

MindSphere

App MindSphere app SIMATIC Energy Manager

Application Manual

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Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

 DANGER
indicates that death or severe personal injury will result if proper precautions are not taken.

 WARNING
indicates that death or severe personal injury may result if proper precautions are not taken.

 CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

 WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Introduction

1.1 Security information

Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement - and continuously maintain - a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit:

<https://www.siemens.com/industrialsecurity> (<https://new.siemens.com/global/en/company/topic-areas/future-of-manufacturing/industrial-security.html>)

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under:

<https://www.siemens.com/industrialsecurity> (<https://new.siemens.com/global/en/company/topic-areas/future-of-manufacturing/industrial-security.html>)

1.2 Note on EU General Data Protection Regulation

Data protection

Siemens observes the principles of data protection, in particular the principle of data minimization (privacy by design). For the SIMATIC Energy Manager product, this means: the product processes / stores the following personal data: User name (first name and last name), email address, user role and app usage data (number of users; number of KPI instances; number of assets showing a media analysis).

No private or intimate data is processed or stored.

The above data are required for the login, the billing function and for the internal user administration (administrator can see the role and the status of other users). The storage of data

is appropriate and limited to what is necessary, as it is essential to identify the authorized operators. The data needs to be maintained manually by you and if necessary, these can also be deleted. If you need support, please contact customer support.

The above data will not be stored anonymously or pseudonymized, because the purpose (identification of the operating personnel) cannot be achieved otherwise.

The above data is protected against loss of integrity and confidentiality by state-of-the-art security measures.

1.3 Function overview

Introduction

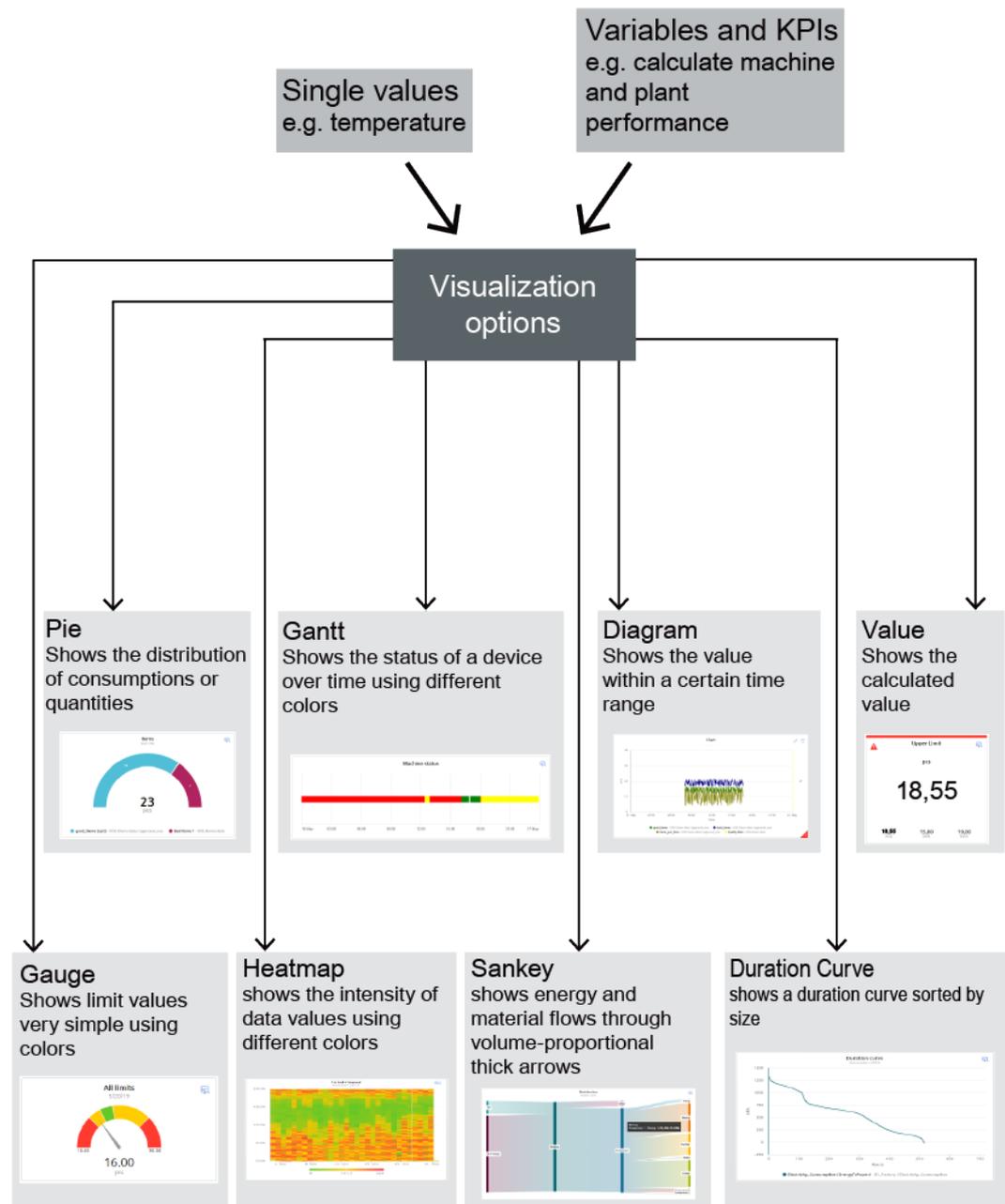
The MindSphere app SIMATIC Energy Manager provides you with information about how much energy has been consumed at any time online:

- You have access to the consumption data of machines and plants worldwide.
- Transparent energy management data to ISO 50001
- With individual KPI types and user-specific dashboards, you are creating a complete overview of the energy consumption of your machines, plants or entire production facilities from which you can subsequently derive measures for energy efficiency.
- In addition to the KPI type and KPI instance application in combination, you can also create a KPI instance directly at the asset in the SIMATIC Energy Manager without having defined a KPI type beforehand.
- In the detail view of the widgets, you can quickly create media analyses.
- Transparent listing of energy costs, energy consumption and CO2 emissions of individual machines and all your production facilities around the globe. (Energy media analysis)
- You obtain valuable information on peaks in energy consumption, for example, to make informed decisions regarding optimization of energy efficiency and reducing energy costs.

The SIMATIC Energy Manager will help you make the transition from energy transparency to energy efficiency. The recorded energy data will provide you with more planning reliability. You optimize processes and plants by analyzing and documenting the energy consumption together with the process data, such as temperatures, pressures, etc. Use the collected energy data to make your procurement process even more precise.

If your plant is already energy-efficient, you can use the SIMATIC Energy Manager to ensure that it will stay this way. For example, you can quickly detect whether a filter is contaminated and replace it.

A dashboard is available for data and energy media analysis. Depending on your needs, you can use a variety of widget types on the dashboard:



Browser recommendation

You require an HTML5-capable Internet browser to run the app.

The Google Chrome and Microsoft Edge browsers are supported. Google Chrome is recommended. You should preferably use 1920x1080 resolution.

The app can run on any mobile device with an HTML5-enabled browser. Tablets are recommended.

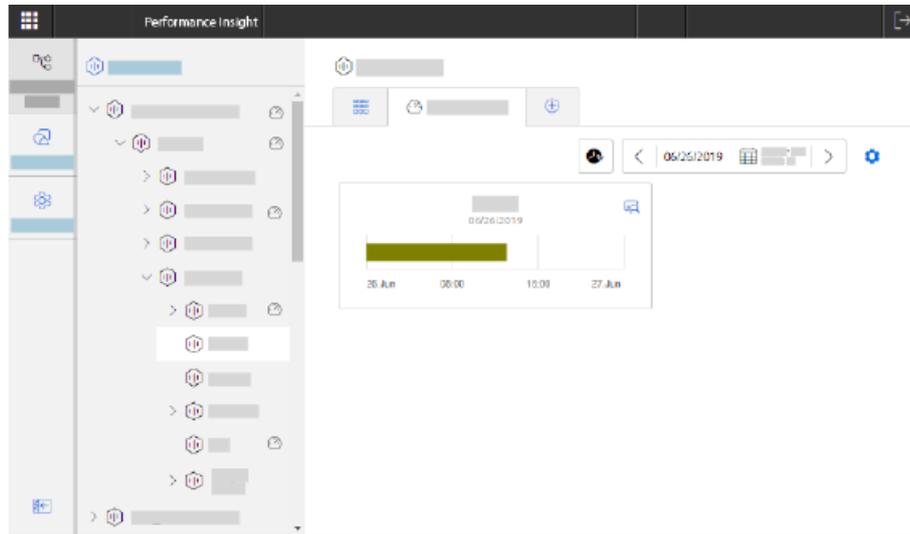
1.4 What's new in Energy Manager?

You can find all important new features in Energy Manager here: New features in Energy Manager (https://sie.ag/whatsnew_energymanager)

Structure of the app

Views in the app

The SIMATIC Energy Manager app has the following tabs:



	<p>My Plant</p>	<p>Energy media assignments, costs and the CO2 equivalent of an energy medium can be configured in the Asset configuration.</p> <p>My Plant is imported from the Asset Manager. You can find additional information on the Asset Manager here: Asset Manager System manual (https://documentation.mindsphere.io/resources/html/asset-manager/en-US/index.html)</p> <p>You can create dashboards and widgets for the individual elements of My Plant.</p>
	<p>Configuration</p>	<p>In the Configuration, you manage the KPI types, energy media and status mappings. The actual status mapping to a tag or a KPI type takes place during configuration of the Gantt widget.</p>

	Settings	In the settings, you manage the <ul style="list-style-type: none">• User information (e.g. the language region and the user roles)• Usage information (e.g. the number of users, the KPI instances and the assets that show an energy media analysis)• User list
	Symbol in My Plant	This symbol indicates that there is at least one dashboard within the asset.

User profile

User information

Here you can see your user information and set both the interface language and the language region of the app. The selection of the language region affects all numbers, such as decimal separators, and dates in dashboards and widgets within the app and can be selected regardless of the interface language.

User roles as tenant

If you are logged on as a tenant user or administrator in MindSphere, you have the following options:

Activities	Users	Administrator
Create and instantiate KPI types (typed)	-	x
Create KPI instances (typeless)	-	x
Create, edit and delete dashboards	-	x
Create, edit and delete widgets	-	x
Display dashboards	x	x
Display widgets	x	x
Create, edit and delete status mappings	-	x
Energy media analysis	-	x
Define limit values for tags and KPI instances and enable the "Activate notifications" function	-	x

Note

General information on tenants and subtenants

A tenant is the digital representation of a real company in MindSphere. A tenant includes users, data, assets, locations and other properties.

You can also create and manage subtenants in a tenant. The subtenants form a self-contained subarea so that users of this subtenant can only access the contents of this area.

Assets can also be shared by one tenant with another tenant. (Cross tenancy)

You can find more on this topic in the documentation for MindSphere Settings.

User roles as subtenant

If you are logged on as a subtenant user or administrator in MindSphere, you have the following options:

Activities	Users	Administrator
Create and instantiate KPI types (typed)	-	x
Create KPI instances (typeless)	-	x
Edit KPI types	-	x <ul style="list-style-type: none"> • From a tenant => read • From the subtenant => write
Create, edit and delete dashboards for an asset that belongs to the subtenant.	-	x
Create, edit and delete widgets for an asset that belongs to the subtenant.	-	x
Show dashboards that belong to an asset of the subtenant.	x	x
Show widgets that belong to an asset of the subtenant.	x	x
Create, edit and delete status mappings	-	x <ul style="list-style-type: none"> • From a tenant => read • From the subtenant => write
Energy media analysis	-	x <ul style="list-style-type: none"> • From a tenant => read • From the subtenant => write
Define limit values for tags and KPI instances and enable the "Activate notifications" function	-	x

Usage information

In the Usage information, you can view the number of assets that show a media analysis, the number of KPI instances and the number of users logged on to the Tenant with the "Energy Manager" role for specific months (mdsp:wccop:energymanager.admin).

If the maximum number of users is reached, purchase an additional user license or remove the role "Energy Manager" from another user.

Note

Automatically created KPI instances for energy media analysis

The automatically created KPI instances are not taken into account in the number of KPI instances because they do not result in additional costs.

Adding/deleting users (as an administrator)

As administrator, you can manage the "Energy Manager" roles of administrator and user for a user in the MindSphere settings as follows:

1. Open the MindSphere settings in the overview page of the MindSphere applications.
2. Select the required user in the "Users" menu. The assigned roles are displayed.
3. Click "Edit direct assignment".
4. Add the "mdsp:wccop:energymanager.admin" role or remove the role and close the dialog.

Deleting users

To free up a user license, you can deregister yourself as a user from the Energy Manager app:

1. Open the "Settings" menu.
2. You can deregister from the Energy Manager app under "User information > User account".

Quality codes

Description

The quality code measures the quality of the connection from a data provider to the MindConnect element. For the SIMATIC Energy Manager app, this means that a value with quality code \neq TRUE is ignored in the app, since the quality code is not transferred to MindSphere. This value is not included in aggregation, not included in KPI calculation, and not included in dashboard.

The following table is based on the OPC UA standard and shows the quality codes possible for OPC UA and S7:

Quality code (hex)	Quality code (dec)	Quality	Description
0x00000000	0	GOOD	Good quality, all values could be read.
0x00BA0000	12189696	GOOD_INCOMPLETE	Good quality, but the values may be incomplete. A least 1 value could be read.
0x002F0000	3080192	GOOD_OVERLOAD	Sampling has slowed down due to resource constraints.
0x40920000	1083310080	UNCERTAIN_INITIAL_VALUE	Uncertain initial value Quality of the value is worse than usual. It might still be possible to use the value.

The quality code has the binary 8-bit structure QQSSSSL. Digits 1 and 2 (QQ) of the quality code define the quality of the value. Digits 3 to 6 (SSSS) of the quality code specify the sub-status of the quality. Digits 7 and 8 (LL) are optional and define possible limits.

Variable declarations

5.1 Introduction to variable declarations

Description

The variables that are available on any asset were transferred from the plant to MindSphere using the Asset Manager. My Plant with all existing variables is mapped on this basis in the SIMATIC Energy Manager.

The name, aspect name and the unit of each variable are transferred from MindSphere.

See also

Variable declarations on the asset (Page 18)

Variable declaration in the widget (Page 22)

5.2 Variable declarations on the asset

Description

You can extend the declaration of each variable directly on the asset in the "Parameter" area by the following properties:

- Unit: You can either apply the unit transferred from MindSphere or specify your own unit.
- Acquisition category:
You use the acquisition category to determine how the value was acquired and stored in MindSphere. In addition, the acquisition category is linked directly to an aggregation function. As soon as you use the variable in a widget, the respective aggregation function is automatically selected:
 - ProcessValue => aggregation function: Average
 - Power => aggregation function: Average
 - Energy => aggregation function: Sum
 - Flow => aggregation function: Average
 - Amount => aggregation function: Sum
 - Counter => aggregation function: Counter
When you select the acquisition category "Counter", you can define additional settings for each counter used.
Additional information on the counting method of the individual counters can be found here: Introduction to the "Counter" acquisition category (Page 22)
 - Status value (State)
- Activate the "The value is aggregated" function:
If the value is not aggregated, the values are continuously (actual values) transferred to MindSphere when the value changes. The currently transferred value is valid until the next value is transferred to MindSphere. When the value is aggregated, the value is always valid for the last cycle, e.g. 15 minutes.
We recommend that you activate the function for the energy data management.
You can find additional information on the aggregation functions here: Introduction to the aggregation functions (Page 24)

Note

Data gaps

Data gaps occur, for example, when the connection to the network is interrupted. No data from the plant is transferred to MindSphere during the interruption.

When you have activated the "The value is aggregated" function and are using an acquisition category with the "Sum" aggregation function, data gaps will distort the final result.

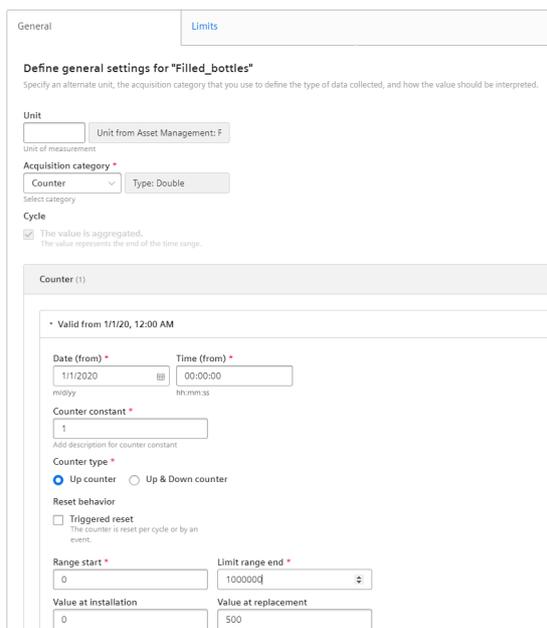
5.3 "Activate notifications" for variables of the data type "Integer" and KPI instances

Procedure

To extend the declaration of a variable on the asset, follow these steps:

1. Click on the required asset and open the "Parameter" area.
2. Next to the variable, click on the "Edit" icon.
3. Select the desired properties.

In addition to the acquisition category, the data type of the variable is displayed.



General Limits

Define general settings for "Filled_bottles"
Specify an alternate unit, the acquisition category that you use to define the type of data collected, and how the value should be interpreted.

Unit
Unit from Asset Management: F

Unit of measurement

Acquisition category *
Counter Type: Double

Select category

Cycle
 The value is aggregated.
The value represents the end of the time range.

Counter (1)

Valid from 1/1/20, 12:00 AM

Date (from) * 1/1/2020 Time (from) * 00:00:00
yyyy hh:mm:ss

Counter constant *
1
Add description for counter constant

Counter type *
 Up counter Up & Down counter

Reset behavior
 Triggered reset
The counter is reset per cycle or by an event.

Range start * 0 Limit range end * 1000000

Value at installation 0 Value at replacement 500

5.3 "Activate notifications" for variables of the data type "Integer" and KPI instances

Description

For each tag of the "Integer" data type and for KPI instances (user-defined and automatically created), you can define high and low limits that trigger a notification when these limits are exceeded or not reached. This notification is displayed in the SIMATIC Notifier MindSphere app and sent directly to the desired mobile device.

Note

SIMATIC Notifier

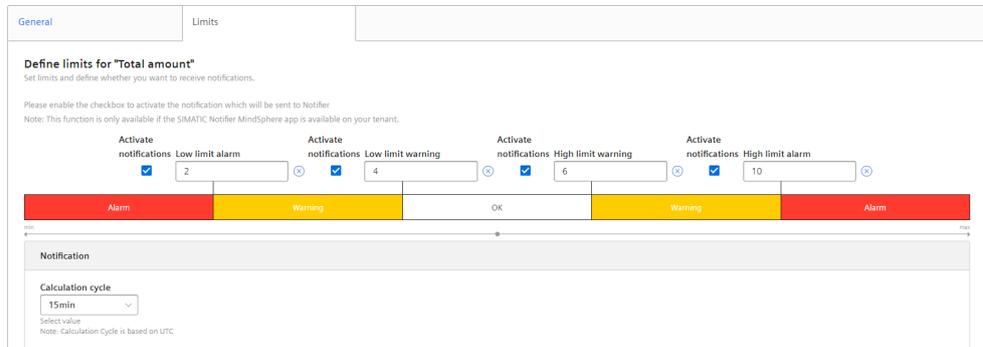
The SIMATIC Notifier must also be installed and running so that you can enable the "Activate notifications" function.

The limits defined here for the tag or user-defined KPI instance are applied by default in the widget as soon as the tag or KPI instance is used. You can adapt the limits in the widget if necessary. This does not apply to automatically created KPI instances.

Procedure

To enable the "Activate notifications" function, proceed as follows:

1. Click on the required asset and open the "Parameter" area.
2. Click the "Edit" icon next to the desired tag or KPI instance, or create a new KPI instance.
3. Click on the "Limits" tab.
You can select the check box for the respective notification next to the fields "Low limit alarm/warning" and "High limit alarm/warning". As soon as the function is activated and the specified high or low limit has been violated, a notification is triggered and sent to the mobile device.
4. You can also select the following settings in the "Notification" section:
 - For tags:
Select whether the raw data or the aggregated data should be validated.
If you want to validate the raw data, a fixed calculation cycle of 10 seconds is used.
If you want to validate the aggregated data, you need to select a calculation cycle and an aggregate function. The following calculation cycles are available:
1 min, 10 min, 15 min, 30 min, 1 hr, 2 hr, 8 hr, 1 day
The calculation cycle always starts at 00:00 UTC time (Universal Time Coordinated), e.g. 00:00:00; 00:15:00; ...
For example, if you define a calculation cycle of 15 minutes, the system checks every 15 minutes whether or not a high or low limit has been violated and sends a notification if necessary.
The following aggregation functions are available: Introduction to the aggregation functions (Page 24)
 - For KPI instances:
Select a calculation cycle:
1 min, 10 min, 15 min, 30 min, 1 hr, 2 hr, 8 hr, 1 day
The calculation cycle always starts at 00:00 UTC time (Universal Time Coordinated), e.g. 00:00:00; 00:15:00; ...
For example, if you define a calculation cycle of 15 minutes, the system checks every 15 minutes whether or not a high or low limit has been violated and sends a notification if necessary.



5.4 "Activate notifications" for variables of the data type "Bool" and "String"

Description

For each variable of the "Bool" or "String" data type, you can define conditions that trigger a notification. This notification is displayed in the SIMATIC Notifier MindSphere app and sent directly to the desired mobile device.

Note

Variables of the data type "Bool" or "String"

You can activate notifications for these tags.

- You cannot use a tag of the data type "String" as a parameter in a widget or a KPI instance.
- You cannot use a tag of the data type "Bool" as a parameter in a widget or a KPI instance.

Limit values can also be defined, but these limit values are not transferred to the widget.

Procedure

To enable the "Activate notifications" function, proceed as follows:

1. Click on the required asset and open the "Parameter" area.
2. Click the "Edit" icon next to the desired variable (Bool or String)
3. Click on the "Notification configuration" tab.

Activate notifications	Type	Value is	Value
<input checked="" type="checkbox"/>	Alert	=	True

4. Select the check box under "Activate notifications".
5. Select a notification type:
 - Alert
 - Warning
6. Select "=" or "<>" as operator and enter a value:
 - For the data type "Bool": "True" or "False"
 - For the data type "String": Enter a value.
7. Click "Save".

Result

A green check mark appears in the parameter list next to the desired variable in the "Notification activated" column.

5.5 Variable declaration in the widget

Description

When you create a widget, you can select one of the following aggregation functions for a variable in step 3 "Parameter":

- None (Only with diagram)
- Average
- Min
- Max
- Sum
- Last
- Counter
- Timer
- EnergyToPower
- PowerToEnergy
- AmountToFlow
- FlowToAmount

You can find additional information on the individual aggregation functions here: [Introduction to the aggregation functions \(Page 24\)](#)

5.6 "Counter" acquisition category

5.6.1 Introduction to the "Counter" acquisition category

Description

You can define properties for each counter:

- Installation date
- Installation time
- Counter constant (value by which the counter is counted up or down, e.g. 1 kWh.)
- Counter types
 - Up counter = The counter can only count up. As soon as a subsequent counter value is less than the current one, it is treated as an overflow and the counter is restarted.
 - Up & Down counter = The counter can count up and down. You can not only calculate the energy consumption of an energy medium, for example, but you can also detect when energy is fed back.

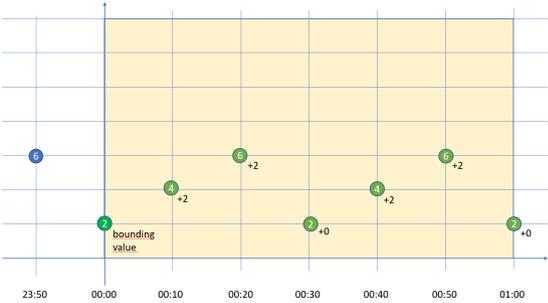
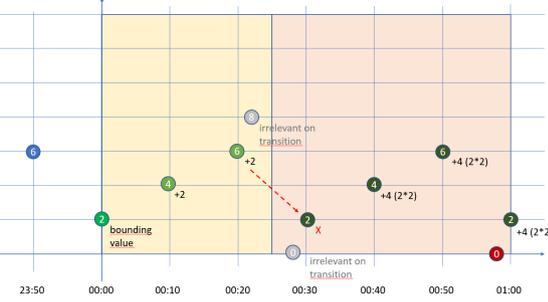
- Reset behavior (Only for an Up counter: You can specify whether the counter is reset daily or by an event, such as a defined overflow limit.)
- Overflow limit (If you have not activated the reset behavior, the counter is automatically reset when it reaches the specified count limit.)
- Value at installation (Here you can specify the actual value at which the counter is to start. If the counter is not to start with the start value of the limit range.)
- Value at replacement of the counter

5.6.2 Counting method of the "Up" counter

Description

Only positive changes in value are recorded. The sum of the positive value changes between two points in time is output in each case. If the value remains the same between two points in time or is reduced, the value is not counted.

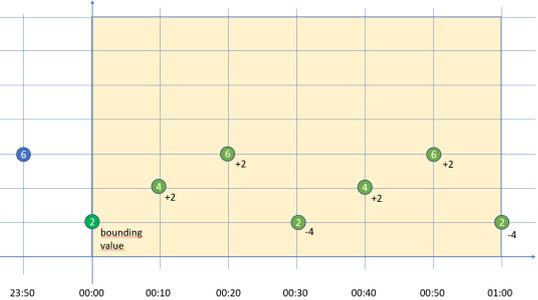
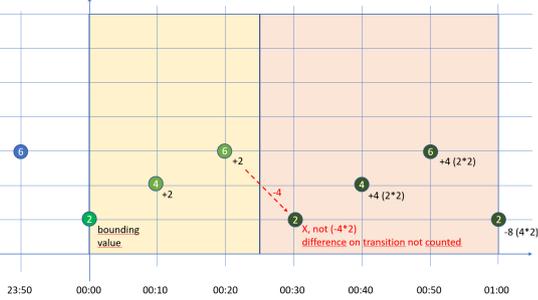
Depending on the settings you select for a counter, you will see different counter values as a result. By default, the "The value is aggregated" function is activated:

Settings	Explanation		
Start and end of the limit range is not defined. Result: $+ 2 + 2 + 0 + 2 + 2 + 0 = 8$			
When you change the counter, you can define different settings for each counter. This example shows the transition from one counter to the next: <table border="1" data-bbox="387 1485 762 1789"> <tr> <td>Counter for the year 2018 00:00 - 00:25 Counter constant: 1 End of the limit range: 8 Result: $+ 2 + 2 = 4$</td> <td>Counter for the year 2019 00:25 - 01:00 Counter constant: 2 Start of the limit range: 0 Result: $+ 4 + 4 + 0 + 4 = 12$</td> </tr> </table> Final result: $4 + 12 = 16$	Counter for the year 2018 00:00 - 00:25 Counter constant: 1 End of the limit range: 8 Result: $+ 2 + 2 = 4$	Counter for the year 2019 00:25 - 01:00 Counter constant: 2 Start of the limit range: 0 Result: $+ 4 + 4 + 0 + 4 = 12$	
Counter for the year 2018 00:00 - 00:25 Counter constant: 1 End of the limit range: 8 Result: $+ 2 + 2 = 4$	Counter for the year 2019 00:25 - 01:00 Counter constant: 2 Start of the limit range: 0 Result: $+ 4 + 4 + 0 + 4 = 12$		

5.6.3 "Up & Down" counting method of the counter

Description

Depending on the settings you select for a counter, you will see different counter values as a result. By default, the "The value is aggregated" function is activated. You cannot define any limit ranges for the "Up & Down" counter.

Settings	Explanation				
Result: $+ 2 + 2 - 4 + 2 + 2 - 4 = 0$					
When you change the counter, you can define different settings for each counter. This example shows the transition from one counter to the next:					
<table border="1" style="width: 100%;"> <tr> <td style="width: 50%;"> Counter for the year 2018 00:00 - 00:25 Counter constant: 1 Result: $+ 2 + 2 = 4$ </td> <td style="width: 50%;"> Counter for the year 2019 00:25 - 01:00 Counter constant: 2 Result: $+ 4 + 4 - 8 = 0$ </td> </tr> <tr> <td colspan="2"> Final result: $4 + 0 = 4$ </td> </tr> </table>	Counter for the year 2018 00:00 - 00:25 Counter constant: 1 Result: $+ 2 + 2 = 4$	Counter for the year 2019 00:25 - 01:00 Counter constant: 2 Result: $+ 4 + 4 - 8 = 0$	Final result: $4 + 0 = 4$		
Counter for the year 2018 00:00 - 00:25 Counter constant: 1 Result: $+ 2 + 2 = 4$	Counter for the year 2019 00:25 - 01:00 Counter constant: 2 Result: $+ 4 + 4 - 8 = 0$				
Final result: $4 + 0 = 4$					

5.7 Aggregation functions

5.7.1 Introduction to the aggregation functions

Description

You use an aggregation function to select which value is to be output for a variable.

- Output the last read value with "Last".
- Use the other functions to gather summary information from the read values, for example, the sum of all read values.

The following aggregation functions are available:

Function	Meaning
Average	Calculates the time-weighted average value of the read values.
Min	Outputs the smallest read value.
Max	Outputs the largest read value.
Sum	Adds all read values.
Last	Outputs the last read value.
Counter	The sum of the positive value changes between two points in time is output in each case.
Timer	The Timer calculates the time interval in which the variable was not 0. Unit = milliseconds.
EnergyToPower	A consumption value can be converted into power. This aggregation function can only be selected in combination with the acquisition category consumption value (Energy) and Counter.
PowerToEnergy	Power can be converted into a consumption value. This aggregation function can only be selected in combination with the acquisition category power value (Power).
AmountToFlow	An amount (per hour) can be converted directly into a flow value. This aggregation function can only be selected in combination with the acquisition category amount value (Amount) and Counter.
FlowToAmount	A flow value (amount/h) can be converted directly into an amount value. This aggregation function can only be selected in combination with the acquisition category flow value (Flow).

Note

Activating the interval in the first step of the Widget wizard

For this function to be executed, the aggregation function of the variable must not be set to "None" because the values are displayed directly in the widget without further processing in this case.

5.7.2 Aggregation functions in combination with the "The value is aggregated" function:

Description

For each variable and thus for each aggregation function, you can activate the "The value is aggregated" function:

"The value is aggregated" = not activated	"The value is aggregated" = activated
When the "The value is aggregated" function is not activated, actual values are transferred to MindSphere every 10 minutes, for example. The respective actual value is valid for 10 minutes until the next actual value is transferred to MindSphere. If the time of the last reading operation is identical to the end of the specified period, the last value is not read.	When the "The value is aggregated" function is activated, no actual values are transferred but the value that has already been calculated or processed in the last 10 minutes is transferred to MindSphere. Application example: A temperature measured value is recorded in the plant every minute, and an average value of the recorded values is then transferred to MindSphere every 10 minutes.
Result: Different results are calculated for the same time range, depending on the initial situation of how you want to collect data. Only the values marked in green are taken into account for the calculation of the result.	

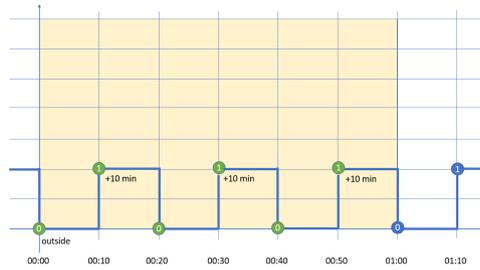
"Counter" aggregation function

"The value is aggregated" = not activated	"The value is aggregated" = activated
<p>Calculation example: The calculation period is from 00:10 to 00:50. Result: 1 + 1 + 1 + 1 = 4</p>	<p>Calculation example: The calculation period is from 00:10 to 00:50. Result: 1 + 1 + 1 + 1 = 4</p>

"Timer" aggregation function

The timer calculates the time interval in which the variable was not "0". Unit = milliseconds.

For the timer, the "The value is aggregated" function is always = False.



Calculation example:

The calculation period is from 00:00 to 01:00.

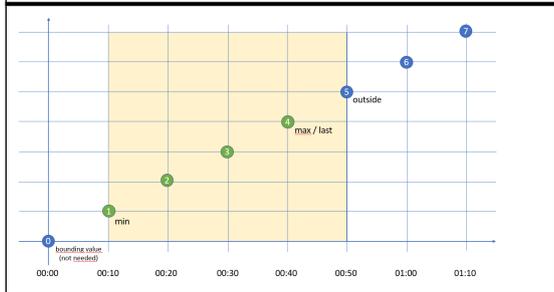
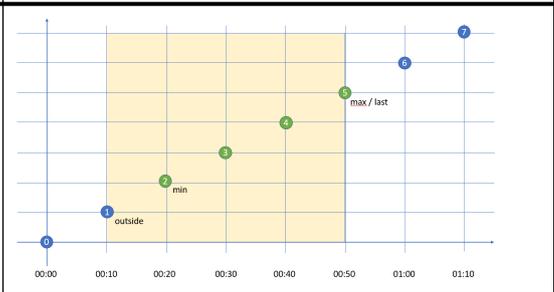
Result: 10 Min + 10 Min + 10 Min = 30 Min => $30 * 60 * 1000 \text{ ms} \Rightarrow 1,800,000 \text{ ms}$

"Average" aggregation function

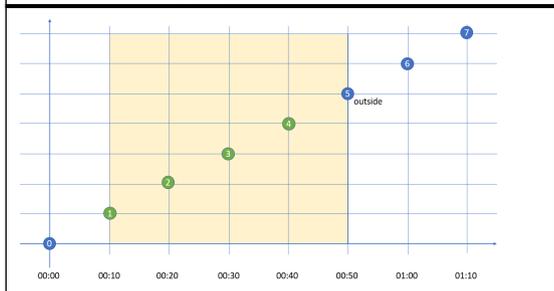
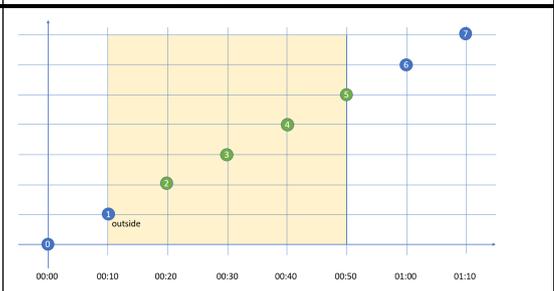
"The value is aggregated" = not activated	"The value is aggregated" = activated
<p>Calculation example: The calculation period is from 00:10 to 00:50. $(10 + 20 + 30 + 40) / 40 = 2.5$ (average value across the calculation period)</p>	<p>Calculation example: The calculation period is from 00:10 to 00:50. $(20 + 30 + 40 + 50) / 40 = 3.5$ (average value across the calculation period)</p>
<p>The aggregation function determines the weighted average depending on the time interval (every 10 minutes). If the time interval changes within a period, e.g. from 10 minutes to 12 minutes, then the values with the time interval 10 minutes are first added and divided by the number of read values. The values are then added together with the time interval 12 minutes and divided by the number of values read. The weighted average is formed from the two results of the two time intervals (result1 + result2) / 2=x.</p>	

5.7 Aggregation functions

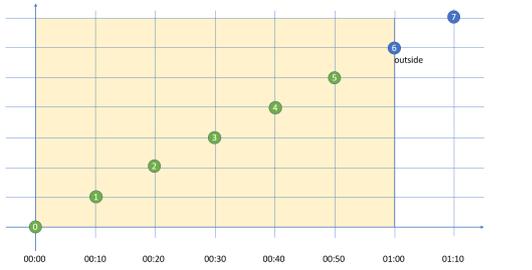
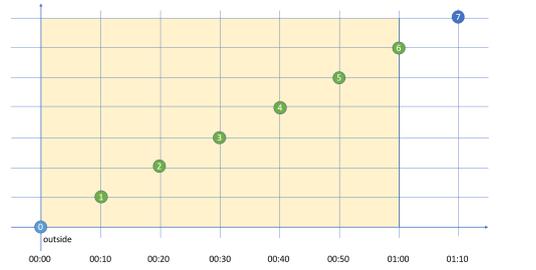
"Min", "Max" and "Last" aggregation functions

"The value is aggregated" = not activated	"The value is aggregated" = activated
	
<p>Calculation example: The calculation period is from 00:10 to 00:50. Min: 1 Max: 4 Load: 4</p>	<p>Calculation example: The calculation period is from 00:10 to 00:50. Min: 2 Max: 5 Load: 5</p>

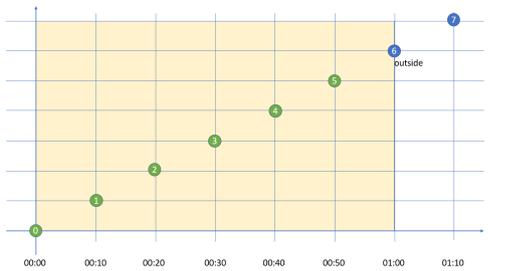
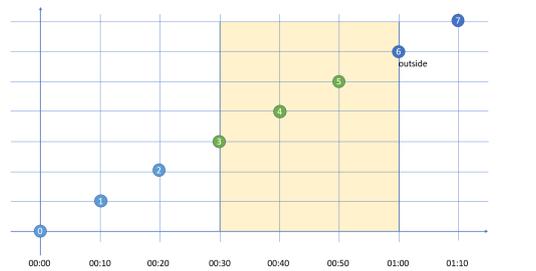
"Sum" aggregation function

"The value is aggregated" = not activated	"The value is aggregated" = activated
	
<p>Calculation example: The calculation period is from 00:10 to 00:50. $1 + 2 + 3 + 4 = 10$</p>	<p>Calculation example: The calculation period is from 00:10 to 00:50. $2 + 3 + 4 + 5 = 14$</p>

"AmountToFlow" aggregation function

"The value is aggregated" = not activated	"The value is aggregated" = activated
	
<p>Calculation example: The calculation period is from 00:00 to 01:00. Sum: $0 + 1 + 2 + 3 + 4 + 5 = 15$ AmountToFlow: $\text{Sum} / \text{time in hours} = 15 / 1 = 15$</p>	<p>Calculation example: The calculation period is from 00:00 to 01:00. Sum: $1 + 2 + 3 + 4 + 5 + 6 = 21$ AmountToFlow: $\text{Sum} / \text{time in hours} = 21 / 1 = 21$</p>

"EnergyToPower" aggregation function

"The value is aggregated" = not activated	"The value is aggregated" = activated
	
<p>Calculation example: The calculation period is from 00:00 to 01:00. Sum: $0 + 1 + 2 + 3 + 4 + 5 = 15$ AmountToFlow: $\text{Sum} / \text{time in hours} = 15 / 1 = 15$</p>	<p>Calculation example: The calculation period is from 00:30 to 01:00. Sum: $3 + 4 + 5 = 12$ AmountToFlow: $\text{Sum} / \text{time in hours} = 12 / 0.5 = 24$</p>

Example of process tags of BOOL data type

This example only applies when the "The value is aggregated" function is not activated:

- Only the values = "1" are added.
- Time intervals are only recorded when the new value = "1" (Timer).
- One value is read every 10 minutes between 10:00 a.m. and 11:00 a.m., i.e. six in total. One value is read every 12 minutes between 11:00 a.m. and 12:00 a.m., i.e. five in total. Because the last reading operation takes place at 12:00 a.m. and the evaluation period also ends at 12:00 a.m, the last value is not read. To evaluate the last value at 12:00 a.m., you must set the end of the evaluation period to at least 12:01 a.m.

Time	Sum (BOOL)	INT	Timer (BOOL)	In minutes
10:00	1	1	1	+ 10
10:10	1	2	1	+ 10
10:20	1	3	1	+ 10
10:30	1	4	1	+ 10
10:40	1	1	1	+ 10
10:50	1	2	1	+ 10
11:00	0	0	0	
11:12	1	3	1	+ 12
11:24	1	4	1	+ 12
11:36	1	5	1	+ 12
11:48	1	2	1	+ 12
12:00	1	0	1	+ 12
Result	10	27		108 (1 h 48 min)
Aggregation function	Sum	Sum	Timer	Timer

Evaluation:

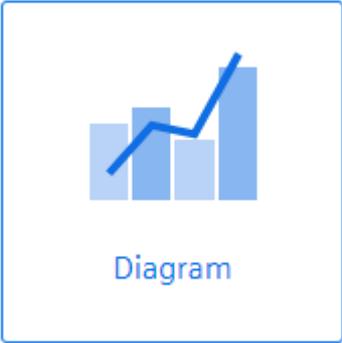
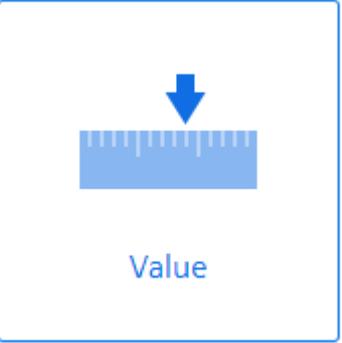
- The "Sum" aggregation function returns the result = 10
All values = "1" between 10:00 a.m. and 11:48 a.m. are added.
- The "Timer" aggregation function returns the result = 108 minutes (1 hour 48 minutes)
The sum of all time intervals with the state "1" is recorded. The value "1" is read six times between 10:00 and 10:50, with 10-minute intervals between each read. This results in a sum of 60 minutes. No value is read at 11:00. The value "1" is read four times between 11:12 and 12:00. The time interval is 12 minutes each. This results in a sum of 48 minutes. The total is a sum of 108 minutes or 1 hour 48 minutes or 6,480,000 milliseconds.

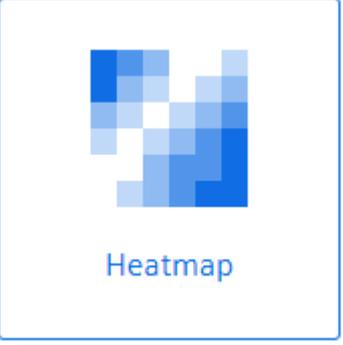
Data analysis

6.1 Introduction to data analysis (widgets)

Description

The following widget are available for data analysis:

Widget type	Description
	<p>Displays the value of variables or KPI calculations as a diagram over time.</p> <p>You can find additional information here: Visualizing correlations in the diagram (Diagram) (Page 37)</p>
	<p>Displays the current value of a variable or a KPI.</p> <p>You can find additional information here: Visualizing individual values (Value) (Page 39)</p>
	<p>The Gantt widget shows you the status of a device at a glance using different color codes. For example, the status can represent the current state or the state within a specific time range.</p> <p>This allows you to see at a glance, for example:</p> <ul style="list-style-type: none"> • When the device started up and how long it was in the "RUN" operating state. • When it switched to the "STOP" operating state and how long it remained in this state. <p>You can find additional information here: Visualizing machine statuses (Gantt) (Page 41)</p>

Widget type	Description
 <p data-bbox="485 538 579 570">Gauge</p>	<p data-bbox="791 276 1434 363">Using the gauge, you can display limit values very simply using colors and thus recognize at a glance whether limit values are exceeded.</p> <p data-bbox="791 372 1434 431">You can find additional information here: Visualizing the violation of limit values (gauge) (Page 43)</p>
 <p data-bbox="507 917 549 949">Pie</p>	<p data-bbox="791 655 1434 742">Using the pie chart, you can display the distribution of consumption or quantities very simply. Clicking on a segment highlights the segment and displays the corresponding value.</p> <p data-bbox="791 751 1434 810">You can find additional information here: Visualizing the distribution of consumptions or quantities (Pie chart) (Page 45)</p>
 <p data-bbox="464 1291 592 1323">Heatmap</p>	<p data-bbox="791 1034 1434 1121">Using the Heatmap, you can visualize the intensity of data values. You can, for example, display the energy consumption (green = low consumption; red = high consumption).</p> <p data-bbox="791 1129 1434 1189">You can find additional information here: Visualizing the intensity of data values (Heatmap) (Page 47)</p>

Widget type	Description
 <p data-bbox="512 534 619 570">Sankey</p>	<p data-bbox="825 283 1471 395">In the Sankey diagram, energy and material flows can be displayed as arrows whose width is proportional to the flow rate. This makes it easy for you to recognize, for example, how energy is flowing through your plant.</p> <p data-bbox="825 406 1471 463">You can find additional information here: Visualizing energy flows (Sankey) (Page 49)</p>
 <p data-bbox="456 910 676 946">Duration Curve</p>	<p data-bbox="825 655 1471 712">By using the duration curve, you can visualize a chart sorted by size.</p> <p data-bbox="825 723 1471 780">You can find additional information here: Visualizing a chart sorted by size (Duration curve) (Page 50)</p>

Error display in the widget

If a network error occurs or an operand required to display the widget has been deleted, for example, the error symbol is shown in the bottom right corner of the widget.



6.2 Creating a widget

Requirement

To visualize and calculate the data from the plant, such as production figures, machine operating times or water consumption, using KPIs, these figures must be transferred from the plant to MindSphere using the Asset Manager. The data structure of your plant is then automatically displayed in the app.

At least one dashboard is created on the desired asset.

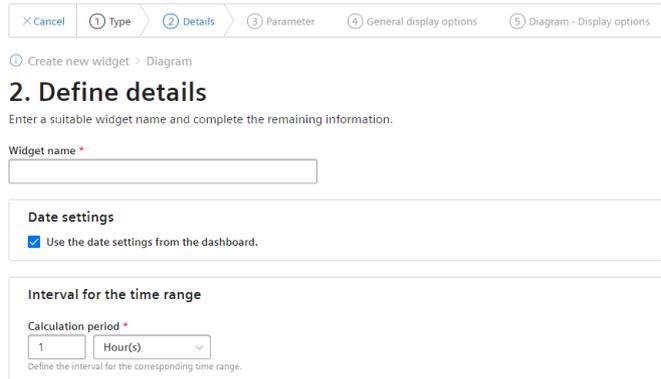
Widget configuration

A wizard will guide you through the individual steps when creating a widget. However, the first four steps are identical for all widget types:

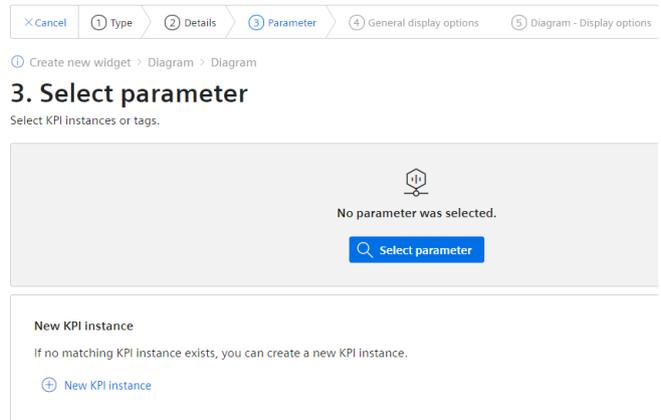
- Step 1: Select the widget type



- Step 2: Define details



- Step 3: Select parameters



- Step 4: Define general display options

[Cancel](#)
1 Type
2 Details
3 Parameter
4 General display options
5 Diagram - Display options
< Back
Continue >

[Create new widget](#) > [Diagram](#) > [Diagram](#)

4. Define general display options

Define the general display options for the selected parameters.

01 **Filled_bottles (Sum)** Path: ... / Production / Filling Type: WAR Aggregation: Sum

Alternative label <input style="width: 90%;" type="text"/> <small>Optionally, you can specify an alternative label for the display in the widget.</small>	Number of decimal places * <input style="width: 90%; text-align: center;" type="text" value="2"/> <small>The values in the widget are displayed according to the specified number of decimal places.</small>	Color <input style="width: 20px; height: 20px; background-color: #000; border: 1px solid #000;" type="color"/> <small>Select the color which is to be used for displaying the parameter values.</small>
--	---	--

Limits
Optional. The limits are used to display general restrictions.

Low limit alert	Low limit warning	High limit warning	High limit alert
<input style="width: 80%;" type="text"/>	<input style="width: 80%;" type="text"/>	<input style="width: 80%;" type="text"/>	<input style="width: 80%; text-align: right;" type="text" value="120"/>

Alert

Warning

OK

Warning

Alert

min ← → max

Note: The notifications have been activated for this tag.

- Step 5: Define widget-specific display options

[Cancel](#)
1 Type
2 Details
3 Parameter
4 General display options
5 Diagram - Display options

[Create new widget](#) > [Diagram](#) > [Diagram](#)

5. Diagram - Define display options

Define the widget specific display options.

01 **Filled_bottles (Sum)** Path: ... / Production / Filling Type: WAR Aggregation: Sum

Type <input style="width: 90%;" type="text" value="Line"/> <small>Shows how the parameter will be displayed.</small>	Further options <input checked="" type="checkbox"/> Visible <input type="checkbox"/> Stacked <small>Shows whether the parameter is displayed stacked with another one.</small>
---	---

Y-axis (1)

Procedure for creating the general steps of a widget

To create a widget, follow these steps:

1. Either click "Create first widget" or click  and "New widget" and select a widget type.
2. Assign a name and define the date settings:

Define date settings:

With the date settings you define the time range from which the values are to be visualized. You can apply the dashboard date settings to a widget or define your own date settings for this widget.

The following variants are available for setting your own date:

- Default: "Use the date settings from the dashboard" to use the time range that is defined in the dashboard.
- You disable "Use the date settings from the dashboard" to define a specific time range. You have the following options to do this:
 - Default: "Use current date" and enter the duration (e.g. week) under "Time range". The start and end time are given by the predefined time ranges (day, week, month, year, etc.). If you prefer, you can also disable "Use current date" and enter the start date and start time manually. The end time is calculated based on the duration under "Time range". Under "Offset", you can enter the number of days, weeks, months or years by which the start time should be postponed. The start time can be either in the future or in the past.

If you use the dashboard date settings for the widget, all changes to the date settings are displayed directly in all widgets of the dashboard.

Define interval:

You can also specify an interval at which the values are to be displayed, e.g., every 5 minutes, every 2 hours, etc..

3. You can select either a variable or a KPI type as parameter. Up to 10 parameters can be defined.

For each variable you can select one of the aggregation functions (Average, Min, Max, Sum, Last, Counter, Timer, EnergyToPower, PowerToEnergy, AmountToFlow, FlowToAmount). You can find additional information on the aggregation functions here: [Introduction to the aggregation functions \(Page 24\)](#)

In this step, you can also directly create KPI instances and link the operands with the desired parameters. You can find additional information on KPI instances here: [Introduction to KPI calculations \(Page 55\)](#)

4. In the general display options, you can assign an alternative label for the variable or KPI type. This label is then displayed in the legend in the detail view instead of the asset and the aspect name of a parameter.
In this step, you can also enter the limit values for warnings and alerts.
 - Red = the alert limit was violated
 - Yellow = the warning limit was violated

The limit values are also displayed in the detail view as dashed lines.
You can also specify the number of decimal places and a color for each parameter in which the graph is displayed in the detail view.
If you have already defined limits for the variable or KPI used, these are displayed in the widget as pre-setting. However, these limits can be overwritten at any time.
5. In this last tab, you define all the widget-specific details. You can find additional information on the the respective details of the widgets here:
 - Visualizing correlations in the diagram (Diagram) (Page 37)
 - Visualizing individual values (Value) (Page 39)
 - Visualizing machine statuses (Gantt) (Page 41)
 - Visualizing the violation of limit values (gauge) (Page 43)
 - Visualizing the distribution of consumptions or quantities (Pie chart) (Page 45)
 - Visualizing the intensity of data values (Heatmap) (Page 47)
 - Visualizing energy flows (Sankey) (Page 49)
 - Visualizing a chart sorted by size (Duration curve) (Page 50)

6.3 Visualizing correlations in the diagram (Diagram)

Description

Displays the value of variables or KPI calculations as a diagram over time. The following diagram types are available:

- Line graph (Line)
- Bar graph (Bar); the bars of multiple parameters can also be stacked
- Area graph (Area)
- Spline curve
- Scatter diagram (Scatter)

The following views are also available in the diagram:

- Detail view
- Histogram
- Regression

6.3 Visualizing correlations in the diagram (Diagram)

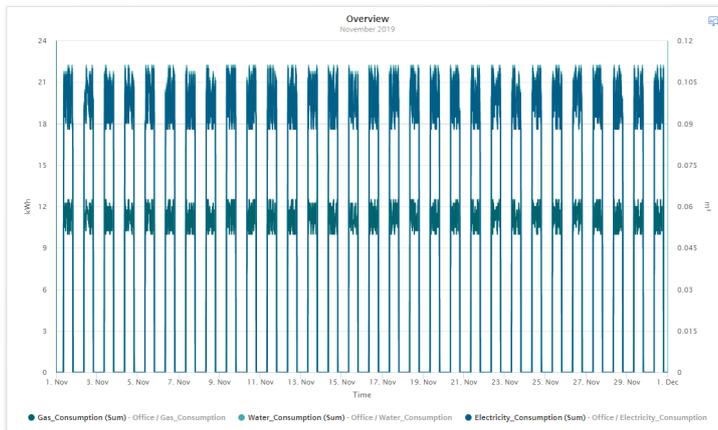
Procedure

To define widget-specific display options for a bar graph, follow these steps:

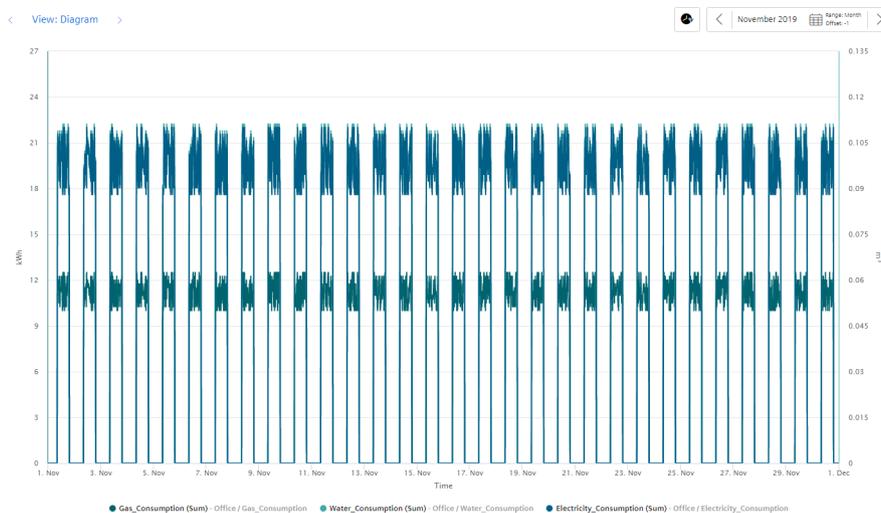
1. In the last step, select a diagram type. You can also specify whether the value should be visible and/or stacked (in the case of a bar graph).
2. A Y-axis is created for each unit that a parameter provides. A maximum of 5 Y-axes can be defined per widget.
Each parameter is automatically assigned to a Y-axis. However, you can also manually assign the parameters to a different Y-axis.
You can define a low and high limit for each Y-axis. This means that you can only display a section between specific values in the widget.

Result

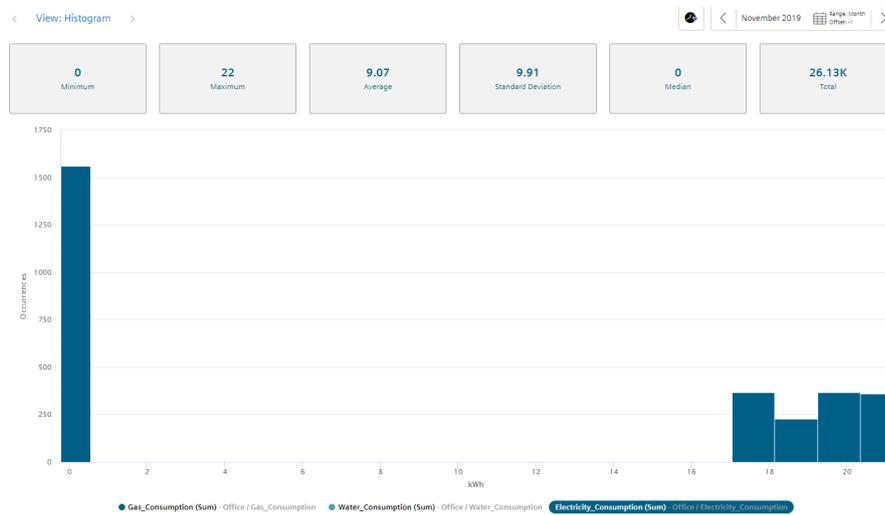
As a result, you see a line graph:



In the detail view, you can see the graphs of the parameters "Gas_Consumption", "Water_Consumption" and "Electricity_Consumption" in the colors that you have defined in the display options:



In the histogram, you can see the frequency distribution of the parameter "Electricity_Consumption":



In the regression analysis, you can see the correlation between the two parameters "Gas_Consumption" and "Electricity_Consumption":



6.4 Visualizing individual values (Value)

Description

Displays the value of a specific time range. The value is derived either from a variable with a corresponding aggregation function or from a KPI result.

6.4 Visualizing individual values (Value)

The following views are also available for Value:

- Detail view
- Histogram

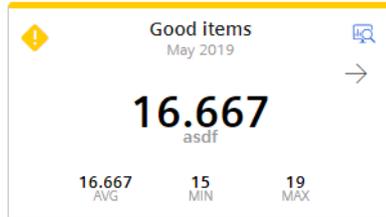
Procedure

To define widget-specific display options, follow these steps:

1. In the last step, you select whether the statistics (average, minimum, maximum) should be displayed or not.

Result

As a result, you see an individual value that violated the warning limit. A yellow bar and the warning symbol are therefore displayed.



The arrow shows you the tendency of the displayed value.

The statistical data of average, minimum and maximum are displayed in the bottom line if they were activated in the last step.

Note

Values of the statistical data

The displayed statistics is calculated from the calculated values in the cycle that is specified in the widget configuration.

View of the detail view with activated limit values:



6.5 Visualizing machine statuses (Gantt)

Description

The Gantt widget shows you the status of a device at a glance using different color codes. For example, the status can represent the current state or the state within a specific time range.

This allows you to see at a glance, for example:

- When the device started up and how long it was in the "RUN" operating state.
- When it switched to the "STOP" operating state and how long it remained in this state.

In addition to the complete overview, you can also see all status displays broken down individually in the detail view.

Procedure

To define widget-specific display options, follow these steps:

1. In the last step, select a status mapping from the drop-down list. If no status mapping exists yet, you can create one with "Create new status mapping".

Result

The result shows the machine status:

- Red: Machine 1 in RUN mode
- Blue: Machine 1 in OFF mode

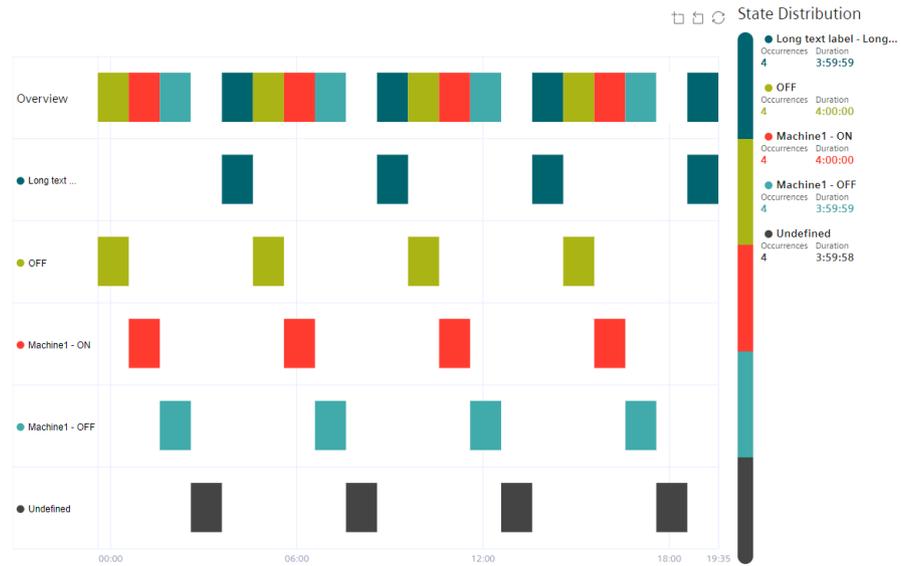
The tooltips offer more information extending beyond the selected time range of the widget. For example, in the figure below, you can see that the machine status with the color "Blue" was on March 4, 2021 from 6:35 AM to 7:35 AM.

Using the tooltip for each machine state you can see exactly when this operating state occurred. In the case of the blue machine state, this is of particular importance, for example, to determine immediately when the machine stopped.

6.6 Creating status mappings for the "Gantt" widget



The individual values are still displayed itemized in the detail view:



6.6 Creating status mappings for the "Gantt" widget

Description

Using a status mapping, you can display changes in the value of a variable at a glance in the "Gantt" widget.

In addition to a color, you can also assign a label and a description to a value (machine status).

Status mappings

You can either create status mappings directly when creating a Gantt widget or you can create a new status mapping in the "Configuration" tab. This tab also shows you a list of the existing status mappings.

Creating and editing a status mapping

To create a status mapping, follow these steps:

1. Open the "Configuration"> "Status mappings".
2. Click on "New status mapping".
3. Assign a unique name and a description.
4. You can assign a color, a label and a description for each value that a tag can assume. If a value that is not defined in the status mapping table occurs in the variable, it is displayed with the status "not defined" and the color white in the Gantt widget.

Name *

mystatusmapping
The status mapping name must be unique.

Description

Description

Color *	Value *	Label *	Description
	0	running	Description
	1	stopped	Description

* These fields must be filled out.

Save Cancel Delete

You use the created status mapping in connection with the "Gantt" widget. The order of each state mapping is reflected in the Gantt widget in the same way as shown in the table. You can change the order using drag-and-drop.

6.7 Visualizing the violation of limit values (gauge)

Description

Using the gauge, you can display limit values very simply using colors and thus recognize at a glance whether limit values are exceeded.

The following views are also available in the gauge:

- Detail view
- Histogram

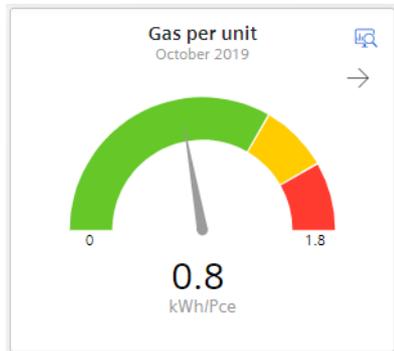
Procedure

To define widget-specific display options, follow these steps:

1. The final step is to apply the limit values from the general display options if you have already defined them there. In addition, you specify the value with which the gauge scale starts and ends.

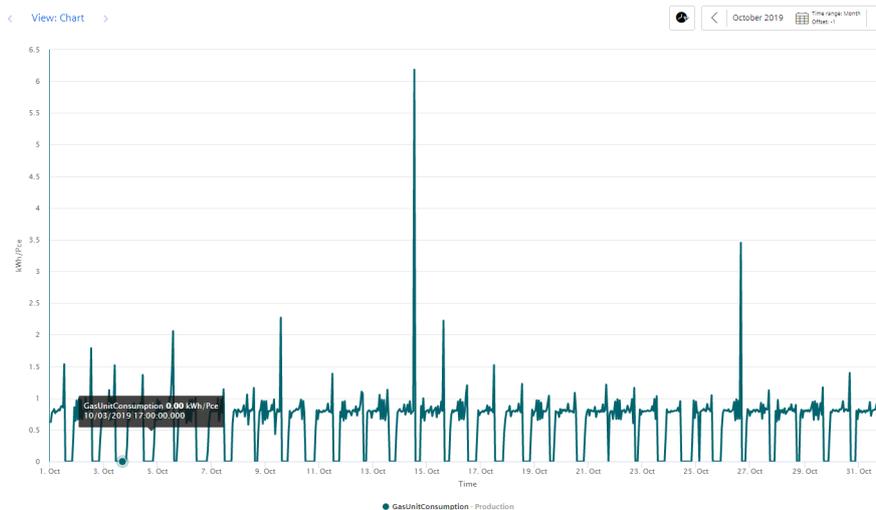
Result

The gauge shows you that the gas consumption per unit is in the acceptable range (green):



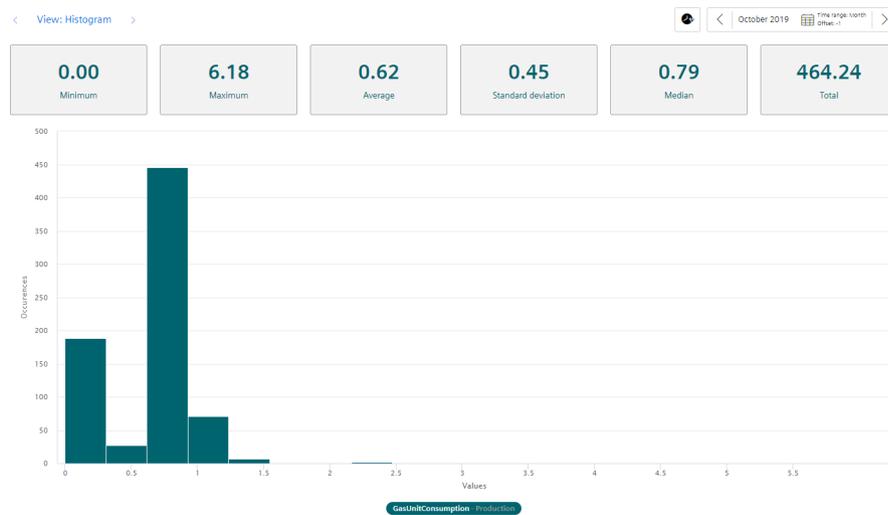
The arrow at the top right shows you the tendency of the displayed value.

In the detail view, you see the graph of the KPI instance "GasUnitConsumption" in the color that you have defined in the display options:



In the histogram, you can see the frequency distribution of the KPI instance "GasUnitConsumption":

6.8 Visualizing the distribution of consumptions or quantities (Pie chart)



6.8 Visualizing the distribution of consumptions or quantities (Pie chart)

Description

Using the pie chart, you can display the distribution of consumption or quantities very simply. Clicking on a segment highlights the segment and displays the corresponding value.

The following views are also available in the pie chart:

- Detail view
- Histogram
- Regression

Procedure

To define widget-specific display options, follow these steps:

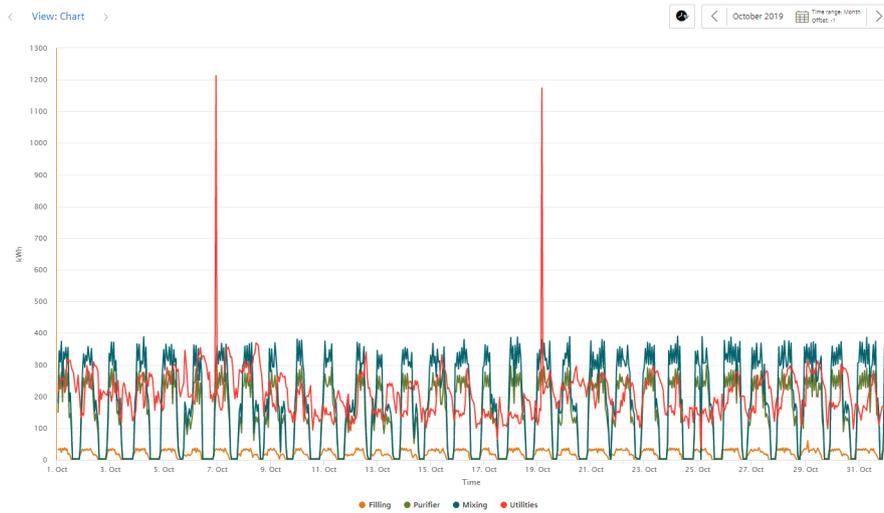
1. In the last step, you specify whether the values are to be displayed as absolute or percentage values.

Result

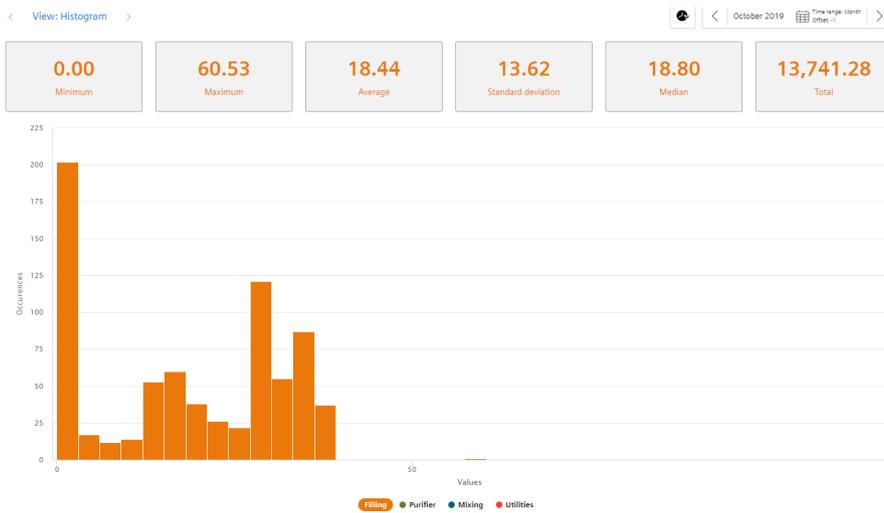
The pie chart shows you the percentage values of the parameters "Filling", "Purifier", "Mixing" and "Utilities":



In the detail view, you can see the graphs of all four parameters in the colors that you have defined in the display options:



In the histogram, you can see the frequency distribution of the parameter "Filling":



In the regression analysis, you can see the correlation between the two parameters "Filling" and "Purifier":



6.9 Visualizing the intensity of data values (Heatmap)

Description

Using the Heatmap, you can visualize the intensity of data values over time. You can, for example, display the energy consumption (red = high energy consumption; green = low energy consumption), temperatures or production quantities in a specific time range.

The following additional views are also available in the Heatmap:

- Detail view
- Histogram

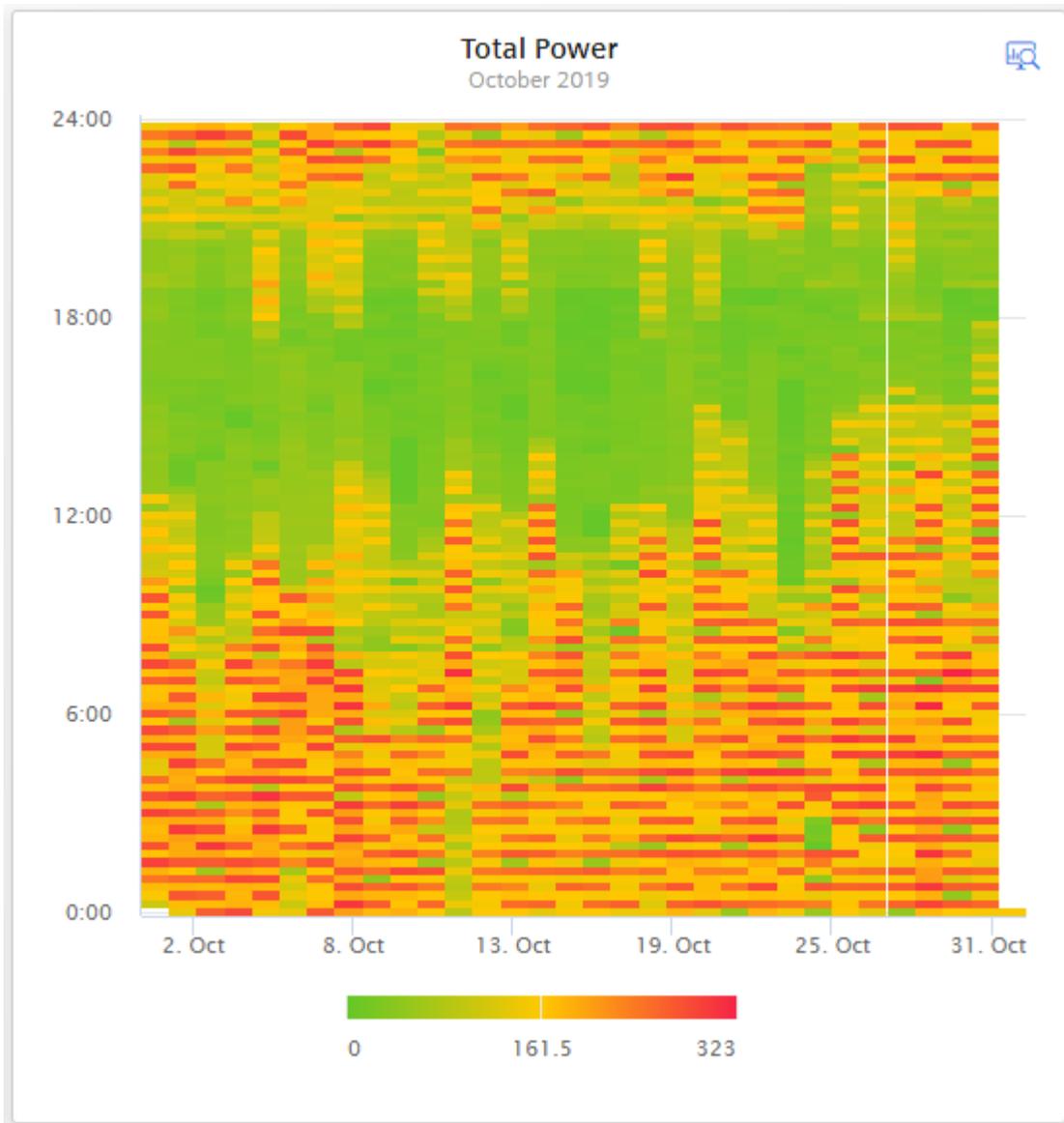
Procedure

To define widget-specific display options, follow these steps:

1. In the last step, you define the following settings:
 - Whether the data is displayed in the day view or the week view.
 - The color in which the different intensities are going to be displayed.
 - You can enter a fixed range for the color scaling.
If you do not define fixed values, the lowest and the highest measured value is used for the color scale. This may result in a distorted picture displayed by the heatmap in case of extreme peaks.

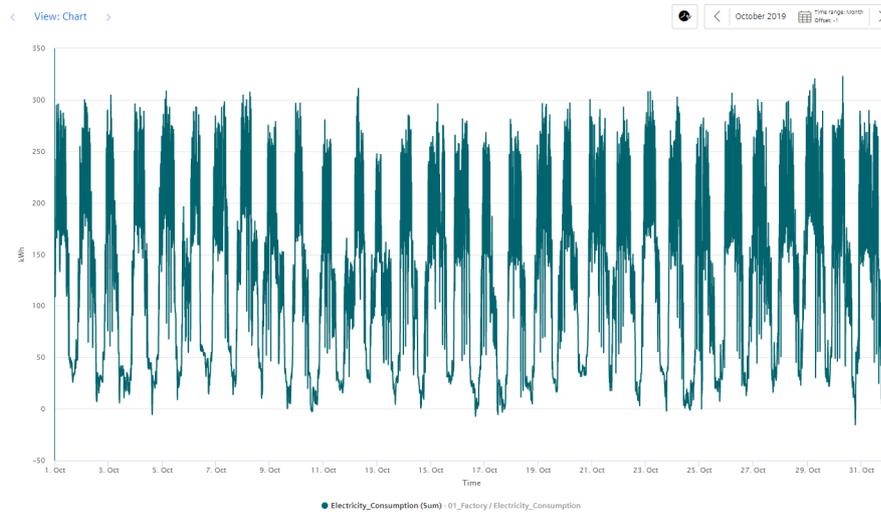
Result

The Heatmap shows the energy consumptions for the entire month of October (y-axis), broken down by each day (x-axis). You can see at a glance that frequent energy peaks occurred between 0:00 and 12:00 o'clock and that energy consumption was lower in the afternoon and evening.

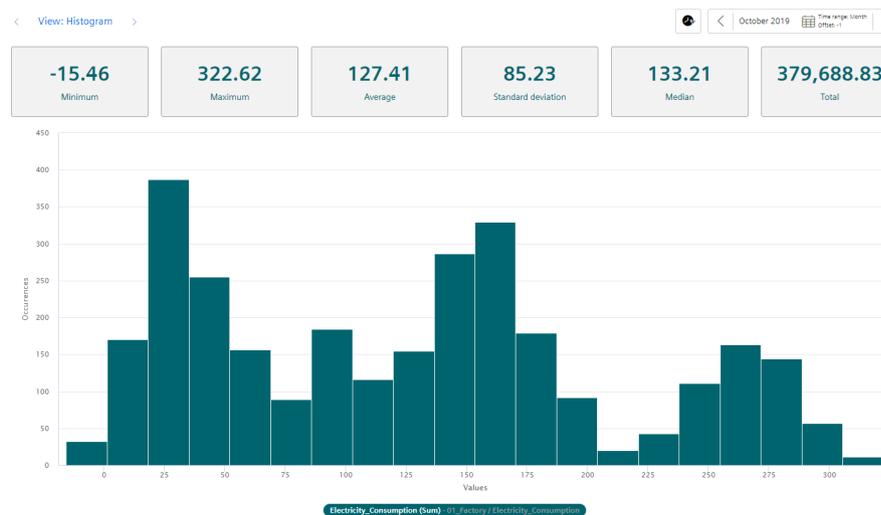


In the detail view, you can see the graph of the "Electricity_Consumption" parameter in the color that you have defined in the display options:

6.10 Visualizing energy flows (Sankey)



In the histogram, you can see the frequency distribution of the parameter "Electricity_Consumption":



6.10 Visualizing energy flows (Sankey)

Description

Using the Sankey diagram, energy flows can be displayed as arrows whose width is proportional to the flow rate. This makes it easy for you to recognize, for example, how energy is flowing through your plant.

6.11 Visualizing a chart sorted by size (Duration curve)

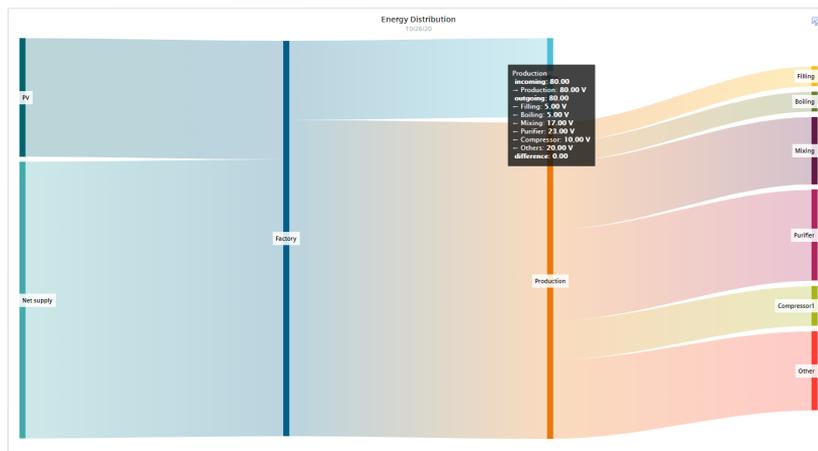
Procedure

To define widget-specific display options, follow these steps:

1. In the last step, you define the required nodes in the "Nodes" tab. You assign a node name and select a color for the node.
In the "Links" tab, you specify the links for each parameter from source node to destination node. This defines the volume flows.
You can also scale each link so that you can still show the proportions of the arrows correctly even with different units, such as kilowatts or liters.

Result

The Sankey diagram shows you how the energy is flowing through your plant:



6.11 Visualizing a chart sorted by size (Duration curve)

Description

By using the duration curve, you can display a chart sorted by size.

In the duration curve, the measured values of a specific time range are displayed collected and sorted. The highest value is displayed on the far left, and the lowest value on the far right.

This way you can see, for example, how high the highest value was and how long this value was present. If you want to reduce the highest value to a lower value, you can easily see in the duration curve how often you have to switch off the supply object every month for 15 minutes (active load management), for example, to achieve the lower value and thus conserve energy.

The following additional views are also available in the duration curve:

- Detail view
- Histogram

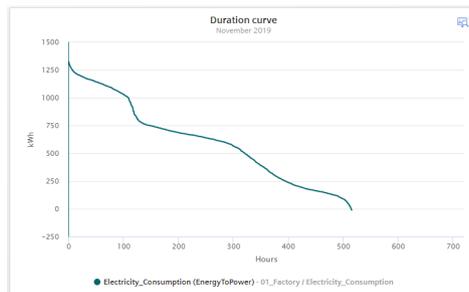
Procedure

To define widget-specific display options, follow these steps:

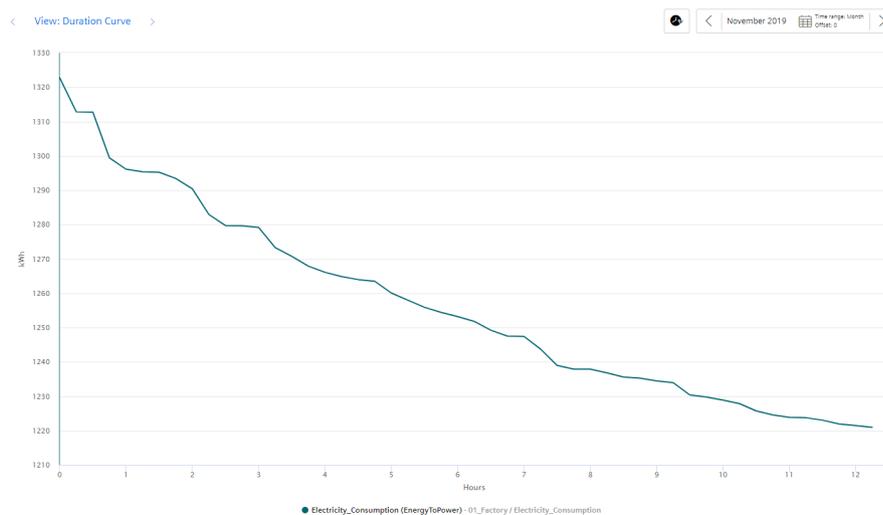
1. In the last step, you define the following settings:
 - The maximum number of values to be displayed.

Result

The duration curve shows the values of the "Electricity_Consumption" parameter for the last 700 hours:

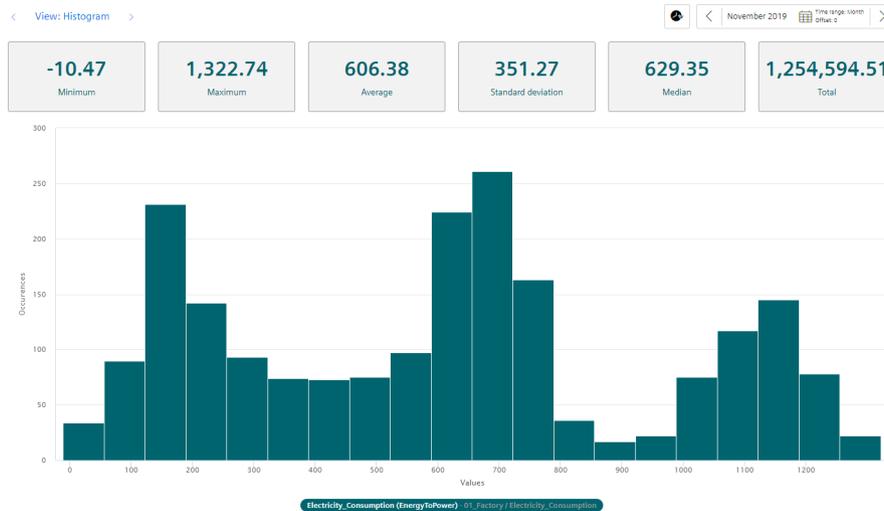


In the detail view, you can see the graph of the "Electricity_Consumption" parameter in the color that you have defined in the display options. The 50 highest values are displayed:



In the histogram, you can see the frequency distribution of the parameter "Electricity_Consumption":

6.13 Copying widgets



6.12 Editing widgets

Description

If you have already created a widget, you can also change it later.

Procedure

To change an existing widget, follow these steps:

1. Click the  symbol on the dashboard.
The dashboard is now in edit mode.
2. Click the  icon in the desired widget.
The Widget Wizard opens.
3. You can switch between steps 2 and 5 freely and change the details accordingly.
4. When you are finished, click "Finish" in the wizard and on "Exit" in the dashboard.

Result

All changes are applied in the widget and are displayed directly.

6.13 Copying widgets

Description

If you have already created a widget, you can also copy it.

Procedure

To copy an existing widget, do the following:

1. Click the  icon in the dashboard.
The dashboard is now in edit mode.
2. Click the  icon in the desired widget.
The widget is copied to the clipboard and can be pasted to any dashboard.
3. If there is sufficient space available in the desired dashboard, you can paste the widget using the  icon.
The widget wizard opens.
4. You can switch freely between steps 2 and 5 and change the details accordingly.
5. Then click on "Finish" in the wizard and on "Finish" in the dashboard.

Result

The copied widget is displayed in the dashboard.

6.14 Export widget data

Description

If you have already created a widget, you can also export the widget data.

You can do this with the following widgets:

1. Diagram
2. Gantt
3. Heatmap
4. Duration curve

Procedure

To export the widget data, follow the steps below:

1. In the dashboard, click the icon  in the widget.
Or
2. Open the details view of the widget  and click  Export widget data.

Result

A .csv file is created that contains, for example, information about local_time, UTC_time and the parameters used.

KPI calculations (KPIs)

7.1 Introduction to KPI calculations

Description

The acronym KPI stands for Key Performance Indicator. KPI types are formulas made up of operands, constants, and operators. The definition and calculation of KPI types are plant-specific. An example of a KPI type could be:

- $\text{Quality rate} = \text{Good Items} / \text{Total Items} * 100$

The KPI instance can be created either during the widget configuration in the "Parameter" step or in the parameter list on the asset. The KPI instance can

- be derived from a KPI type (typed)
- or can be created typeless.

The KPI types can be instantiated multiple times. When you make changes to the KPI type, these changes are also implemented in all KPI instances.

Note

Data in the buffer

The KPIs are saved in a buffer (cache). If values were overwritten in MindSphere in the past (except for the current and last hour), it may take up to one hour before you will be able to see the data or KPIs and aggregations based on them.

Automatically created KPI instances in the SIMATIC Energy Manager

The SIMATIC Energy Manager also includes automatically created KPI instances. These KPI instances are created based on contract information for the individual energy media, the assigned variables, and KPI types as well as the reference mappings.

For automatically created KPI instances, you can define limits that trigger a notification when these limits are exceeded or not reached. The green check mark in the "Notifications activated" column shows that a notification has already been configured. Additional information on the configuration of notifications can be found here: "Activate notifications" for variables of the data type "Integer" and KPI instances (Page 19)

In the parameter list, you can identify the automatically created KPI instances by the blue icon:

7.1 Introduction to KPI calculations

Name	Aspect name	Data type	Unit	Notifications activated
KPI	ElectricityConsumption	Double	kWh	
KPI	ElectricityUnitCount	Double	m ³	
KPI	ElectricityUnitConsumpti...	Double	kWh/m ³	
KPI	ElectricityCosts	Double	INR	
KPI	ElectricityUnitCosts	Double	INR/m ³	
KPI	ElectricityCO2Emissions	Double	tCO ₂	
KPI	ElectricityUnitCO2Emissi...	Double	tCO ₂ /m ³	

The automatically created KPI instances do not generate any additional costs.

Operands

Operands serve as placeholders that are later filled with actual values from the variables. They are created directly when creating a KPI type and defined more precisely during the instantiation of the KPI type. Operands may contain no space, mathematical symbols or numbers at the beginning of the operand name. They can be moved and copied.

Structure of a KPI instance

The KPI instance is created as follows:

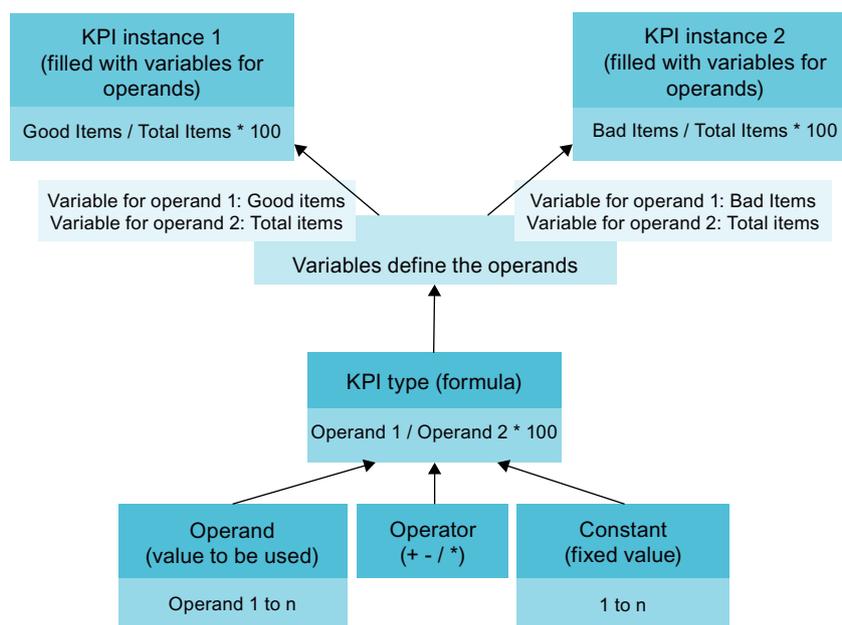
- You either instantiate a KPI type including linked variables or KPI instances (typed; multiple use is possible) or
- You create a KPI instance directly and link it to variables or KPI instances (typeless).

Each KPI instance must be assigned to an asset, but variables from other assets can also be linked to the KPI instance.

The following figure shows the individual components that make up a KPI instance.

- Operands serve as placeholders that are later filled with actual values from the variables or KPI instances.
- Constants can only contain numerical values
- Operators

The following diagram shows the structure of the KPI type/instance concept:



7.2 Creating KPI types

Description

In the "Configuration" tab, you can create new KPI types and a list of existing KPI types is displayed.

Procedure

Follow these steps to create a KPI type:

1. Click "New KPI type".
2. Assign a unique name and a unit.
3. In the formula editor, use operands, constants and operators to compose the formula that is used to calculate the KPI. You can create operands and constants directly for this purpose. An operand is a placeholder that is later filled with actual values from the variables or KPI instances.

Create new KPI type

Name *
QualityRate

Unit *
%

Formula editor *

+ - * / () Operand Constant ?

OPERAND / OPERAND CONSTANT
BadItems / GoodItems * 100

* These fields must be filled out.

Save Cancel

Connect the operands with the variables or KPI instances transferred to the MindSphere.

7.3 Creating and deleting KPI instances

KPI instances

KPI instances can be created either in the parameter list of the respective dashboard or in the 3rd step when a widget is created. You can create the KPI instance either directly when creating a widget or later by editing the widget again.

Automatic KPI instances are created additionally when you create energy media and assign contract information.

You have several options to create a KPI instance:

- You create a KPI type in the configuration and instantiate it either directly in the widget or in the parameter list. (typed)
- You create a new KPI instance directly in the widget or the parameter list. (typeless)

In the preview, you can see the formula it contains and which operand is linked to which variable.

New KPI instances cause costs. The number of currently used KPI instances is displayed in the "Settings" menu under "Usage information".

If all KPI instances are occupied, order additional KPI instances or delete a KPI instance that is no longer needed.

Creating KPI instances based on a KPI type (typed)

Follow these steps to create a KPI instance:

1. Click "Create a new KPI instance".
2. Click the "General" tab.
3. Assign a unique KPI instance name per plant object.
4. Select "On basis of a KPI type (typed)".
5. Select the desired KPI type. The preview shows the formula it contains.
6. Link all operands contained therein to a variable or a KPI type. If you assign a variable to the operand, you also need to select an aggregation function.

Add KPI instance

General
Limits

Define general settings
Define a name, the type of the KPI instance, the unit and the formula and link each operand with a parameter.

i **Costs for one KPI**
 Creating a KPI instance incurs costs.

KPI instance name *

Select a KPI basis

On basis of a KPI type (typed)
Select this option if the KPI definition is inherited from a KPI type.

 Without KPI type (type less)
Select this option if the KPI definition is used only once.

KPI type

Choose a predefined KPI type

1. Formula preview ?

OPERAND	/	OPERAND	*	CONSTANT
GoodItems		BadItems		100

2. Link each operand to a tag to continue. ?

GoodItems	↗	VAR	Total <small>EEMonitor</small>	⊗	Average	⌵
BadItems	↗	Find parameter	OR	Set static value	⊗	

Creating KPI instances without KPI type (typeless)

Follow these steps to create a KPI instance:

1. Click "Create a new KPI instance".
2. Click the "General" tab.
3. Assign a unique KPI instance name per plant object.
4. Select "Without KPI type (typeless)".
5. Enter a unit.

- 6. Create the desired formula from constants, operands, and operators.
- 7. Link all operands contained therein to a variable or a KPI type. If you assign a variable to the operand, you also need to select an aggregation function.

Add KPI instance

General Limits

Define general settings for "QualityRate"
Define a name, the type of the KPI instance, the unit and the formula and link each operand with a parameter.

Costs for one KPI
Creating a KPI instance incurs costs.

KPI instance name *
QualityRate

Select a KPI basis
 On basis of a KPI type (typed) Without KPI type (type less)

Unit *
%

1. Formula editor

+ - ÷ × () Operand Constant

OPERAND OPERAND CONSTANT
GoodItems / BadItems * 100

2. Link each operand to a tag to continue.

GoodItems **Total EEMonitor** Average

BadItems **Find parameter** OR Set static value

Defining limits

You can define limits for typed, typeless as well as for automatically created KPI instances.

To define the limits, follow these steps:

- 1. Click the "Edit" icon next to the KPI instance.
- 2. Click the "Limits" tab.

3. Enable the "Activate notifications" function for the desired limit area, e.g. low limit alarm.
4. Enter a limit.

The screenshot shows the 'Limits' configuration page for 'Total amount'. It includes a 'General' tab and a 'Limits' section. The 'Define limits for "Total amount"' section contains instructions and a note about the SIMATIC Notifier MindSphere app. Below this, there are four limit settings, each with an 'Activate notifications' checkbox and a numerical value:

- Low limit alarm: Value 2, Alarm status (red bar)
- Low limit warning: Value 4, Warning status (yellow bar)
- High limit warning: Value 6, Warning status (yellow bar)
- High limit alarm: Value 10, Alarm status (red bar)

Below the limit settings is a 'Notification' section with a 'Calculation cycle' dropdown menu set to '15min' and a note: 'Note: Calculation Cycle is based on UTC'.

You can find additional information on the "Activate notifications" function here: "Activate notifications" for variables of the data type "Integer" and KPI instances (Page 19)

Deleting KPI instances

You can delete KPI instances in the parameter list on the asset.

Follow these steps to delete a KPI instance:

1. Under "My Plant", open the dashboard in which the KPI instance is used.
2. Next to the plant object, click the downward arrow and select the "Parameter" view. A list with all variables and KPI instances used is displayed.
3. Click on the delete icon next to the KPI instance.

Energy media analysis

8.1 Introduction to the energy media analysis

Description

You use the energy media analysis to manage and calculate energy data, such as power and gas from the machines and plants. In the configuration, you create all required energy media and can then define for each asset which energy data it requires. Using the stored contract information, you can then convert the consumption of the individual energy media directly into the resulting costs and CO2 emissions.

Requirement

To visualize and calculate the data from the plant, such as production figures, machine operating times or water consumption, using KPIs, these figures must be transferred from the plant to MindSphere using the Asset Manager. The data structure of your plant is then automatically displayed in the app.

At least one dashboard is created on the desired asset.

Widget configuration

A wizard will guide you through the individual steps when creating a widget. However, the first four steps are identical for all widget types:

- Step 1: Select the widget type
- Step 2: Define details
- Step 3: Select parameters
- Step 4: Define general display options
- Step 5: Define widget-specific display options

Procedure for creating the general steps of a widget

To create a widget, follow these steps:

1. Either click "Create first widget" or click  and "New widget" and select a widget type.
2. Assign a name and define the date settings:

Define date settings:
You can apply the dashboard date settings to a widget or define your own date settings for this widget.
The following variants are available for setting your own date:

 - Default: "Use the date settings from the dashboard" to use the time range that is defined in the dashboard.
 - You disable "Use the date settings from the dashboard" to define a specific time range. You have the following options to do this:
Default: "Use current date" and enter the duration (e.g. week) under "Time range". The start and end time are given by the predefined time ranges (day, week, month, year, etc.). If you prefer, you can also disable "Use current date" and enter the start date and start time manually. The end time is calculated based on the duration under "Time range". Under "Offset", you can enter the number of days, weeks, months or years by which the start time should be postponed. The start time can be either in the future or in the past.

If you use the dashboard date settings for the widget, all changes to the date settings are displayed directly in all widgets of the dashboard.

Define interval:
You can also specify an interval at which the values are to be displayed, e.g., every 5 minutes, every 2 hours, etc..
3. You can select either a variable or a KPI type as parameter. Up to 10 parameters can be defined.
For each variable you can select one of the aggregation functions (Average, Min, Max, Sum, Last, Counter, Timer, EnergyToPower, PowerToEnergy, AmountToFlow, FlowToAmount).
You can find additional information on the aggregation functions here: [Introduction to the aggregation functions \(Page 24\)](#)
In this step, you can also directly create KPI instances and link the operands with the desired parameters.
You can find additional information on KPI instances here: [Introduction to KPI calculations \(Page 55\)](#)
4. In the general display options, you can assign an alternative label for the variable or KPI type. This label is then displayed in the legend in the detail view instead of the asset and the aspect name of a parameter.
In this step, you can also enter the limit values for warnings and alerts.
 - Red = the alert limit was violated
 - Yellow = the warning limit was violated

The limit values are also displayed in the detail view as dashed lines.
You can also specify the number of decimal places and a color for each parameter in which the graph is displayed in the detail view.

Editing widgets and adding more widgets

To edit existing widgets or add more widgets in a dashboard, click .

Error display in the widget

If a network error occurs or an operand required to display the widget has been deleted, for example, the error symbol is shown in the bottom right corner of the widget.



See also

[Detail view \(Page 75\)](#)

[Histogram \(Page 76\)](#)

8.2 Configuration of the energy media analysis

Description

The energy media analysis is made up of several steps:

1. Some energy media are already included when you purchase the SIMATIC Energy Manager app:

Energy medium

Energy medium name	Color	Unit		
Cold		kWh		
Compressed Air		m³		
Electricity		kWh		
Gas		kWh		
Heat		kWh		
Oil		Liter		
Steam		t		

But you can also create additional energy media for each tenant in the configuration of the SIMATIC Energy Manager app or change existing energy media.

As soon as a created energy medium is used, it can no longer be deleted.

You can find additional information here: [Creating energy media \(Page 68\)](#)

2. Next, you define for each asset which of the created energy media is required. You can define, for example, that electricity, gas, and oil are consumed on the "Filling station" (Filling) asset. You can then assign the variables from MindSphere to the energy media. You can also assign a reference value to the energy medium, for example, so that you can create a relationship between production quantities and energy consumption.

🏠 Filling > ⚙️ Asset Configuration > 📄 Energy media assignment

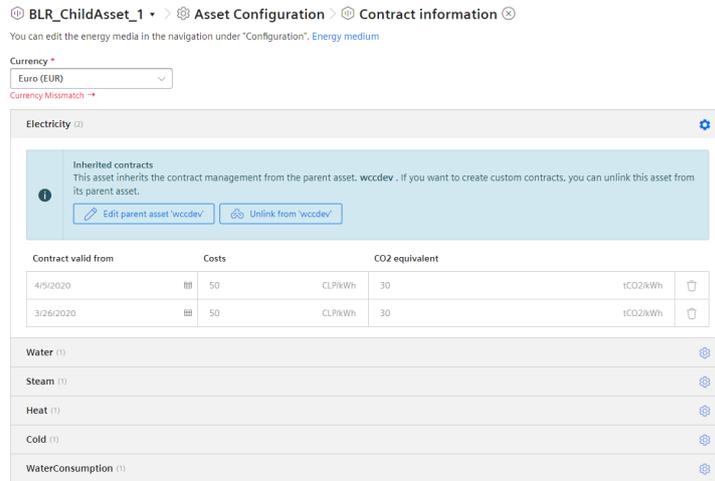
You can edit the energy media in the navigation under "Configuration", [Energy medium](#)

Assign parameters of the energy medium
For each assignment, you can aggregate either one asset below the selected asset (sub-asset) or you can select a new asset in My Plant.

Energy medium *	Standard source *	Reference *
 Electricity kWh	<input type="checkbox"/> Sub-asset VAR: Electricity_Consumption Electricity_Consumption	<input type="checkbox"/> Sub-asset VAR: Filled_bottles Filled_bottles
 Water m³	<input type="checkbox"/> Sub-asset VAR: Water_Consumption Water_Consumption	<input type="checkbox"/> Sub-asset Select reference

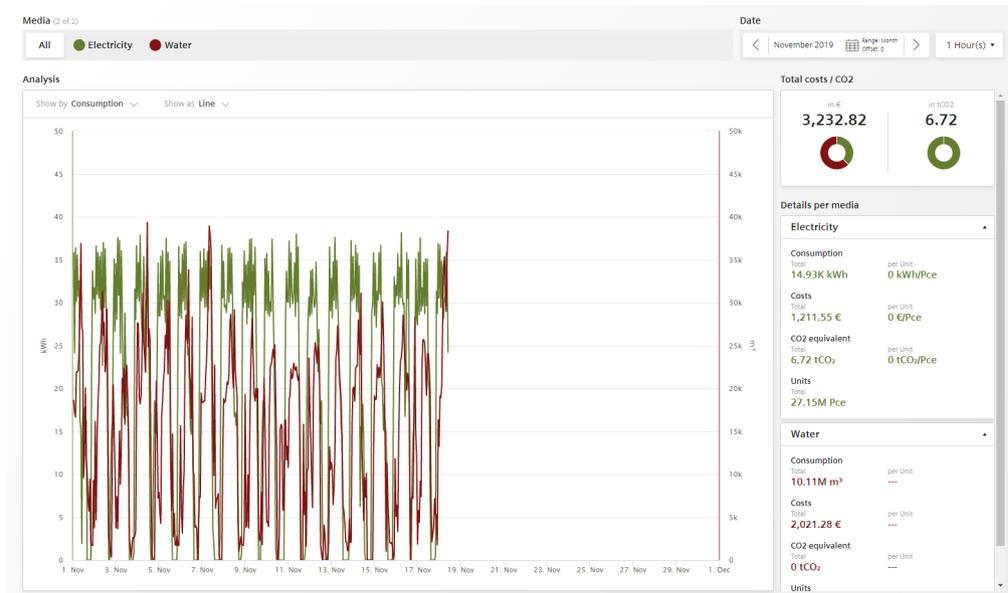
You can find additional information here: [Defining energy media for an asset \(Page 68\)](#)

3. You can also store prices and other contract information, such as CO2 consumption, for each energy medium:



You can find additional information here: Defining contract information for energy media (Page 70)

4. Next, you can display the energy media analysis directly in the energy media dashboard. The dashboard is displayed automatically:



In addition to the graphs of the two energy media "Electricity" and "Water", you can also see the costs in € and the CO2 consumption.

You can find additional information here: Displaying the energy media analysis (Page 71)

8.3 Creating energy media

Creating and editing an energy medium

To create an energy medium, follow these steps:

1. Open "Configuration" > "Energy medium".
2. Click "New energy medium".
3. Assign a unique name and a description.
4. Assign a color to each energy medium.

Result

All energy media you have created are displayed in the list:

Energy medium

Search + New energy medium

Energy medium name	Color	Unit		
Cold		kWh		
Compressed Air		m³		
Electricity		kWh		
Gas		kWh		
Heat		kWh		
Oil		Liter		
Steam		t		

8.4 Defining energy media for an asset

Description

You specify for each asset which energy media created in the configuration are required.

Procedure

To define energy media, follow these steps:

1. Click on the desired asset in My Plant.
2. Open the "Asset Configuration" by clicking on the arrow next to the asset name.



3. Click on "Assignment of energy media".

- Specify all energy media you need and assign a parameter to each energy medium. You can assign either an individual parameter that represents the respective energy medium or you can enable the "Sub-asset" button.

Note

Sub-asset

We recommend that you enable the "Sub-asset" button when you have selected an energy medium in a higher-level asset of My Plant and want to show, for example, the energy consumption not only with the value of a single variable but the entire energy consumption of all lower-level assets.

Note

Energy media analysis

As soon as you have created an energy medium, the corresponding energy media dashboard with energy media analysis is automatically created. This results in costs. The six KPI instances that are necessary for calculations of the energy media analysis do not incur any additional costs.

- In addition, you can also assign a reference value to each energy medium/parameter pair:

By assigning a reference, you can define the energy medium in more detail. You can define, for example, that an asset consumes electricity. To do so, you assign the variable for electricity consumption "Electricity_Consumption" to the energy medium "Electricity" on the asset. You can also assign the variable for bottling "Filled_bottles" as a reference, for example, and calculate how much electricity was consumed per filled bottle ($\text{UnitConsumption} = \text{energy consumption per unit}$).

Result

By assigning parameters that represent the energy medium and references (xxxUnitxxx), all KPI instances required for the energy media analysis are automatically created in the parameter list:

KPI	ElectricityConsumption	kWh
KPI	ElectricityUnitCount	Pce
KPI	ElectricityUnitConsumption	kWh/Pce
KPI	ElectricityCosts	€
KPI	ElectricityUnitCosts	€/Pce
KPI	ElectricityCO2Emissions	tCO ₂
KPI	ElectricityUnitCO2Emissions	tCO ₂ /Pce

8.5 Defining contract information for energy media

Description

You can store the following contract information for each energy medium:

- Contract valid from
- Currency
- Costs
- CO2 equivalent

We recommend defining the contract information per energy medium directly on the top-level asset. This ensures that all contract information for a new energy medium as well as all changes are transferred to the lower-level assets.

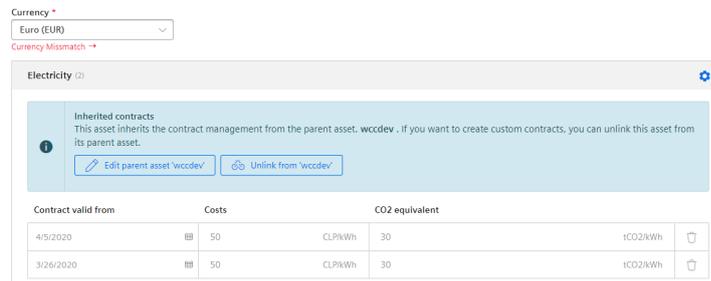
Procedure

To define contract information, follow these steps:

1. Click on the desired asset in My Plant.
2. Open the "Asset Configuration" by clicking on the arrow next to the asset name.



3. Click on "Contract information".
4. If contract information is already available from the higher-level asset, it can be applied. However, you can also separate the linking and create your own contract information.



Note

Selecting currency

The currency is defined uniformly for all contracts in the contract definition.

8.6 Deleting contract information for energy media

Description

You can delete a created energy medium.

Procedure

To delete an energy medium, follow these steps:

1. Click on the desired asset in My Plant.
2. Open the "Asset Configuration" by clicking on the arrow next to the asset name.
3. Click on "Contract information".
4. Click on the icon  next to the desired energy medium that you want to delete.
5. Click "Delete energy medium".

Note

Energy medium is inherited from higher-level asset

When the energy medium is inherited from a higher-level asset, you cannot delete it directly. You must first revoke the connection to the higher-level asset by clicking on "Disconnect connection of ...".

8.7 Displaying the energy media analysis

Description

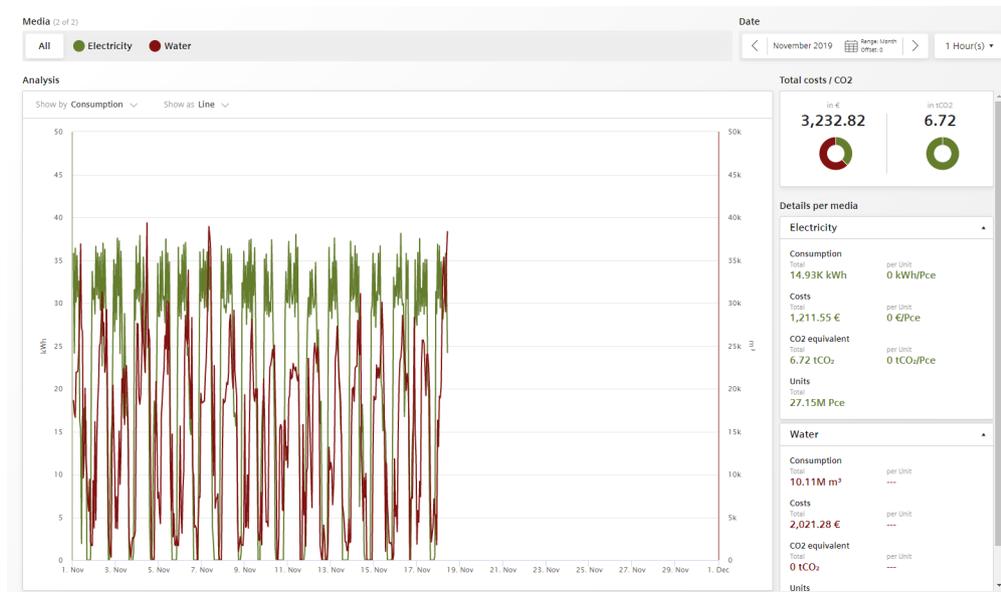
The energy media analysis is automatically displayed in the energy media dashboard.

As soon as you have assigned a reference value to an energy medium, you will not only see the total for consumption, costs and CO2 equivalent but also the amount per unit, for example, per filled bottle.

Procedure

To display the energy media analysis, follow these steps:

1. Click on the energy media dashboard.
2. In the energy media analysis, you can display either the collective information for all energy media or for each energy medium:
 - Display of individual energy media: You can display the costs, for example, as line, bar or pie chart or as a histogram.
 - Total costs
 - Total CO2 equivalent
 - Total consumption of the individual energy medium
 - Consumption per unit
 - CO2 equivalent per unit



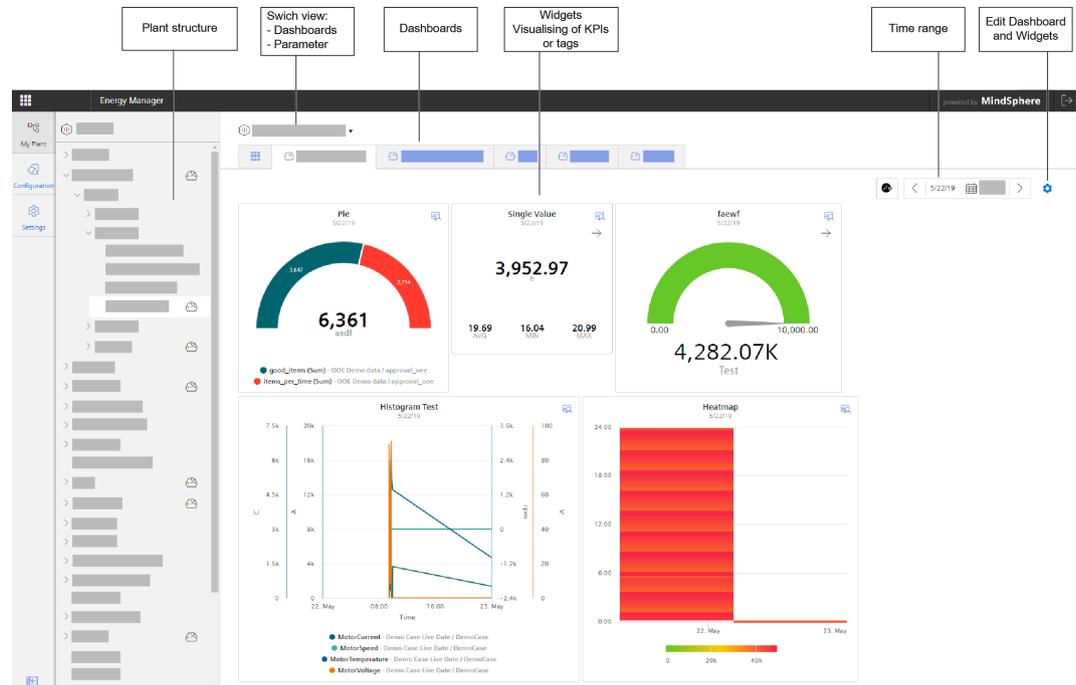
Creating dashboards

9.1 Structure of the dashboards

Overview

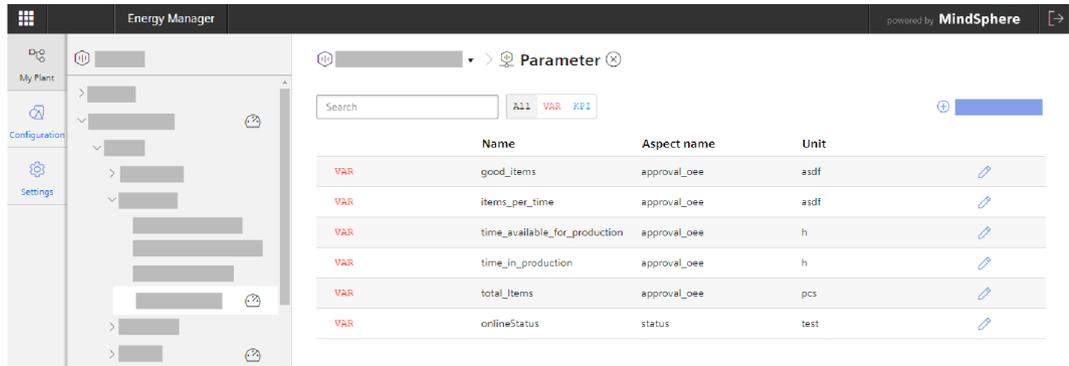
The dashboards contain a graphical representation of variables or KPI types. Widgets are used for the graphical representation. A maximum of 5 dashboards can be created per asset object within My Plant.

The figure below provides an overview of the structure of a dashboard:



Parameter overview

You can switch the view of the parameters using the drop-down list of the plant object. Here you can create additional KPI instances. The list of existing KPI instances and variables that were created for the selected plant object or a lower-level plant object can be seen below.



9.2 Setting the time period in dashboards and widgets

Description

For each dashboard, you can define a specific time period for which the values of all parameters are to be read and displayed in the widgets. In addition, you also have the option of specifying a separate time period for each individual widget.

The values of the current date are always displayed by default. You can use the left < and right > arrows to jump forward or backward day by day. As soon as you deviate from the current day, -1 (one day back) or 1 (one day forward) is displayed accordingly as offset.

The current date is displayed again when you click on the symbol .

However, instead of "Day", you can also, for example, select "Week", "The last 3 hours", "The last 7 days" etc. as time period. If you select "The last 3 hours" as the time period, then you can specify an exact time from which the last 3 hours are to be displayed.

Result

The values of the parameters for the period from 14.10.2019 to 21.10.2019 are displayed in all widgets of the dashboard.



Widget views

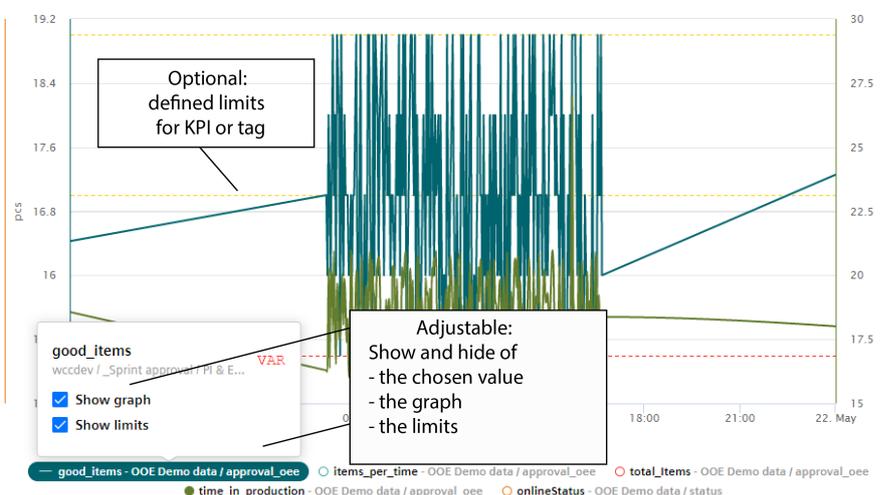
10.1 Detail view

Description

In the detail view, you can display the load profile of the parameters, for example, or an enlarged view of the widget. To open the detail view, click  in the widget. The functions of the detail view depend on the widget type.

For a widget of the "Diagram" type, the detail view contains the following functions, for example:

- Showing and hiding individual lines
- Showing and hiding limits
- Output of detailed values when you move over the line with the mouse
- Zooming in on the diagram



See also

Visualizing correlations in the diagram (Diagram) (Page 37)

Visualizing individual values (Value) (Page 39)

Visualizing machine statuses (Gantt) (Page 41)

Visualizing the violation of limit values (gauge) (Page 43)

Visualizing the distribution of consumptions or quantities (Pie chart) (Page 45)

10.2 Histogram

Description

In addition to the detail view, you can also display the Histogram if you want to see the curve of the frequency distribution. A variety of statistic KPIs are available for this:

- Minimum
- Maximum
- Average
- Standard deviation
- Median (central value)
- Total



10.3 Regression analysis

Description

In the x-y display, the production amount is mapped on the x-axis and the energy consumption is mapped on the y-axis. By using the regression line, you can determine, for example, whether too much energy is being consumed for a specific production amount. This is the case when the dot is above the regression line.

The regression analysis is available for the widgets "Pie chart" and "Diagram":

