



Energy and Flexibility Modelling

Hands-on 6 (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 represent the following in OSeMOSYS:

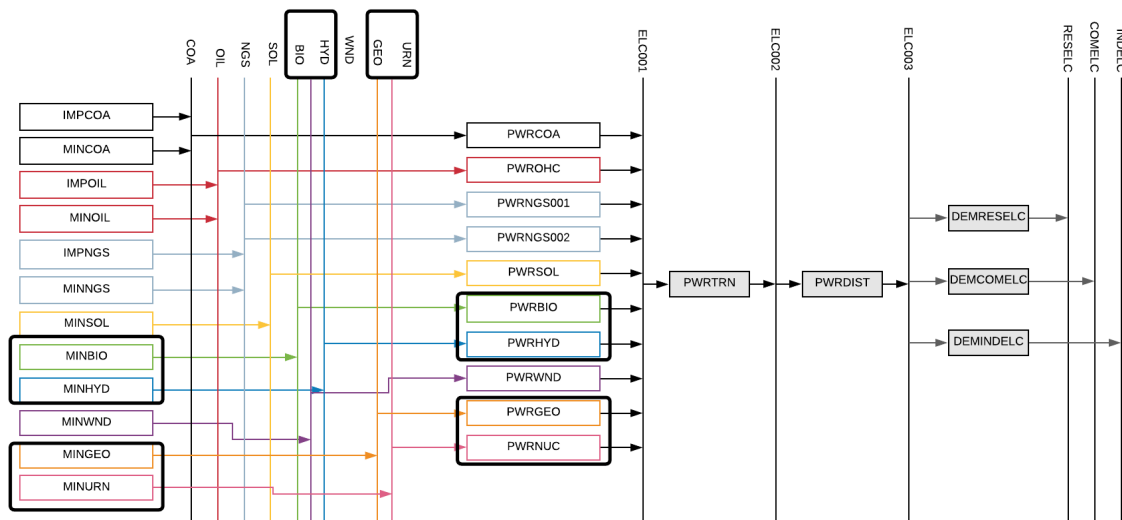
- 1) Biomass-fueled power plants and biomass primary supply
- 2) Geothermal power plants and geothermal energy primary supply
- 3) Hydropower technologies and hydropower primary supply
- 4) Nuclear power plants and uranium primary supply



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)



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](#).

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.

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.

Parameter	TECHNOLOGY	TIMESLICE	2015	2016	2017	2018
1637 CapacityFactor	PWRBIO	S421	0.5	0.5	0.5	
1638 CapacityFactor	PWRBIO	S422	0.5	0.5	0.5	
1639 CapacityFactor	PWRBIO	S423	0.5	0.5	0.5	
1700 CapacityFactor	PWRBIO	S424	0.5	0.5	0.5	
1737 CapacityFactor	PRWHYD	S101	0.396239	0.396239	0.396239	0.396239
1738 CapacityFactor	PRWHYD	S102	0.396239	0.396239	0.396239	0.396239
1739 CapacityFactor	PRWHYD	S103	0.396239	0.396239	0.396239	0.396239
1800 CapacityFactor	PRWHYD	S104	0.396239	0.396239	0.396239	0.396239
1801 CapacityFactor	PRWHYD	S105	0.396239	0.396239	0.396239	0.396239
1802 CapacityFactor	PRWHYD	S106	0.396239	0.396239	0.396239	0.396239
1803 CapacityFactor	PRWHYD	S107	0.396239	0.396239	0.396239	0.396239
1804 CapacityFactor	PRWHYD	S108	0.396239	0.396239	0.396239	0.396239
1805 CapacityFactor	PRWHYD	S109	0.396239	0.396239	0.396239	0.396239
1806 CapacityFactor	PRWHYD	S110	0.396239	0.396239	0.396239	0.396239
1807 CapacityFactor	PRWHYD	S111	0.396239	0.396239	0.396239	0.396239
1808 CapacityFactor	PRWHYD	S112	0.396239	0.396239	0.396239	0.396239
1809 CapacityFactor	PRWHYD	S113	0.396239	0.396239	0.396239	0.396239
1810 CapacityFactor	PRWHYD	S114	0.396239	0.396239	0.396239	0.396239
1811 CapacityFactor	PRWHYD	S115	0.396239	0.396239	0.396239	0.396239
1812 CapacityFactor	PRWHYD	S116	0.396239	0.396239	0.396239	0.396239
1813 CapacityFactor	PRWHYD	S117	0.396239	0.396239	0.396239	0.396239
1814 CapacityFactor	PRWHYD	S118	0.396239	0.396239	0.396239	0.396239
1815 CapacityFactor	PRWHYD	S119	0.396239	0.396239	0.396239	0.396239
1816 CapacityFactor	PRWHYD	S120	0.396239	0.396239	0.396239	0.396239
1817 CapacityFactor	PRWHYD	S121	0.396239	0.396239	0.396239	0.396239
1818 CapacityFactor	PRWHYD	S122	0.396239	0.396239	0.396239	0.396239
1819 CapacityFactor	PRWHYD	S123	0.396239	0.396239	0.396239	0.396239
1820 CapacityFactor	PRWHYD	S124	0.396239	0.396239	0.396239	0.396239
1821 CapacityFactor	PRWHYD	S201	0.672067	0.672067	0.672067	0.672067
1822 CapacityFactor	PRWHYD	S202	0.672067	0.672067	0.672067	0.672067
1823 CapacityFactor	PRWHYD	S203	0.672067	0.672067	0.672067	0.672067
1824 CapacityFactor	PRWHYD	S204	0.672067	0.672067	0.672067	0.672067
1825 CapacityFactor	PRWHYD	S205	0.672067	0.672067	0.672067	0.672067
1826 CapacityFactor	PRWHYD	S206	0.672067	0.672067	0.672067	0.672067
1827 CapacityFactor	PRWHYD	S207	0.672067	0.672067	0.672067	0.672067
1828 CapacityFactor	PRWHYD	S208	0.672067	0.672067	0.672067	0.672067
1829 CapacityFactor	PRWHYD	S209	0.672067	0.672067	0.672067	0.672067
1830 CapacityFactor	PRWHYD	S210	0.672067	0.672067	0.672067	0.672067
1831 CapacityFactor	PRWHYD	S211	0.672067	0.672067	0.672067	0.672067
1832 CapacityFactor	PRWHYD	S212	0.672067	0.672067	0.672067	0.672067
1833 CapacityFactor	PRWHYD	S213	0.672067	0.672067	0.672067	0.672067
1834 CapacityFactor	PRWHYD	S214	0.672067	0.672067	0.672067	0.672067
1835 CapacityFactor	PRWHYD	S215	0.672067	0.672067	0.672067	0.672067
1836 CapacityFactor	PRWHYD	S216	0.672067	0.672067	0.672067	0.672067
1837 CapacityFactor	PRWHYD	S217	0.672067	0.672067	0.672067	0.672067
1838 CapacityFactor	PRWHYD	S218	0.672067	0.672067	0.672067	0.672067
1839 CapacityFactor	PRWHYD	S219	0.672067	0.672067	0.672067	0.672067
1840 CapacityFactor	PRWHYD	S220	0.672067	0.672067	0.672067	0.672067
1841 CapacityFactor	PRWHYD	S221	0.672067	0.672067	0.672067	0.672067
1842 CapacityFactor	PRWHYD	S222	0.672067	0.672067	0.672067	0.672067
1843 CapacityFactor	PRWHYD	S223	0.672067	0.672067	0.672067	0.672067
1844 CapacityFactor	PRWHYD	S224	0.672067	0.672067	0.672067	0.672067
1845 CapacityFactor	PRWHYD	S301	0.29054	0.29054	0.29054	0.29054
1846 CapacityFactor	PRWHYD	S302	0.29054	0.29054	0.29054	0.29054
1847 CapacityFactor	PRWHYD	S303	0.29054	0.29054	0.29054	0.29054
1848 CapacityFactor	PRWHYD	S304	0.29054	0.29054	0.29054	0.29054
1849 CapacityFactor	PRWHYD	S305	0.29054	0.29054	0.29054	0.29054
1850 CapacityFactor	PRWHYD	S306	0.29054	0.29054	0.29054	0.29054
1851 CapacityFactor	PRWHYD	S307	0.29054	0.29054	0.29054	0.29054
1852 CapacityFactor	PRWHYD	S308	0.29054	0.29054	0.29054	0.29054
1853 CapacityFactor	PRWHYD	S309	0.29054	0.29054	0.29054	0.29054



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](#).

You have now 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.

Remember to filter for the Technologies modelled in this Hands-On – **PWRHYD**, **PWRBIO**, **PWROHC**, **PWRNGS002**, **PWRNGS001**, **PWRCOA**, and **PWRGEO**.

