2015	2016	2017
21262	InputActivityRatio	RE1	MINCOA		COM050	0	0	0
31124	OperationalLife	RE1	MINCOA					
31372	OutputActivityRatio	RE1	MINCOA		ELC003	0	0	0
31373	OutputActivityRatio	RE1	MINCOA		COA	1	1	1
31374	OutputActivityRatio	RE1	MINCOA		COM003	0	0	0
31375	OutputActivityRatio	RE1	MINCOA		COM004	0	0	0
31376	OutputActivityRatio	RE1	MINCOA		COM005	0	0	0

    b. **Variable Cost**:

	Parameter	REGION	TECHNOLOGY	EMISSION	FUEL	2015	2016	2017	2018	2019	2020	2021	2022	2023	20
47220	TotalAnnualMinCapacity	RE1	MINCOA			0	0	0	0	0	0	0	0	0	
47419	TotalAnnualMinCapacityInvestment	RE1	MINCOA			0	0	0	0	0	0	0	0	0	
47618	TotalTechnologyAnnualActivityLowerLimit	RE1	MINCOA			0	0	0	0	0	0	0	0	0	
47817	TotalTechnologyAnnualActivityUpperLimit	RE1	MINCOA			99999	99999	99999	99999	99999	99999	99999	99999	99999	
48016	TotalTechnologyModelPeriodActivityLowerLimit	RE1	MINCOA												
48215	TotalTechnologyModelPeriodActivityUpperLimit	RE1	MINCOA												
48464	VariableCost	RE1	MINCOA			3.3	3.5401	4.29278	4.22632	4.1601	4.09411	4.02926	3.964608	3.900171	3.

    c. **TotalTechnologyModelPeriodUpperLimit** - 400 Mt of domestic coal converted to PJ is 11723 PJ.

	Parameter	REGION	TECHNOLOGY	EMISSION	MODE_OF_OPERATION	FUEL	TIMESLICE	STORAGE	REGION2	Time indipendent variat	2015
47021	TotalAnnualMaxCapacityInvestment	RE1	MINCOA								99999
47220	TotalAnnualMinCapacity	RE1	MINCOA								0
47419	TotalAnnualMinCapacityInvestment	RE1	MINCOA								0
47618	TotalTechnologyAnnualActivityLowerLimit	RE1	MINCOA								0
47817	TotalTechnologyAnnualActivityUpperLimit	RE1	MINCOA								99999
48016	TotalTechnologyModelPeriodActivityLowerLimit	RE1	MINCOA							0	
48215	TotalTechnologyModelPeriodActivityUpperLimit	RE1	MINCOA							11723.04	
48464	VariableCost	RE1	MINCOA			1					3.3

d. **TotalAnnualMaxCapacity** - we will leave the default number (99999) which by being very high, means that we are not constraining the installed capacity of this technology.

	Parameter	REGION	TECHNOLOGY	TIMESLICE	Time indipendent varial	2015	2016	2017	2018
41574	ReserveMarginTagTechnology	RE1	MINCOA			0	0	0	0
41773	ResidualCapacity	RE1	MINCOA			0	0	0	0
46822	TotalAnnualMaxCapacity	RE1	MINCOA			99999	99999	99999	99999
47021	TotalAnnualMaxCapacityInvestment	RE1	MINCOA			99999	99999	99999	99999
47220	TotalAnnualMinCapacity	RE1	MINCOA			0	0	0	0
47419	TotalAnnualMinCapacityInvestment	RE1	MINCOA			0	0	0	0
47618	TotalTechnologyAnnualActivityLowerLimit	RE1	MINCOA			0	0	0	0
47817	TotalTechnologyAnnualActivityUpperLimit	RE1	MINCOA			99999	99999	99999	99999
48016	TotalTechnologyModelPeriodActivityLowerLimit	RE1	MINCOA		0				
48215	TotalTechnologyModelPeriodActivityUpperLimit	RE1	MINCOA		11723.04				
48464	VariableCost	RE1	MINCOA			3.3	3.5401	4.29278	4.22632

e. **CapacityToActivityUnit** - set to 1

	Parameter	REGION	TECHNOLOGY	TIMESLICE	Time indipendent vari	2015	2016
449	CapacityFactor	RE1	MINCOA	S421		1	1
450	CapacityFactor	RE1	MINCOA	S422		1	1
451	CapacityFactor	RE1	MINCOA	S423		1	1
452	CapacityFactor	RE1	MINCOA	S424		1	1
19366	CapacityOfOneTechnologyUnit	RE1	MINCOA			0	0
19565	CapacityToActivityUnit	RE1	MINCOA		1		
19764	CapitalCost	RE1	MINCOA			0.0001	0.0001
19969	EmissionActivityRatio	RE1	MINCOA			0	0
19970	EmissionActivityRatio	RE1	MINCOA			0	0

Repeat the same steps for

1) **MINOIL** - domestic extraction/production of Oil
2) **MINNGS** - domestic extraction/production of Natural Gas

Using the data provided in the DataPrep file.

You have now added 3 new technologies (MINCOA, MINOIL, MINNGS) and 3 fuels (COA; OIL, NGS) to your model.

Define technologies representing the import of energy commodities

We will repeat the exercise once more giving the example of a technology which represents the **import of coal (IMPCOA)**. When representing an Import technology, the following parameters must be considered:

- **OutputActivityRatio**: defines the rate of fuel provided (in this first example Coal)
- **VariableCost**: defines the cost of importing the fuel.

- **CapacityToActivityUnit**: used to convert data related to the Capacity of technology into the Activity it can generate. For primary supply technologies, this value should be set to 1.

Now let's add this technology in the model.

1. Go to SETS and add **IMPCOA** in Cell B7 (remember that you should have previously added **MINOIL** and **MINNGS**).
2. You should not add any new fuel as COA, OIL and NGS were defined in the previous section.

B	C	D	E	F
Technologies			**Commodities**	
Code	*Description*		*Code*	*Description*
BACKSTOP	Backstop technology		ELC003	Final Electricity demand
MINCOA	Coal domestic production		COA	Coal
MINOIL	Oil domestic production		OIL	Oil
MINNGS	Natural gas domestic production		NGS	Natural Gas
IMPCOA	Import of Coal		COM005	Additional Fuel
IMPOIL	Import of Oil		COM006	Additional Fuel
IMPNGS	Import of Natural Gas		COM007	Additional Fuel

3. Add data for **OutputActivityRatio**, **VariableCost** and **CapacityToActivityUnit** as presented in the DataPrep file.
4. Repeat the same steps for **IMPOIL** and **IMPNGS** using the data provided in the DataPrep file.