Energy and Flexibility Modelling

Hands-on 12: Running a demo model

Pease use the following citation for this exercise:

Learning outcomes

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

1) Run a demo model.

2) Understand the inputs of a demo model.

3) Understand the results of a demo model.

4) Adjust the inputs of a model.

Investigating and running the demo model

In this activity, we want to investigate and run the demo model which comes with FlexTool. To do this, open the following excel file at the location that you downloaded FlexTool:

"inputData\demoModel-1.xlsm"

At the bottom of this excel sheet, you will see different sheets. Click the "units" tab so that we can see the electricity supply mix of this model.

You will now be presented with the units which make up this model. We can see that this model is made up mainly of fossil fuel based electricity generation, with some hydro power in nodeB, wind power in node C, and small shares of PV and biomass in most nodes.

We can see that

- nodeA has 500 MW of coal capacity, 200 MW of oil, 30 MW of biomass amongst others.
- nodeB has 150 MW of Hydro_SES (reserve hydro), 120 MW of Hydro_ROR (run of river hydro) and 150 MW of oil amongst others.
- nodeC has 500 MW of coal capacity, 300 MW of natural gas engine capacity, 200 MW of oil and 150 MW of wind amongst others.

The Figure below shows the electricity mix for nodeA.

unitGroup	unit type	fuel	cf profile	inflow	input grid	input node	output grid	output node	capacity (MW)
		Choose one input option (none, fuel, cf profile, inflow **or** input grid+node)					**Output #1**		
Coal	ST_coal	coal					elec	nodeA	500
Oil	CC_oil	oil					elec	nodeA	200
Bio	ST_bio	biomass					elec	nodeA	30
Wind	wind		wind_A				elec	nodeA	0.01
PV	PV		PV				elec	nodeA	15
Battery	battery						elec	nodeA	0.01

Next, we want to run the model. To do this, open the following file in the topmost model folder:

flexTool.xlsm

Once this is opened, click the "Sensitivity scenarios" sheet. This is shown below.

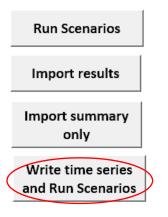| Getting Started	🔒 **Sensitivity scenarios**	Sensitivity definitions	Settings and filters	Tool Information

Next, we want to ensure that the demoModel-1.xlsm model is in the "Active input files" column, and that the "template.xlsm" isn't. To do this, click the light green "<->" button to toggle the location of the input files.

This tells FlexTool which of the input files to run.

The sheet should look like the following:

Active input files:			Inactive input files:
		<->	template.xlsm
		<->	
demoModel-1.xlsm		<->	
		<->	
		<->	demoModel-2-2017.xlsm
		<->	demoModel-2-2030.xlsm
		<->	
		<->	template-EVs.xlsm

Once we have selected demoModel-1, we can run the model. To do this, click the "write time series and Run scenarios button" in the top left of the sheet:

Run Scenarios

Import results

Import summary only

Write time series and Run Scenarios

A "cmd" box should open, which means that FlexTool is running. Once FlexTool has run, a excel results spreadsheet will open called "Results_YEAR_MONTH_DAY_HOUR_MINUTES", with the respective date and time that you run the model.
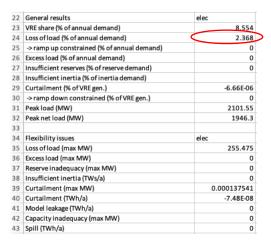
In the next activity we will see how we can interpret the results.

Quick check of flexibility issues

Now that we have the results, we want to see whether there are any issues with regards to flexibility in this system. To do this, we should check the "summary_D" tab of the results spreadsheet, as shown below.

summary_D	node	node_plot	events	rampRoom_1h_elec	rampRoom_1h_elec_plot	rampRoom_4h_elec	rampRoom_4h_elec_plot

Once we have opened "summary_D", we see a lot of information relating to our run, as can be seen below.

22	General results	elec
23	VRE share (% of annual demand)	8.554
24	Loss of load (% of annual demand)	2.368
25	-> ramp up constrained (% of annual demand)	0
26	Excess load (% of annual demand)	0
27	Insufficient reserves (% of reserve demand)	0
28	Insufficient inertia (% of inertia demand)	
29	Curtailment (% of VRE gen.)	-6.66E-06
30	-> ramp down constrained (% of VRE gen.)	0
31	Peak load (MW)	2101.55
32	Peak net load (MW)	1946.3
33		
34	Flexibility issues	elec
35	Loss of load (max MW)	255.475
36	Excess load (max MW)	0
37	Reserve inadequacy (max MW)	0
38	Insufficient inertia (TWs/a)	0
39	Curtailment (max MW)	0.000137541
40	Curtailment (TWh/a)	-7.48E-08
41	Model leakage (TWh/a)	0
42	Capacity inadequacy (max MW)	0
43	Spill (TWh/a)	0

First, we see that the variable renewable energy share (VRE) as a percentage of demand is over 8.5%. However, we can also see that we have a loss of load of over 2%. This is amount of loss of load is notable, and so we need to find out where and why we have this.

We see a very minor about of curtailment, which isn't a real issue in this case, and no further flexibility issues.

If you would like to see understand the meaning of the rest of the results, open the result file to see definitions for each.
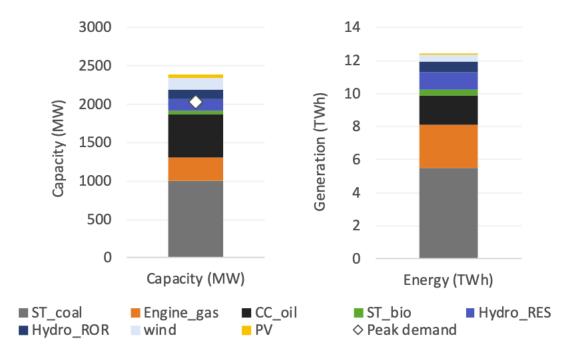
Investigating loss of load

We want to find out where this loss of load is coming from. So, to achieve this, we will begin to investigate the results from FlexTool.

The loss of load may be due to the capacity in the system.

First, plot the capacity and energy of each of the different unit types. This data can be found in the "summary_D" sheet, between rows 81 and 104. With the peak demand being displayed at row 31. An example is shown below:
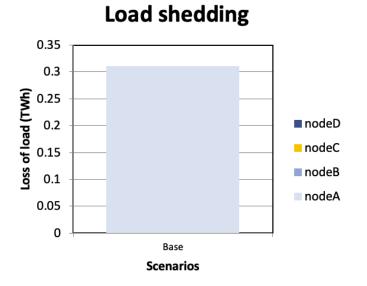
This figure shows us that peak demand is below dispatchable capacity (ST_coal, Engine_gas, CC_oil, ST_bio and Hydro_RES).

Therefore, on the country level there should not be any issues with flexibility. The problem, may therefore arise from certain nodes or a single node.
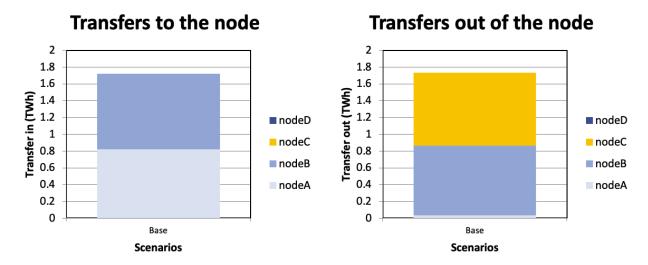

Activity 4

In this activity, we will try to further investigate where the origin of this loss of load is. To allow us to investigate whether this loss of load is originating from one of the nodes, open the "node_plot" sheet from the results file.

Within this "node_plot" sheet, we see a number of different plots which give us information on each of the nodes. The very first plot shows us that all of the load shedding occurs in nodeA, as shown below:

Load shedding

Next we'll look at the transfers between nodes, shown in the Figures below:

We see in these figures that nodeC transfers electricity to nodeA.

The conclusion that we can get from these plots is that there is enough generation capacity, as shown in the previous activity, but this generation capacity is not where demand is and/or there is not enough transmission capacity.

This brings us to 3 possible solutions:

1. Invest in more transmission capacity.
2. Invest in more generation capacity.
3. Invest in storages

For this, the benefits and costs of each option should be explored before making a decision.