Modelling Renewable Energy Integration Technologies in the EnergyPLAN Tool

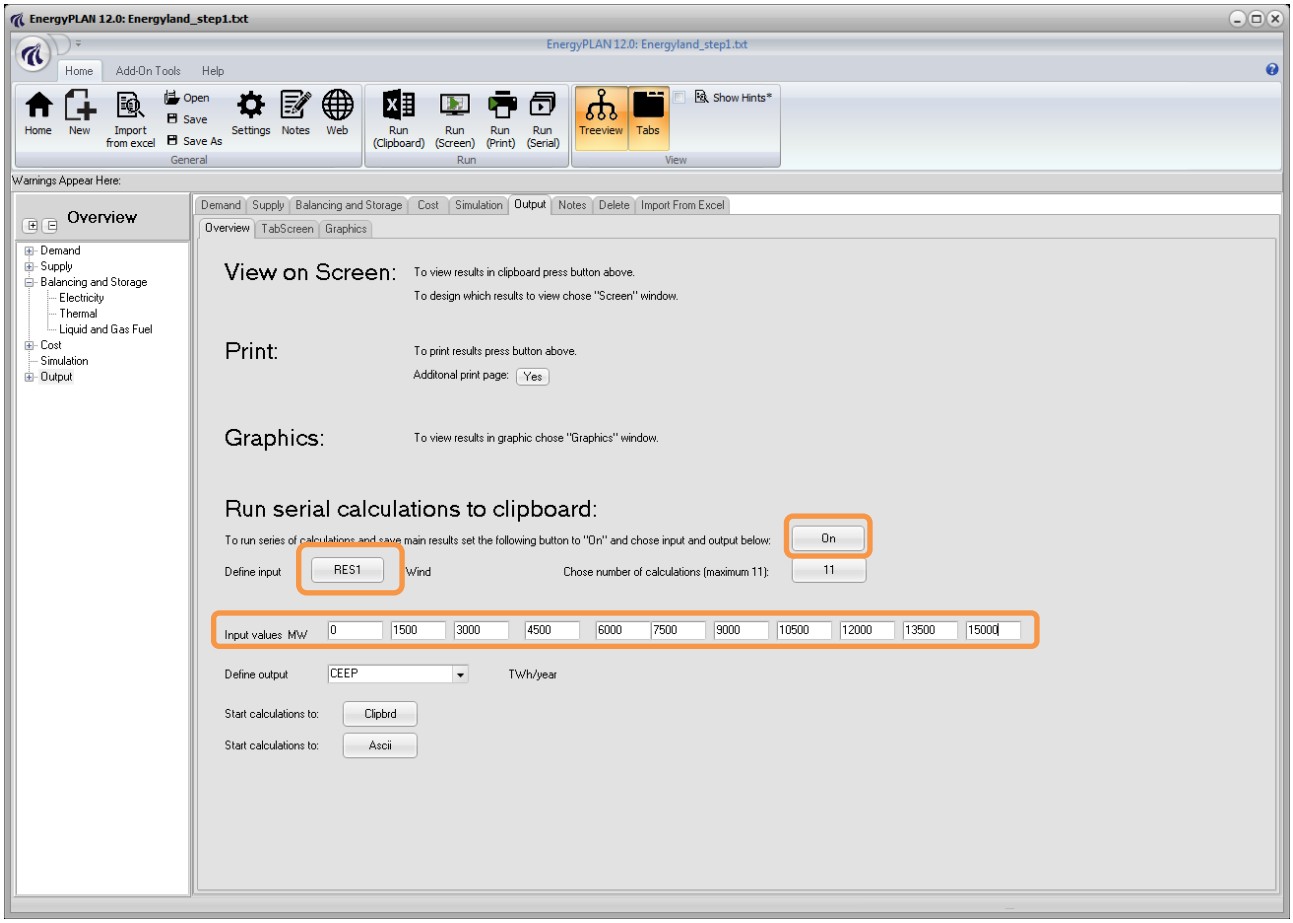
Exercise B: Adding wind power by regulating existing power plants (~30 minutes)

When creating the scenarios in the next few sections, it is always useful to follow this procedure when making changes:

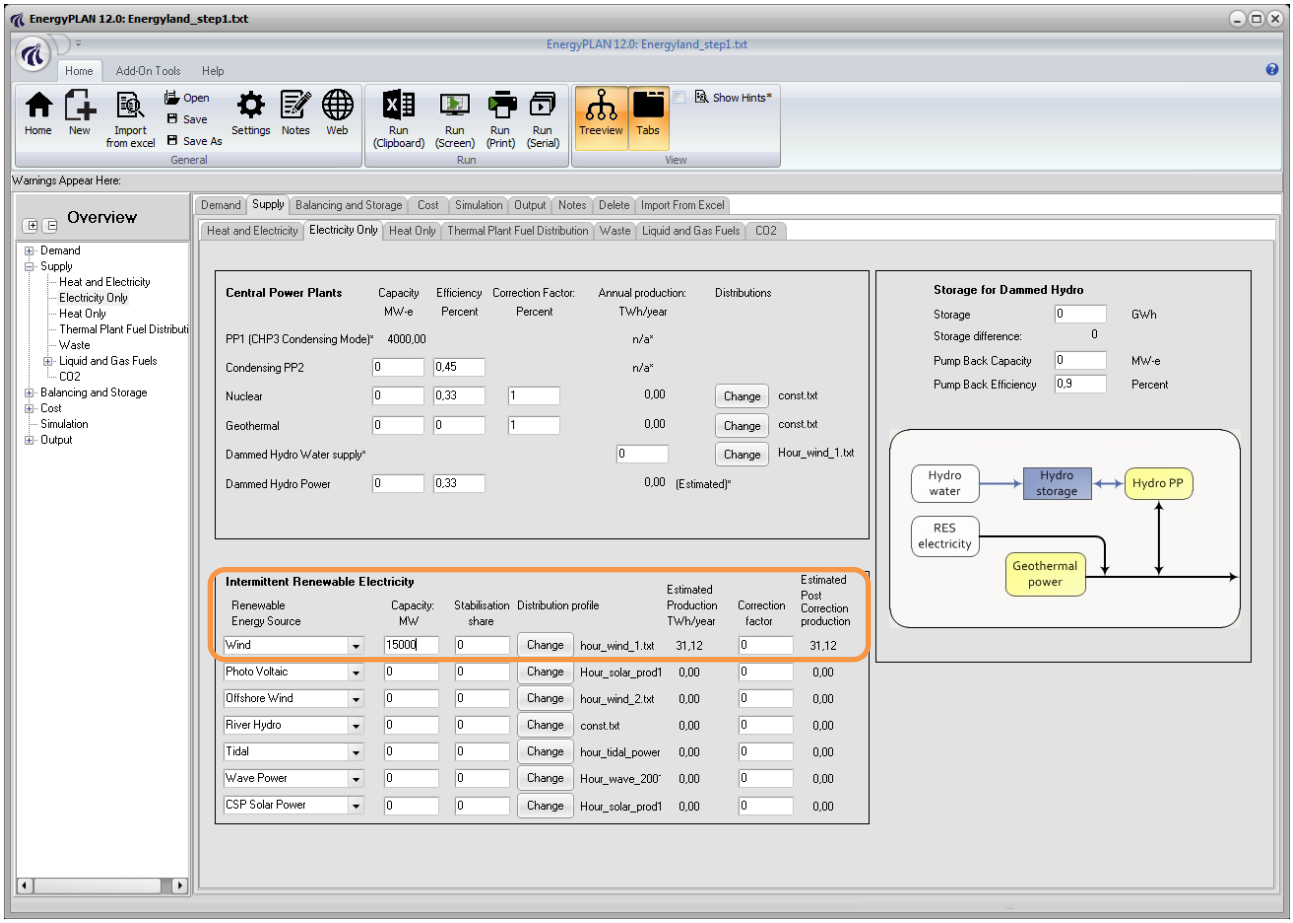
1. Update the demand
2. Update the supply
3. Check the costs and think about how they have changed
4. View the regulation tab to see if you need to apply any
5. Create the results

In each of the scenarios, we will vary the amount of intermittent renewable energy, which in this example will be wind power. To analyse the results with varying amounts of wind, we can use the series calculator.

- Open the file “Energyland_step0_REF.txt” from Exercise A.
- Go to the Output->Overview tabsheet.
- Turn on the series calculator
- Beside the “Define Input” option, select RES1, which is wind power in this tutorial.
- For the input values, insert increasing amounts of wind power from 0 to 15,000 MW



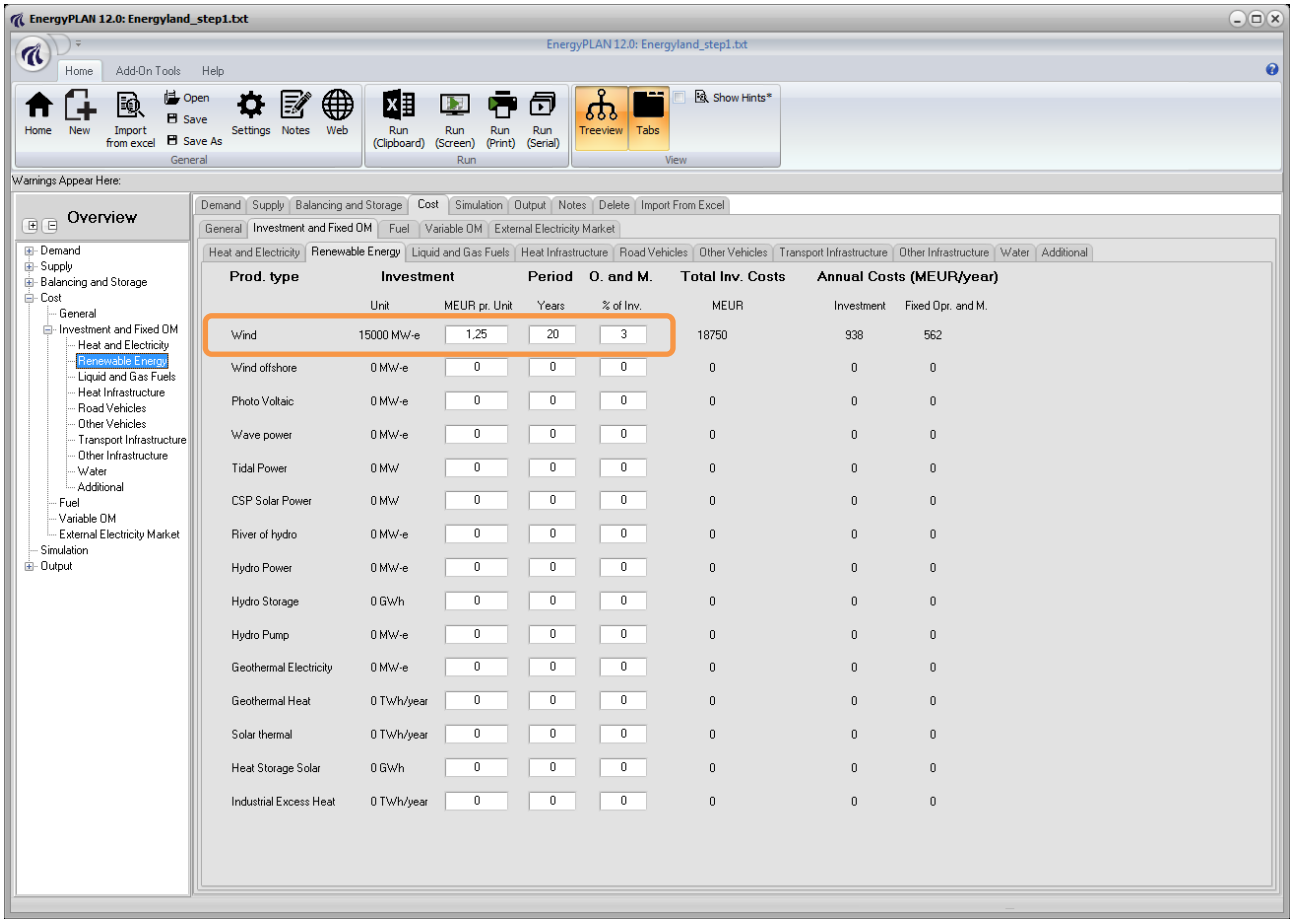
You can check how much electricity is produced from these various amounts of wind power, by going to the Input-RenewableEnergy tabsheet. For example, 15000 MW of wind produces 31.1 TWh of electricity, which is just over 100% (103.7%) of the electricity demand.



Make sure you delete this 15,000 MW of wind power from EnergyPLAN before you proceed.

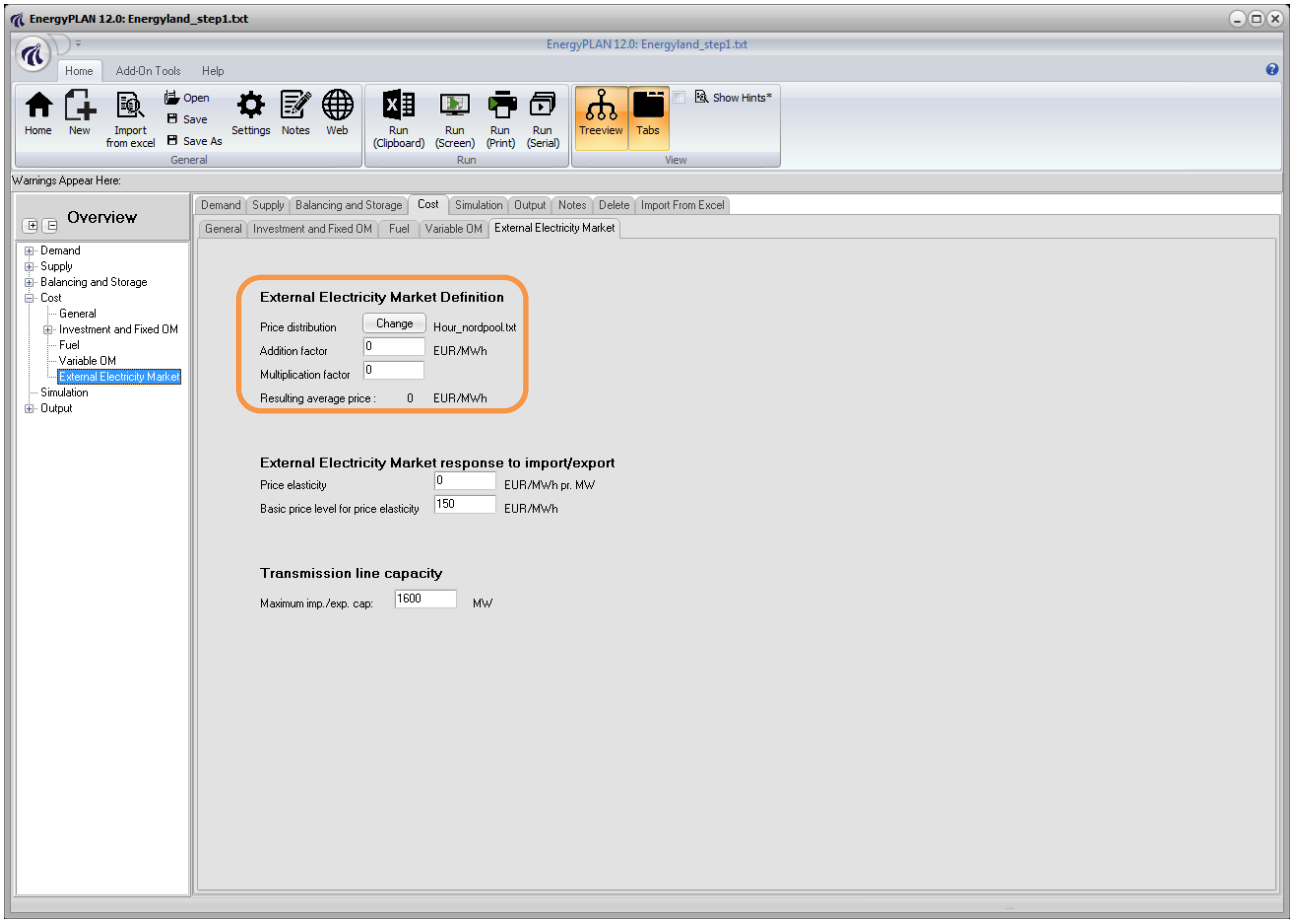
We also need to add a cost for installing this wind power. Go to the Cost-> Investment tabsheet and insert the following for wind power:

- Investment: 1.25 M€/MW
- Lifetime: 20 years
- Operation and maintenance: 3%



Finally, we will assume that you do not get paid for wind power that you are forced to export.

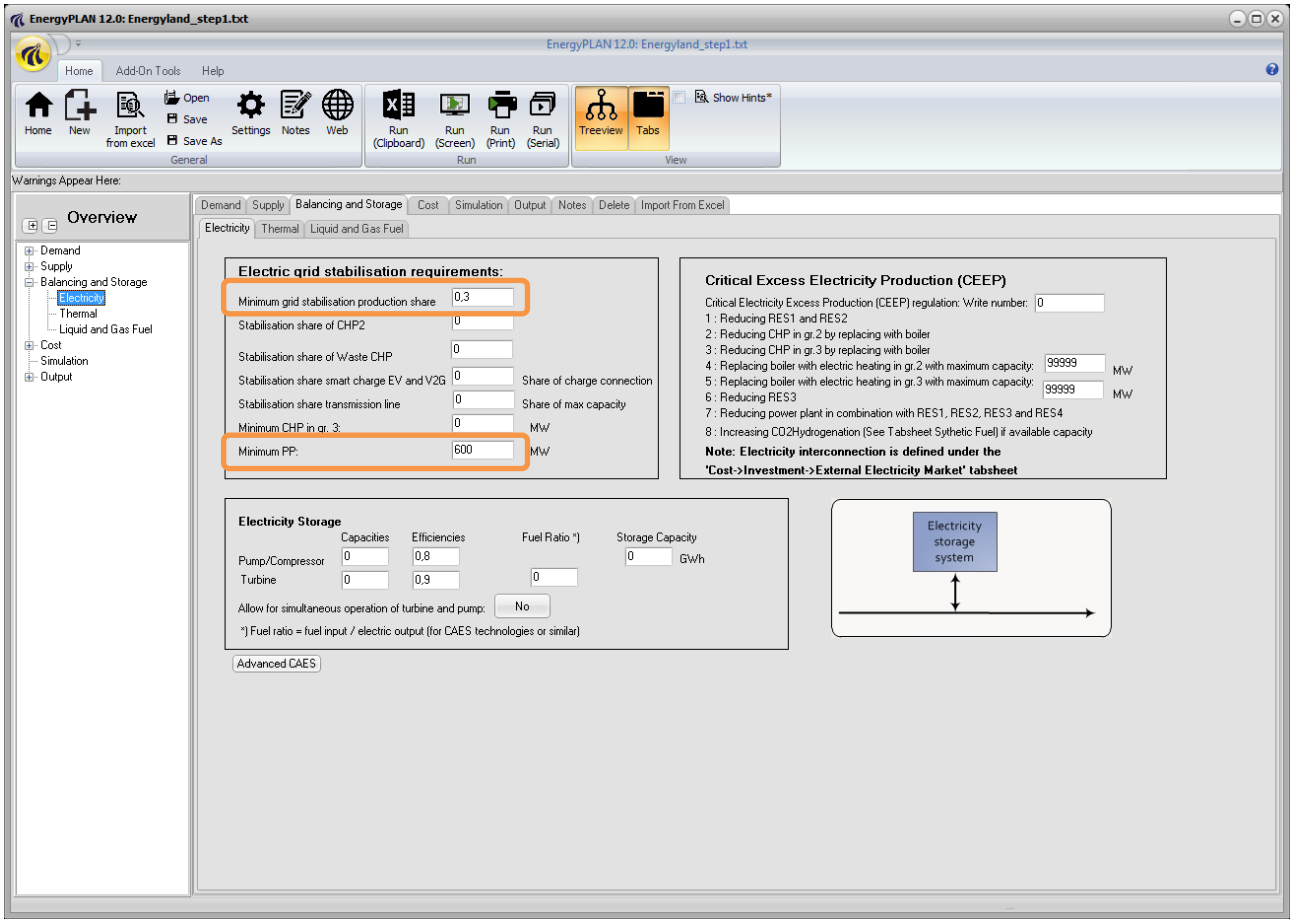
- Go to the Cost tabsheet and under “External Electricity Market Definition”, ensure that both the “Addition Factor” and “Multiplication Factor” are 0. This means that EnergyPLAN will assume an electricity price of 0 when electricity has to be exported.



- Save your file “Energyland_step0_REF.txt”
- Then go to File->Save As and save a new file called “Energyland_step1_powerplants.txt”

It is now possible to analyse the implications of the first scenario, which is regulating existing power plants. To do so, the first important step is to specify what limitations exist for the power plants.

- Go to the Electricity tabsheet and under “Balancing and Storage” and specify the following:
    - Minimum grid stabilisation share = 30% (This means that during every hour, at least 30% of electricity production must be supplied by units which can provide grid stabilisation).
    - Minimum PP = 600 MW (This means that the power plants cannot produce less than 600 MW during any hour, since it is too expensive to shut them down completely).



Go to the Output->Overview tabsheet and run the series calculation for the following metrics by clicking on the “Define output” button:

- CEEP
- Fuel
- CO2
- Total Costs

Fill in the following results:

Wind Power	Wind Power	Wind	CEEP	CEEP	Fuel	CO2	2020 Total Costs
%	TWh/year	MW	TWh/year	(% of Demand)	TWh/year	Mt/year	M€/year
0%	0.00	0	0.0	0%	193.4	49.27	17,060
10%	3.11	1,500	0.0	0%	189.6	47.86	16,984
21%	6.22	3,000	0.2	1%	186.2	46.53	16,922
31%	9.34	4,500	1.3	4%	184.8	45.61	16,936
41%	12.45	6,000	3.4	11%	185.7	45.14	17,032
52%	15.56	7,500	6.1	20%	187.9	44.96	17,182
62%	18.67	9,000	9.2	31%	191.0	44.96	17,364
73%	21.78	10,500	12.6	42%	194.8	45.09	17,571
83%	24.90	12,000	16.2	54%	198.9	45.31	17,793
93%	28.01	13,500	19.9	66%	203.4	45.59	18,026
104%	31.12	15,000	23.7	79%	208.1	45.91	18,267

The results suggest that a 21% wind penetration is the cheapest alternative, which equates to a wind power capacity of 3000 MW.