



Energy and Flexibility Modelling

Hands-on 6

Please use the following citation for:

- **This exercise**

Cannone, Carla, Allington, Lucy, & Howells, Mark. (2021, March). Hands-on 6: Energy and Flexibility Modelling (Version 2.0.). Zenodo. <https://doi.org/10.5281/zenodo.4609769>

- **clicSAND Software**

Cannone, C., Allington, L., de Wet, N., Shivakumar, A., Goynes, P., Valderamma, C., & Howells, M. (2021, March 10). ClimateCompatibleGrowth/clicSAND: v1.1 (Version v1.1). Zenodo. <http://doi.org/10.5281/zenodo.4593100>

- **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 represent the following in OSeMOSYS:

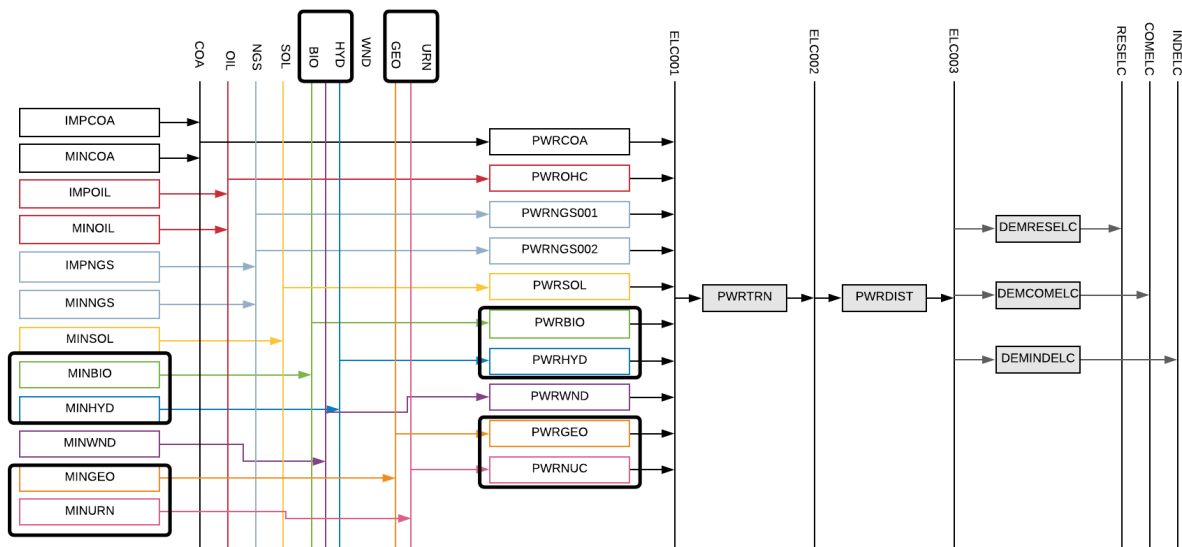
- 1) Biomass-fueled power plants in and biomass primary supply
- 2) Geothermal power plants and geothermal energy primary supply
- 3) Hydropower technologies and hydropower primary supply
- 4) Nuclear power plants and uranium primary supply



Define the Hydropower Primary Supply Technology

In Lecture 7 we learnt how to represent a technology in OSeMOSYS and which parameters characterize biomass-fueled, geothermal, hydropower and nuclear power plants. In this hands-on, we will focus on an example for Hydropower Plants. The same process should be used for Biomass, Geothermal, and Nuclear power plants.

In this Hands-on, we will add 8 technologies in total: 4 power plants (PWRBIO, PWRHYD, PWRGEO, PWRNUC) and 4 primary supply technologies (MINBIO, MINHYD, MINGEO and MINURN). Four new fuels will be added to the model: BIO (Biomass), HYD (Hydro), GEO (Geothermal) and URN (Uranium). We will build the highlighted parts of the RES:



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

- **OutputActivityRatio**: defines the fuel provided (i.e. Biomass)
- **CapacityToActivityUnit**: 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.
- **Fixed Cost**: defines the fixed Operation & Maintenance cost (\$/kW)



- **CapitalCost**: defines the overnight investment cost of the plant (\$/kW)
- **OperationalLife**: defines the lifetime of the technology (in years)

Try it: Let's add **MINHYD** - the technology representing the primary supply of water **MINHYD** (Hydro Potential) and the correspondent fuel **HYD** (Hydro) following the steps explained in Hands-on 4.

Repeat the same steps for

- 1) **MINBIO** - Biomass Extraction
- 2) **MINGEO** – Geothermal Potential
- 3) **MINURN** – Uranium Extraction

Using the data provided in the [DataPrep file](#).

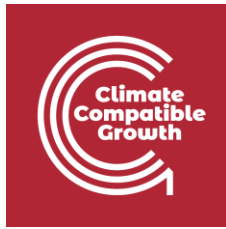
Voilà: you have now added 4 primary supply technologies (**MINBIO**, **MINHYD**, **MINGEO**, **MINURN**) and 4 fuels (**BIO**, **HYD**, **GEO**, **URN**) to your model.

Add a Hydropower plant

In order to represent a power plant, remember that the following **parameters** must be considered:

- **InputActivityRatio**: defines the rate of fuel consumed (i.e. Hydro)
- **OutputActivityRatio**: defines the fuel provided (i.e. Electricity)
- **CapacityToActivityUnit**: 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.
- **Fixed Cost**: defines the fixed Operation & Maintenance cost (\$/kW)
- **CapitalCost**: defines the overnight investment cost of the plant (\$/kW)
- **OperationalLife**: defines the lifetime of the technology (in years)
- **ResidualCapacity**: defines the existing capacity of the technology (in GW) and its expected decommissioning
- **Capacity Factors**: represents the variability in generation at each point in time.

Try it: Let's add **PWRHYD** - the technology representing a hydro power plant, following the steps presented in **Hands-on 5**.



The only new parameter that needs to be added compared to those instructions in **Hands-on 5** is the **Capacity Factor**. This represents the variability in generation at each point in time. You need to define capacity factors values for all the modelling years from 2015 to 2070. Therefore, copy-paste the 96 values available in the [Data Prep file](#) for year 2015 to **Cell K1797 of SAND**. You will see that those values change depending on the time slice. Then copy paste the **same** values for all the years until **column BN** correspondent to 2070.



Repeat the same steps for

- 1) **PWRBIO** - Biomass Power Plant
- 2) **PWRGEO** – Geothermal Power Plant
- 3) **PWRNUC** – Nuclear Power Plant

Using the data provided in the [DataPrep file](#).

Voilà: you now have added 4 primary supply technologies (**PWRBIO**, **PWRHYD**, **PWRGEO**, **PWRNUC**) to your model.

Run the model and check the results

This is the graph of Annual Production by Technology in PJ that you should obtain at the end of this Hands On exercise.

