Energy and Flexibility Modelling

Hands-on 8 (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.

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Learning outcomes

By the end of this exercise, you will be able to represent the following in OSeMOSYS:

1) Emissions

2) Reserve Margin

Emissions representation

As we learnt in Lecture 9, to account for emissions we need to use specific OSeMOSYS parameters:

- **EmissionActivityRatio** [kg/GJ or Mt/GWh]: defines the rate of emission by each technology
- **EmissionsPenalty** [M$/Mt]: used to define a cost per unit of emission
- **AnnualExogenousEmission** [Mt]: defines the annual level of emissions not captured by the modelled system but that should be accounted for
- **AnnualEmissionLimit** [Mt]: sets an annual upper limit on the total annual emissions of a particular pollutant
- **ModelPeriodExogenousEmission** [Mt]: defines the model period level of emissions not captured by the modelled system but that should be accounted for
- **ModelPeriodEmissionLimit** [Mt]: sets an upper limit on total model period emissions of a particular pollutant
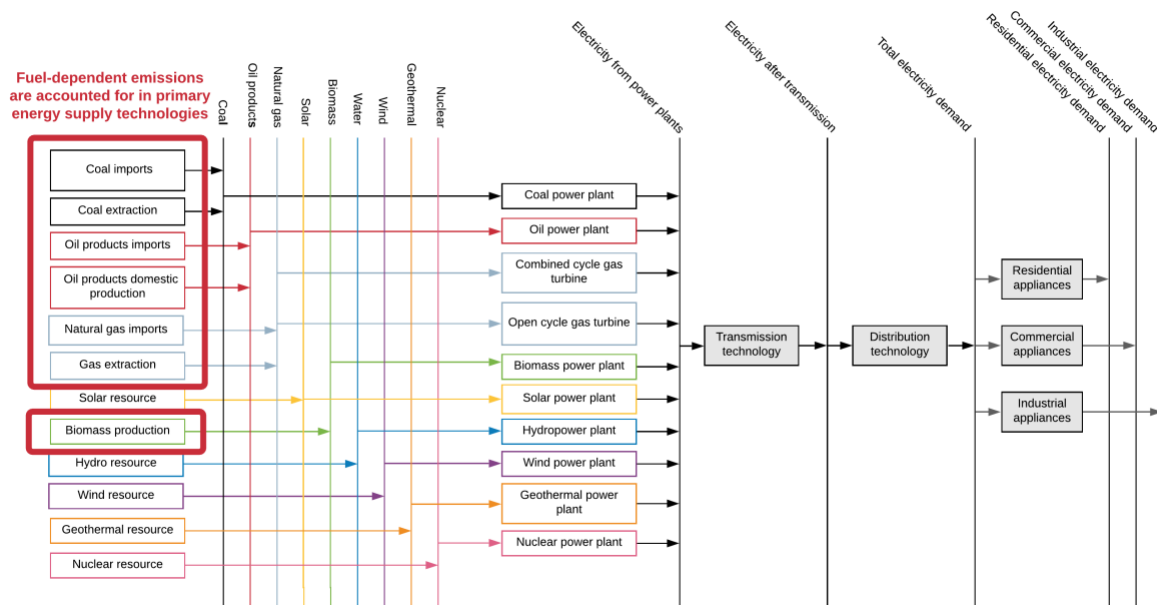
In this exercise we will add Fuel-dependent emissions. Therefore, we will associate emission flows to the primary supply technologies.

Try it: add **Emissions Activity Ratios** for the following primary technologies.

1. We will NOT add any new technologies or fuels in this exercise.

2. Go to **Parameters Sheet** -> Filter out in column A for **Emission Activity Ratio**
3. Filter out in Column C for
    a. **MINCOA**
    b. **MINOIL**
    c. **MINNGS**
    d. **IMPCOA**
    e. **IMPOIL**
    f. **IMPNGS**
    g. **MINBIO**
4. Filter out in column D (Emissions) for **EMICO2** which corresponds to the Emissions of Carbon Dioxide.
5. Add the data from 2015 to 2070 for each of the filtered rows as shown below. You will find the data in the Data Prep file for this exercise.
6. For the moment, this is the only Parameter related to Emissions that we will employ.

	A	B	C	D	K	L	M	N	O	P
1	Parameter	REGION	TECHNOLOGY	EMISSION	2015	2016	2017	2018	2019	2020
13363	EmissionActivityRatio	RE1	MINCOA	EMIC02	94.6	94.6	94.6	94.6	94.6	94.6
13974	EmissionActivityRatio	RE1	MINOIL	EMIC02	73.3	73.3	73.3	73.3	73.3	73.3
13979	EmissionActivityRatio	RE1	MINNGS	EMIC02	56.1	56.1	56.1	56.1	56.1	56.1
13984	EmissionActivityRatio	RE1	IMPCOA	EMIC02	94.6	94.6	94.6	94.6	94.6	94.6
13989	EmissionActivityRatio	RE1	IMPOIL	EMIC02	73.3	73.3	73.3	73.3	73.3	73.3
13994	EmissionActivityRatio	RE1	IMPNGS	EMIC02	56.1	56.1	56.1	56.1	56.1	56.1
20023	EmissionActivityRatio	RE1	MINBIO	EMIC02	100	100	100	100	100	100

Reserve Margin

Try it: add reserve margin values

1. Clear all the filters from Parameters Sheet
2. Filter out in Column A for **Reserve Margin Parameter**, you will see that there is only one row as this value applies to the whole model
3. Add a 15% Reserve Margin. You will find the values in the Data Prep File.

	A	K	L	M	N	O	P	Q	R	S
1	Parameter	2015	2016	2017	2018	2019	2020	2021	2022	2023
41522	ReserveMargin	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15

Reserve Margin Tags

Try it: add reserve margin tags for technologies contributing to the reserve margin.

1. Go to Parameters Sheet

2. In Column A, filter out for **ReserveMarginTagTechnology**
3. Add 1 in all the years if a technology is contributing to the reserve margin (indicated in red in the picture below).

	A	C	K	L	M	N	O	P
1	Parameter	TECHNOLOGY	2015	2016	2017	2018	2019	2020
41573	ReserveMarginTagTechnology	BACKSTOP	1	1	1	1	1	1
41574	ReserveMarginTagTechnology	MINCOA	0	0	0	0	0	0
41575	ReserveMarginTagTechnology	MINOIL	0	0	0	0	0	0
41576	ReserveMarginTagTechnology	MINNGS	0	0	0	0	0	0
41577	ReserveMarginTagTechnology	IMPCOA	0	0	0	0	0	0
41578	ReserveMarginTagTechnology	IMPOIL	0	0	0	0	0	0
41579	ReserveMarginTagTechnology	IMPNGS	0	0	0	0	0	0
41580	ReserveMarginTagTechnology	PWRCOA	1	1	1	1	1	1
41581	ReserveMarginTagTechnology	PWROHC	1	1	1	1	1	1
41582	ReserveMarginTagTechnology	PWRNGS001	1	1	1	1	1	1
41583	ReserveMarginTagTechnology	PWRNGS002	1	1	1	1	1	1
41584	ReserveMarginTagTechnology	PWRTRN	1	1	1	1	1	1
41585	ReserveMarginTagTechnology	PWRDIST	1	1	1	1	1	1
41586	ReserveMarginTagTechnology	MINBIO	0	0	0	0	0	0
41587	ReserveMarginTagTechnology	PWRBIO	1	1	1	1	1	1
41588	ReserveMarginTagTechnology	MINHYD	0	0	0	0	0	0
41589	ReserveMarginTagTechnology	PRWHYD	1	1	1	1	1	1
41590	ReserveMarginTagTechnology	MINGEO	0	0	0	0	0	0
41591	ReserveMarginTagTechnology	PWRGEO	1	1	1	1	1	1
41592	ReserveMarginTagTechnology	MINURN	0	0	0	0	0	0
41593	ReserveMarginTagTechnology	PWRNUC	1	1	1	1	1	1
41594	ReserveMarginTagTechnology	MINSOL	0	0	0	0	0	0
41595	ReserveMarginTagTechnology	PWRSOL	0	0	0	0	0	0
41596	ReserveMarginTagTechnology	MINWND	0	0	0	0	0	0
41597	ReserveMarginTagTechnology	PWRWND	0	0	0	0	0	0

4. Use ReserveMarginTagFuel to select which fuel(s) the reserve margin applies to. In Column A, filter out for ReserveMarginTagFuel, in column F filter out for ELC003 and add a 1 for all the years.

	A	C	F	K	L	M	N	O
1	Parameter	TECHNOLOGY	FUEL	2015	2016	2017	2018	2019
41523	ReserveMarginTagFuel		ELC003	1	1	1	1	1
41524	ReserveMarginTagFuel		COA	0	0	0	0	0
41525	ReserveMarginTagFuel		OIL	0	0	0	0	0

Run and check Emissions graphs

Below you will see the graph for the Annual CO2 and Annual CO2 by Technology that you will obtain when running the HO8 model and using the Results Template.

Annual Emissions

Annual CO₂eq Emissions by Technology