COPADATA
do it your way

zenon manual

Energy Management System (EMS)

v.7.10

Contents

1. Welcome to COPA-DATA help

GENERAL HELP

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2. Energy Management System (EMS)

The Energy Management System is a tool for the support of the economical management. It serves a conversion of a energy supply management for small and middle power supply companies but also for industrial firms whose energy supply is arranged by special contracts.

The module includes two quality functions for the support of the user:

- Prognosis (short term prognosis): In order to prevent power peaks and to automate load shedding.
- Optimization: Optimization of the averaged power supply in a billing period.

The focus is on electrical equipment but the module can be applied for mixing equipment which use natural gas and electricity without problem. For natural gas grids special prognosis and optimization models were implemented.

License information

Must be licensed in Editor and Runtime.

PROJECT MANAGER CONTEXT MENU

Menu item	Action
`Export XML all ...`	Exports all entries as an XML file.
`Import XML...`	Imports entries from an XML file.
`Help`	Opens online help.

2.1 Introduction

The task of an energy management system (EMS) is to optimize the economic management of special customers such as power supply companies (PSC) or industrial firms. The most important tool for that is the energy-trend-calculation which is the basis of an automated energy supply optimization.

The situation in the electrical and natural gas grid differentiates in parts essentially. Therefore it is treated differently in the EMS concerning prognosis and optimization.

2.1.1 Initial situation in the electricity industry

As a ruler in the energy industry a rate is used which includes both the investments of the provider and the arising costs for power generation and grid maintenance.

In order to set the price, these companies normally take into consideration a number of the peak power consumptions which arose over the year. The determination of the average power consumption takes place in a fixed measuring time, normally 15 to 30 minutes. In addition the price also includes the received power. Contracts concluded on this basis are valid on the long term.

2.1.2 Initial situation in the natural gas industry

When working with natural gas, peaks in demand can be compensated by taking natural gas from gas storages, storing it in the natural gas grid (pressure adaptation) and device which can be switch or turned off.

In gas storages or in the grid certain amount of natural gas can be stored preventively in order to use them on demand. In addition non-contractual supplied natural gas contingents are used which are referred to as spotgas.

2.1.3 Aims of an economic management

The aim of the economic management when using electricity and natural gas as power source is to receive as much energy as possible from your provided for an as low as possible price (optimization).

Potential savings come along when expensive peak power consumptions are avoided. The peak power consumptions during a measuring period can be avoided by pointedly controlled interventions.

- Load shedding at switchable devices
- Input of own generators

In order to do this, it is necessary to anticipate the average power consumption of a measuring period (prediction). Thus a threatening violation of the set limit can be recognized timely and an appropriate intervention can be carried out.

2.2 Functionality of the whole system

The electrical energy area and the natural gas area act in quite similar ways. As it is not possible to store electrical energy in noteworthy amounts, the contract conditions of the electrical energy providers are adjusted to this fact.

In the natural gas area not only the contract conditions must be adhered to but there are also arrangements necessary in order to store the natural gas.

2.2.1 Function of the system when electricity is used as the power source

The measuring period for the supply with electrical power is normally 15 or 30 minutes. During this time the averaged power received at the hand-over point - from here on it is referred to as power or load - or the equivalent amount of energy is determined and recorded.

The price is usually fitted to the three highest values which accrued for the measuring periods in different months. The price is then valid on the long term.

The average power which is used to calculate the price can be reduced when corresponding peak power consumptions are limited due to pointedly controlled interventions. This short term optimization can be achieved by the following interventions:

- Load shedding at switchable devices
- Increasing input of own generators

The aim of this optimization is to not exceed the contractual set limit for the power in a measuring period under no circumstances. Additionally, the energy consumption should stay very close below the set limit in order to receive as much energy as possible.

The consumption optimization is performed by way of a short-term trend calculation. The measured values which were gathered during the handling interval (typically 30, 60 or 180 seconds) are used to perform a trend analysis. The calculated trend is projected to the end of the period.

2.2.2 Function of the system when natural gas is used as the power source

The measuring period normally is an hour or a day when natural gas is supplied. During this time the determined amount of natural gas at the hand-over point is rated.

If the limit is exceeded, here a high price must also be paid. The definition of the price when the limit is exceeded is much more specific than in the electricity area.

Basically in the gas grid it is also targeted to not exceed the agreed limit.

Possible interventions are the following:

- Load shedding at switchable devices
- Own production of natural gas in liquified gas facilities
- Switching boilers to other fuels
- Switching combined heat and power units to other fuels
- Using natural gas from gas storages

Using natural gas which is stored in gas storages is important because it may only be small amounts which are available but these are needed during peak demands. Independent of the amount of the stored natural gas, a strategy must be defined how these storages are filled again over short or long periods of time.

POSSIBLE ACTIONS

The exceeding of the limit with hour contracts is inhibited by a consumptions projection with turning off or switching devices.

Basically the expansion of the measuring period to a (gas) day is possible. However there are times during the day in which the behavior of the trend leads to unrealistic large amounts at the end of the day. In addition the balance between night and day is not taken into consideration. Therefor in this case the system is built in a way that:

- a prediction of the consumption takes palce
- a plan is created which guarantees that the limit is not exceeded
- a short term projection observes that the planned maximum amount is not exceeded

2.2.3 Principal thoughts

The following chapter deals with thoughts and examples which make it easier for the user to indentify and select changeable elements of your plant. The question is what elements and devices can be influenced by the EMS directly or indirectly in a sensible way.

Options in order to influence the output in the electrical power area

Option	Description
Directly switchable devices	Devices which can be switched off briefly without interrupting any production processes are part of this group (industrial furnaces, pumps for water storages etc.). The loads have a fixed value. In general the are depended on the device and therefore known of measureable.
Direct heatings	Because of their storage effect, these device can be switched off briefly without decreasing the quality of supply significantly (heating in warm water storages, electrically operated floor heatings etc.). The loads consist of a consistent part and a part which is temperature-dependent. Additional the load is dependent on how long the device was switched off.
Monovalent heat pumps	In general these pumps are operated in the same way as direct heatings. The temperature-dependent part is more distinctive and rise with falling outside temperatures (pumps used for generating heat including air conditioners) or rises with rising outside temperatures (air conditioners). The load is dependent on how long the device was switched off.
Bivalent heat pumps	These can choose between fuels they use. Beneath a certain temperature they are switched to a different fuel by their control unit of by the optimization. At that no supply constraints emerge for the devices. These components are only switched in the long term and restrictively because the switching should not take place constantly. When the temperature falls, the load increases up to the switching point. There it vanishes completely.
Night storage heatings	These devices are supplied with energy according to schedule or if there is any needed output during low rate periods. They are switched off during the remaining time. The load depends essentially on the outside temperature. It is noticeable how many heatings are switched on (this is limited by

	the installed power) and how long they are charged.
Peak load aggregates and emergency power aggregates	These aggregates are switched on/off as required. In some cases these aggregates are controllable. The number of uses should be limited because the start of these aggregates coupled with additional costs on wear. In addition these aggregates should run for a minimum time in order to avoid thermal damages.
Combined heat and power units (CHPs)	These aggregates were primarily built to generate heat and are controlled by the heat demand during their operation (heat priority). Some aggregates can be directly used to generate electric power (electric power demand). In general this operational mode is inefficient if the generated heat is not used at the same time. Therefore the use is only beneficial if the heat demand is corresponding or there is a possibility to store the heat. The load reduction with regard to the take over point depends on the nominal size and for controlled or heat demand controlled aggregates from their working point. It is quiet common to combine aggregates to groups. According to the heat demand, a certain quantity from the group is used. The maximum power lowering in the electrical power area is given by the number an nominal power of the used aggregates.
Lowering the voltage	In the electrical power area it is possible to lower the voltage in some grids. In order to achieve this, the transformers to the medium voltage level are switched to a lower level. The voltage-dependence of the devices (ohmic load) causes another load demand provided that the voltage or output is not adjusted by subordinated controls. The load reduction is dependent on the grid load, on the possible lowering of the voltage (minimum voltages must be adhered to) and on the composition of the devices.

Options in order to influence the output in the gas area

Option	Description
Directly switchable devices	Devices which can be switched off briefly without interrupting any production processes are part of this group.
Furnaces or combined heat and power unit	These can be switched to another fuel (e.g. from natural gas to oil) according to their design.
Natural gas storage	These are available in different sizes depending on the company. The piping can also be used as a storage if its volume is appropriate and its geographical extension and the operation mode are suitable. Natural gas can be taken from the storage in order to compensate peaks.

Power consumption characteristics of devices

In order to reconstruct the actual needed output, models must be used which represent the power consumption of the switched off components. These models are allocated to different classes.

Type	Description
Constant output	When switched on, an aggregate (pump, furnace) runs with a previously defined power consumption. Accordingly the output is reduced by the amount of the power consumption when the device is switched off. In this case it is enough to indicate the nominal power as a constant.
Directly temperature-dependent	The temperature dependence of the devices is directly dependent of weather effects and rises with thermal output approximately proportional to the negative gradient of the outdoor temperature. With respect to cooling capacity the behavior inverses itself.
Loading period model	At that the temperature makes itself felt with the size of the switch-on output and the length of the following loading period until the output drops when all heat stores are full.
Dependence on the switch-off time	At that several devices - because of the temporary cool down or warm up - are switched on dependent on the previous switch-off time. After a short period of time they switch themselves off again.
Dependent on the production process	In the industry sector behavior can occur - caused by production processes - which are subject to no behavior patterns or dependencies. These can only be determined by the production schedules.

2.3 Method of the EMS

The EMS for electrical energy (electric current) is based on a time line analysis. At that the measured output progress is analyzed and extrapolated to the future. The forecast horizon of the EMS corresponds to the remaining time of the measuring period.

2.3.1 Input values

As input value the EMS expects a value from a counter or a calculated value which is supplied by the drivers or the result of the calculation of a mathematical formula in zenon.

Attention: It must be made sure that the value is supplied exactly one time in the update interval. Values must not be absent or be there twice.

THE DIMENSION: MW, KW , KWH OR M³

The system is designed on the basis of kW and hour. Therefore all power and energy amounts which must be entered in parameterization masks refer to these dimension. Internally the EMS functions calculate without the dimensions. Thus it does not really matter in what dimensions the values are delivered and interpreted as long as they refer to the same basis. The base unit can be either kW or MW.

In the natural gas area it is also possible to calculate with standard m^3. Combarability of the cubicmeters must be granted. This is only possible when using the standard cubic meter. The conversion of cubic meters in amount of energy and its timely connection is not necessary.

> **Info**
>
> *Because the EMS is a component which can cause high costs if it fails, it is very important the the input values are secured. It is recommended that values for this module are secured by using sensible alternate values or an alternate value strategy.*

2.3.2 The model for the short term prognosis

For the projection of the current power progress it is necessary to design a mathematical model of the power progress. By extrapolation of the power progress of this model over the remaining time of the billing period, the expected power value at the end of the period is estimated.

POWER TREND

At the end of the period `T` the power `P prog (T)` is to calculate. In order to calculate the current power trend a linear function is used which is extrapolated to the end of the period.

```
P prog (T) = P const (t) + P trend (t) * ( T - t )
```

The mathematical polygon factors `p0, p1` are named after their physical meaning in order to make it easier to understand.

Factor	Description
P prog	prognosticated power value
P const	Power constant (value of the last values)
P trend	Power trend (linear ascent(descent)
T	Point in time of the end of the measuring period
t	current time

ENERGY TREND

Deducted from this the energy trend up to the end of the period E(T) can be calculated with the function

```
E prog (T) =P aver (t) * t + P const (t) * (T - t) + ½ * P trend (t) * (T - t)
```

Factor	Description
E prog	prognosticated energy value
P aver	average power value

The first addend describes the determined energy up to the time t. The energy can be either determined by the average power value as described in the formula or is is given as a direct calculated energy value E(t).

The second addend continues the present constant power to the end of the period and calculates the constant energy amount from that.

The third addend describes the additional influence of the trend.

Concerning the energy calculation for the actual billing a value is necessary which is set back exactly at the beginning of the measuring period. Therefore it is not possible to use externally filtered values.

From the formula mentioned above the average value at the end of the period is determinable.

```
P prog aver (T) = E prog (T) / T
```

Parameter	Description
P prog aver	prognosticated average power value

Calculation of the correction power

During the measuring period the average power

```
P limit = agreed limit
```

can be obtained. Over the measuring period `T` this power equals

```
E limit = P limit * T
```

.

By comparing this power with the expected energy `E prog (T)` at the end of the period, the de- and exceedance of the agreed limit

```
E corr = E prog (T) - E limit
```

can be assessed. The de-/ or exceedance can be balanced by carrying out the corresponding switchings.

Minding that at time `t` only `T−t` balance time is available. Therewith a large correction power

```
P corr (t) = E corr / (T-t)
```

is necessary.

Actual value and real value forecast

The forecast is carried out for several trends in the EMS.

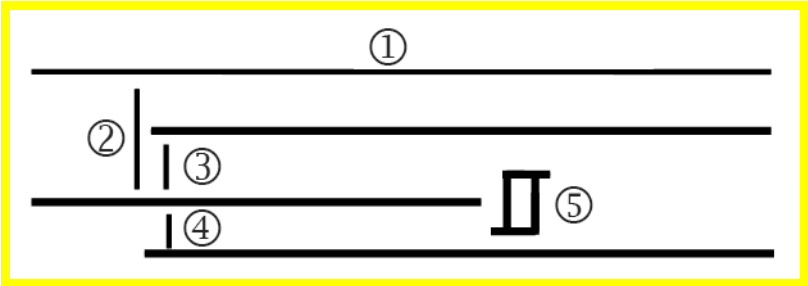
- The first trend considers the power consumption. This trend calculates the ascent of the the power requirement as actual value forecast.
- A second trend factor considers the switchings which have taken place in the past.
- A third trend factor calculates the influence of the switchings which will take place in the future.

The trend functions are laid on top of each other and result in the real value forecast. It describes the actual power consumption to the end of the billing period which is to be expected.

Lowering the supply limit

As the load trend can never be exactly predicted and as there are usually deviations of the switchable loads, it is necessary to go slightly below the actual supply set value for security reasons.

This is why there is a percentage `Safety distance [%]` for the supply limit during parameterization, which must be undershot before connections are triggered.



Digit	Description
1	Supply limit (set value)
2	Safety distance
3	Deactivate hysteresis
4	Activate hysteresis
5	Hysteresis for switching

Around this limit a hysteresis can be built with the help of `Activate hysteresis [%]` and `Deactivate hysteresis [%]` . In doing so the `Activate hysteresis [%]` eliminates a part of the `Safety distance [%]`.

> **Attention**
>
> *Take care that `Activate hysteresis [%]` is in any case smaller than the `Safety distance [%]`. Otherwise the system reacts too late if the agreed limit is exceeded*

2.3.3 Operating principle of the obtaining rule

CLOSED LOOP OPERATION

Normally the obtaining rule is applied in the Closed Loop operation. There switch on and switch off times are calculated in accordance with the results of the optimization part. The switching is triggered directly by the corresponding switching commands.

Info

In the EMS module the immediate switching points do not have to be used at the devices. You can decide whether you want to make direct switching possible or whether switching must be cleared by the user first.

Attention

The unchecked use of the closed loop operation necessitates an intensive pilot stage. At that all switchings which are then done by the control must be checked by the user. This pilot stage must be adjusted to the size and complexity of the system. It is possible that the pilot stage lasts up to one year.

Output determination for the devices

The output determination for the devices is especially important with regard to the assessment of the effect caused by switchings. The problem is that the output of the switched off devices cannot be measured directly and must sometimes be estimated.

In the system two mechanisms are implemented in order to determine the output

- Fixed value by parameterization

  The value (e.g. the nominal power) is considered by the optimization as fixed and is always available.

- Measuring the current value.

  The value is measured and zenon describes this value with the help of a variable in the devices.

The initial value for the output of the device is determined with a polling of the variable value during the beginning of the optimization. In order to compensate errors due to fluctuations, the optimization calculates a gliding average value using the consecutively arriving measurements.

Info

If a component is switched off when the optimization starts, its output is presumed as zero. Thus the SCADA function cannot determine a valid output value as prerequisite for the use of the component. The component must be switch on by hand once.

Attention

As long as not at least one value has arrived, the output value of the component is not known and cannot be used for the optimization.

Primary factors

THE AMOUNT OF THE ENERGY

In general the device selection is determined by the amount of energy which can be switched on or off.

If the requested amount of energy cannot be reached exactly, it is treated as a minimum value at a switch-off request and a maximum value at a switch-on request. At that you are on the save side regarding the adherence of the datum line.

Info

During the Runtime the amount of energy can be adjusted dynamically with the help of a variable.

AVAILABILITY

The availability controls if the device is usable in general. The availability can be set manually and is always set back when the component can not be used because of operational reasons (e.g. at overhauls) or when the optimization should not use it.

Conditions which arise during the process can also determine the availability of the component and control its use by the optimization.

Info

In the Runtime the availability can be adjusted dynamically with the help of a variable. For example time tables with respect to the availability can be implemented with the help of a scheduler or the Production & Facility Scheduler.

Secondary factors

LOCK TIMES AND RELEASE TIMES OF THE DEVICES

With the help of the lock times you can control during which times the components are not available for the optimization. The times which are not designated as lock times represent the release times.

Attention

During the lock times the components are not influenced by the optimization - or only in the released direction. Thus the components remain in the state they had reached at the end of the release time.

MINIMUM AND MAXIMUM SWITCHING TIMES

You can specify the minimum and maximum time for the single switch states (on/off) for each used device and generator. The time indicates what time period must have elapse at least in order to trigger a switching in the opposite direction.

This parameter is important for aggregates because in order to avoid thermal damages and damages caused by soot they must not be switched off right after they were switched on. Thus for example a certain amount of time must have passed after the heating groups had been activated before they switch on.

SWITCHING FREQUENCY

If devices and generators can only be switched a limited number of times in a certain time period, the components are no longer switched when this number is exceeded. Beside the number of switchings a time period must also be defined in order to carry out the parameterization.

Example

Maximum 25 switchings in 12 hours

SWITCHING PRIORITIES

The switching of the components is planned in accordance with a priority schedule. At that switch-on and switch-off priorities are listed separately. The user can determine the priorities in accordance with the operation requirements. The component with the highest priority (highest numerical value) is switched first.

If there is a requirement to switch the components in a sorted order by having the device that was switched on first be the one switched off last, a number pattern must be applied to all components: ascending for the first switch-on and descending for the last switch-off.

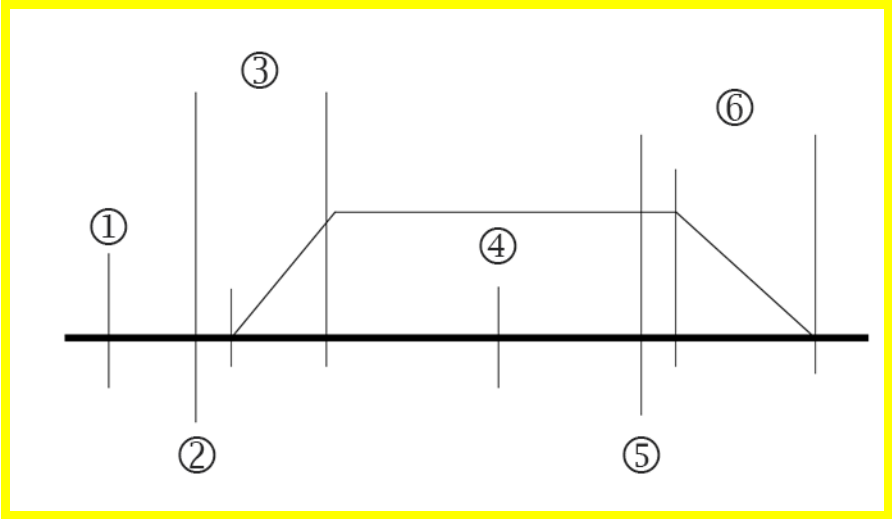
Info

If several devices have the same priority in one plant, the EMS automatically ensures that on average all devices of the same level are switched equally often.

Switching process

The term switch-off request on the part of the optimization always refers to the reaction of the device which decreases the needed output and therewith the obtained output because it is switched-off. Therefore the request for the switch-off can be fulfilled by switching on an aggregate.

PROCESSES DURING A SWITCHING



DELAY TIME FOR THE SWITCH-ON (SWITCH-ON DEAD TIME)

Equals the time period from activating the switching order until the nominal power is reached.

This time - dependent on the aggregate - can be quite long; e.g starting up the aggregate und synchronization, rearwards controlled heating etc.

DELAY TIME FOR THE SWITCH-OFF (SWITCH-OFF DEAD TIME)

Time period from activating the switching order until the output is zero. You must add the time of the activation of the switching order to the time when the total output is zero.

FOREWARN TIME FOR THE SWITCHING-ON AND THE SWITCHING-OFF (LENGTH OF FOREWARN TIME)

The switching times are planned to a second in order to exactly control the amount of energy. In order to give the user the opportunity to adhere to the times in the open-loop operation a certain lead time to carry out the switching is necessary. This is defiend by `Duration pre-warn time`. Hereby the user receives information about switchings which are planned before they are actually carried out.

> ⚠ **Attention**
>
> *As the EMS assumes that the switchings are carried out, the suggested switchings should be carried out in the corresponding time in respect to the exactness of the forecast.*

TACTIC OF THE SWITCHING SCHEDULE

In general the switching selection happens in a away that as few switchings as possible are carried out. This calms the grid operation and keeps up the availability of the devices whose use are limited by a maximum of switchings. In addition conflicts are minimized which can occur at the command output of the switchings.

The use of components with a much higher output than that is used for the correction is possible by a specific time control. The components are used for such a short time that the compensate the needed output.

SUPPRESSED SWITCHINGS AT THE BEGINNING OF A MEASURING PERIOD

At the beginning of a measuring period it is possible that larger switchings are carried out or large deviations to the actual output average value are set in order to compensate large amounts of energy at the end of the period. That is way it is necessary at the beginning of the period to give the system the opportunity to adjust itself to the new circumstances.

That is why a `Down time begin tariff interval` can be engineered in the system. During this time the optimization doe not carry out any switchings.

> **Attention**
>
> *If for a long time no response is received for a switch command which was issued by the EMS (on the response variable), the EMS assumes that the action failed und tries to carry out another switching (on the next available component). Therefore you must always ensure that the correct response about the success of a switchng operation is transferred to the EMS.*

2.3.4 Overlapping of schedule inputs

The switching of aggregates and devices according to fixed times with the help of the Scheduler or the Production & Facility Scheduler is possible with several applications. As there is not explicit link between these modules and the short term optimization, these switchings are not monitored in regard of the output trend. They are also not displayed in the trend of the obtained output. They are interfering in the short time optimization with regard to its result.

In order that these interferences do not have radical effects, external switchings should be engineered in a way that they take place at period change. If this is not possible, they should be scheduled right

after a period change so that the interfering influence on the control can still be compensated. These switchings should be finished within `Down time begin tariff interval` and the influence of the switching on the input value should be present.

2.4 Multi-level combined heat and power plants (CHPs)

Multi-level CHPs can be regarded as one component. It is possible to describe CHPs with 2 to n levels.

The CHPs are controlled by a set value. Additionally different output levels can be defined which this set value can take on. The actual output of the CHP is registered by a measurement (variable) and sent to the EMS.

> **Attention**
>
> *A CHP is only available when it has reached its nominal power. The availability flag is set accordingly by the engineering. The EMS cannot switch off the CHP but only switch it to its nominal power.*

2.4.1 Set value processing at CHPs

The number of values which the set value can become equals the number of the defined levels. The value which the set value can become always equals exactly one of the defined values for the levels. The EMS does not allocate another number to the set value.

The initialization is carried out with the currently measured output. If this value does not equal a defined level, the next smaller level is allocated. The CHP is treated as unavailable as long as the measured output does not match a level. If the measured output is disturbed, the CHP is not available and the set value is initialized as recently as a valid measured value arrives.

As a measured output does not have to equal a set value exactly, a hysteresis is defined around the set value. A level counts as reached or set as soon as the current output value is within the hysteresis of the given set value. The hysteresis can be defined for each CHP individually.

The defined levels must not be skipped when allocating the set value. The EMS appoints the set value only to the next higher or lower level.

A set value input is only carried out if the CHP shows an explicit level (considering the hysteresis) at that time. Otherwise the CHP is not available because the measured value does not equal a level.

2.4.2 Planned switchings for CHPs

When planning the set value inputs for a CHP, the conditions for the set value inputs must be taken into consideration. If several levels of a CHP are necessary in order to cover the output, keep in mind that it is only possible to switch from one level to the next level when executing a switching schedule. At that the set value inputs for each level must be in accordance with the delay times for the switch-on and switch-off of each level.

> **Attention**
>
> *You must consider that the forewarning is only given at a defined level setting. Thus you must regard the length of the forewarning time for the individual levels when creating the switching schedule.*

2.4.3 Priorities of CHPs

A CHP has a fixed switch-on and switch-off priority. The values can be controlled by variables. Thus priorities can be controlled flexible. The takeover of a new priority takes place at the next rate interval change.

The priorities are not set for each level individually but are valid for the whole CHP.

If a least two CHPs have the same priority, the rolling priority procedure is used. A more important condition for CHPs with same priority is that they are set to the same level if possible or that they differentiate by one level at the most. The prerequisite for this is that both the switch-on priority and the switch-off priority of these CHPs is the same.

The internal reference counter for the number of switchings is incremented when the CHP is switched on. This is exactly the case when the current output passes over from one level to the next higher level. At devices using electrical current the reference counter is incremented when the component is switched off. Thus within one priority level the switching between two CHPs is compared to the switch-on and switch-off of a device.

2.4.4 Time-dependent restrictions for CHPs

CHPs need special care with regard to their time behavior. The EMS must consider special requirements at a level switch and at delay times while the CHP are running.

Running time according to level switching

The minimum and maximum running time of CHPs must be set for each level. Instead of four times for a component (minimum switch-on time, minimum switch-off time, maximum switch-on time and maximum switch-off time) there are only two times - minimum and maximum running time per level - in order to describe a CHP with levels.

The minimum running time (switch-on time) of a level indicates how long the CHP has to run at the least on this level. After a level is reached, the optimization must wait at least this amount of time before a new set value input can be made for the next lower level.

The maximum running time of a level indicates how long a CHP is allowed to run on this level at the most. With the exception of the lowest level (nominal power), the CHP is switched to the next lower level after this time expires. At that a level counts as active even if the CHP actually runs on a higher level. The maximum running time of the individual levels must be attuned to other restrictions with regard to minimum running time and forewarning. Thus a timely switch to a lower level is possible. The optimization must also prevent set value inputs to a higher level when the maximum running time cannot be adhered to e.g. because of the minimum running time of the higher level.

> **Info**
>
> *Manual switching can cause violations of the defined restrictions. These are intercepted by the EMS.*

For the lowest level (nominal level) the maximum running time has a different meaning than for the other levels. The maximum running time of the lowest level indicates how long a CHP is allowed to run on this level alone at the most. After that the CHP must be switched to the next higher level.

EXAMPLE FOR THE PARAMETERIZATION OF THE INDIVIDUAL LEVELS:

Step	0	1	2	3	4
Output	100	200	300	400	500
minimum switch-on time (in seconds)	--	60	60	60	60
Forewarn time (in seconds)	--	210	0	0	0
Delay time for switch-on (in seconds)	--	30	30	30	30
Delay time for switch-off (in seconds)	--	30	30	30	30
Minimum value for the maximum switch-on time (in seconds)	210	240	180	120	60

The times which must be entered in the parameterization for the switch-on and switch-off always refer to the level for which they are entered. This means that the switch-off time which is parameterized for one level is considered if a "switching" is carried out from this level to the next lower level. The switch-on time is considered if a "switching" is carried out from a lower level to this level.

As the lowest level represents the CHP running with nominal power, no information for minimal running time, forewarn time, delay time for switch-on and delay time for switch-off is necessary.

The minimal allowed values for the maximum switch-on times of each level are as follows:

- For the first level:

  Forewarn time of the next higher level

- For the last level:

  maximum/minimum switch-on time, forewarn time of the last level

- For all other levels:

  maximum/minimum switch-on time, forewarn time of next higher level

  + delay time for switch-on for the next higher level

  + minimum value for the maximum switch-on time of the next higher level

  + forewarn time of the next higher level

  + delay time for switch-off for the next higher level

If for one CHP the maximum switch-on time for one level is below the calculated minimum value for the maximum switch-on time, the CHP is treated as not available and a corresponding availability identification is set for the readiness.

Expiration of the delay time

A set value remains at a certain level until that level is reached or until the defined delay time has passed. In case the delay time expires, the set value is re-initialized according to the currently measured performance. This requires determining the level of the current performance. The following cases can apply:

- The current performance value matches the old level:

  The set value did not have any effect and is therefore reset to the old value.

- The current value does not match any level:

  There can be a check whether the current performance has approached the new set value. In that case, the configured set value can be kept; otherwise, it must be reinitalized.

- The current value matches another level:

  The performance of the CHP has changed in contrast to the set value input. This corresponds to a manual switch despite availability for the EMS. See Manual switch (on page 28) for further steps.

Switching plans to the next levels must be revised or exchanged if the previously configured set value of a switching action for a CHP was not reached. For any further switching actions, different components will be preferred.

2.4.5 Manual operation of CHPs

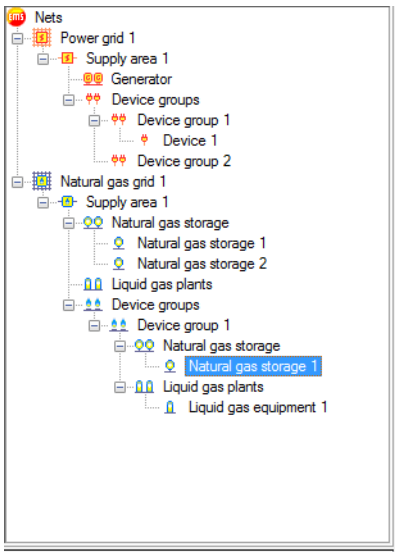
If a measured value of the current output without set point input is outside of the level set by the EMS, this component is accepted as not available because it is obvious that the EMS is not controlling it at the time.

If a measured value of the current output re-enters the hysteresis area of a defined level, the difference to the set value is registered and the difference at the level setting is assumed to be manual operation. The set value is set to the newly identified level.

A recognized manual operation is transmitted to the forecast so that it can be considered in the trend calculation.

2.5 Parameterization of the EMS

The engineering of the EMS is carried out via a hierarchic tree structure. There corresponding sub-objects are linked to individual objects depending on their type. Sub-objects are added by selecting the corresponding menu item in the context menu of the selected node.



All object have property `Name` and `Identification`. The engineering of the individual objects is carried out via the property window.

All adjustable properties which are available in the property window are described in the help window after you click on them.

Info

All mentioned or shown properties are only visible if the EMS is licensed. The licensed EMS module is a separate element in the project tree. The settings in the EMS can be made with the help of this entry.

Attention

Within the EMS all existing units (grids, device groups, generators, devices etc.) should have a distinct name in order to ensure the perfect function of the forecast and the optimization.

All objects have the following menu entries:

Menu/Entry	Description
Cut	Cuts the selected object(s) and copies it/them to the clipboard.
Copy	Copies selected object(s) to the clipboard.
Paste	Pastes object(s) from the clipboard. Starting from the selected node, only objects from the same level or the level directly beneath it can be pasted.
Delete	Deletes selected object(s) including all sub-objects.
Export XML all ...	Exports the whole project to an XML file.
Export selected XML ...	Exports selected objects including sub-objects to an XML file.
Import XML...	Imports objects from an XML file. Only objects (and their exported sub-objects) can be imported which are of the level directly beneath the selected node.

Info

All values of variables which are used in the EMS to state or adjust time values during the Runtime (e.g. switch-on time variable) are interpreted as seconds. Therefore a numerical value of 300 corresponds to a time period of 5 minutes (=300 seconds).

In order to ensure the correct functionality of the EMS, you must create at least the following variables for a supply area:

- Current consumption
- Supply limit
- Forecast for start consumption
- First switching value
- Forecast for error area
- Forecast for final consumption
- Last switching value
- Gross actual deviation
- Net actual deviation

> **Info**
>
> *In the context menu for a supply area you can find the menu item "Create variable". When selected, it automatically creates variables for the properties listed above and links the variables with the properties.*

You must at least create the following variables for a generator/device in order to ensure the functionality of the EMS.

- `Switching state` for the generator
- `Switching state` for the device
- `Availability flag`

2.5.1 Minimum requirements

SUPPLY AREA

For the correct functionality of the EMS, you must create at least the following variables for a supply area:

- `Current consumption`
- `Supply limit`
- `Forecast for start consumption`
- `First switching value`
- `Forecast for error area`
- `Forecast for final consumption`
- `Last switching value`
- `Gross actual deviation`
- `Net actual deviation`

> **Info**
>
> *In the context menu for a supply area you can find the menu item `Create`*

> *`variable`. It automatically creates variables for the properties listed above and links the variables with the properties. Properties `Current consumption` and `Supply limit` are an exception. You must create them manually.*

GENERATORS/DEVICES

For the correct functionality of the EMS, you must create at least the following variables for a generator/device:

- for the device
  - `Switching state`
  - `Standby output variable`
    or value for property `Standby output`
- for the generator
  - `Switching state`
  - `Nominal output variable`
    or value for property `Nominal output`
- for the generator and the device
  - `Availability flag`

2.5.2 EMS detail view toolbar and context menus

Entry	Action
New	Creates a new object, depending on the position in the tree.
Gas grid new	Creates a new gas grid.
Copy	Copies selected element to the clipboard.
Paste	Pastes objects from the clipboard.
Delete	Deletes selected element after confirmation message.
Export selected XML	Exports all selected elements as an XML file.
Import XML...	Imports objects from an XML file .
Properties	Opens the property window for the selected element.
Help	Opens the EMS online help.

CONTEXT MENUS GRIDS

Entry	Action
New power grid	Creates a new power grid.
Gas grid new	Creates a new gas grid.
Paste	Inserts objects of the type `Grid`.
Export XML all...	Exports all defined grids to an XML file.
Import XML...	Imports objects of the type `Grid`.
Properties	Opens the property window for the selected element.
Help	Opens the EMS online help.

Additional context menus:

Eletric grids (on page 34)

Natural gas grids (on page 38)

Power grids

CONTEXT MENU POWER GRID

Entry	Action
New supply area	Creates a new supply area.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `gas storage`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the selected entries as an XML file.
Import XML ...	Imports objects of the type `Supply area`.
Properties	Opens the properties window.
Help	Opens the online-help for the EMS module.

CONTEXT MENU SUPPLY AREA

Entry	Action
Generator new	Creates a new generator in the selected supply area.
New device group	Creates a new device group in the supply area.
Creating variables	Automatically creates the minimally required variables for the selected supply area and links them with the fitting properties.
Cut	No function at the supply area.
Copy	Copies the currently selected supply area. You can copy more than one supply area at a time using multi-select.
Paste	It is possible to paste objects of the type `Supply area`.
Delete	Deletes the currently selected supply area. You can delete more than one supply area at a time using multi-select.
Export XML selected...	Exports the currently selected supply area. You can export more than one

	supply area at a time using multi-select.
Import XML ...	Imports objects of the type `Supply area`.
Properties	Opens the properties window.
Help	Opens the online-help for the EMS module.

CONTEXT MENU GENERATOR (GROUP)

Entry	Action
Generator new	Creates a new generator for the selected supply area.
Paste	Inserts objects of the type `Generator`.
Export XML all...	Exports all generators of the supply area
Import XML...	Imports objects of the type `Generator`.
Help	Opens the online-help for the EMS module.

CONTEXT MENU GENERATOR

Entry	Action
Generator new	Creates a new generator for the selected supply area.
Paste	Inserts objects of the type `Generator`.
Export XML all...	Exports all generators of the supply area
Import XML...	Imports objects of the type `Generator`.
Help	Opens the online-help for the EMS module.

CONTEXT MENU DEVICE GROUPS (GROUP)

Entry	Action
New device group	Creates a new device group.
Paste	Inserts objects of the type `Device group`.
Export XML all...	Exports the device group including all defined devices within the group.
Import XML...	Imports objects of the type `Device group`.

Help	Opens the online-help for the EMS module.

CONTEXT MENU DEVICE GROUP

Entry	Action
New device	Creates a new device in the selected device group.
Cut	No function at the device group.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type Device group, Device.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
Import XML ...	Imports objects of the type Supply area.
Help	Opens the online-help for the EMS module.

CONTEXT MENU DEVICE

Entry	Action
Cut	No function at the device group.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type Device group, Device.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Properties	Opens the properties window.
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
Import XML ...	Imports objects of the type Supply area.

Help	Opens the online-help for the EMS module.

Natural gas grids

CONTEXT MENU NATURAL GAS GRID

Entry	Action
New supply area	Creates a new supply area.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `gas storage`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML selected...	Exports the selected entries as an XML file.
Import XML ...	Imports objects of the type `Supply area`.
Properties	Opens the properties window.
Help	Opens the online-help for the EMS module.

CONTEXT MENU SUPPLY AREA

Entry	Action
Gas storage new	Creates a new gas storage in the selected supply area.
Liquid gas plant new	Creates a new liquid gas storage in the selected supply area.
New device group	Creates a new device group in the supply area.
Creating variables	Automatically creates the minimally required variables for the selected supply area and links them with the fitting properties (on page 31).
Copy	Copies the currently selected supply area. You can copy more than one supply area at a time using multi-select.
Paste	It is possible to paste objects of the type `Supply area`.
Delete	Deletes the currently selected supply area. You can delete more than one supply area at a time using multi-select.
Export XML selected...	Exports the currently selected supply area. You can export more than one supply area at a time using multi-select.

Import XML ...	Imports objects of the type Supply area.
Properties	Opens the properties window.
Help	Opens the online-help for the EMS module.

CONTEXT MENU GAS STORAGE

Entry	Action
Gas storage new	Creates a new gas storage for the selected supply area.
Paste	Inserts objects of the type Generator.
Export XML all...	Exports all generators of the supply area
Import XML...	Imports objects of the type Generator.
Help	Opens the online-help for the EMS module.

CONTEXT MENU LIQUID GAS PLANT

Entry	Action
Liquid gas plant new	Creates a new liquid gas plant for the selected supply area.
Paste	Inserts objects of the type Generator.
Export XML all...	Exports all generators of the supply area
Import XML...	Imports objects of the type Generator.
Help	Opens the online-help for the EMS module.

CONTEXT MENU DEVICE GROUPS

Entry	Action
New device group	Creates a new device group.
Paste	Inserts objects of the type Device group.

Export XML all...	Exports the device group including all defined devices within the group.
Import XML...	Imports objects of the type `Device group`.
`Help`	Opens the online-help for the EMS module.

CONTEXT MENU DEVICE GROUP

Entry	Action
Gas storage new	Creates a new gas storage in the selected supply area.
Liquid gas plant new	Creates a new liquid gas storage in the selected supply area.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `Device group, Device`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the selected entries as an XML file.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

CONTEXT MENU GAS STORAGE (GROUP)

Entry	Action
Gas storage new	Creates a new gas storage.
Paste	Inserts objects of the type `Device group, Device`.
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the selected entries as an XML file.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

CONTEXT MENU GAS STORAGE

Entry	Action
Cut	No function at the device group.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `gas storage`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Properties	Opens the properties window.
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
Export XML selected...	Exports the selected entries as an XML file.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

CONTEXT MENU LIQUID GAS PLANTS (GROUP)

Entry	Action
Liquid gas plant new	Creates a liquid gas plant.
Paste	Inserts objects of the type `Device group, Device`.
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the selected entries as an XML file.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

CONTEXT MENU LIQUID GAS PLANT

Menu/Entry	Description
Cut	No function at the device group

Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `Liquid gas plant`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Properties	Opens the properties window.
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the selected entries as an XML file.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

CONTEXT MENU DEVICE

Entry	Action
Cut	No function at the device group.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `Device group, Device`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Properties	Opens the properties window.
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

2.5.3 Data for the EMS

The EMS needs a historic data basis in order to calculate the trend and to perform the optimization. If no historic data are available for the data points, the EMS cannot start the calculation. Therefore no calculated value is displayed for the `Forecast for final consumption`.

At the moment the EMS has no interface to the Historian. This is not necessary for the short term optimization. For this the historic data which were recorded via option `Harddisk data storage` are enough.

The following settings depending on the period length are recommended for the recording of the HD data.

NUMBER OF PAST VALUES

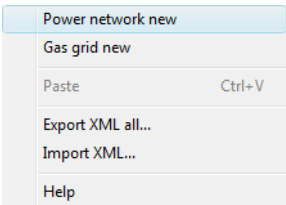
As guideline use the following rule-of-thumb:

The `Historic data` area which is provided by the `Harddisk data storage` has to be at least 1.5 times the size of the corresponding `Forecast horizon`. If not enough data are available, the calculation of the optimization is not started.

> **Attention**
>
> *At the beginning of the `Forecast horizon` the EMS needs a `Current consumption` for the displayed supply area. Thereby the new value must be transferred to the EMS during the next but one `Optimization cycle`, i.e. if the optimization cycle is 30 seconds, the value must be transferred in the period between 30 an 60 seconds.*
>
> *If the EMS does not receive a value in this period, the new initialization of the EMS can be carried out during the next billing period at the earliest.*

2.5.4 Grids

The collective node contains all projects which have been created in the grid but does not offer any setting possibilities itself.



Options:

Menu/Entry	Description
New power grid	Creates a new power grid.
Gas grid new	Creates a new gas grid.
Paste	Inserts objects of the type `Grid`.
Export XML all...	Exports all defined grids to an XML file.
Import XML...	Imports objects of the type `Grid`.
Help	Opens the EMS online help.

You must place a distinct `Name` with each created grid. In order to ease identification you can place a free `Identification` with each grid as an option. This is not mandatory. Gas grids contain a few additional Settings (on page 44).

> **Info**
>
> *For each project only 1 power grid and 1 gas grid can be created or administrated.*

Natural gas grids

For natural gas grids additional configuration possibilities are available. With their help you can configure grid-wide parameters such as `Temperature` or `Characteristic days` and total results such as `Adjusted consumption` or `Forecast` for the whole grid.

All adjustable properties which are available in the property window of the natural gas grid are described in the help window after you click on them.

2.5.5 Supply area

The supply area is the level of the object hierarchy which is used as a basis for the forecast and the optimization.

> **Info**
>
> *In order to start the EMS for a particular supply area, a function of the type "Start EMS" must be executed which has this supply area as parameter.*

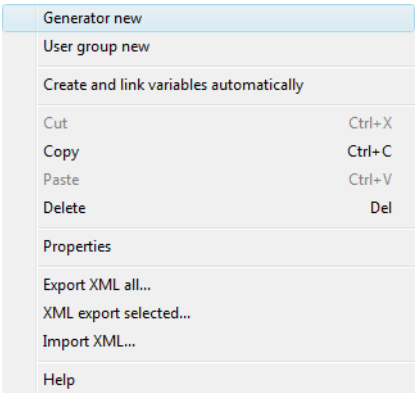
SETTINGS FOR THE SUPPLY AREA OF A POWER GRID

For supply areas the following settings are available:

- `Input values`: Defines variables for the supply of the current values and the supply limits.
- `Calculated values`: Settings in order to adjust parameters for the forecast and the optimization with the help of variables during the Runtime.
- `Parameter`: Important settings for the optimization of the supply area with direct influence to the switchings of the EMS.
- `Status information`: Setting which variable holds the information about the availability of the EMS screen.

All in the respective groups adjustable properties are described in the help window after you click on them.

CONTEXT MENU ENTRIES



Menu/Entry	Description
Generator new	Creates a new generator in the selected supply area.
New device group	Creates a new device group in the supply area.
Creating variables	Automatically creates the minimally required variables for the selected supply area and links them with the fitting properties (on page 31).
Cut	No function at the supply area.
Copy	Copies the currently selected supply area. You can copy more than one supply area at a time using multi-select.
Paste	It is possible to paste objects of the type `Supply area`.
Delete	Deletes the currently selected supply area. You can delete more than one supply area at a time using multi-select.
Export XML all...	Exports all supply areas of the selected grid.
Export XML selected...	Exports the currently selected supply area. You can export more than one supply area at a time using multi-select.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

Additional parameters for the gas supply areas

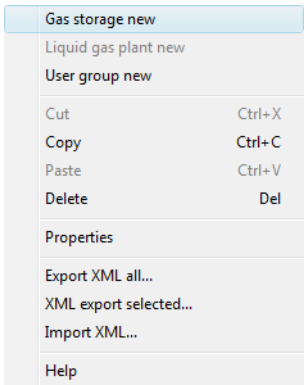
The supply area is the level of the object hierarchy which is used as a basis for the forecast and the optimization.

Info

In order to start the EMS for a particular supply area, a function of the type "Start EMS" must be executed which has this supply area as parameter.

Supply areas for a gas grid have `Specific gas parameters`. With the help of them e.g. `Adjusted consumption`, `Forecast` and `Optimum load` can be defined but also the relation between liquid gas supply and general supply. All adjustable properties are described in the help window after you click on them.

CONTEXT MENU ENTRIES:

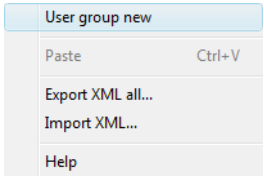


Menu/Entry	Description
Gas storage new	Creates a new gas storage in the selected supply area.
Liquid gas plant new	Creates a new liquid gas storage in the selected supply area.

2.5.6 device group

Individual devices are combined in a device group. At that each device group can contain any number of devices.

CONTEXT MENU ENTRIES AT NODE "DEVICE GROUPS".

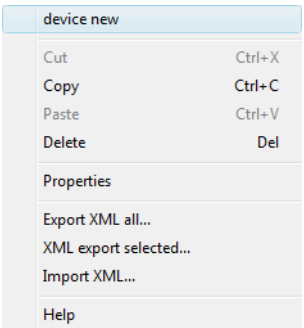


Menu/Entry	Description
New device group	Creates a new device group.
Paste	Inserts objects of the type `Device group`.
Export XML all...	Exports the device group including all defined devices within the group.
Import XML...	Imports objects of the type `Device group`.
`Help`	Opens the online-help for the EMS module.

Info

These settings are identical for device groups in the power grid and in the gas grid.

CONTEXT MENU ENTRIES AT THE NODE OF A DEVICE GROUP:



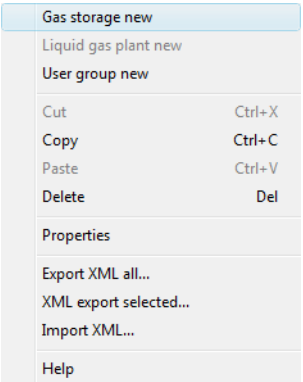
Menu/Entry	Description
New device	Creates a new device in the selected device group.
Cut	No function at the device group.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `Device group, Device`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

Additional parameters for the gas device groups

Individual devices are combined in a device group. At that each device group can contain any number of devices.

Device groups in gas grids have additional settings such as `Adjusted consumption` or `Forecast` with the configuration of upper and lower forecast errors. In addition, there are `Optimum load`, `Current consumption` and `Daily energy`.

CONTEXT MENU ENTRIES



Menu/Entry	Description
`Gas storage new`	Creates a new gas storage in the selected supply area.
`Liquid gas plant new`	Creates a new liquid gas storage in the selected supply area.

Attention

A liquid gas storage can be created using the node "Supply area" no sooner than a gas storage with option `Piping storage` has been created.

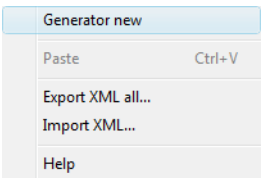
Directly creating a liquid gas storage (without creating a gas storage first) is only possible in a device group.

2.5.7 Generator

Using the node **`Generator`** you can create `new Generators` for the selected supply area using the context menu.

Generators serve to lower the currently obtained power. Basically it is possible to engage each generator or to set it on higher load (`Peak performance`). If a generator is engaged, the power currently obtained (`Current average consumption`) is immediately lowered.

Context menu entries at node "Generator".



Menu/Entry	Description
Generator new	Creates a new generator for the selected supply area.
Paste	Inserts objects of the type `Generator`.
Export XML all...	Exports all generators of the supply area
Import XML...	Imports objects of the type `Generator`.
Help	Opens the online-help for the EMS module.

PROPERTIES

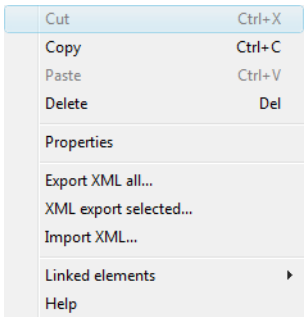
In addition to name and identification, properties can be defined in different groups for the generator:

- `Capacity/Priority`: Defines the basic behavior of pieces of equipment in the electric grid.
- `Switching times`: Default of different life spans or timely requirements to single pieces of equipment.
- `Switching frequency`: Definition of the maximum number of switchings per time unity.
- `Switching variables`: Variable for the adaption of important parameters during the Runtime.
- `Blocking times`: Excludes single pieces of equipment of the EMS from the optimization.
- `Switching steps`: Define switching levels for combined heat and power units. (on page 52)

All adjustable properties are described in the help window after you click on them.

> **Attention**
>
> *The switching priority is regarded by the EMS taking all equipment into account. That means the same number circle is applied for generators and devices. Therefore the priorities for all defined equipment must be considered because it is not distinguished between generators and devices.*

CONTEXT MENU ENTRIES FOR THE SELECTED GENERATOR:



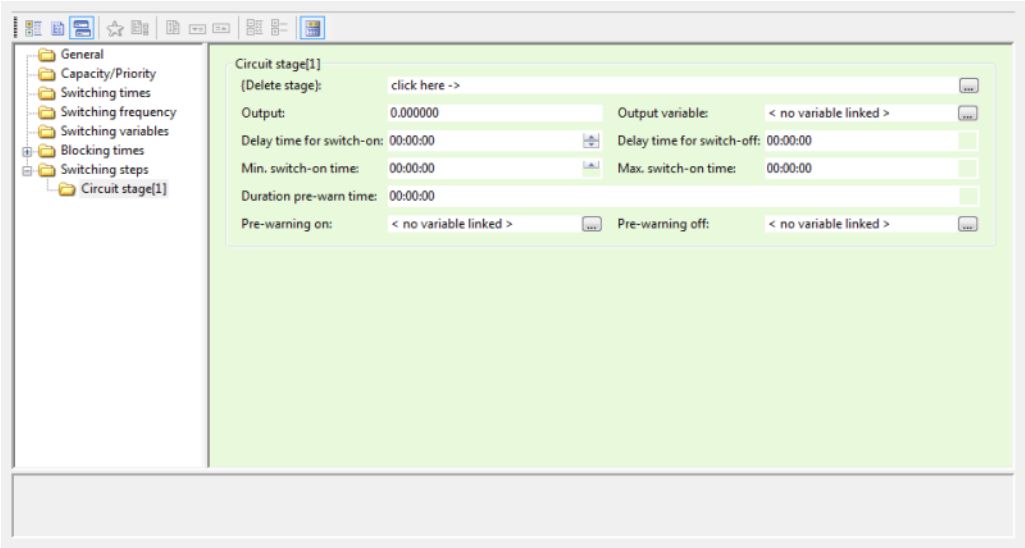
Menu/Entry	Description
Cut	No function at the device group.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `Device group, Device`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

Switching steps

The CHPs (on page 24) (combined heat and power units) are a special case within the EMS. This special type of generators can adjust their output in levels. In order to define a CHP, you can define switching levels for a random device in the EMS.

Basically you can define under the node `Switching steps` settings for the `Setpoint variable`, for the current output and for the `Hysteresis` for each CHP.

For every CHP any number of switching levels can be defined:



Each switching level offers settings for the output, the forewarning of the switching and the switch-on and switch-off. All adjustable properties are described in the help window after you click on them.

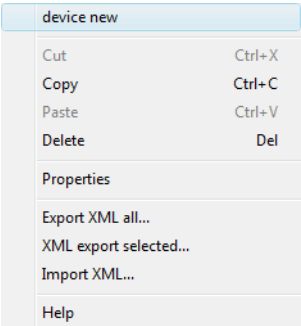
Attention

If switching levels are defined for a generator, these settings overwrite the standard parameters of the generator. An according warning is displayed during compiling in the output window. "

2.5.8 Devices

In the EMS devices are the essential components which "use up" energy. By switching devices on and off the EMS can interfere in a regulative way. At that it helps to avoid peak loads.

CONTEXT MENU ENTRIES FOR THE SELECTED DEVICE GROUP:



Menu/Entry	Description
New device	Creates a new device in the currently selected supply area.
Cut	No function at the device group.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `Device group, Device`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

PROPERTIES

In addition to name and identification, properties can be defined in different groups for the device:

`Capacity/Priority`: Defines the basic behavior of pieces of equipment in the electric grid.

`Switching times`: Default of different life spans or timely requirements to single pieces of equipment.

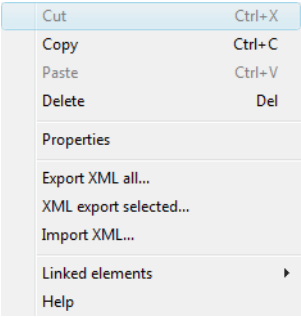
`Switching frequency`: Definition of the maximum number of switchings per time unity.

`Switching variables`: Variable for the adaption of important parameters during the Runtime.

`Blocking times`: Excludes single pieces of equipment of the EMS from the optimization.

All adjustable properties are described in the help window after you click on them.

CONTEXT MENU ENTRIES FOR THE SELECTED DEVICE:



Menu/Entry	Description
`Cut`	No function at the device group.
`Copy`	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
`Paste`	Inserts objects of the type `Device group, Device`.
`Delete`	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
`Export XML all...`	Exports all device groups of the selected grid.
`Export XML selected...`	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
`Import XML ...`	Imports objects of the type `Supply area`.
`Help`	Opens the online-help for the EMS module.

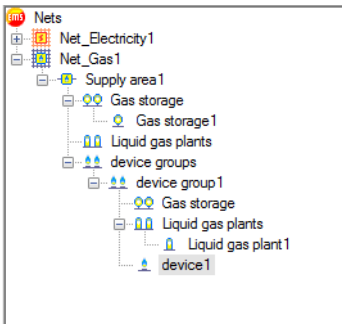
Additional settings for the gas devices

In the EMS devices are the essential components which "use up" energy. By switching devices on and off the EMS can interfere in a regulative way. At that it helps to avoid peak loads.

Devices in gas grids have additional settings for output such as `Proportion of group [%]`, `Return [€/kWh]/Priority` and information about minimum and maximum temperature. All adjustable properties are described in the help window after you click on them.

2.5.9 Specific elements of the natural gas grid

Hereafter the devices and elements used when working with natural gas grids are described. The settings documented hereafter are not available for electricity grids.

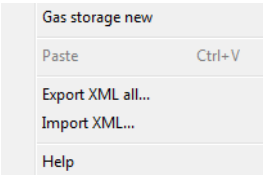


Natural gas storage

With the help of a gas storage, it is possible to shape the storage capacity of a natural gas supply area. They can be used in the following situations:

1. As gas storage in the `supply area`
2. As a piping storage a gas storage can be used to display the storage capacity of a geographically expanded piping.
3. As gas storage in `device group`.

CONTEXT MENU ENTRIES FOR THE SELECTED GAS STORAGE GROUP:



Menu/Entry	Description
Gas storage new	Creates a new gas storage.
Paste	Inserts objects of the type `Device group, Device`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

PROPERTIES

In addition to name and identification, properties for the gas storage can be defined in different groups:

`Type/Capacity`: Settings for the basic behavior of the devices in the gas grid.

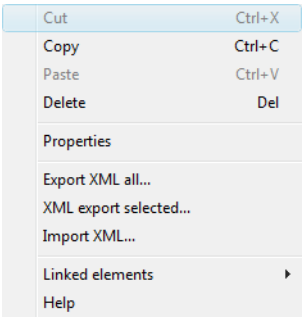
`Switching variables`: Variable for the adaption of important parameters during the Runtime.

`Fill level`: Here the EMS receives important information about filling level and minimal and maximal value.

`Switching times`: Default of different life spans or timely requirements to single pieces of equipment.

All adjustable properties are described in the help window after you click on them.

CONTEXT MENU ENTRIES FOR THE SELECTED GAS STORAGE:

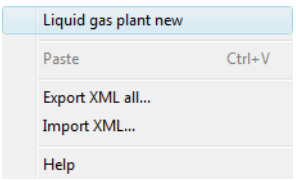


Menu/Entry	Description
Cut	No function at the device group.
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `gas storage`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the currently selected device group. You can not export more than one group at a time (no multi-select).
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

Liquid gas plant

In the EMS liquid gas plant are classical gas storage devices. Basically they are used to equalize peaks. In case of a peak, gas can be taken from the storage.

Context menu entries for the selected gas storage group:



Menu/Entry	Description
Liquid gas plant new	Creates a liquid gas plant.
Paste	Inserts objects of the type `Device group, Device`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

PROPERTIES

In addition to name and identification, properties for the liquid gas plant can be defined in different groups:

`Type/Capacity`: Settings for the basic behavior of the devices in the gas grid.

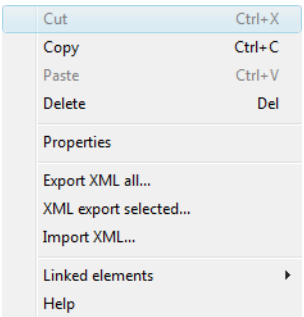
`Switching variables`: Switching variables: Variable for the adaption of important parameters during the Runtime.

`Fill level`: Here the EMS receives important information about filling level and minimal and maximal value.

`Switching times`: Default of different life spans or timely requirements to single pieces of equipment.

All adjustable properties are described in the help window after you click on them.

CONTEXT MENU ENTRIES FOR THE SELECTED LIQUID GAS PLANT:



Menu/Entry	Description
Cut	No function at the device group
Copy	Copies the currently selected device group. You can not copy more than one group at a time (no multi-select).
Paste	Inserts objects of the type `Liquid gas plant`.
Delete	Deletes the currently selected device group. You can not delete more than one group at a time (no multi-select).
Export XML all...	Exports all device groups of the selected grid.
Export XML selected...	Exports the selected entries as an XML file.
Import XML ...	Imports objects of the type `Supply area`.
Help	Opens the online-help for the EMS module.

2.5.10 Lock times

For both generators and devices it is possible to define times in which switchings can be carried out only restricted or not at all. Any number of lock times can be defined for each generator/device.

> **Info**
>
> *In natural gas grids lock times are only available for `devices`.*

Any number of lock times can be defined for each element. You must ensure that the lock times do not overlap. If they do, it is possible that the component cannot be switched by the EMS anymore.

> **Info**
>
> *The lock time parameters are set in the project and cannot be changed during the Runtime.*

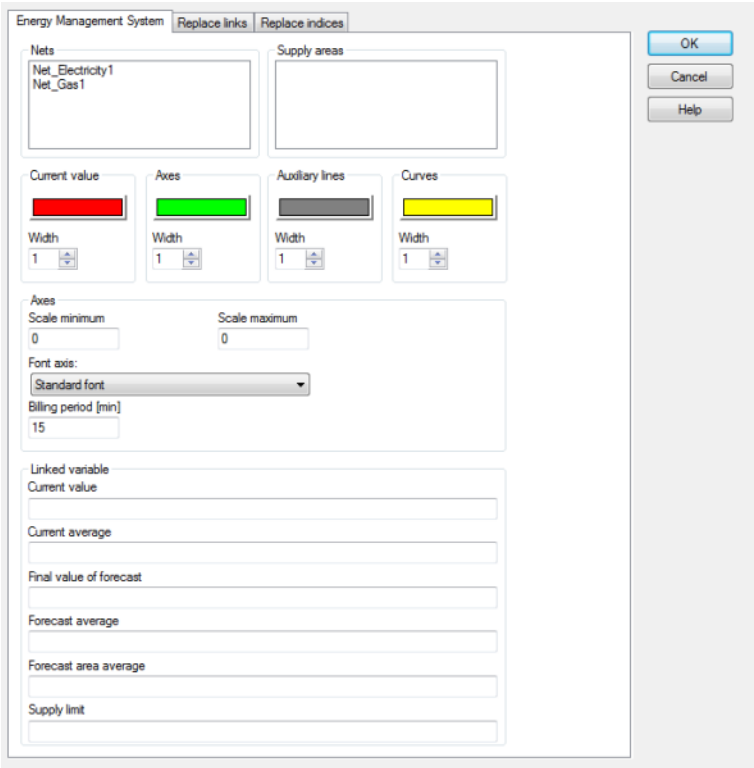
2.5.11 Creating a process screen

The operating of the EMS modules during the Runtime is done with a screen of the type **`Energy Management System`**. This screen must be created in the editor first. (You will find more information on the pre-defined screen types in the chapter Screens / Pre-defined screen types.)

After the screen is opened an empty screen is displayed. You can add control elements via menu **`Control elements`**.

2.5.12 Engineering the screen switch function

When creating a screen switch function for a screen of the type **`Energy Management System`** the following dialog is displayed:



In the Runtime the EMS screen is opened with the help of a screen switch function. For the screen call-up the following parameter can be set:

Property	Description
Grids	Selection of the grids. After that the available areas are displayed in the selection box Supply area.
Supply areas	The selected supply area is displayed in the Runtime n of the optimization. Only one supply area can be displayed per screen. You have however the possibility to open several screens of the type **Energy Management System** parallel. At that several supply areas can be displayed parallel.
Current value	This field is only for display. You cannot change the value. The variable of the property Current value of the currently selected supply area is displayed.
Final value of forecast	This field is only for display. You cannot change the value. The variable of the property Final value forecast of the currently selected supply area is displayed.
Forecast average	This field is only for display. You cannot change the value. The variable of the property Forecast average of the currently selected supply area is displayed.
Supply limit	This field is only for display. You cannot change the value. The variable of the property Supply limit of the currently selected supply area is displayed.
Scale maximum	Upper limit of the range scale for the display of the characteristic curve in the EMS screen.
Scale minimum	Lower limit of the range scale for the display of the characteristic curve in the EMS screen.
Billing period (min.)	This field is only for display. You cannot change the value. Shows the currently set length of the **Billing period** for the selected supply area.
Value color and width	Color and line width for the display of the elements for the current average value and for the forecasted average value.
Axis color and width	Color and line width for the display of the chart axes.
Curve color and width	Color and line width for the display of the chart curves (display of the current value and the scheduled switchings).
Font axis	Font which is used for the axis caption and the trend curve.

SWITCHING OPERATION

For the engineering of the switching operation you define the filter settings for the display in the Runtime in tab **`Column settings for the switching operations preview`**. You can find details in chapter Column settings for the switching operations preview (on page 65).

2.5.13 Create function start/stop

For each area you must start the optimization separately in the Runtime. For this you use the function **`Start EMS`**.
In order to stop started areas, create the function **`Stop EMS`**.

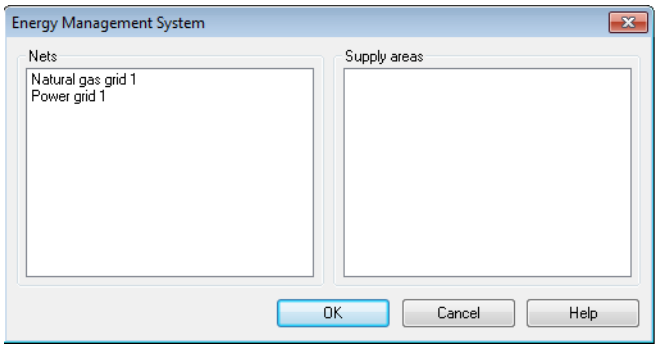
Note: These functions are only carried out on the server.

> **Attention**
>
> *In the Runtime all started areas recorded by the licensing. Take care of sufficient licensing.*

Hint: Stop the optimization of areas if they are not needed in order to use your license in an optimal way.. In order to stop areas regularly e.g. in the night or in certain shifts, you can control functions **`Start EMS`**/**`Stop EMS`** with the help of the Production & Facility Scheduler.

START EMS

- select New Function
- click on **`Start EMS`** in the node applications
- the dialog for the selection of the areas opens

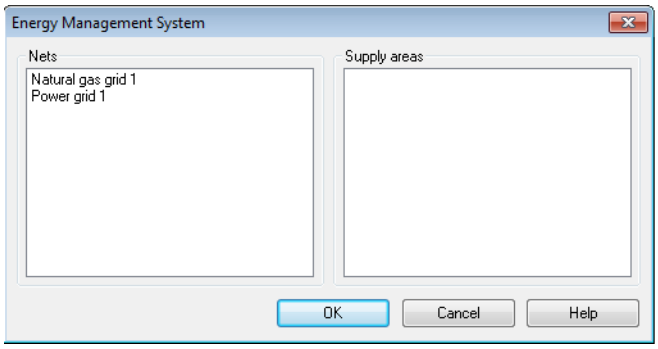


- first select the desired grid
- then select the desired area

- by clicking `OK` the function is created

STOP EMS

- select New Function
- click on `Stop EMS` in the node applications
- the dialog for the selection of the areas opens



- first select the desired grid
- then select the desired area
- by clicking `OK` the function is created

2.5.14 Engineering switching operations preview

Planned switching operations can be displayed as a preview in the Runtime.

In order to engineer the switching operations preview in the Runtime:

1. Link a String variable to the desired EMS supply area with the help of property `Planned switchings` (group `Status information`). The variable receives a list of all planned switching operations from the EMS.

Hint: A String variable from the internal driver makes most sense.
For server operation set the calculation to `Network`. Thus the variable is distributed in the whole zenon network.

2. Define the desired content of the switching operations preview. For this open tab EMS **`Column settings for the switching operations preview`** (on page 65) in the dialog of the screen switch function (on page 61) to the screen EMS.

3. Insert the **`Table view:`** control element into the the EMS screen. **`Switching operations preview`** on.

You can customize color and font using its properties.

LANGUAGE SWITCH

You can switch between languages for all information displayed in the switching operations preview with the help of the language table.

For this you can define the name for the column titles in the filter dialog (on page 65). For example if you define a name such as `@Switching time`, `@Object name` or similar, these names are replaced by the corresponding entries from the language table in the Runtime.

In addition the whole content of the switching operations preview can be replaced:

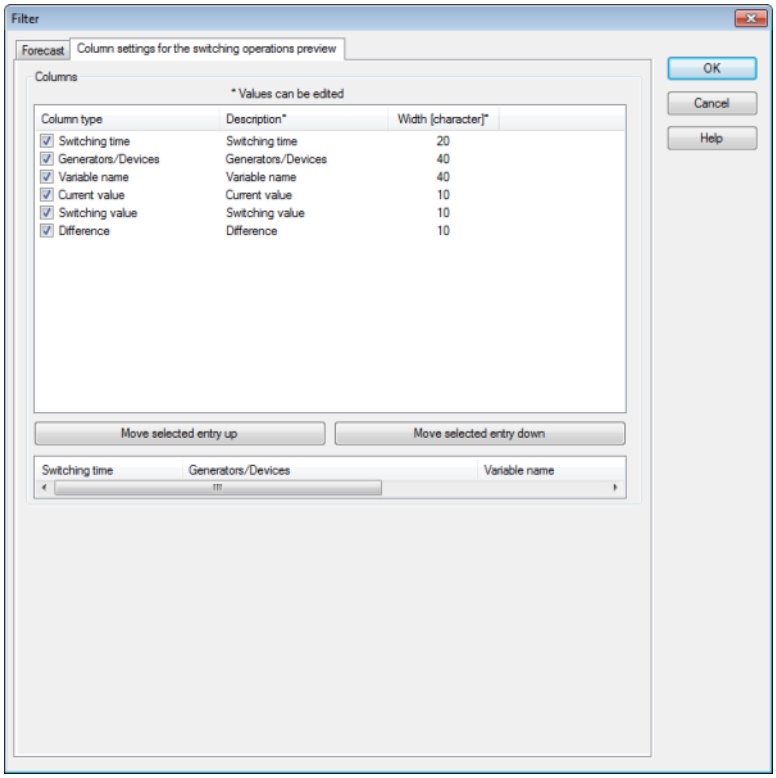
1. Object names are replaced by putting a @ in front of them during the EMS engineering. For example: `@Generator1`

2. Current value and switching value can either have a numerical content (with CHP steps) or `@On`/`@Off`

Column settings for the switching operations preview

Via the column setting you can define which information is displayed in what order.

Note: The language of all information displayed in the switching operations can be switched via the language table:
Select the name with a `@ before it, for example @Schaltzeit`, so that this can be replaced with the corresponding language table entries in Runtime.



In the list field of this tab all available column types are displayed. With the help of a checkbox you decide which column types are displayed. You can change the description and the width of each column type by left-clicking the corresponding area and entering the desired value in the input field.

TAG	Description
`Column type`	Type of the column. Cannot be edited. The display in the Runtime is activated or deactivated with the help of a checkbox.
`Description`	Defines the header of the respective column. You can configure it as language switchable. The value can be edited.
`Width`	Defines the width of the column in pixels. You can also define the width of the column by clicking and dragging the column with the mouse in the list with the horizontal display of the column names. The value can be edited.
`Move selected entry up`	Moves the selected column up. You can also move the columns with drag&drop.
`Move selected entry down`	Moves the selected column down. You can also move the columns with drag&drop.
`Field with horizontal display of the column names`	Shows the columns which are active in the list. You can define the size of the columns by clicking and dragging the column borders with the mouse.

Attention

The column width is dependent on the used font. If the column width is not a multiple of the character width of the used font, the actual column width can differ from the set column width.

Switching operations preview in the Runtime

In the Runtime screen Switching operations preview displays the upcoming switching operations with date and consequence:

Switching time	Generators/Devices	Variable name	Current value	Switching value	Difference
04.11.2009 11:49:06	Heating2	sP1/Global/Hall1_Body_Shop_Heating2_Off	On	Off	400
04.11.2009 11:49:06	Heating1	sP1/Global/Hall1_Body_Shop_Heating1_Off	On	Off	400
04.11.2009 11:49:06	Ventilation	sP1/Global/Hall1_Body_Shop_Ventilation_Off	On	Off	300
04.11.2009 11:49:58	DieselGen	sP1/Global/DieselGen_On	Off	On	1000

2.6 Internal state of the components

Internally in the EMS different states for the components are carried along. This states can be shown using a variable. We recommend to monitor the states with reaction matrix and e.g. to evaluate them in the Chronological Event List.

The variable `Internal switching state` of components can take on the following values:

GENERAL REASONS (VALID FOR ALL COMPONENTS)

Value	Description
0	Not used (Booting).
100	Service is possible.
101	No switching request of the peak load forecast.
102	Deactivated until the end of the rate interval.
103	The switching forewarn command is invalid.
104	Not enough time in order to forewarn.
105	The forewarn time has not yet expired.
106	It is not possible to add output at the end of the rate interval because of the parameterization.
107	The switching state cannot be detected.
200	Delay time has not expired yet.
201	Component is set to "not available.
202	Availability message is invalid.
203	No variable is defined in order to determine the operation state.
204	Parameterization is faulty.
205	Dead time has not expired yet.
206	Report of the current switching state is invalid.
207	No data for the gliding average value of the output are available yet.
208	Current output value is invalid.
209	Is set to "implicit" (schedule medium-term).
210	Text address or value for switch-on priority is invalid.
211	Text address or value for switch-off priority is invalid.
212	Blocking time is active, blocking time type OFF.
213	Blocking time is active, blocking time type ON.
214	Maximum number of switchings has already been reached.
215	Switching command cannot be used.

216	Minimum switching time has not been reached yet.
217	Schedule data have not been written completely yet.
218	General problem.
219	Command variable cannot be used for switching.
220	No command defined for sending the switching forewarning.
221	Extended parameterization for minimum power-on time per time unit not valid.
222	Because of other restrictions, it is not possible to stick to restriction "Adhere to minimum power-on time per time unit".
223	Switched on implicitly because of "minimum switch-on time per time unit".
250	Variable or value for minimum switch-on time is invalid.
251	Variable or value for minimum switch-off time is invalid.
252	Variable or value for maximum switch-on time is invalid.
253	Variable or value for maximum switch-off time is invalid.
254	Restrictions are not reasonable.

REASONS FOR STORAGE

Value	Description
4000	Current filling level value is invalid.
4001	Current roll out (actual value) is invalid.
4001	Roll out is implicit because of the manual set value.
4003	Storage capacity limited because of filling level limit.
4004	Storage is full.
4005	Set value for storage is not defined.
4006	Maximum roll in capacity and maximum roll out capacity are both 0.
4007	Variable which is used to measure the current filling level is invalid.

REASONS FOR CHPS (GENERATOR)

Value	Description

5000	The current output does not comply with a level output.
5001	CHP does not run below nominal power.
5002	The CHP only has one level can cannot be switched.
5003	The CHP runs with nominal power and cannot be switched down further.
5004	The highest switched on level cannot be switched off because of the minimal switch-on time per time unit.
5005	The CHP is already running on its highest level.
5006	The variable which is used to measure the current output is invalid.
5007	The forewarning for a level was activated. Waiting for set value input.
5008	The variable for the set value is invalid.
5009	The order of the output guidelines by variables is not ascending.
5010	The value of a parameterized maximum switch-on time of a level is too small.
5011	Maximum running time of a level has been reached. The level is switched off.

2.7 Creation of the Runtime files

After engineering the functions `Start EMS` or `Stop EMS` a consistency check of the EMS engineering is carried out during the creation of the Runtime files. If problems occur, a corresponding message is displayed in the output window (e.g. if necessary variables were not allocated).

RUNTIME DOES NOT START

If a project cannot be started in the Runtime, it can have the following reasons:

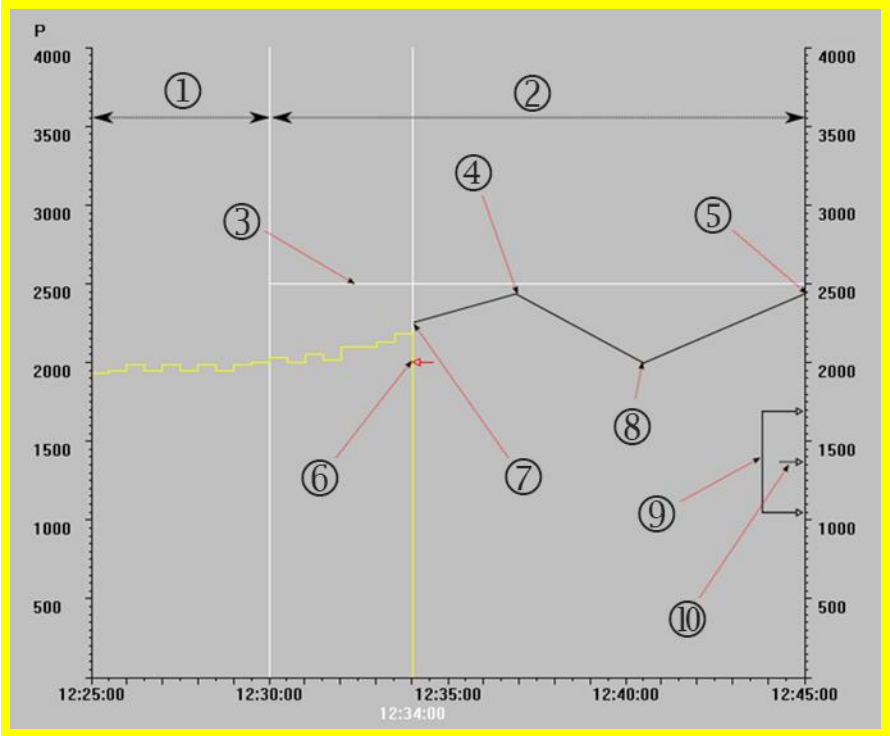
- wrong engineering
- missing license: With the function `Start EMS` the license is checked. If the license is not available, the EMS does not start and a corresponding entry is generated in the log.

2.8 Control the EMS in the Runtime

Screens of the Energy Management System make it possible to monitor the prognosis and the optimization during the Runtime in form of a trend screen.

The single operating elements are positioned in the screen with the help control elements (prognosis area and the display of the current supply area).

For example a prognosis can look like this:



Digit	Description
1	Previous period
2	Current billing period
3	Supply capacity limit
4	Value 1. Switching
5	Final value of forecast
6	Current average
7	Start value for forecast
8	Value of last switching
9	Forecast channel
10	Forecast average value

Info

The screen which is shown in the Runtime acts only as the display of the optimization and prognosis data. No interventions can be carries out in the screen. Parameters of the EMS module are exclusively controlled via variables.