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Guideline to EnergyPLAN Exercise 1:
Define and calculate a simple national energy system.
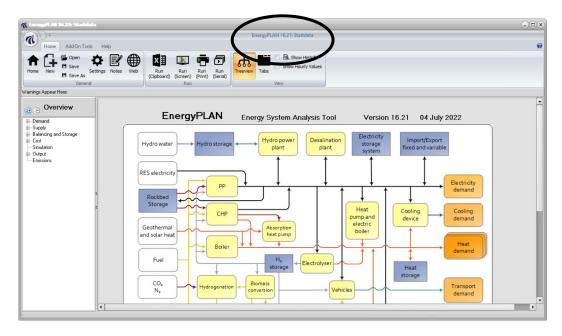
Exercise 1.1: Define an electricity demand

Open the EnergyPLAN model. Initialise data and define a simple national/regional energy system with an electricity demand of 49 TWh/year. Use the hour-distribution file of "hour-eldemand-eltra-2001" (The distribution of the western Danish region in 2001).

Question 1.1.1: What is the peak hour electricity demand?

Question 1.1.2: What is the peak hour electricity demand for 40 TWh/year and distribution data file "Hour_electricity.txt"?

How to do exercise 1.1:

Step 1: Open the EnergyPLAN model. You will see the following front page (version 16.21):
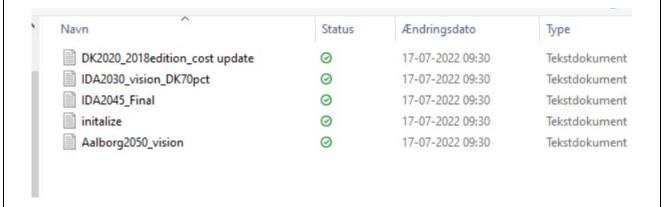

Look at the top: The EnergyPLAN model is loaded with "Startdata"

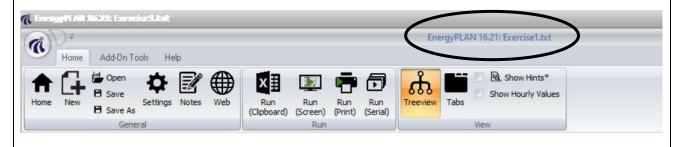*Step 2: Reset data by pressing "New" in the top bar.*

Step 3: Save Data

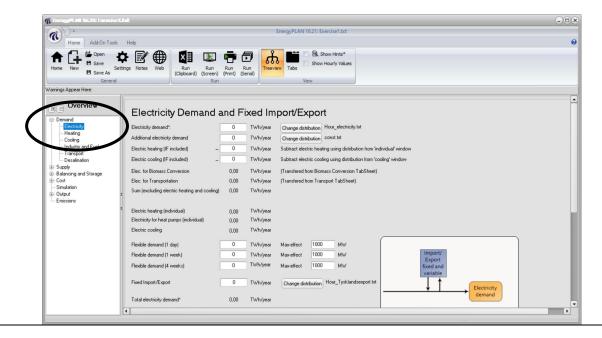Activate "save as" in the top left-hand corner and the following window will open:

Give your file a name, e.g. "Exercise1" and press save.

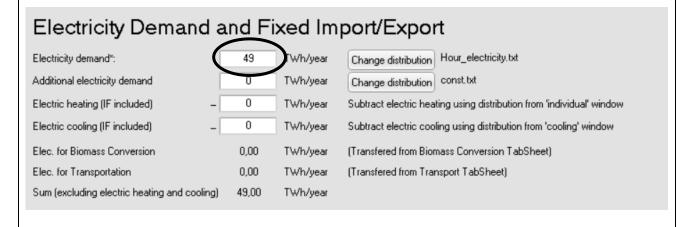Look at the top of the bar: The EnergyPLAN model is loaded with "Exercise 1" data.

Step 4: Write input-data electricity demand 49 TWh/year.

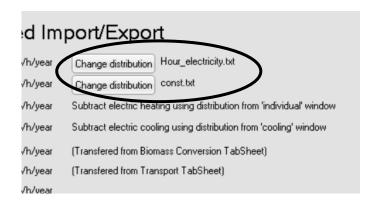To the left chose "Demand" and then "Electricity" and the following window will open:

Place the cursor in the electricity input square and type in 49.

Electricity Demand and Fixed Import/Export

Electricity demand*:	49	TWh/year	Change distribution	Hour_electricity.txt
Additional electricity demand	0	TWh/year	Change distribution	const.txt
Electric heating (IF included)	– 0	TWh/year	Subtract electric heating using distribution from 'individual' window	
Electric cooling (IF included)	– 0	TWh/year	Subtract electric cooling using distribution from 'cooling' window	
Elec. for Biomass Conversion	0,00	TWh/year	(Transfered from Biomass Conversion TabSheet)	
Elec. for Transportation	0,00	TWh/year	(Transfered from Transport TabSheet)	
Sum (excluding electric heating and cooling)	49,00	TWh/year		

Step 5: Change hour-distribution to "hour-eldemand-eltra-2001"

Look at the "Demand > Electricity" input window:
The model is loaded with "Hour-electricity" distribution data.

Activate the [Change distribution] button and the following window will open:

Choose "DK 2013 Electricity demand" and activate the Open/Åbn button.

Look at the Demand > Electricity input window:

The model is now loaded with "DK 2013 Electricity demand" distribution data:
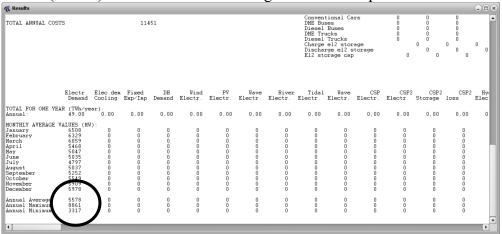

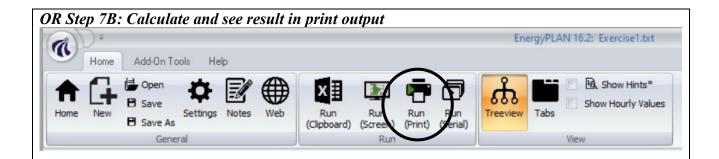**Step 6: Save data:**

Activate the ⊟ Save button.

EITHER Step 7A: Calculate and see result in clipboard
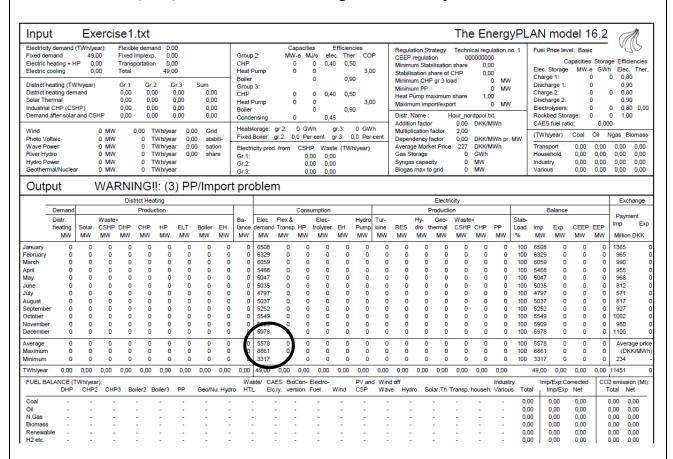
Activate the "Run (Screen)" button and the following window will open:

Read the result: 8861 MW

OR Step 7B: Calculate and see result in print output

Activate the "Run (Print)" button and the following window will open:

Read the result: 8861 MW

Step 8: Repeat steps 4 to 7 using 40 TWh/year and "Hour_electricity.txt".
The result is 7023 MW

Exercise 1.2: Define wind power and a power plant

Use the same electricity data as in exercise 1.1: Electricity demand of 49 TWh/year and "DK 2013 electricity demand". Define a wind power input of 2000 MW using "Hour_wind_1" and a condensing power plant of 9000 MW burning coal.
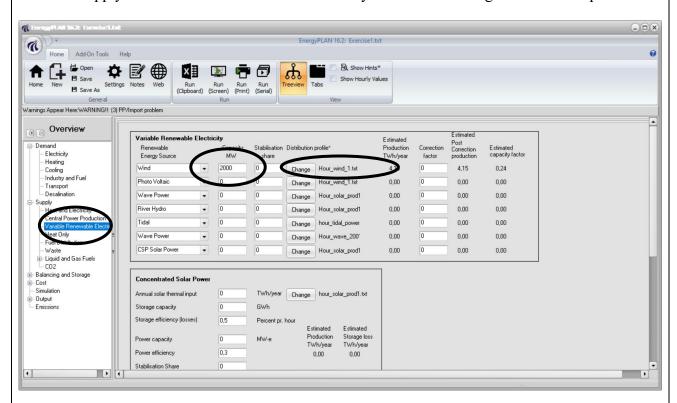
Question 1.2.1: What are the annual wind power and condensing power plant productions? What is the annual coal consumption? What is the annual CO_2 emission?

Question 1.2.2: What are the annual wind power and condensing power plant productions, if the installed wind power capacity is raised to 6000 MW? What are the annual coal consumption and the CO_2 emission?

How to do exercise 1.2: Use input data file from exercise1.1.

Step 1: Define wind power

Choose "Supply" and "Variable Renewable Electricity" and the following window will open:

Place cursor at the first RES Capacity input square and write 2000.
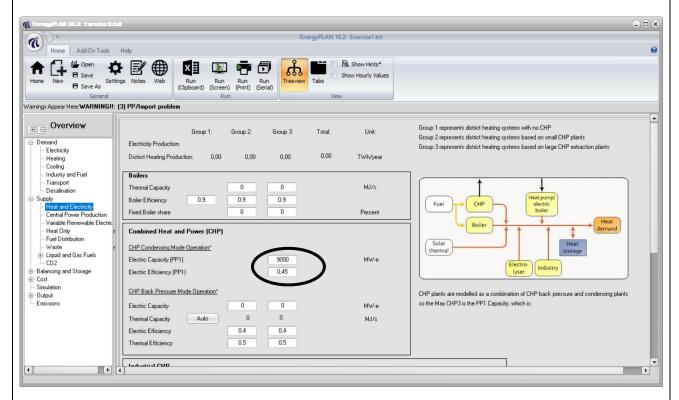
Step 2: Change hour distribution file

The Distribution profile is "Hour_wind1".

Activate the Change button and change to "DK 2013 Wind onshore" as shown in exercise 1.1, step 5.
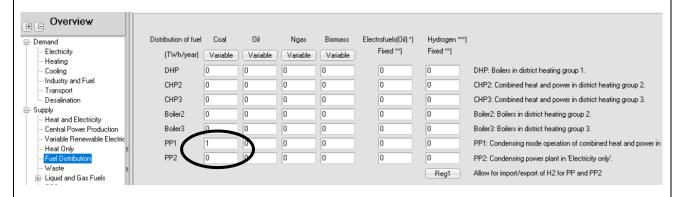
Step 3: Define condensing Power plant

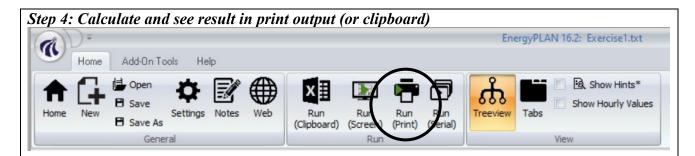Choose the "Supply > Heat and Electricity" window:

Place the cursor at the condensing Capacity input square and type in 9000.
Place the cursor at the condensing Efficiency input square and type in 0.45.

Choose the "Supply > Fuel Distribution" window:

Place the cursor at the PP1 coal input square and type in 1 (Any number will do, they are all relative to the other fuel input squares)

Step 4: Calculate and see result in print output (or clipboard)

Home | Add-On Tools | Help

Home | New | Open | Save | Save As | Settings | Notes | Web | Run (Clipboard) | Run (Screen) | Run (Print) | Run (Serial) | Treeview | Tabs | Show Hints* | Show Hourly Values

General | Run | View

Activate the "Run (Print)" button and look at the following print output:

[EnergyPLAN model 16.2 print output — Input/Output tables for Exercise1.txt showing district heating, electricity production, consumption, balance, exchange, and fuel balance data]

Read results:

Wind power production = 4.15 TWh/year.

Condensing Power production = 44.85 TWh/year.

Coal consumption = 99,67 TWh/year.

CO_2 emissions = 34.09 Mt.

Step 5: Change installed wind power capacity

Repeat step 1 for 6000 MW wind power. The results are now:

Wind power production = 12.45 TWh/year.

Excess production (export) = 0.07 TWh/year.

Condensing Power production = 36.62 TWh/year.

Coal consumption = 81.38 TWh/year.

CO_2 emission = 27,83 Mt

Exercise 1.3: Define district heating and individual house heating

Use the data from exercise 1.2:

- Electricity demand of 49 TWh/year and "DK 2013 electricity demand"
- Condensing power plant: 9000 MW coal –fired
- 2000 MW wind power using "DK 2013 Wind onshore"

Define 1) an annual district heating demand of 39.18 TWh (distribution "hour_distr_heat") of oil boilers and 2) a fuel demand for individual house heating of 23.07 TWh divided into 0.01 coal, 6.72 oil, 9.05 natural gas and 7.29 biomass. Use the efficiencies already used in the model.

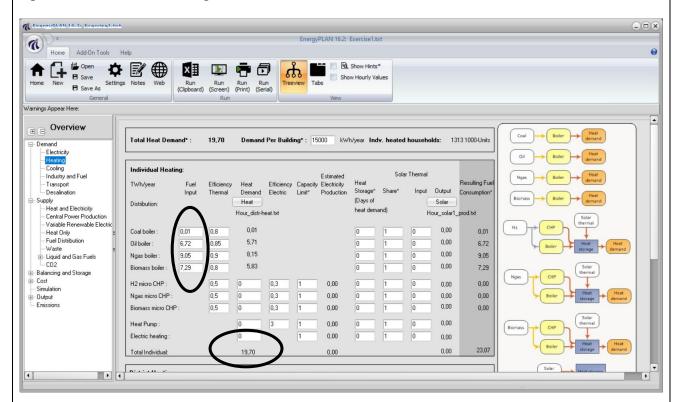*Question 1.3.1: What is the net annual heat demand for individual houses?*

Question 1.3.2: What is the peak hour district heating demand?

Question 1.3.3: What is the annual primary energy supply of the system? And what is the annual CO2 emission?

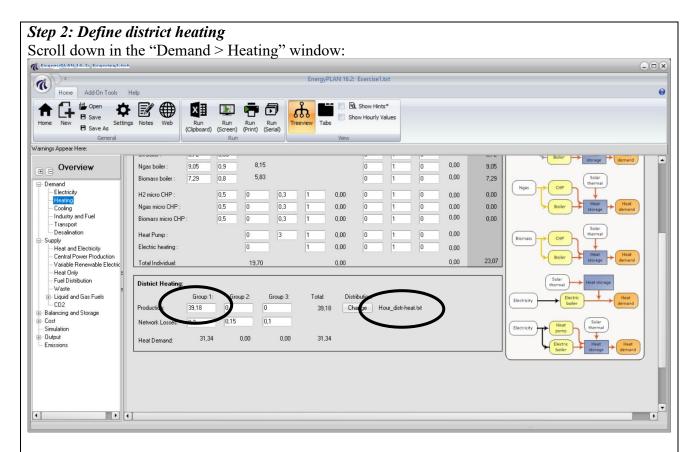**How to do exercise 1.3:** Use input data file from exercise1.2.

Step 1: Define individual house heating
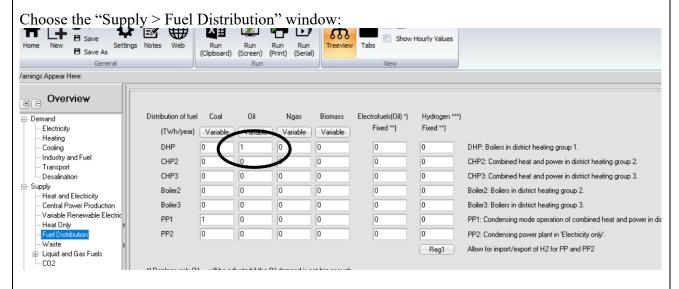
Open the "Demand > Heating" window:

Place the cursor in the input squares of coal, oil, Ngas and Biomass boilers and type in the fuel demands.

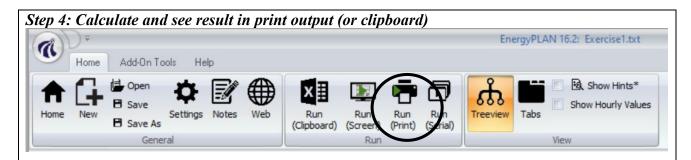Read the answer of question 1.3.1: The annual house heat demand is 19.70 TWh.

Step 2: Define district heating

Scroll down in the "Demand > Heating" window:

Place the cursor in the district heating group I input square and type in 39.18.
Make sure that the distribution is already "hour-distr-heat"

Choose the "Supply > Fuel Distribution" window:

Place the cursor in the DHP oil input square and type in 1 (Any number will do, they are all relative to the other fuel input squares)

Step 3: Calculate and see result in clipboard

The district heating peak hour load demand is 7932 MW (Question 1.3.2)

Step 4: Calculate and see result in print output (or clipboard)

Activate the "Run (Print)" button and look at the following print output:

Read the results of question 1.3.3:
Primary energy supply = 170.42 TWh/year.
CO_2 emissions = 49.33 Mt.

Exercise 1.4: Define industrial fuel demand and heat and electricity productions.
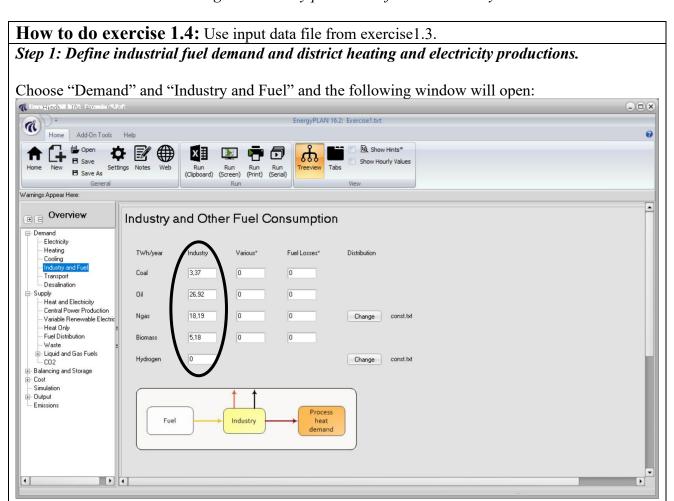
Use the data from exercise 1.3:

- Electricity demand of 49 TWh/year and "DK 2013 electricity demand"
- Condensing power plant: 9000 MW coal –fired
- 2000 MW wind power using "DK 2013 Wind onshore"
- Annual district heating demand of 39.18 TWh (distribution "hour_distr_heat")
- Fuel demand for individual house heating of 23.07 TWh divided into 0.01 coal, 6.72 oil, 9.05 natural gas and 7.29 biomass.

Define an 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). Define an industrial district heating production of 1.73 TWh and an electricity production of 2.41 TWh. Use the hour distribution file "const".

Question 1.4.1: What is the annual primary energy supply of the system? And what is the annual CO2 emission?

Question 1.4.2: What are the annual primary energy supply of the system and the CO2 emission when there is no district heating or electricity production from the industry?

How to do exercise 1.4: Use input data file from exercise1.3.

Step 1: Define industrial fuel demand and district heating and electricity productions.

Choose "Demand" and "Industry and Fuel" and the following window will open:

Place the cursor in the input squares of coal, oil, Ngas and Biomass and type in the fuel demands.

Choose "Supply" and "Heat and Electricity" and the following window will open:

Place the cursor in the input squares of group I DH prod and electricity production and type in 1.73 and 2.41.

The hour-distribution-file is "Hour_cshpel".

Activate the [Distribution] button and change to "const" as shown in exercise 1.1, step 5.

Step 2: Calculate and see result in print output (or clipboard)

Read the results of question 1.4.1:

Primary energy supply = 217.56 TWh/year.
CO_2 emissions = 59.33 Mt.

Step 3: Change district heating and electricity production

Repeat steps 1 and 2:

Place the cursor in the input squares of group I DH prod and electricity production and type in 0.

Read the results of question 1.4.2:
Primary energy supply = 224.08 TWh/year.
CO_2 emissions = 61.36 Mt.

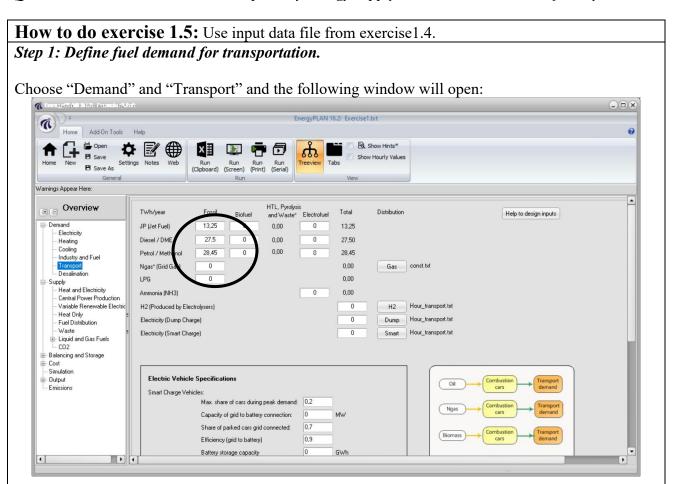## Exercise 1.5: Define fuel demand for transportation.

Use the data from exercise 1.4:

- Electricity demand of 49 TWh/year and "DK 2013 electricity demand"
- Condensing power plant: 9000 MW coal –fired
- 2000 MW wind power using "DK 2013 Wind onshore"
- Annual district heating demand of 39.18 TWh (distribution "hour_distr_heat")
- Fuel demand for individual house heating of 23.07 TWh divided into 0.01 coal, 6.72 oil, 9.05 natural gas and 7.29 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".
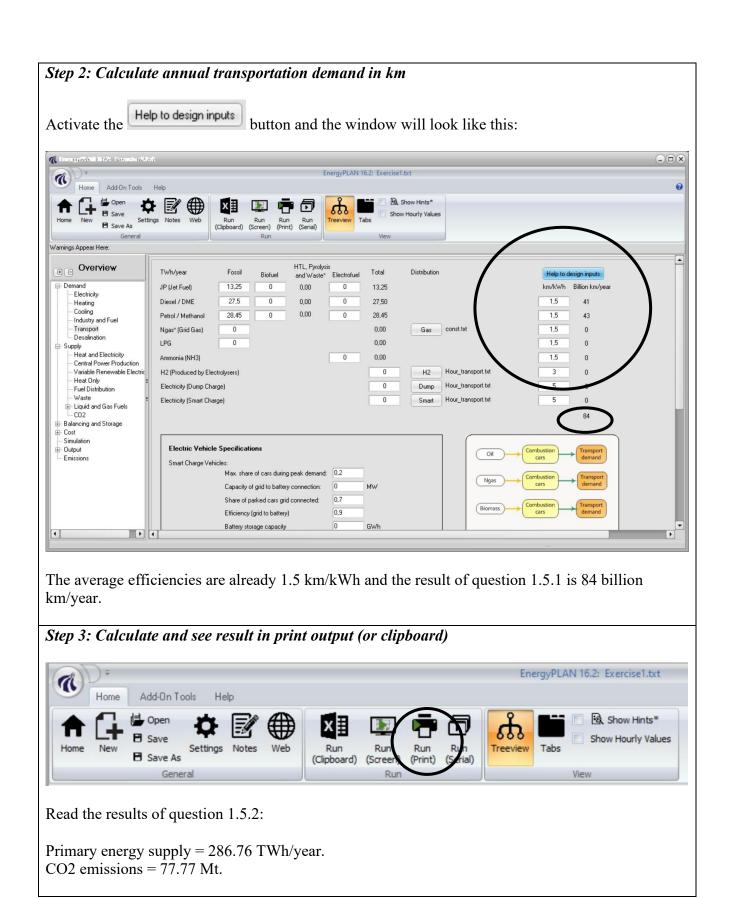
Add fuel demand for transportation: 13.25 TWh Jet Petrol, 27.50 TWh Diesel and 28.45 TWh Petrol.

Question 1.5.1: Assuming an average car efficiency of 1.5 km/kWh what is the transportation demand in km/year of the diesel and petrol supply?

Question 1.5.2: What are the annual primary energy supply and the CO2 emission of the system?

How to do exercise 1.5: Use input data file from exercise1.4.
Step 1: Define fuel demand for transportation.

Choose "Demand" and "Transport" and the following window will open:

Place the cursor in the input squares of JP, Diesel and Petrol and type in the fuel demands.

Step 2: Calculate annual transportation demand in km

Activate the Help to design inputs button and the window will look like this:

The average efficiencies are already 1.5 km/kWh and the result of question 1.5.1 is 84 billion km/year.

Step 3: Calculate and see result in print output (or clipboard)

Read the results of question 1.5.2:

Primary energy supply = 286.76 TWh/year.
CO_2 emissions = 77.77 Mt.

REMEMBER to save exercise 1. You will need it when doing exercise 2.