Power Plan Help File

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PowerPlan is an interactive simulation model with which a future for the electricity supply system can be planned. With PowerPlan you can build scenarios for the intermediate and long term. PowerPlan is a so-called forecasting model: given an existing power system and year, an electricity supply system future will be simulated. It is thus *not* a optimization model but a model from which the consequences of decisions can be evaluated (a "What – If" model).

From a certain reference year the future electricity supply system can be built. At each time interval or planning round (1 year or more) the user can make decisions about:

- adjustments in the existing supply system;
- new power plants to be build;
- investments in energy conservation programs;
- investments in decentralized generating capacity.

The consequences of decisions made can be calculated for each planning round (typically one year). The results of the decisions made can be used as input for the next planning round.

The results are not only determined by the decisions made by the user, but also by several exogenous factors. The model contains exogenous factors such as: electricity demand, oil price, population growth etc. The factors are fixed in scenarios. Such scenarios are the starting point for the planning of the future electricity supply.

(Note that in the current version of PowerPlan a distinction is made between centralized generating plants the decentralized generation of electricity. Due to the free market policy of the European union, this division is becoming more and more out of date.)

Quickstart with PowerPlan

- Select [File] [New scenario], select a scenario.
- Select [Calculate], determine the number of years to be calculated (default is 1), click on the [**Calculate**] button, click on the [**Close**] button.
- Select [Output][Electricity generation] to view the result in table form.
- Select [Output][Planning] to view the installed capacity in relation to the (expected) electricity demand.
- Select [Decisions] [Add power plants] to start with building your electricity future.
- The yellow notes which become visible if the cursor moves over a certain position in the window give some explanation.

How to use PowerPlan

New scenario

To start, you first have to initialize the system, that is, supply the relevant data for the country/region you want to simulate. To get an overview of your possible countries/regions, first choose [File] and then [New scenario]. The list of countries/regions for which input files are available is shown to you. Make your choice.

The other items in the File menu will be discussed later. All data needed to run a scenario are read from in input file. These data consist for example of all the existent power plants and those ordered in the past and under construction, the present and future fuel prices. The nest step is to calculate the first year of the simulation.

Load scenario

With this option you can load a scenario which was saved before. These files have the extension *sdt*.

Save scenario

With this option you can store the results of a scenario so you can continue your session later on.

Exit

With this option you can close PowerPlan. Don't forget to save your scenario.

Decisions

- Retrofit
- Add power plants
- Add conservation & decentralized capacity
- Fuel contracts

Retrofit

In this window you get a list with all power plants available in the present year or under construction. It is possible to make several adjustments in these plants:

- increase or decrease the life time of a plant (Yr out);
- change the capacity of a plant (Cap.);
- change the efficiency (Eff.);
- change the fuel type (Fuel);
- change the load type: base, middle or peak (Load);
- change the SO2-emission reduction (SO2-r);
- change the NOx-emission (NOx-e).

Adjustments in power plants inevitably will cost money. So if you change the specifications of a power plant you ought to charge for it in the column Costs by hand.

Add power plants

In this window you order new power plants. The window shows you a graph with all the power plants present and under construction over time.

Also the electricity demand and the required capacity are drawn. Due to depreciation of the plants future capacity will decline till there is a capacity shortage. So new power plants should be build in order to meet future electricity demand.

Ordering new plants can take place in table the lower part of the window. For each type of power plant you can enter how many of them you want to be build (column Nr). If you order a number of a certain type click on the [Rebuild] button and look what happens. Only after a number of years these ordered plants become operational. This has to do with the time needed to get permission to build and to construct these plants.

So this screen informs you about the effect of ordering new plants on the total electricity supply system.

Some energy sources like hydro power, have a limited capacity. This of course is country specific. If a certain type of power plants is limited you will get the warning that it is not technical or economical feasible to build more than the maximum when you exceed this maximum capacity.

This table also gives some extra information about the characteristics (construction time, life-time etc) of in the order list present power plants.

The meaning of the used abbreviations are explained if you mode the cursor over the column titles.

If you click on the [Info] button, a new window pops-up with information of the costs and the emissions of the defined power plants. In this window you also can examine what the effects are of a change in load and interest rate (for the loans needed to finance the building of the new plant) on the costs of each type of power plant.

Add conservation & decentralized capacity

This window gives you the opportunity to save electricity and/or to build decentralized generating units. In the case of saving electricity we talk about "Negawatts" (Negative Megawatts) because they are subtracted from total electricity demand.

Decentralized units are private power stations owned by industry, farmers or citizens Cogeneration, wind power and solar PV De beslissingsoptie [Bijbouwen besp. + dec.] geeft de mogelijkheid om elektriciteit te besparen, en om decentrale eenheden in te zetten. Bij besparing spreken we van Negawatts (ze worden afgetrokken van de totale vraag). Elektrici-teitsbespa-ring is in PowerPlan mogelijk bij particulieren en in de industrie. Decentrale eenheden betreffen hier WKK, windenergie en zonne-energie. Het gaat hierbij weer om Megawatts.

Fuel contracts

This window offers you the possibility to do the calculation with, for example two or more different types of coal, one clean and expensive and other cheap and high sulphur- and/or ash-content. If you e.g. the coal tabs sheet the screen shows you information about four different coal grades. You can change these parameters (price, sulphur content etc.) and their share in the total coal use. In this way you can make up new fuel contracts.

Calculate

Here you can decide the number of years to be calculated this round. Close the window after the calculation. Now, with [Output] you can examine the results of the calculations in the present year.

Output

- Electricity generation
- Time-series
- Fuel use and costs
- Environment
- Planning
- Decentralized capacity and conservation

Electricity generation

This table will show you how much electricity has been produced by each power plant category as specified on the input file, its installed capacity and its average costs etc.. It shows total electricity generated, total capacity installed and the ratio of installed capacity and peak demand (reserve margin).

RF = (Capacity-Peakdemand)/Peakdemand

Also shown are total electricity generation and electric power capacity as well as two widely-used yardsticks for system reliability: Expected Unserved Electricity (EUE) and Loss Of Load Probability (LOLP).

LOLP: Loss of Load Probability: This indicator indicates the number of days in a period of 10 years, the installed capacity can not meet the demand (the indicator tell you something about the change of shortages);

EUE: Expected Unserved Energy: This indicator give an estimation of the amount of electricity (GWhe/jr) which could not be delivered as a consequence of shortages (this indicator tells you something about the dimension of the shortages).

The higher the Reserve margin the lower the values for LOLP and EUE. For western Europe the RF can vary between 1.25 and 1.50. The more unreliable sources (wind) present the higher the RF should be.

With the scrolbar you get a similar presentation of conservation measures ("Negawatts") and decentralized power generation capacity if present. You can 'walk' through history by clicking on the arrows

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Time-series

This table lists some key economic and environmental variables: installed capacity and peak power (or maximum) demand, system reserve factor, kWhe-costs, fossil-fuel inputs, SO2/NOx/CO2-emissions.

To get a better view on the historical trends of these parameters, they can be displayed in graphs by clicking on the [Show graph] button. Three tabsheet appear: Economy, Fuel and Emissions. In each tabsheet you can select one or more variables to be shown. You can choose for an absolute or relative (normalised on 1 in the starting year) presentation by clicking on the [Abs], [Rel] button. The [zero], [auto] button let you select the Y-axis origin be 0 or automatically scaled.

Fuel use and costs

In this window you get a graphical account of past and present kWhe-costs and fuel inputs - very helpful in assessing, for example your vulnerability for sudden fuel price changes or a planned transition to non-fossil fuels.

Environment

In this window you get a graphical account of past and present emissions of SO2/NOx/CO2 and cumulated solid waste from coal and uranium use.
You can print these graphs separately or all together.

Planning

Be careful in this window, you are now entering the domain of the decision-maker! The graph you see here is for most utilities a crucial element in their planning procedure.

It shows the development of installed capacity operated and ordered up to now, including the anticipated technical lifetimes of these plants.

It also shows the anticipated change - usually: growth - in electric peak power demand (SMD).

And, finally, the dotted line shows you how much capacity should be installed to meet this demand at the reliability level given by the reserve factor percentage indicated on the right-hand side of the graph.

The value of the reserve factor is taken from the input file. However, on basis of the EUE- and LOLP-values you may find a lower reserve factor more appropriate in the European grid (alternatively, you may argue that a higher margin is more realistic because you plan a large-scale transition to windpower!). When the reserve margin percentage is adjusted the graph shows immediately the new situation.

If the output is satisfying, you are ready now for capacity expansion decisions!

Decentral capacity and conservation

This window shows you four tabsheets with information about how much you have invested in electricity conservation or "Negawatts", and in decentralized generation. The costs sheets give you an indication how the price of the conservation and decentralized capacity options changed due to investments in these options, see also [Marginal costs]

Advanced

- Starting variables
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  - Other variables
  - Fuel prices
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  - Decentral capacity and Conservation order list
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  - Fuel parameters
  - Marginal costs
  - Pattern generator
  - Foreign companies

Starting variables

The variables in this window can only be adjusted at the beginning of a simulation. After the first period is calculated, it will be impossible to open this window.

Other variables

In this window several and various variables can be adjusted here.

Fuel prices

In this window the fuel price paths can be adjusted graphically. Select the desired fuel by clicking on one of the tabsheets. These graphs can also be printed. Use for printing and printer setup the three buttons at the top left in the window.

SMD growth

The growth of the electricity demand is in PowerPlan modeled as the increase of the peakdemand (SMD = Simultaneous Maximum Demand). This can be calculated out of the growth of the population, the growth of the GDP and the elasticity between GDP growth and electricity demand. An other option is to define the SMD growth directly as a time series. In this window the SMD growth can be adjusted graphically.

GDP growth

Dependently on the presents of certain data in the input file, the growth of the electricity demand will be calculated out of the growth of the population, the growth of the GDP and the elasticity between GDP growth and electricity demand. An other option is to define the SMD growth directly as a timeseries. If this SMD time series is present the GDP-electricity elasticity is not used.
In this window the GDP growth can be adjusted graphically.

GDP-Energy elasticity

The GDP-energy elasticity is a measure for the relation between the growth of the GDP and the growth of the energy demand (in this model the electricity demand). In empirical research one concluded that there is definitely a relation between economic growth and the demand for energy. For electricity this relation is even stronger. Not only in the production sectors more electricity is needed but also on the demand side (households) the consumption of electricity will increase.

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In this window the GDP-electricity elasticity can be adjusted graphically.

Population growth

Dependently on the presents of certain data in the input file, the growth of the electricity demand will be calculated out of the growth of the population, the growth of the GDP and the elasticity between GDP growth and electricity demand. An other option is to define the SMD growth directly as a time series. If this SMD time series is present the Population growth is not used.

In this window the Population growth can be adjusted graphically.

Power plants order list

This option contains a list of existing power plants. These are the power plants to be selected in the window: Add power plants.
If you want to build in new types of power plants or if you want to adjust existing ones, for instance because you expect the efficiency of a power plant will be improved, than you can do this in this window.

It is possible to insert and delete items from this list. Click with the right mouse button on the item you want to delete or the power plant type you want an extra option for. Select for [Delete] or [Insert] respectively.

Decentralized capacity and Conservation order list

This option contains a list of existing conservation options and decentral capacity. These are the options to be selected in the window: Add conservation & decentralcapacity.

If you want to build in new types of conservation options or decentral capacity or if you want to adjust existing ones, for instance because you expect the efficiency of decentral capacity will be improved, than you can do this in this window.

It is possible to insert and delete items from this list. Click with the right mouse button on the item you want to delete or the conservation options or decentral capacity you want an extra option for. Select for [Delete] or [Insert] respectively.

Load Duration curve

The yearly electricity demand will be calculated in PowerPlan by using the Load Duration Curve (LDC). This curve indicates how many hours per year the electricity demand exceeds a certain load value. The curve will be sorted from the highest to the lowest load per hour. Out of this figure you can get an indication how many peak load, intermediate load and base load you need in your production system. The integral of this curve will give you the total demand for electricity for a year (8760 hours). This load duration curve will differ between countries.

< In this window load duration curve can be adjusted graphically.

Fuel parameters

This window gives you the opportunity to adjust the CO_2-emission coefficients en two price parameters per type of fuel. The emission coefficients for oil, coal and natural gas can be seen as fixed values. But for waste this is not the case. For waste the composition play an important role. The content of food residuals and plastics determine the energy content and the CO_2-emission.

When no separate price path is defined, the price path will be based on parity with the oil price and the initial fuel price in the year the oil price path starts. The parity with the oil price is the coupling between the world market oil price and the price of an other fuel. The price of the Dutch natural gas for example is direct coupled with this world market oil price.

The initial fuel price is the price of a fuel in the starting year of the time series of the oil price.

Marginal costs

This window contains some tabsheets: for conservation and decentralized generation. For each of the technologies within these both options a graph is present in which the investment costs are displayed against the degree of penetration of the technology. Dependently on the degree of penetration it can be, from economic point of view, attractive or not to build more capacity of a certain technology.

Patroongenerator

In this window the demand pattern can be adjusted. The idea is to generate a realistic pattern with as less values as possible.

The three most important variations for a year pattern are:

1. the day and night rhythm
2. differences between working day and the weekend
3. seasonal fluctuations

To overcome the first two an average working day pattern and an average sunday and saturday must be entered. In the table the seasonal corrections for base and peak load are present. Each season consist of the following months:

- Winter: December – February
- Spring: March – May
- Summer: June – August
- Autumn: September – November

The five working days are supposed to be similar. The seasonal correction values are supposed to be in the middle of each season.

The values between the seasons are interpolated between two values from the table. The value between the peak load correction and the base load correction is calculated (weighted) through the distances of the value of an hourly number with the minimum and the maximum of the daily pattern.

Buitenlands bedrijven

In this window foreign companies can be added, adjusted and deleted. The values in this table will be used to calculate fuel use and emissions for the imported electricity.
The fuel fractions must add up to 1, but there is no internal check on it, so the user has to do in manually.