OSeMOSYS/FLEXTOOL

Hands-on 12: Free investment run

Learning outcomes

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

1) Run DemoModel-2.

2) Explore the results of DemoModel-2.

3) Remove maximum investment limits.

4) Create your own scenario.

Activity 1

In the final slide of the previous lecture, we ran the base and invest scenarios of DemoModel-2. In this hands-on exercise, we will further explore the results of some DemoModel-2 scenarios. These are scenarios as we are making assumptions about what the future will look like in 2030.

For example, the prices are the prices estimated for 2030, which mean lower wind, photovoltaics (PV), and battery prices than currently. These kinds of checks are useful when we want to know how the model will solve some flexibility issues, as well as discussing long-term planning.
To begin the exercise, run the scenarios circled in green:

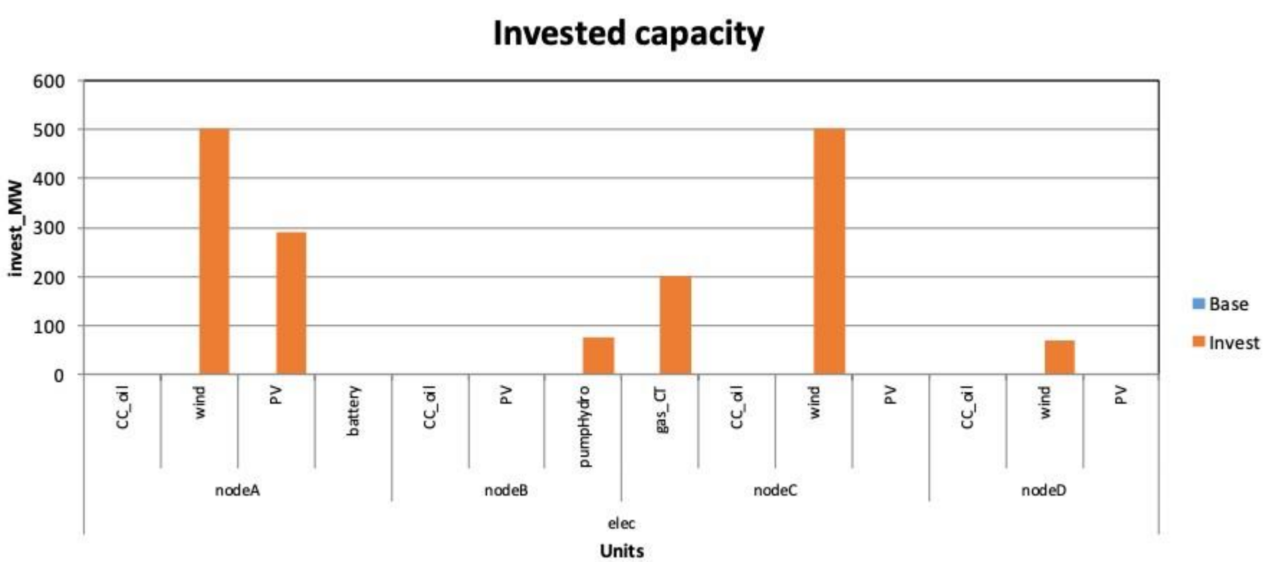
Active input files:		Inactive input files:	Active scenarios:		Ina
	<->	template.xlsm	Base	<->	
	<->		Invest	<->	
	<->	demoModel-1.xlsm		<->	
	<->			<->	der
	<->	demoModel-2-2017.xlsm		<->	der
demoModel-2-2030.xlsm	<->			<->	der
	<->			<->	der
	<->	template-EVs.xlsm		<->	

Next, check the **unit_type, capacity (MW)** and **Transfer, capacity (MW)** from the **Summary_D** for capacity comparison between base and invest.

	A	B	C
1	Update sheets	demoModel-2-2030	demoModel-2-2030
2		Base	Invest
65			
66	Unit type	Capacity (MW)	Capacity (MW)
67	ST_coal	600	600
68	gas_CC	300	300
69	gas_CT	100	300
70	CC_oil	1580	1580
71	wind	250	1319.89
72	PV	300	591.362
73	battery	5	5
74	pumpHydro	10	87.992

	A	B	C
1	Update sheets	demoModel-2-2030	demoModel-2-2030
2		Base	Invest
75			
96	Transfer	Capacity (MW)	Capacity (MW)
97	nodeA - nodeB	250	398.49
98	nodeB - nodeA	250	398.49
99	nodeB - nodeC	200	616.891
100	nodeC - nodeB	200	616.891

Then check the **units_invest_plot** to see the specific nodes where units are invested.

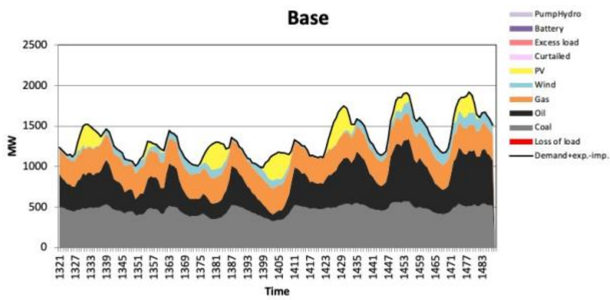


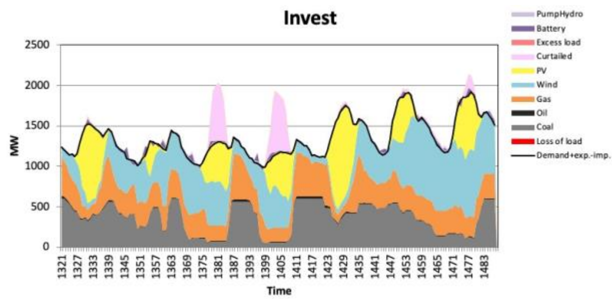
We see that wind power is invested in all allowed nodes. We also see that pumped hydro is invested in in NodeB, as well as additional PV to nodeA.

Activity 2

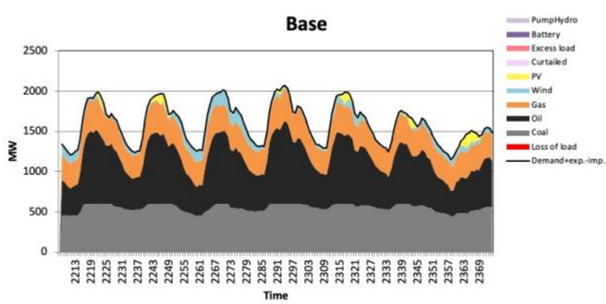
Next, we will check the results of these scenarios. Navigate to the "**genUnitGroup_elec_plot**" sheet. This will show dispatch figures for each week.

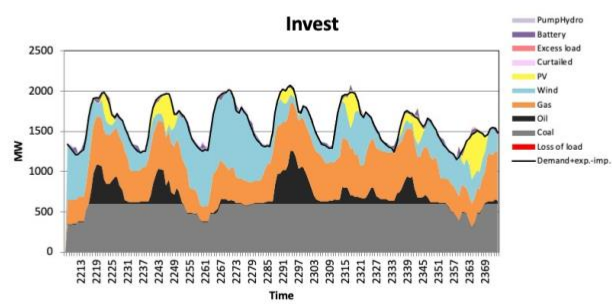
Below are the dispatch figures for the first week, and the two scenarios "Base" and "Invest."





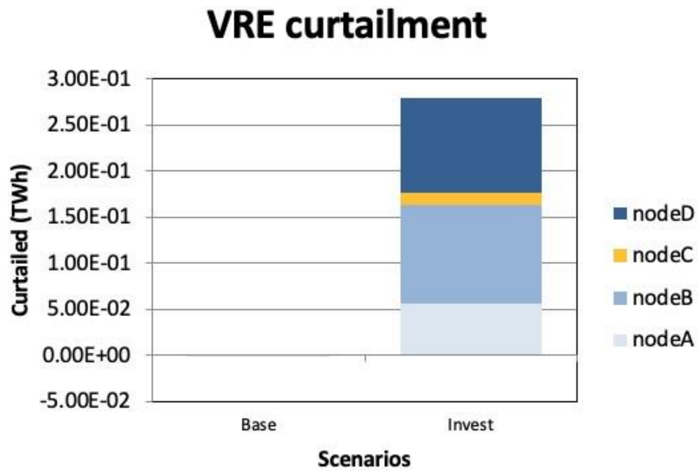
The dispatch figures below are for the third week. Again, we display the "Base" and "Invest" scenarios. This week has high demand, whereas the first week has a lower demand.



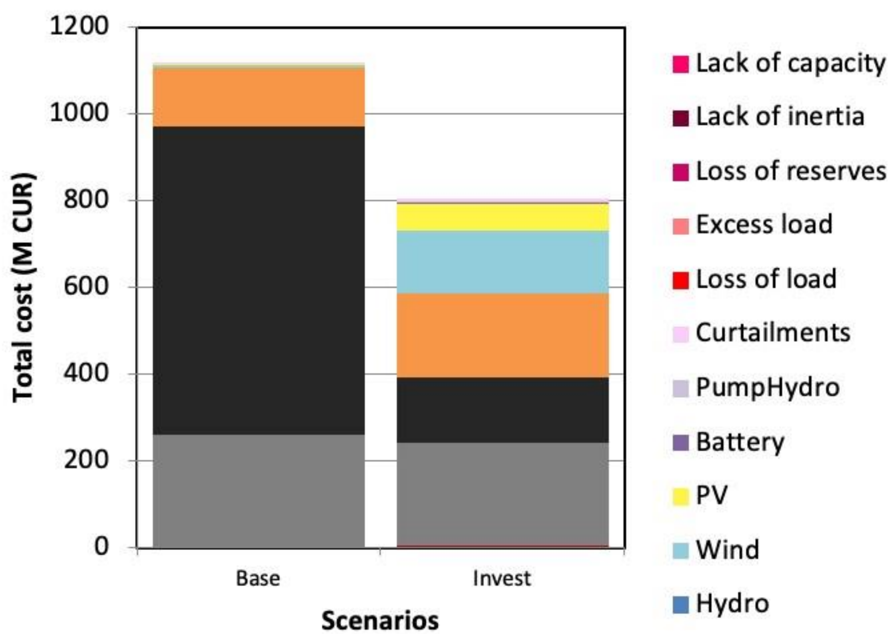


Next, we can check "**summary_D**" for flexibility issues in general, and **node_plot** for a graphical version.

We see that the VRE share for the base scenario is much lower than the invest scenario (8.988% compared to 39.29%). This leads to a larger amount of curtailment, but considerably lower costs. See the plot below for the VRE curtailment.

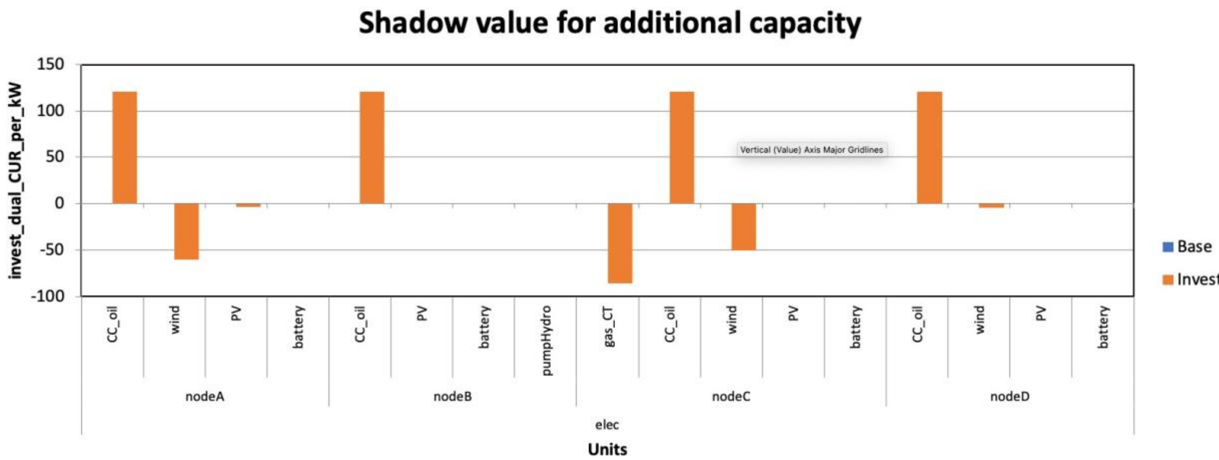


The investment scenario is able to have higher curtailment costs than the base scenario. This is due to the fact that savings in fuel costs are larger than (annualized) investment costs + curtailment penalties. This can be seen in the plot below found in the "**costs_unitGroup_plot**" sheet:



Next, check the "**units_invest_plot**" to see the specific nodes where the units are invested.

The investment shadow values detail how additional investments to each capacity type would affect the total costs. In this example, gas and wind have negative shadow values, which means that additional investments in these technologies would lower the total costs of the system. These investments are limited by investment constraints in the input data.



Removing max investment limits in wind and gas

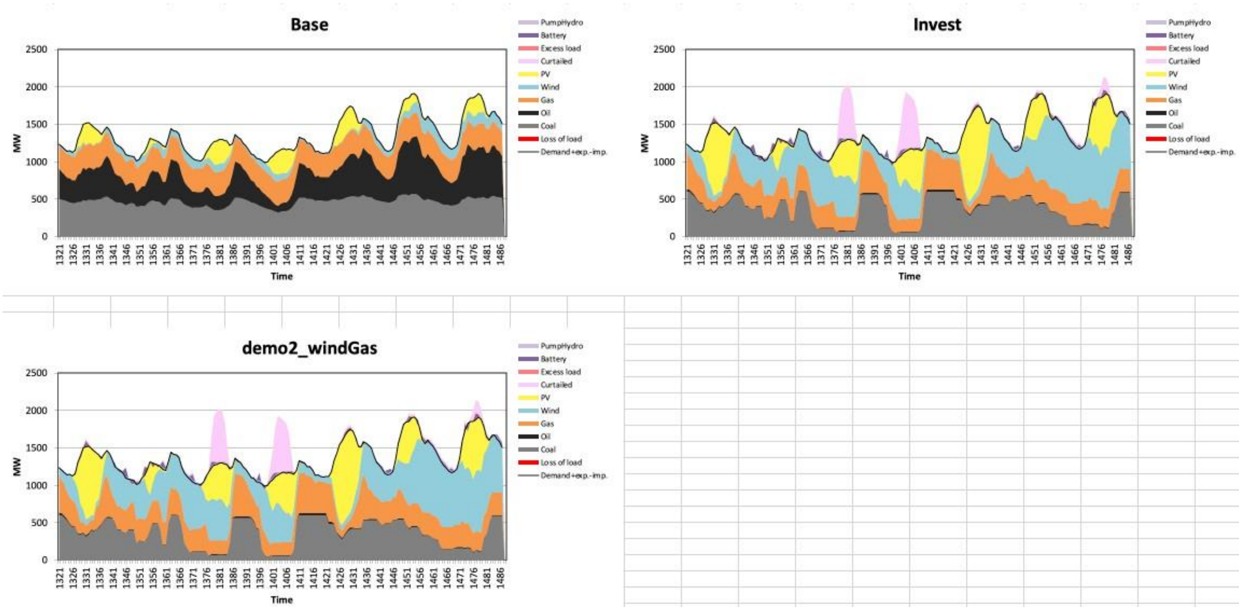
Active input files:		Inactive input files:	Active scenarios:		Inactive scenarios:
	<->	template.xlsm	Base	<->	
	<->		Invest	<->	
	<->	demoModel-1.xlsm		<->	
	<->			<->	demo1_invest_transCap
	<->	demoModel-2-2017.xlsm		<->	demo1_invest_genCap
demoModel-2-2030.xlsm	<->			<->	demo1_invest_storages
	<->			<->	demo1_invest_all
	<->	template-EVs.xlsm		<->	
	<->	template-Storages.xlsm		<->	demo2_storages
	<->			<->	demo2_PV
	<->		demo2_windGas	<->	

In this next activity, select and run the 3 scenarios circled in green:

The demo2_windGas scenario removes max_investment limits to wind power and gas turbines.
For these scenarios, check the **unit_type, capacity (MW)** and **Transfer, capacity (MW)** from **Summary_D** to compare invest capacity in scenarios.

Also check the **units_invest_plot** to see the specific nodes where units are invested in.

Below we check the "**genUnitGroup_elec_plot**" sheet to see the electricity mix. Feel free to go further and compare weeks with different demand profiles.



The conclusions from these exercises seem to be:

- A higher VRE share is cost-effective. It allows the power system to be flexible and to operate with a higher VRE share.
- If possible, it would be better to position VRE capacity near to the demand.
- However, this is just an example, thus further modelling is required to assess large VRE shares.
- Additional natural gas capacity would also decrease the total costs by replacing oil power.
- In this topic, additional modelling is needed about:
  ○ The acceptable minimum loads and annual running hours of the thermal capacity. ○ Possible required additional investments to natural gas grid (locations, if operating at full capacity or not, etc).

Create your own scenario

As a final exercise, create your own scenario for demo model 2 and check how it affects the investment run.

1. Open flexTool.xlsm and sensitivity scenario sheet
   a. Add new scenario names to list of inactive scenarios.
2. Open sensitivity definition sheet

a. Add data to some input scenario definition table.
b. This example increases the annual demand of nodeA by 20%
c. If you want to study a scenario in the invest mode, you must also add this to the first scenario definition table. Do not add this if creating a dispatch scenario.