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EnergyPLAN Exercise 3:

More Simple Energy System Analyses.

Exercise 3 continues from exercise 2 and here you are asked to implement more energy system improvements in the energy system. Through the exercise and the guideline, you learn step by step how to analyse more changes to the energy system.

Exercise 3 continues with the system defined in exercise 2, which is:

- Electricity demand of 34.3 TWh/year and "DK 2013 electricity demand"
- Condensing power plant: 9000 MW coal –fired
- 2000 MW on-shore wind power using "Hour_wind_1"
- 3000 MW off-shore wind power using "DK 2013 Wind Offshore"
- Annual district heating demand of total 27.43 TWh divided into 1.59 TWh district heating oil-boilers, 10 TWh small-scale CHP and 15.84 TWh large-scale CHP extraction plants (distribution "Hour_distr-heat-2-50procent.txt").
- Decentralised CHP of total 1350 MW, eff-th = 50%, eff-el = 41% on natural gas, and Heat Pump of 300 MWe, COP=3.
- Large-scale CHP of total 2000 MW, eff-th = 50%, eff-el = 41% on coal.
- Fuel demand for individual house heating of total 14.42 TWh divided into 0.01 coal, 4.2 oil, 5.66 natural gas and 4.55 biomass.
- Industrial fuel demand of 53.66 TWh divided into 3.37 coal, 26.92 oil, 18.19 natural gas and 5.18 biomass (including fuel for district heating and electricity production).
- Industrial district heating production of 1.73 TWh and an electricity production of 2.41 TWh. Use the hour distribution file "const".
- Fuel demand for transportation: 13.25 TWh Jet Petrol, 27.50 TWh Diesel and 28.45 TWh Petrol.

The system has a primary energy supply of 200.64 TWh/year and CO2 emissions of 46.45 Mt. and excess electricity production of 0 TWh/year.

Exercise 3.1: Add Waste Resources

Open the EnergyPLAN model. Load the data of exercise 2. Add 6 TWh/year of waste resources to the system. Divide the resources geographically into

- 1 TWh in gr. 1,
- 2 TWh in gr. 2 and
- 3 TWh in gr. 3.

Question 3.1.1: What are the excess production, the primary energy supply and the CO2 emission of the system, IF all waste resources are converted into heat with an efficiency of 80%?

Question 3.1.2: What are the excess production, the primary energy supply and the CO2 emission of the system, IF all waste resources are utilised in CHP with an electric efficiency of 30% and a heat efficiency of 50%?

Exercise 3.2: Waste Resources used for producing biogas for transportation

Use the waste resources for producing biogas and heat instead of CHP with a biogas output of 50% and a heat output of 30%. Let the biogas replace diesel in cars by 1 to 1.

Question 3.2.1: What are the excess production, the primary energy supply and the CO2 emission of the system?

Exercise 3.3: Wind and hydrogen for transportation

Add 2000 MW wind power producing 4,15 TWh electricity in combination with electrolysers producing 3.00 TWh hydrogen for transportation with an efficiency of 72,3% and a capacity of 500 MW. Let the hydrogen replace petrol cars (1.5 km/kWh) with HFCV (3.0 km/kWh).

Question 3.3.1: What are the excess production, the primary energy supply and the CO2 emission of the system?

Exercise 3.4: Add Solar Thermal in Individual houses

Add 1 TWh solar thermal (equal to app. 20% of heat demand) to individual houses with natural gas boilers. Use the hour distribution "Hour_SolarThermal_CenDK.txt".

Question 3.4.1: How much of the solar thermal can be utilised?

Question 3.4.2: How much storage capacity is needed in order to utilise all solar thermal production?

Question 3.4.3: What are the excess production, the primary energy supply and the CO2 emission of the system?

Exercise 3.5: Add Solar Thermal to the district heating system

Add 2 TWh solar thermal (equal to app. 20% of district heating demand) to district heating group 2. Use the hour distribution "Hour_SolarThermal_CenDK.txt".

Question 3.5.1: How much of the solar thermal can be utilised?

Question 3.5.2: How much storage capacity is needed in order to utilise all solar thermal production?

Question 3.5.3: What are the excess production, the primary energy supply and the CO2 emission of the system?

REMEMBER to save exercise 3.