

HOW TO GUIDE

The REGION module and multiple sites in energyPRO



energyPRO



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About energyPRO

energyPRO is a Windows-based modeling software package for combined techno-economic analysis and optimisation of complex energy projects with a combined supply of electricity and thermal energy from multiple different energy producing units.

The unique programming in energyPRO optimises the operations of the plant including energy storage (heat, fuel, cold and electrical storages) against technical and financial parameters to provide a detailed specification for the provision of the defined energy demands, including heating, cooling and electricity use.

energyPRO also provides the user with a detailed financial plan in a standard format approved by international banks and funding institutions. The software enables the user to calculate and produce a report of the emissions by the proposed project.

energyPRO is very user-friendly and is the most advanced and flexible software package for making a combined technical and economic analysis of multi-dimensional energy projects.

For further information concerning the applications of energyPRO please visit www.emd.dk.

Terms of application

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Introduction

With the REGION module it is possible to model, analyse and optimise the operation of multiple sites in an energyPRO project. A site in energyPRO is a location that contains demands, energy units and/or storages, from which energy is exchanged to other sites via transmission lines. The possibility of having multiple sites in energyPRO is useful for instance when analyzing the economic and technical consequences of connecting two district heating grids or adding a solar collector field located at a distance from the district heating grid.

The REGION module can be use in a wide range of projects, but it is typically used when the modelled system consists of production units, which are physically located far from each other or far from where the heat is delivered. It is, however, also possible to use sites as a way to model a system's flow constraints and other limitations that are not otherwise possible to model.

Figure 1 shows an example of an energyPRO model with multiple sites.

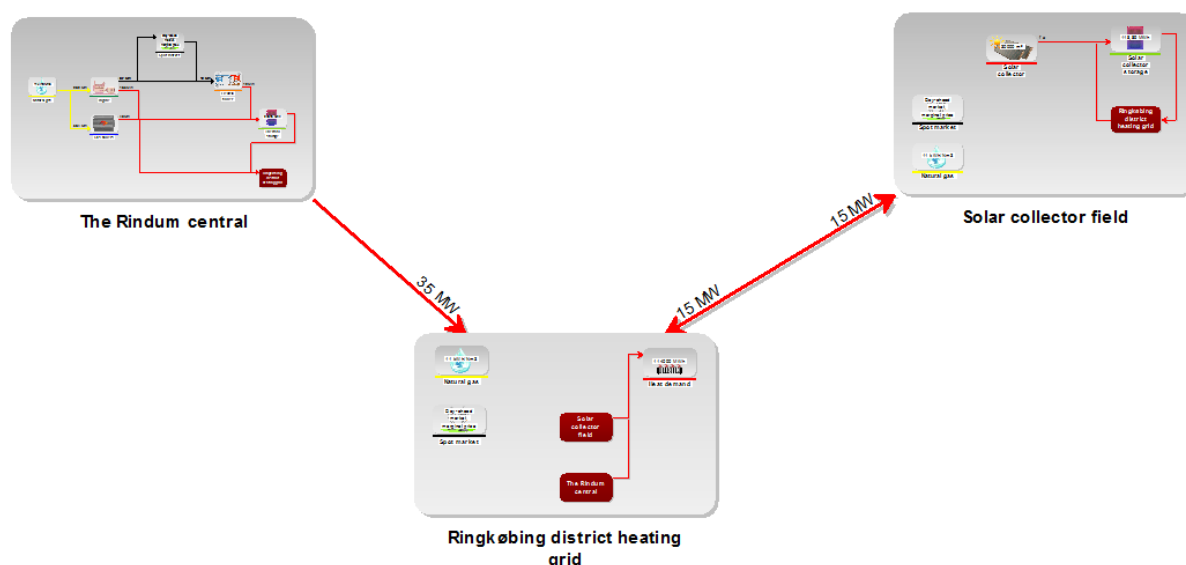


Figure 1. Example of a site overview with three different sites and two transmission lines

In order to set up multiple sites in energyPRO, you must have access to the REGION module. You can check what modules that are included in your license in "About" under "Help" in the main menu.

If you do not have a license to the REGION module, this can be purchased by contacting the sales department at EMD International: sales@emd.dk

Step-by-step guide

There are, as mentioned, many useful applications with the possibility of having multiple sites in energyPRO. As an example of how sites can be used, this step-by-step guide will go through how to add another district heating system to an existing energyPRO project. In the example, it is assumed that a smaller village

is located at a distance from the existing district heating grid and a connecting transmission line is desired.

Add a new site to an existing project

We start the example by opening the existing energyPRO project: “*Cogeneration plant on a spot market_DESIGN module*”. Select ‘File’ in the upper left corner of energyPRO, click ‘Open’ and find the aforementioned file, which is typically located in C:\energyPRO Data\English\Project examples, as shown in Figure 2.

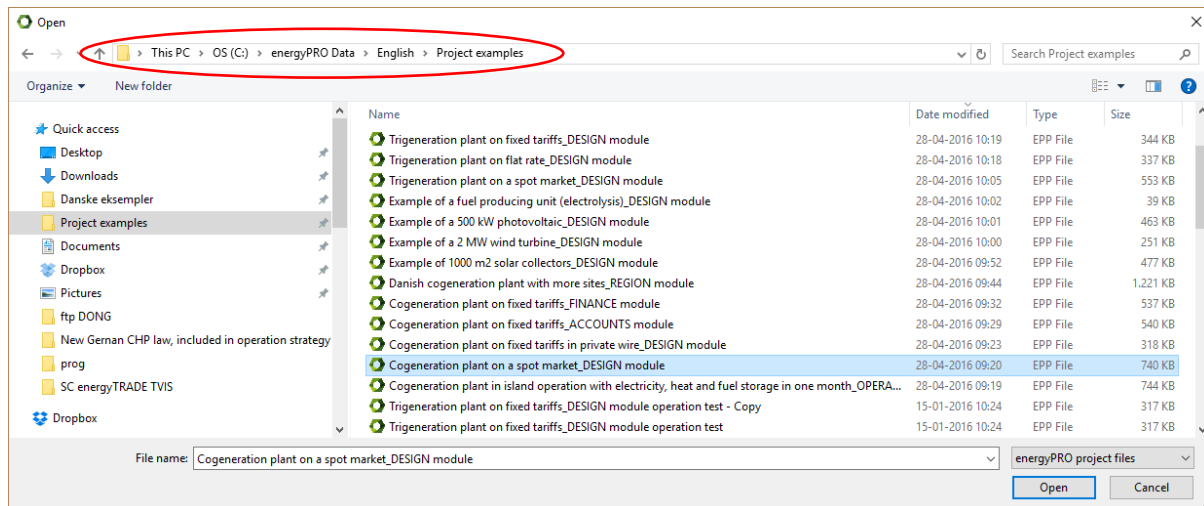


Figure 2. Open the file “Cogeneration plan on a spot market_DESIGN module.epp”

You should now have an energyPRO window similar to the one shown on Figure 3 with two CHP’s participating on the spot market.

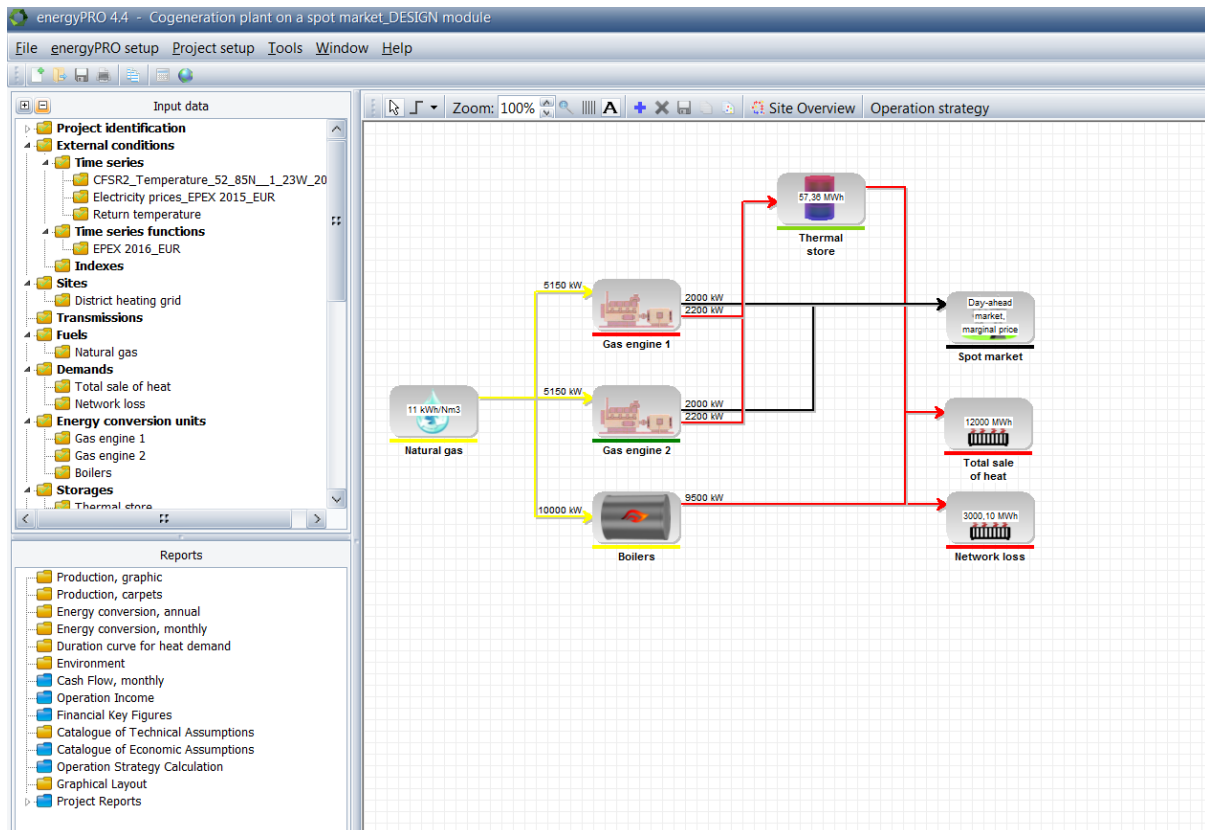


Figure 3. An energyPRO model of two CHP's participating on the spot market

Add a new site by right clicking on 'Sites' and select 'Add new site' as shown on Figure 4.

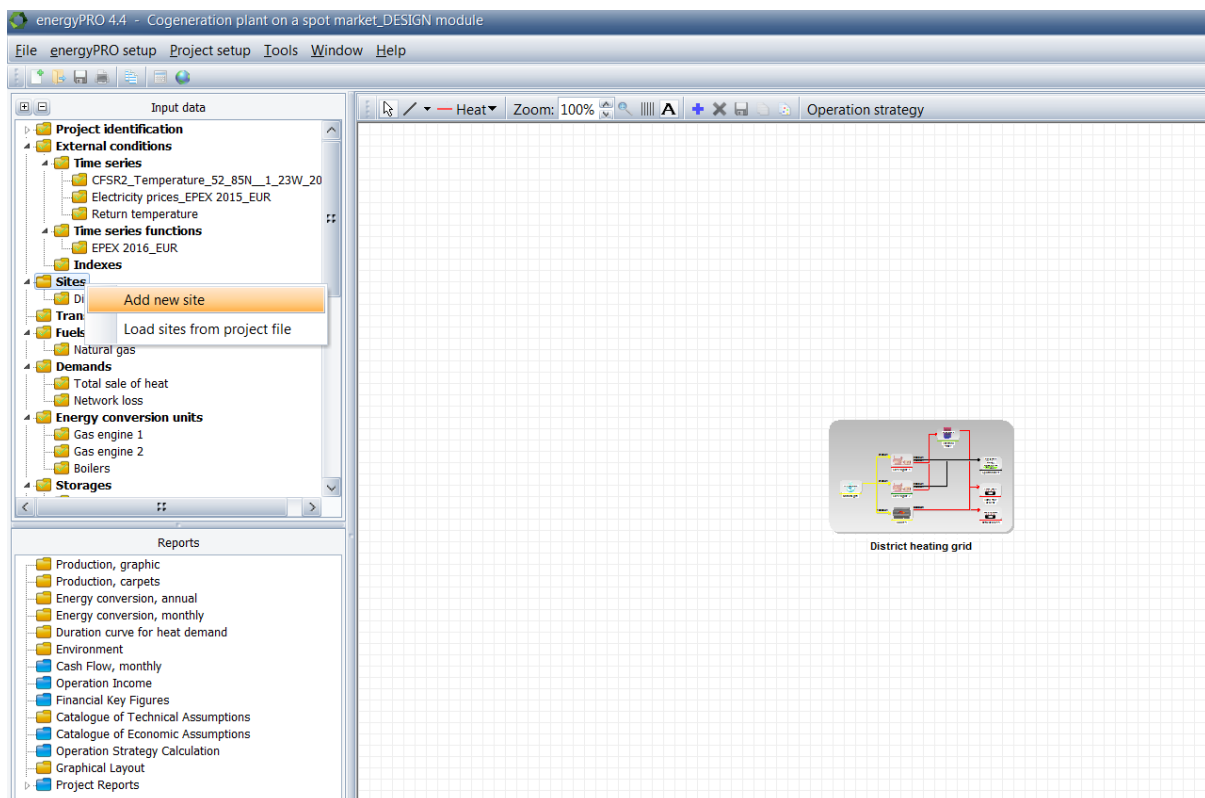


Figure 4. Add a new site

You should now see another site 'New Site'. Rename this site by right clicking on it in the sites folder and select rename. Since we want to add a small village in this site, name the site 'Small Village'. To view the two sites, click 'Sites' and two sites should appear instead of one.

To begin with, the new site will contain the fuels and markets used in existing sites, as seen on Figure 5.

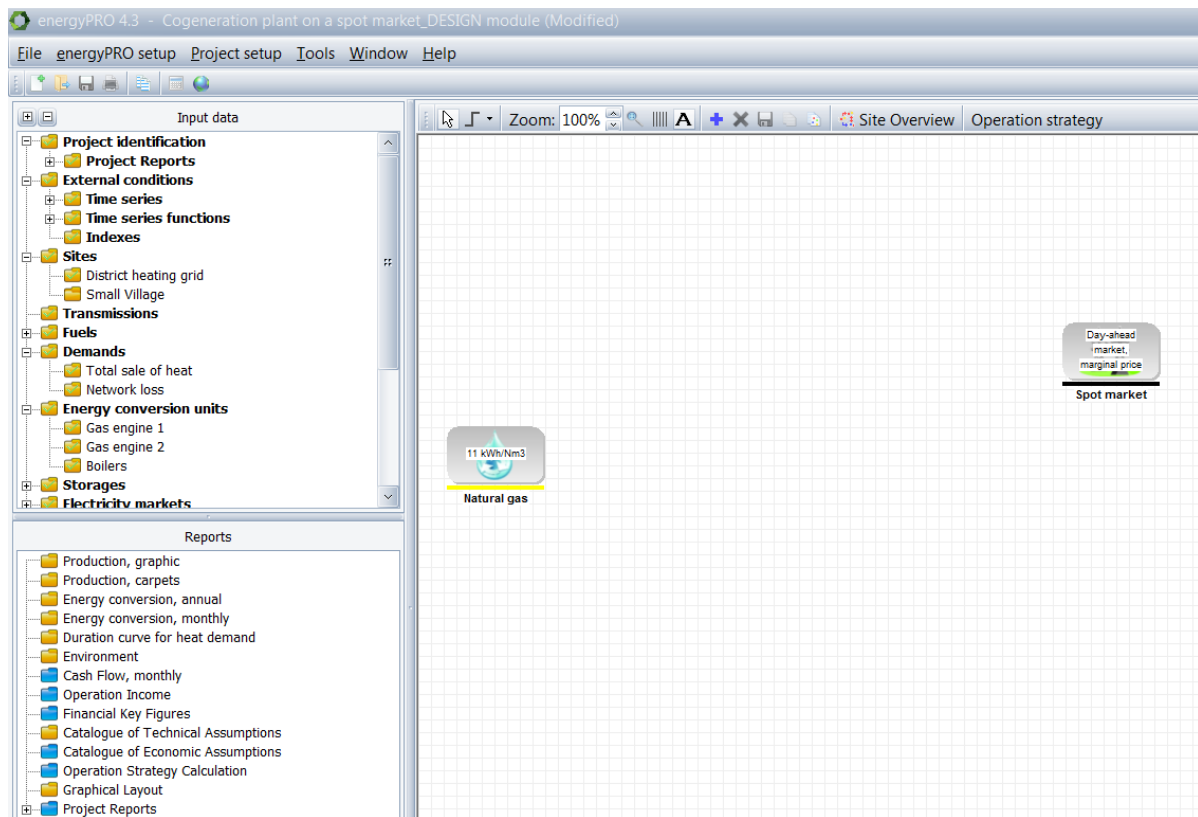


Figure 5. The new site has been added and renamed

Add a heat demand and a boiler to the site

Once the new site is added, it is time to add an energy conversion unit to the new site – in this case a natural gas fired boiler. Add the boiler by right clicking anywhere on the graphical window and click 'Add' followed by 'Energy Conversion Unit' and 'Boiler' as shown on Figure 6.

You can also access this menu by clicking the blue cross in the toolbar.

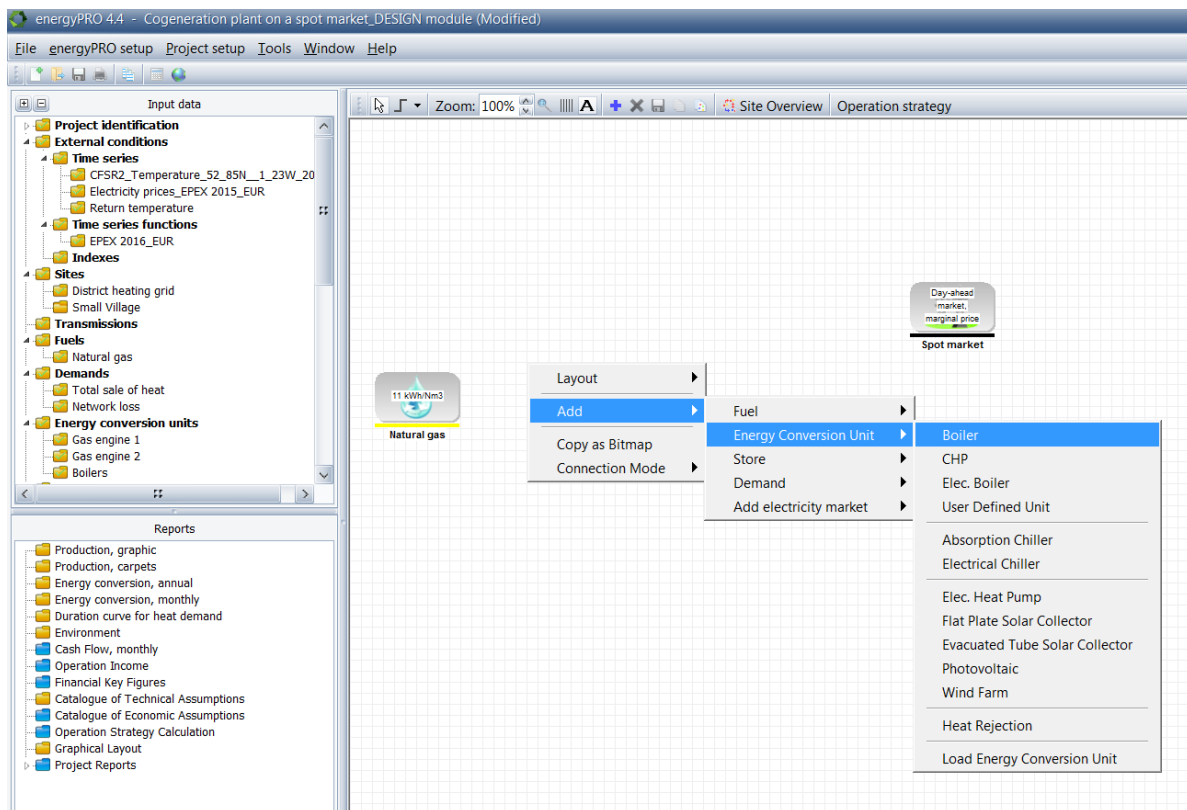


Figure 6. Add a boiler to the site.

Once the boiler has been added, a window as the one shown in Figure 7 will appear. In this window, the boiler's specifications must be entered.

The 'Boiler' specification window is shown. It contains the following fields and options:

- Name:** Boiler
- Connected to Site:** Small Village
- Production unit type:** Boiler
- Fuel:** (no fuel)
- Powerunit:** kW
- Non availability periods:** ☐
- Operation period:** An operation period shall minimum be (0):
- Non operation period:** A non operation period shall min. be (0)
- Power curves table:**

Operation	Fuel	Heat
Performance	kW	kW
Linear	0,0	0,0
- Buttons:** Add line, Delete line, Enable formulas in power curve
- Operation dependent on other unit:** ☐
- Comments:** (empty text area)
- Buttons:** OK, Cancel

Figure 7. Type in the boiler's specifications

In this window, name the boiler: "Small Village Boiler", select 'Natural gas' as fuel and select 'MW' as the power unit. Next, type in 3 MW Fuel and 2.7 MW Heat in the Power curves and click 'OK' to finish the setup of the boiler.

Next, add a heat demand in the new site. This is done in the same way as when adding a boiler: Right click and select 'Add', then 'Demand' and then 'Heating Demand'. The following window should appear.

Figure 8 shows the 'New Heat demand' window. The 'Name' field is 'New Heat demand'. The 'Heat demand' label is present. The 'Connected to Site' dropdown is set to 'Small Village'. The 'Development of Demand in Planning Period' section is active. Under 'Demand in Specified year', the 'Fixed' radio button is selected. The date range is '01-16' to '12-16'. The value is '0,0' and the unit is 'MWh'. The 'Demand depends on external conditions' checkbox is unchecked. The 'Fixed profile of demand' checkbox is also unchecked. The 'Monthly amounts' table shows the following data:

Month	[MWh]
January	0,0
February	0,0
March	0,0
April	0,0
May	0,0
June	0,0


The 'As timeseries' button is located below the table. The 'Move demands on' section has 'Date basis' selected. The 'Developing over the years' checkbox is unchecked. The 'Restricted period of connection' checkbox is also unchecked. The 'OK' and 'Cancel' buttons are at the bottom right.

Figure 8. In this window you can define the heat demand.

Set the annual heat demand to 6,000 MWh and put a check in the box, 'Demand depends on external conditions'. You should now see a window similar to the one in Figure 9

Figure 9. This wizard helps you to define a heat demand that depend on external conditions

Type in 75 % as the 'Dependent fraction' and make sure to select the 'T1' time series as the ambient temperatures under 'Formula for dependency'.

Hit the icon,  to see a graph of the heat demand. Click 'OK' to finish the setup of the new heat demand.

Your new site should now look like the one in Figure 10.

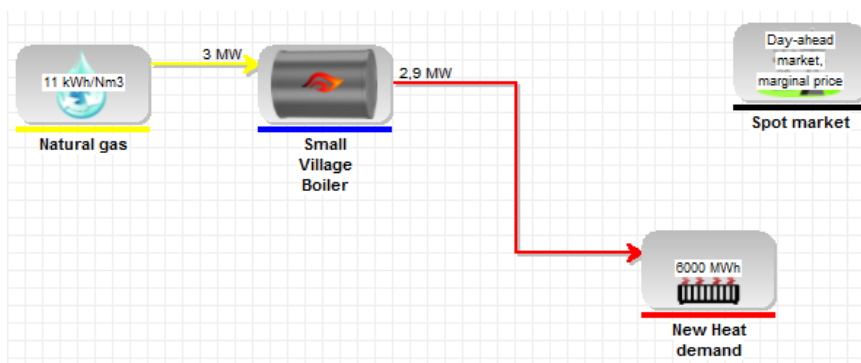


Figure 10. Schematic of the units in site, "Small Village"

Add a transmission line between two sites

With the new site completed, it is time to connect the two sites by adding a transmission line. This is done by right clicking the 'Transmissions' folder and selecting 'Add new heat transmission' as shown in Figure 11.

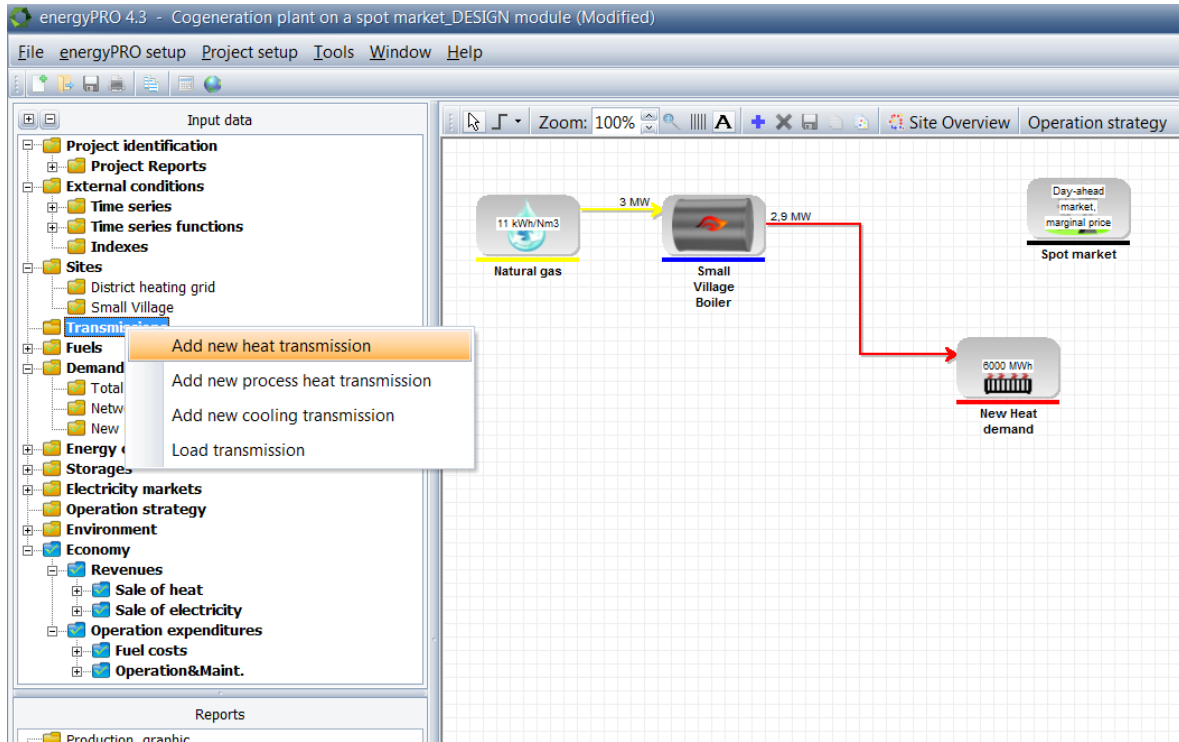


Figure 11. Add a heat transmission line

When the transmission line has been added, open the transmission line by right clicking the new transmission in the 'Transmissions'-folder. A window similar to the one shown on Figure 12 should appear.

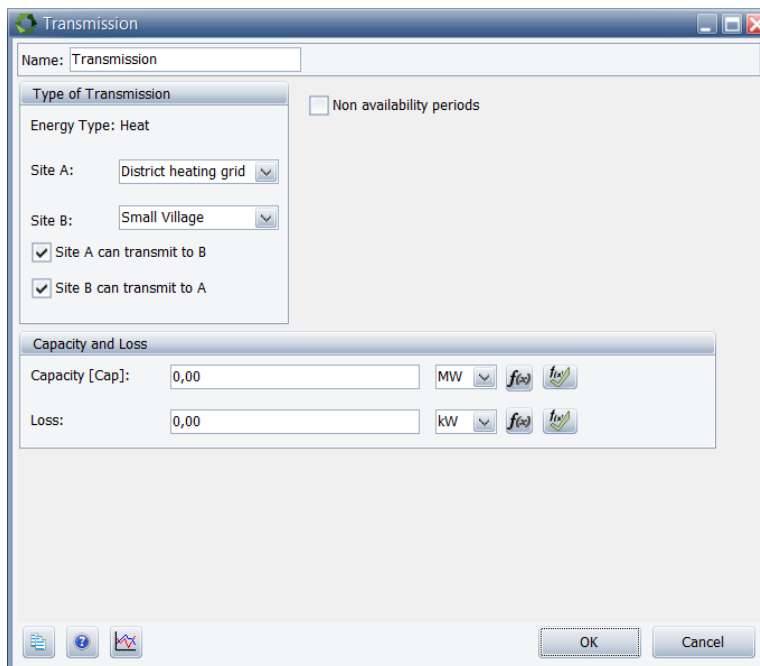


Figure 12. Set the capacity to 5 MW

To make sure that there will be sufficient transmission capacity, set the capacity to 5 MW.

Adjust the operation strategy

The last thing to do is to check that the operation strategy is set up correctly with the new site. Click on the 'Operation strategy' button in the top right of the energyPRO window. A window similar to the one shown on Figure 13 will appear.

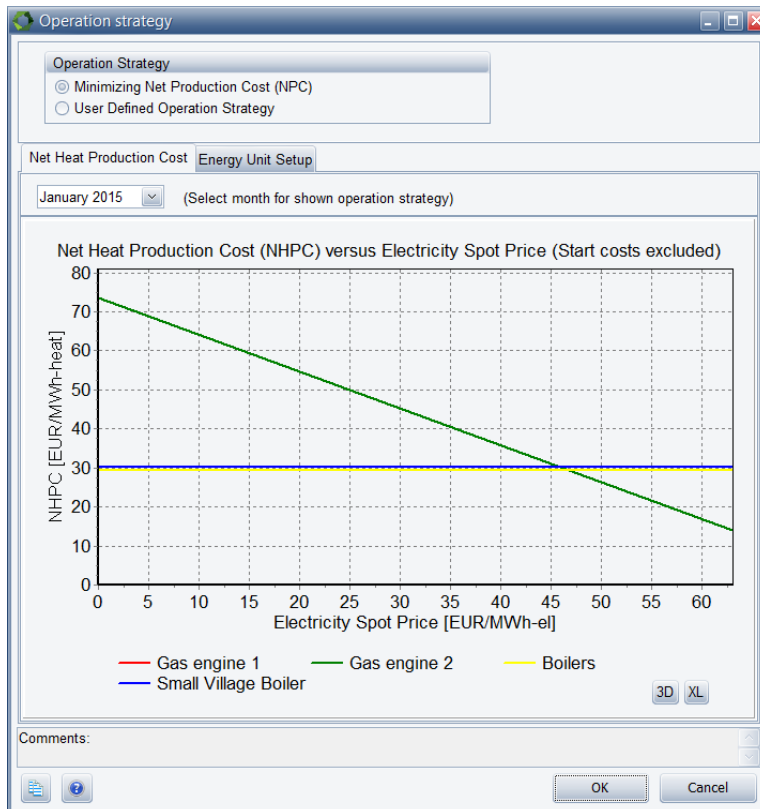


Figure 13. Here you can adjust the operation strategy

The figure shows the net heat production costs (NHPC) of each unit as a function of the electricity spot price. The 'Small Village Boiler' is slightly more expensive than the boilers in the existing district heating network.

Click the 'Energy Unit Setup' to setup rules for the operation of the units and allow the 'Small Village Boiler' to run at partial load.

Operation strategy

☒ Minimizing Net Production Cost (NPC)
☐ User Defined Operation Strategy

Net Heat Production Cost | **Energy Unit Setup**

Energy unit (or elec. demand)	Production to store allowed	Transmit to other sites allowed	Partial load allowed	Electricity market	Selected priority in operation strategy
Gas engine 1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Spot	Calculated
Gas engine 2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Spot	Calculated
Boilers	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		Calculated
Small Village Boiler	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		Calculated

Comments:

OK Cancel

Figure 14. Here you can set rules for the units, affecting the operation strategy.

Allow the 'Small Village Boiler' to run at partial load and prevent the 'Boilers' in the existing network to transmit heat to other sites. Make sure to have the same setup as in the above figure before clicking 'OK' to finish the setup.

Simulation results

To view the results of the simulation, select one of the reports in the bottom left window. To view a graphical presentation of the production, click 'Production, graphic' as shown on Figure 15.

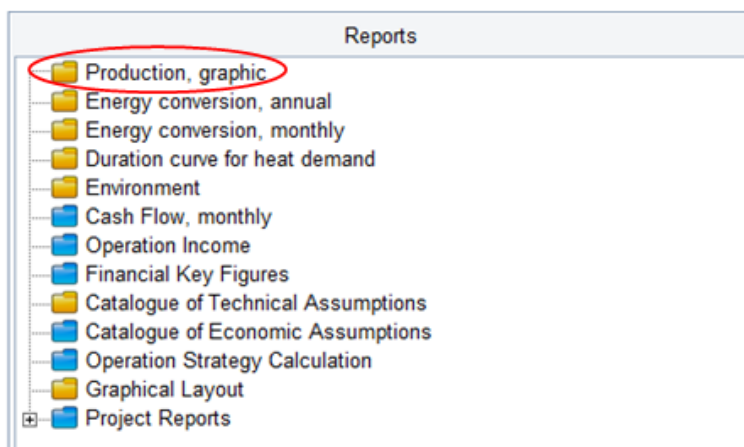


Figure 15. Click Production, graphic

To demonstrate how the two sites are operated, one week's operation from 31/10/2016 to 06/11/2016 is shown in Figure 16 and Figure 17. In both figures, four graphs are shown; the electricity spot price, the heat production and demand and finally the storage content and capacity.

In Figure 16 the operation of the units in the existing site, "District heating grid", is shown. The figure includes three graphs; the electricity spot price, the heat production/demand and finally the storage content and capacity.

From the figure it can be seen that the two gas engines are operated in hours with high electricity prices. In these hours, the engines cover the heat demand in both sites and the additional heat is stored in the thermal storage tank. When electricity prices are low, the stored heat is used to cover the demand until the tank is empty, then the two gas boilers are started to cover the heat demand in each site.



Figure 16. Graphical presentation of the operation of the existing site: "District heating grid". From above: The electricity spot price, the heat production and the storage content

The different colors in the heat production graph represent the different units: Yellow = Boilers, Red/Green = Gas engines, Red line = heat demand in this site and Blue line = heat sent to "Small Village".

In Figure 17 the operation of the boiler in the new site, "Small Village", is shown. The figure includes two graphs; the electricity spot price and the heat production/demand.

The blue color represents the boiler in the small village and the green color represents the heat received from the site: "District heating grid".

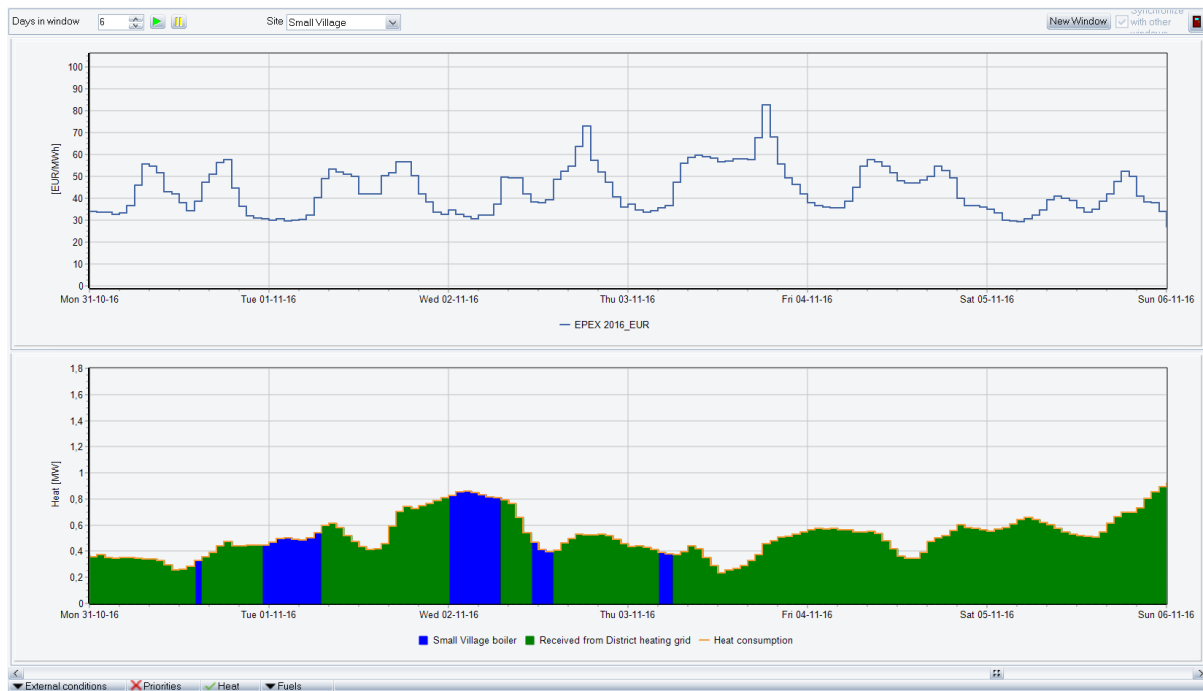


Figure 17. Graphical presentation of the operation of the new site: "Small Village". From above: The electricity spot price and the heat production

The figure shows that the most of the heat is covered by the gas engines in the existing site, "District heating grid".

When Figure 17 and Figure 16 are compared, it is seen that the "Small Village boiler" is only operated in hours with low electricity prices and when the storage tank in the existing site "District heating grid" is low.

Please notice, that you can find more information on how to use energyPRO in the How to Guides, User's Guide and tutorials on EMD's website:

<http://www.emd.dk/energypro/>



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