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EnergyPLAN Exercise 6:

Local Energy System Analysis: Simple Calculations on Small Energy Systems

In Exercise 6, you are asked to conduct a number of informative calculations of typical small local energy systems.

Exercise 6.1: Define a Local Energy System

Press New and initialize the EnergyPLAN model (See exercise 1.1.1)
Define a simple energy system with:

- An electricity demand of 10 TWh/year (distribution=Hour_electricity.txt) supplied from a coal fired power station with an efficiency of 40%.
- A net heat demand of 17 TWh/year covered by individual oil boilers with an efficiency of 85%, i.e. an oil consumption of 20 TWh/year (distribution=Hour_indv-heat-100procent.txt)
- A transport demand divided into 5 TWh JetPetrol for aircraft, 7 TWh Diesel for ships & lorries and 8 TWh Petrol for small cars.

Question 6.1.1: How large does the coal fired power station has to be in order to cover the electricity demand? What is the primary energy consumption and CO_2 *emission of the whole system?*

Exercise 6.2: Different individual heating options

Calculate the influence on the system of different individual heating options.

Question 6.2.1: Change the heating into electric heating and calculate the same results as in 6.1.1.

Question 6.2.2: Change the heating into heat pumps (COP=3) and calculate the same results as in 6.1.1.

Exercise 6.3: Wind power, heat pumps and the need for thermal storage

Continue with the numbers from 6.2.2. but 1) disregard the non-heat pump electricity consumption of 10 TWh, i.e. set it to zero and 2) add wind power to the system using the distribution hour_windEltra2001.

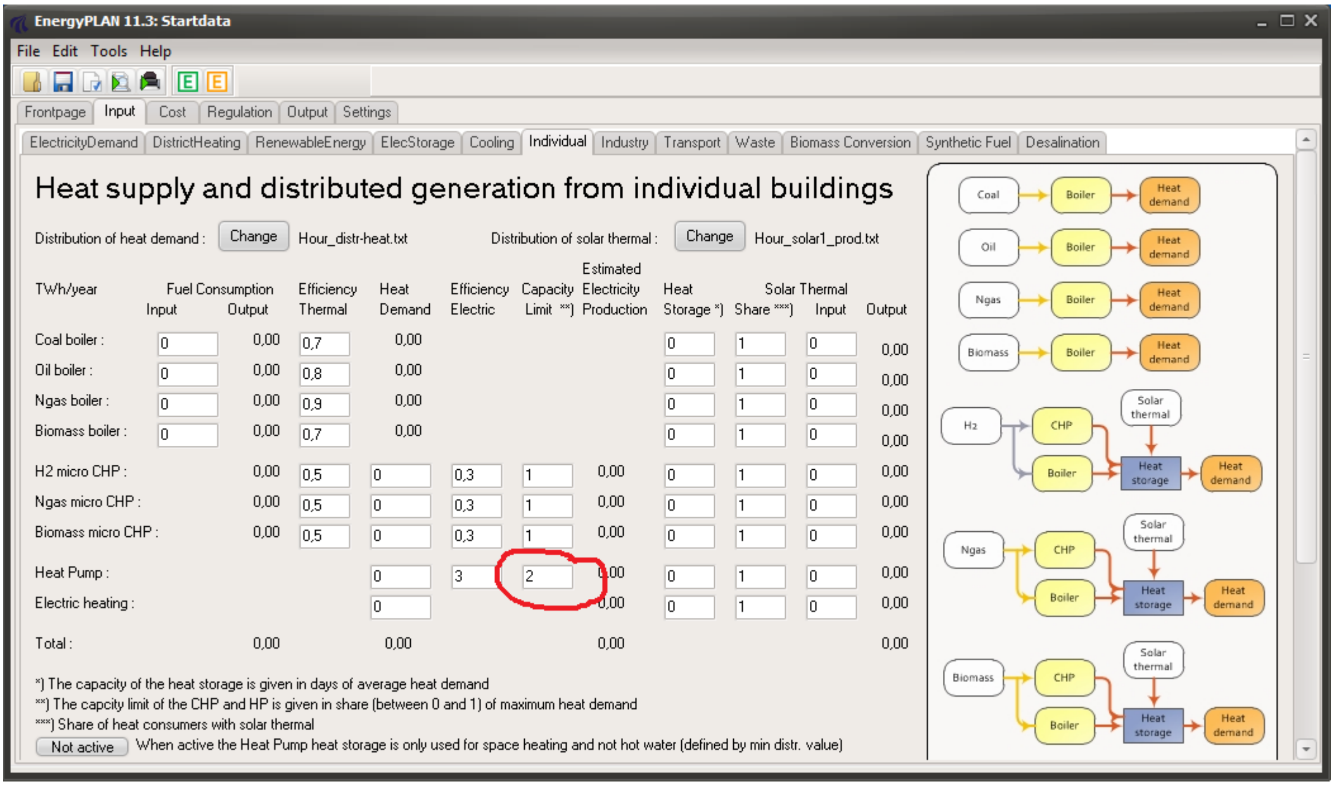
Question 6.3.1: What is the peak heat demand and the needed capacity of the heat pumps of question 6.2.2 if they should cover all the heat demand?(Don't include reserve capacity and give the answer as MW_e*)*

Question 6.3.2 How high is the annual electricity demand for the heat pumps? How much wind power is needed if the annual production should meet the annual demand of the heat pumps?

Question 6.3.3: What is the electricity un-balance, i.e. the needed production on the coal fired power plant and wind power excess electricity production?

Question 6.3.4: How much thermal storage and how much additional capacity of the heat pumps is needed if all excess production should be avoided? (Give the answer in percent additional heat pump capacity and the storage in average days of heat demand).

Hint: The capacity of the heat pumps has to be at least equal to the wind power capacity. EnergyPLAN will automatically identify minimum heat pump capacity to satisfy the hourly peak heat demand. You can increase/decrease the heat pump capacity by changing the “capacity limit” in the “Demand > Heating” window as illustrated below:



Note: In EnergyPLAN the thermal heat storage in individual houses are given in “days of average heat demand”. The reason is to make it easy to change from e.g. oil boilers to heat pumps without having to re-calculate the thermal storage every time.

Question 6.3.5: Given a house of a net heat demand of 17 MWh/year and consequently a peak heat demand of 6.3 kW (6315 MW divided by 17 TWh/year multiplied by 17 MWh/year), how much would one need to increase the heat pump capacity? And given a thermal water storage using a temperature difference of 40°C how many m^3 *would the water tank need to be?*

Hint: Heat capacity of water = 4.186 kJ/kgK. And 1 kWh = 3600 kJ.