



Energy System Modelling Using OSeMOSYS

Hands-on 6

Please use the following citation for:

- **This exercise**

Plazas-Niño, F., Alexander, K. (2025, February). Hands-on 6: Energy System Modelling Using OSeMOSYS (Version 1.0.). Climate Compatible Growth. DOI: 10.5281/zenodo.14871248

- **OSeMOSYS UI software**

Climate Compatible Growth. (2024). MUIO (Version v5.0.0). GitHub.
<https://github.com/OSeMOSYS/MUIO/releases>

Learning outcomes

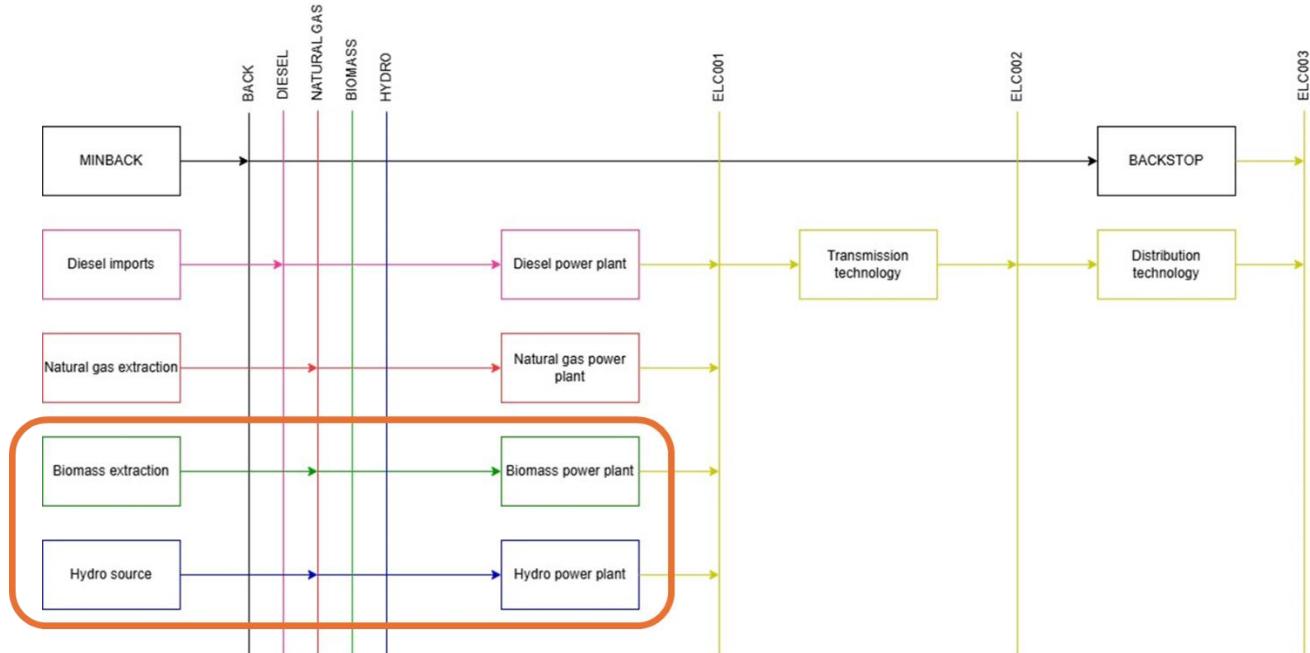
By the end of this exercise, you will be able to represent the following in OSeMOSYS:

- 1) Biomass-fueled power plants in and biomass primary supply
- 2) Hydropower technologies and hydropower 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 power plants.

In this Hands-on, we will add **4 technologies** in total: **2 power plants** (PWRBIO, PWRHYD) and **2 primary supply technologies** (MINBIO and MINHYD). **Two new fuels** (commodities) will also be added to the model: BIO (Biomass) and HYD (Hydro). We will build the highlighted parts of the RES below. **Note:** Update your RES in diagrams.net.



IMPORTANT: Before you can do anything else, you must copy the model and rename it in the same way you have before (OSeHO6 this time).



In order to represent a primary supply technology for renewable sources, the only parameter that needs to be **considered for all technologies** is **OutputActivityRatio**, which defines the fuel provided (i.e., Hydro or Biomass). All other values within the user interface can be left as the default. However, **Variable Cost** and **Total Technology Annual Activity Upper Limit** must also be considered for **MINBIO**. Additionally, we will assign a value of 0.001 for CapitalCost and 100 for OperationalLife to prevent the model from installing unnecessary capacity.

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 and using the data provided in the [Data Preparation File OSeHO6](#).

Repeat the same steps for:

- 1) **MINBIO** - Biomass Extraction and **BIO** – Biomass fuel

Voilà: You have now added 2 primary supply technologies (**MINBIO and MINHYD**) and 2 fuels (**BIO and HYD**) 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 power generation, e.g., PWRHYD, this value should be set to 31.536.
- **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. **Not applicable for this case since there are no hydro or biomass power plants installed in the current system.**
- **Capacity Factors:** represents the variability in generation at each point in time.

Note: We will include an additional parameter for PWRHYD, named **Total Annual Max Capacity**, which represents the technical maximum potential for the country to deploy up to 5 GW of hydropower plants, based on prior assessments of hydrological resources.

Try it: Let's add **PWRHYD** - the technology representing a run-of-river hydro power plant following the steps presented in **Hands-on 5** and using the data provided in the [Data Preparation File OSeHO6](#).

Repeat the same steps for:

1) PWRBIO - Biomass Power Plant

Voilà: You now have added 2 power technologies (**PWRBIO, PWRHYD**) to your model.

The screenshot shows the MUIO 5.0 interface with the title bar "MUIO 5.0" and "MUIO ver.5.0 rc". The "SELECTED MODEL" is "OSeHO6". The main window is titled "Model configuration create & edit". The "Commodities" tab is selected, showing a list of commodities with their descriptions and units. The commodities listed are: BACK (Virtual fuel, PJ), ELC003 (Electricity after distribution, PJ), NGS (Natural gas, PJ), DSL (Diesel, PJ), ELC001 (Electricity from power plants, PJ), ELC002 (Electricity after transmission, PJ), HYD (Hydro source, PJ), and BIO (Biomass, PJ). Each commodity has a "Delete" button next to it. At the bottom, there are buttons for "Go to page: 1", "Show rows: 10", and "1-8 of 8".

Commodity name	Description	Unit	
BACK	Virtual fuel	PJ	Delete
ELC003	Electricity after distribution	PJ	Delete
NGS	Natural gas	PJ	Delete
DSL	Diesel	PJ	Delete
ELC001	Electricity from power plants	PJ	Delete
ELC002	Electricity after transmission	PJ	Delete
HYD	Hydro source	PJ	Delete
BIO	Biomass	PJ	Delete

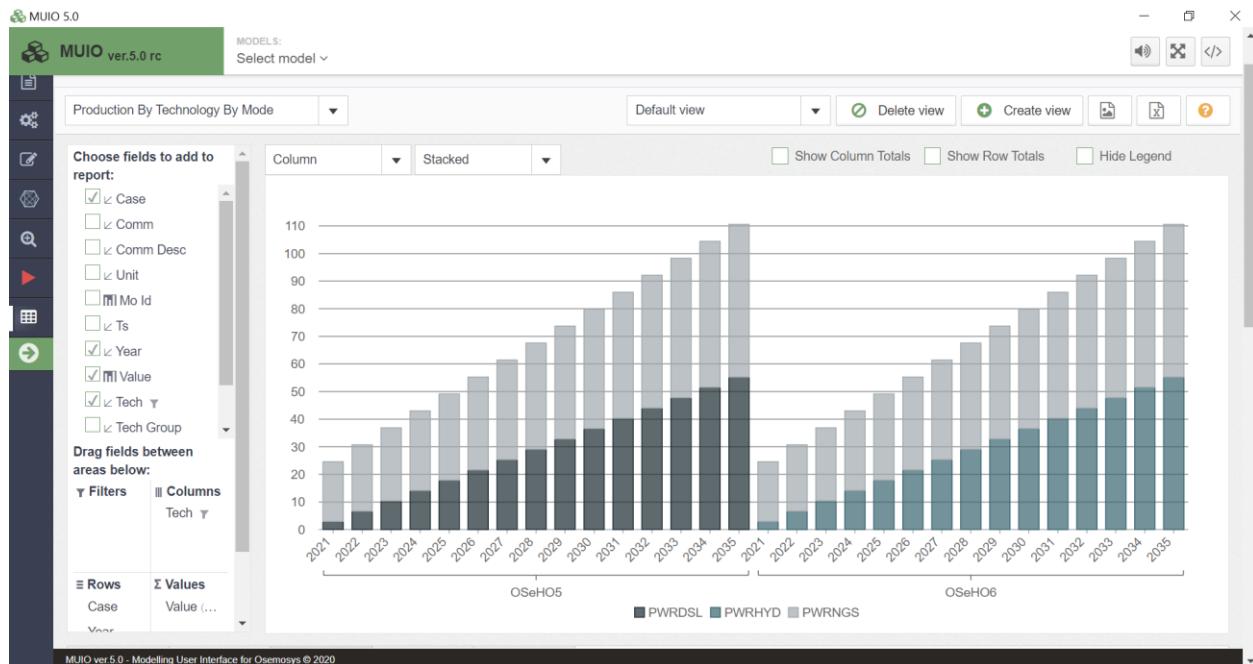


A screenshot of the MUJO 5.0 modeling software interface. The top navigation bar includes 'MUIO 5.0', 'MUIO ver.5.0 rc', 'MODELS: Select model', and various tabs like 'Model data', 'Time sets', 'Commodities', 'Emissions', 'Technology groups', 'Technologies' (selected), 'Storage', and 'Constraints'. The main content area shows a table titled 'Scenarios' with 1 row. The table has columns for Technology, Description, Technolo..., Unit of ca..., Unit of ac..., Input Activity R..., Output Activity ..., Input To New C..., Input To Total C..., Emission Activi..., and a '+' button for Add technol. The data rows include: MINBACK (Virtual mining tech), BACKSTOP (Virtual power plant), MINNGS (Natural gas extr...), IMPDSL (Diesel import), PWRDSL (Diesel power plant), PWRNGS (Natural gas pow...), PWRTRN (Transmission te...), PWRDST (Distribution tech...), MINHYD (Hydro source), MINBIO (Biomass extraction), PWRHYD (Hydropower plant), and PWRBIO (Biomass power ...). Each row has a 'Delete' button on the right. The bottom of the interface shows 'MUIO ver 5.0 - Modelling User Interface for Osmosisys © 2020'.

Run the model and check the results

This graph below is how the **Production by Technology By Mode** (in PJ) you obtain at the end of this hands-on exercise (6) should look. *Again, filter out for the case you want and only the energy producing technologies (not PWRTRN and PWRDST).* As observed in comparison to HO05, PWRDSL has been replaced by PWRHYD, indicating that hydropower plants are cheaper to install and operate than the current diesel power plants. However, this result is not entirely realistic, as hydropower plants would typically require a construction period of around three years, making their installation unlikely in the early years of the modelling horizon. Additionally, it is improbable that the existing installed diesel capacity would remain unused until decommissioning, considering potential mid-term contracts.

We will address how to calibrate the model to better reflect such real-world constraints in hands-on exercise 13. For now, we will work with these results from a purely mathematical perspective.



Question to consider: What is the impact on the newly required installed capacities? Do we need more or fewer gigawatts (GW) from hydropower plants to meet the electricity demand?