

### Festo AX Energy Insights



GASA-ENI-CTR-\*

This document describes how to set up AX Energy Insights from connectivity to asset onboarding and monitoring of electrical and pneumatic energy consumption.

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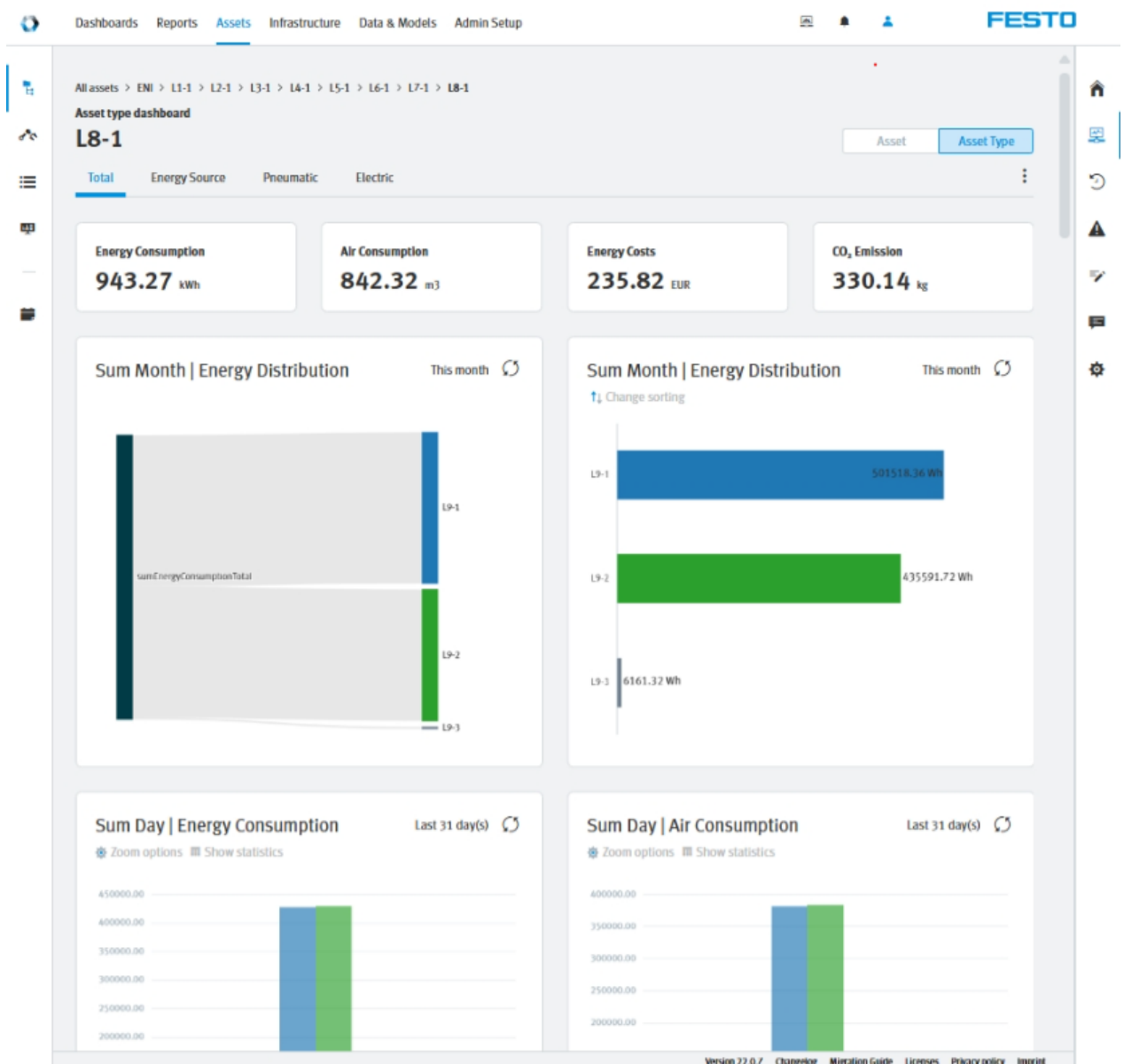
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# 1 Introduction

Festo AX Energy Insights (AX ENI) is an industrial app for continuous monitoring of electric and pneumatic sensor values and energy consumption. It comes with a standardized AI model and a user interface.

## Highlights:

- Standardized app for capturing and analyzing energy data flows
- Automatic creation of visualizations and energy data aggregation across all hierarchy levels of production
- Automatic learning of the AI Model based on the production state and detection of excessive consumption, such as leaks
- Calculation of energy KPIs such as CO2 emission and energy cost
- Generic MQTT interface specification designed to support integration with a huge variety of energy meters and pneumatic sensors



## 2 System Requirements

### 2.1 Computer hardware/runtime environment

#### 2.1.1 Hardware

The Industrial App runs on industrial PCs, virtual machines (VM) or other devices and computing instances that meet the following hardware requirements\*:

- CPU: min. 4-core, x86-64bit (Core i5 or higher)
- HDD: 240 GB or more
- RAM: 8 GB or more
- 1x Ethernet network interface

\* applicable for a reference setup with 100 connected sensors

#### 2.1.2 Network

- Device access:  
Ethernet network access to all involved electric and pneumatic sensors which are provided or mapped over MQTT

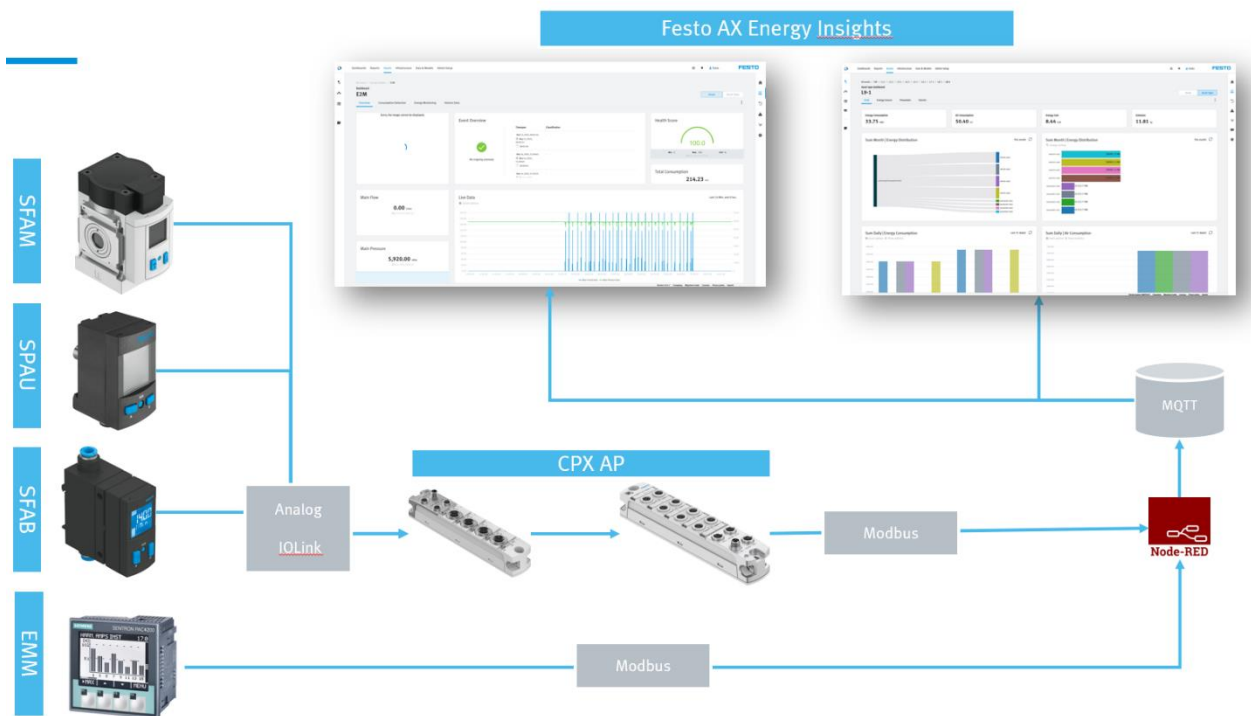


Figure 1: Example architecture for connecting energy meters to MQTT

- Internet access  
For retrieval of the industrial app “AX Energy Insights” from Festo’s central container registry, temporary internet access is necessary. After installation, the internet access can be turned off.

### 2.1.3 Software / runtime environment

- Installed Docker runtime (OCI container)
- Support for Linux-Containers
- Docker-Compose v2.0
- WebUI: optimized for Webkit-based browsers and Firefox
- UI is optimized for a resolution of: 1024x768 or higher

## 2.2 Security/Intended Use

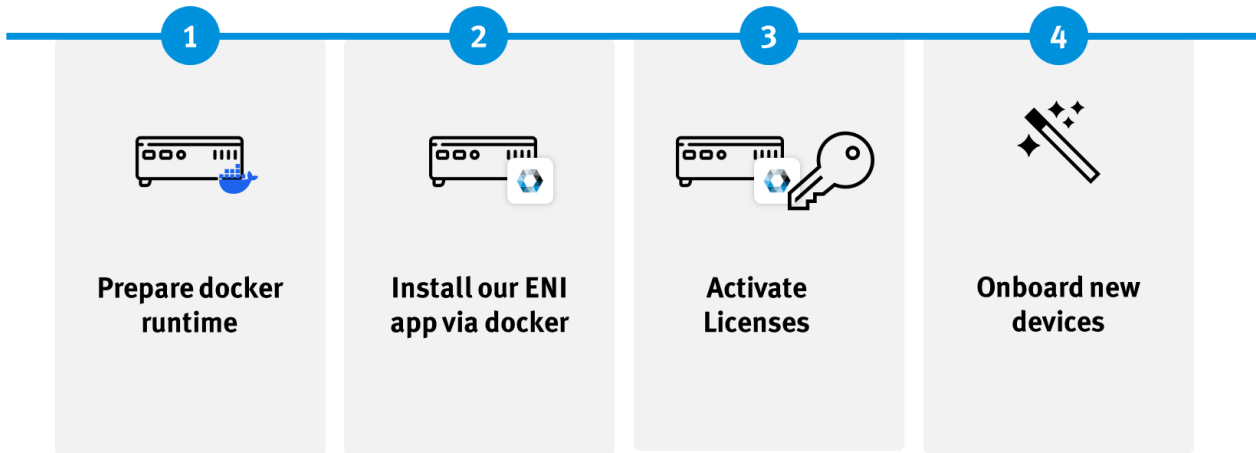
Festo AX Energy Insights (AX ENI) is an industrial app, provided as a set of docker containers, for continuous monitoring of electric and pneumatic sensor values and energy consumption. The data ingest channel of the industrial app is MQTT. All data and its aggregations are stored within a data storage (default setting is a PostgreSQL database).

AX ENI is mainly designed to operate on shopfloor level on e.g. an edge computer inside an internal network with no permanent access to the public internet. If you choose to distribute the Docker container of ENI on different hosting systems or to operate ENI (partly) in a public cloud, please ensure to secure all communication channels like the MQTT broker with methods of authentication like username/password or certificates. Furthermore, keep in mind to restrict the access to the ports of the system via an appropriate firewall configuration (open only necessary ports and filter IP addresses for the access).

AX ENI is a recommendation system, that gives machine operators, maintenance engineers and energy officers insights about the energy consumption in the production on different levels. For detecting abnormal energy consumption – such as leakages – AX ENI analyses data continuously by the use of algorithms from the field of machine learning. It is not recommended to automate an intervention in the control system of the machine based on analysis results from AX ENI.

### 3 Installation and Commissioning

To setup the entire AX Energy Insights (AX ENI) industrial app, these steps have to be conducted:



#### 3.1 Installation and setup of AX ENI containers

To learn more about “Container Applications” please refer to a google search and possible resources (last checked: Feb 2024):

Title	Author	URL
“Docker overview”	docker.com	<a href="https://docs.docker.com/get-started/overview/">https://docs.docker.com/get-started/overview/</a>
„Docker 101 Tutorial“	docker.com	<a href="https://www.docker.com/101-tutorial/">https://www.docker.com/101-tutorial/</a>
„Introduction to Docker containers“	Microsoft Learn	<a href="https://docs.docker.com/reference/cli/docker/image/save/">Introduction to Docker containers - Training   Microsoft Learn</a>
„Using tar archives to install offline“	docker.com	<a href="https://docs.docker.com/reference/cli/docker/image/save/">https://docs.docker.com/reference/cli/docker/image/save/</a> <a href="https://docs.docker.com/reference/cli/docker/image/load/">https://docs.docker.com/reference/cli/docker/image/load/</a>

Table 3.1: Learning material

The tutorials also explain on how to install a docker runtime on your preferred environment.

### 3.1.1 Provisioning of relevant information after purchase

After purchase an email is sent to the purchasing entity that includes all relevant information to fulfill the installation.

The email contains brief step-by-step instructions and links to all relevant document and most important setup and license files (“Download files” Link). Through this link a .zip is provided. It includes the following files:

Filename	Description
<b>.env</b>	File containing all relevant environment variables for the AX ENI instance, such as version, host name information, credentials. Besides other it is used by the docker-compose.yml to setup all containers accordingly. <b>Note:</b> Depending on local file explorer settings, this file might be hidden. Modifications to this file should only be made by knowledgeable persons.
<b>docker-compose.yml</b>	The docker-compose.yml file is a configuration file used in Docker to define and manage multi-container applications. It is used to specify the services, networks, and volumes required for AX ENI to run. The docker-compose.yml, defines the different containers in the AX ENI installation, their dependencies, and the configuration options for each container. <b>Note:</b> Modifications to this file should only be made by knowledgeable persons.
<b>&lt;uuid&gt;-&lt;package&gt;-&lt;nr&gt;.lic</b>	License file for each purchased AX ENI license. The number of .lic files in that package is equal to the number of licenses purchased through Festo online sales channel. The content of the license has to be copied to activate the license in one specific instance of AX ENI.
<b>mosquitto.conf</b>	File containing the configuration for the external facing MQTT broker that can be used to ingest data to Festo AX ENI. Additionally this MQTT broker can also be used to subscribe to the results of ENI. <b>Note:</b> Modifications to this file should only be made by knowledgeable persons.

Table 3.2: File descriptions

### 3.1.2 Pre-Requisites to install and run AX ENI

AX ENI is provided as “docker container application”. To run AX ENI, e.g. on an Industry PC, “Docker” must be installed on the device/OS. Please refer to the provided information in chapter 3.1 or search for preferred and up-to-date installation instructions. This part is not covered in this application note.

It is highly recommended to also know about command line interaction, such as Bash or Windows PowerShell.

For installation, the target device must be connected to the internet (to get the containers). After that, the internet connection can be disconnected again.

### 3.1.3 Retrieve container from Festo’s container registry

Upon purchase you receive an email with instructions and credentials to access our public container registry and retrieve (“download”) AX ENI containers.

The address of Festo AX’s container registry is:

**festoaxregistry.azurecr.io**

### 3.1.4 Authenticate / Login to registry

To authenticate to our registry a login command has to be executed. This authenticates the client to our public Festo AX container registry and allows for pulling of repositories and their stored container(s).

Insert on command line/terminal:

```
docker login -u <user> -p <password> festoaxregistry.azurecr.io
```

The credentials to <user> and <password> are automatically sent after purchase of AX ENI through our online sales channel, e.g. Festo App World. If not available to reader of this document, get in contact with the people that performed the purchase through our online sales channel.



#### Note

- **In case you can not access this registry, check the firewall settings according to <https://learn.microsoft.com/en-us/azure/container-registry/container-registry-firewall-access-rules>**

### 3.1.5 Start with docker compose file

The docker compose file is also attached to the after sales email and is the central setup file to retrieve all containers and set them up in the correct order and configuration. It is configured as an easy-to-use setup. It can be edited and adjusted to individual needs. Note: Modifications to this file should only be made by knowledgeable persons.

Open up a command interface and navigate to the directory where the docker-compose.yml is stored.

To start the application enter the following command. Upon first execution or after version changes in the docker compose file, the containers are retrieved from the central repository and installed locally.

Insert on command line/terminal:

```
docker compose up
```

To stop the container from running again, enter the following command:

Insert on command line/terminal:

```
docker compose down
```

### 3.1.6 Version update

If there is a new version released, the update procedure only needs a docker compose down, change of the version tag at the beginning of the .env file and run docker compose up again like described in 3.1.5:

```
##BEGIN OF COMMON SECTION  
# Version of the Containerset  
VERSION=xx.y.zz
```

### 3.2 Initial Setup: user creation and license activation

To work in the main application browse to <ip-address> without any additional port information (it uses standard http port 80).

During startup, you will be asked to create initial user accounts for Superadmin and Admin:

The screenshot shows the 'Festo Automation Experience' setup interface. At the top, a progress bar indicates three steps: 'Superadmin Account' (completed), 'Admin Account' (current step), and 'License' (pending). The main heading is 'Festo Automation Experience'. Below the progress bar, the text reads: 'Set up of admin user account. Please provide a user name, email and password. More users can be invited later.' The form includes fields for 'Name \*', 'Email \*', 'Password \*', and 'Repeat password \*'. Each field has a placeholder text: 'Please enter name for admin user', 'Please enter email address for admin user', and 'Please enter a password for admin user'. A password strength indicator is shown below the 'Repeat password \*' field, listing requirements: one lowercase character or more, one uppercase character or more, one number or more, one of these special characters or more (#!@#\$%^&\*+\_-), and 8 characters minimum. At the bottom right, there are 'Back' and 'Next' buttons.

In the next step you will be asked for a license key. License keys are provided as files through the after sales email that redirects to the setup package of files.

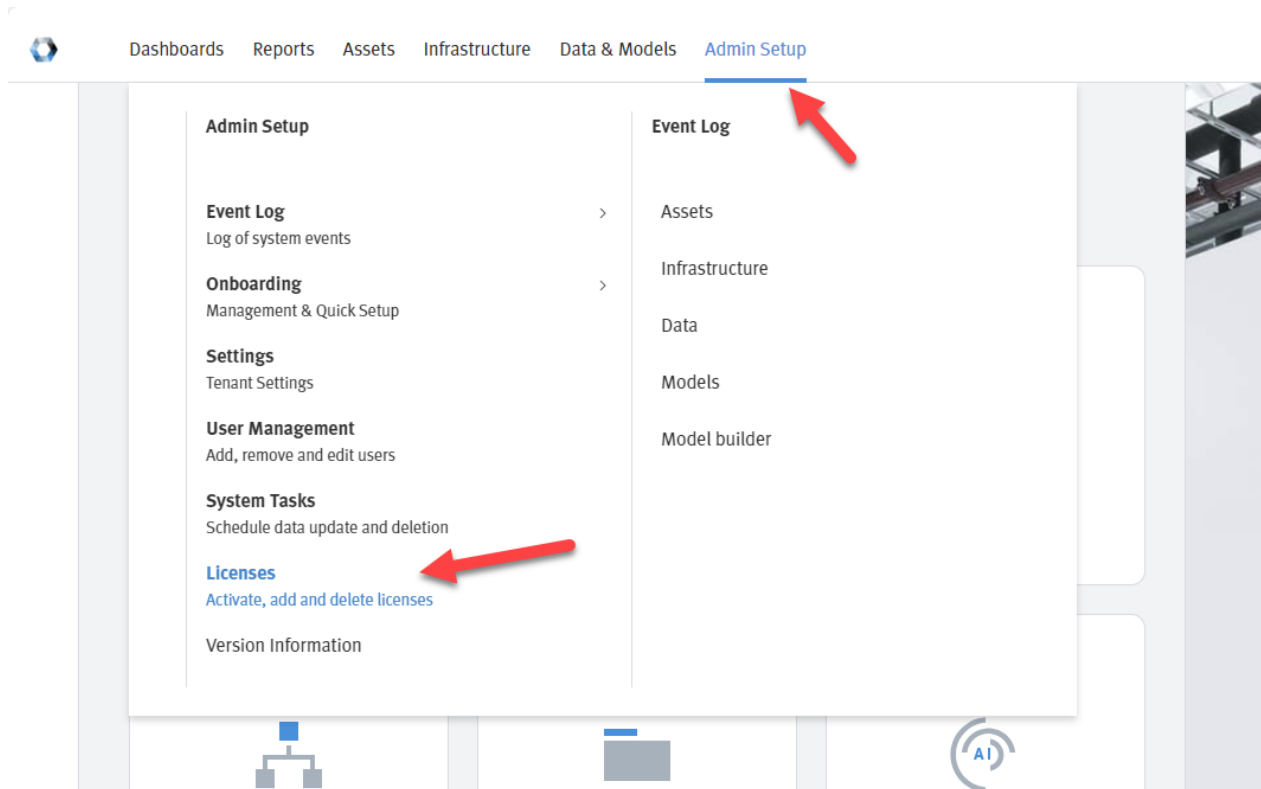
The license files (.lic) include the license key string that is needed to activate a license in one AX ENI instance. Therefore paste the content of your license file (\*.lic) into the form:

The screenshot shows the 'Festo Automation Experience' setup interface. At the top, a progress bar indicates three steps: 'Superadmin Account' (completed), 'Admin Account' (completed), and 'License' (current step). The main heading is 'Festo Automation Experience'. Below the progress bar, the text reads: 'Set up license to activate Festo AX.' The form includes a large text area for 'License \*' with a placeholder text 'Please enter license key for admin user'. A character count '0 / 1000' is shown at the bottom right of the text area. At the bottom right, there are 'Back' and 'Save' buttons.

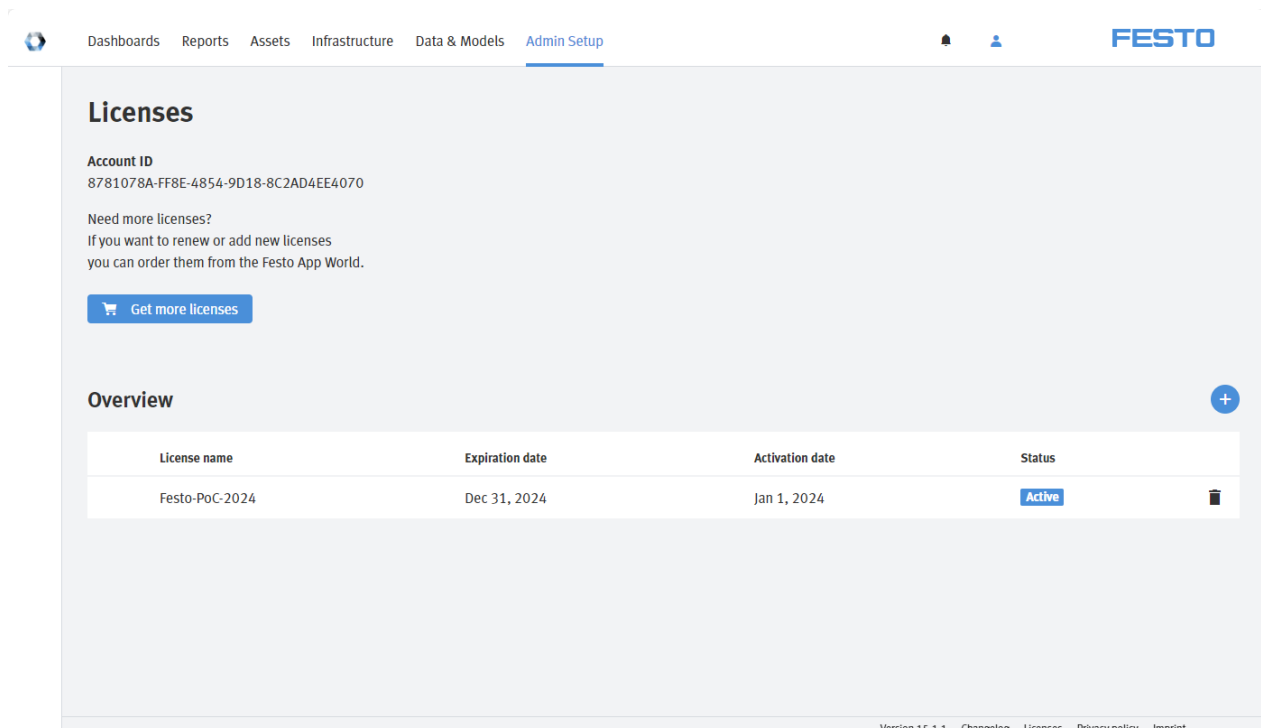
Further licenses can be added later according chapter 3.3.

### 3.3 Additional licenses

To activate further licenses, please navigate to “Admin Setup” > “Licenses”



You will be in the license overview page:



This gives you an overview of the already activated licenses. Furthermore, once assets are onboarded, you will also see the number of already onboarded assets (and the number of licenses left).

## Installation and Commissioning

By clicking on the (+) button, one can add new licenses to the instance. Therefor paste the content of one your license files (\*.lic) into the form:

The screenshot shows a modal dialog titled "Add new license" with a close button (X) in the top right corner. The dialog contains a text input field with a license key: `eyJhbGciOiJIUzUxMiIsInR5cCI6IkpXVCJ9.eyJleHAiOjE3MzkMTQ4MDAwMDAsIm5hbWUiOiJkNDk3NzM3NS03YzgwLTQ5MmWYtOGI1OS0xNDkxYWVmZTAwMDFmdAilCjSaWNibnNicyl6IkdBU0EETUIQLUNUUIoxMkotMTAILCjYXQjOjE3MDk4OTQ4MjV9.gImbU0GkwxMORQUIQmlyTZ-wfxaLmYH52N_HdY75AXZpgN4msss0z8eu-uexzTWEeTWa788-`. Below the input field, there is a character count "272 / 1000" and a prompt "Please copy license key into this field". At the bottom of the dialog are "Cancel" and "Create" buttons. In the background, the "Licenses" page is visible, showing the account ID "8781078A-FF8E-4854-9D18-8C2AD4EE4070", a "Get more licenses" button, and an "Overview" table with two license entries.

The license is then added to the instance. Further assets can be onboarded then!

The screenshot shows the "Licenses" page in the Festo AX Energy Insights interface. The page header includes navigation links: "Dashboards", "Reports", "Assets", "Infrastructure", "Data & Models", and "Admin Setup". The "Licenses" section displays the account ID "8781078A-FF8E-4854-9D18-8C2AD4EE4070" and a "Get more licenses" button. A "Current usage" section shows a progress bar and a legend with "Licenses in use" (blue square) and "Licenses available" (grey square). Below this is an "Overview" table with two license entries:

License name	Expiration date	Activation date	Status	
Festo-PoC-2024	Dec 31, 2024	Jan 1, 2024	Active	🗑️
> d4977375-7c80-491f-8b59-1491acfe0001_00	Mar 27, 2025	Mar 27, 2024	Active	🗑️

The footer of the page includes "Version 15.1.1", "Changelog", "Licenses", "Privacy policy", and "Imprint".



```
25.9.2025, 10:34:28 node: debug 1
ax/ei/L1-1/L2-1/L3-1/L4-1/L5-1/L6-1/L7-1/L8-1/L9-1/pf/pneumatic-mp1 : msg : Object
  object
    payload: object
      rawAirPressure: 5.344326699388813
      rawAirFlow: 66.81838587305282
      rawAirConsumption: 157957
      ts: 1758789268336
      _msgid: "911ab75932063180"
      topic: "ax/ei/L1-1/L2-1/L3-1/L4-1/L5-1/L6-1/L7-1/L8-1/L9-1/pf/pneumatic-mp1"
```

Topic structure example:

ax/ei/Country/Site/Hall/Floor/Segment/Workgroup/Line/Station/Substation/pf/Flowsensor

- MQTT Data Definition Electrical Sensor  
Topic Structure: ax/ei/+/+/+/+/+/+/+/+/+ee/+

Key	Unit	Mandatory	Information
ts	msec	Mandatory	Unix Timestamp in Milliseconds
rawCurrentLn	A	Mandatory	
rawCurrentL1	A	Mandatory	
rawCurrentL2	A	Optional	
rawCurrentL3	A	Optional	
rawVoltageL1Ln	V	Mandatory	
rawVoltageL2Ln	V	Optional	
rawVoltageL3Ln	V	Optional	
rawVoltageL1L2	V	Optional	
rawVoltageL2L3	V	Optional	
rawVoltageL3L1	V	Optional	
rawEffectivePowerL1	W	Mandatory	
rawEffectivePowerL2	W	Optional	
rawEffectivePowerL3	W	Optional	
rawReactivePowerL1	VAR	Mandatory	
rawReactivePowerL2	VAR	Optional	
rawReactivePowerL3	VAR	Optional	
rawApparentPowerL1	VA	Mandatory	
rawApparentPowerL2	VA	Optional	
rawApparentPowerL3	VA	Optional	
rawPowerFactorL1	-	Mandatory	
rawPowerFactorL2	-	Optional	
rawPowerFactorL3	-	Optional	
rawEffectivePowerTotal	W	Optional	If not set, the sum of rawEffectivePowerL1, rawEffectivePowerL2 and rawEffectivePowerL3 integrates to rawEffectivePowerTotal automatically
rawReactivePowerTotal	VAR	Optional	If not set, the sum of rawReactivePowerL1, rawReactivePowerL2 and rawReactivePowerL3 integrates to rawReactivePowerTotal automatically
rawApparentPowerTotal	VA	Optional	If not set, the sum of rawApparentPowerL1, rawApparentPowerL2 and rawApparentPowerL3 integrates to rawApparentPowerTotal automatically
rawPowerFactorTotal	-	Optional	If not set, the sum of rawPowerFactorL1, rawPowerFactorL2 and rawPowerFactorL3 integrates to rawPowerFactorTotal automatically
rawEffectiveEnergy	Wh	Optional	Is calculated with rawEffectivePowerTotal if not set

Table 4.2: Key descriptions

```
ax/ei/L1-1/L2-1/L3-1/L4-1/L5-1/L6-1/L7-1/L8-1/L9-1/ee/electric-mp1 : msg : Object
  ▼object
    ▼payload: object
      rawVoltageL1L2: 404.43406844161746
      rawVoltageL2L3: 404.43406844161746
      rawVoltageL3L1: 404.43406844161746
      rawVoltageL1Ln: 230.63503223350585
      rawVoltageL2Ln: 230.63503223350585
      rawVoltageL3Ln: 230.63503223350585
      rawFrequency: 50.03508675219792
      rawCurrentL1: 44.261061689411186
      rawCurrentL2: 44.261061689411186
      rawCurrentL3: 44.261061689411186
      rawCurrentLn: 0
      rawEffectivePowerTotal: 30.62445416827962
      rawReactivePowerTotal: 15.46973232834431
      rawApparentPowerTotal: 35.484578562750286
      rawPowerFactorTotal: 0.8630355892243131
      rawEffectivePowerL1: 10.20815138942654
      rawEffectivePowerL2: 10.20815138942654
      rawEffectivePowerL3: 10.20815138942654
      rawReactivePowerL1: 5.156577442781437
      rawReactivePowerL2: 5.156577442781437
      rawReactivePowerL3: 5.156577442781437
      rawApparentPowerL1: 11.828192854250094
      rawApparentPowerL2: 11.828192854250094
      rawApparentPowerL3: 11.828192854250094
      rawPowerFactorL1: 0.8630355892243131
      rawPowerFactorL2: 0.8630355892243131
      rawPowerFactorL3: 0.8630355892243131
      rawEffectiveEnergy: 157957
      ts: 1758789268336
      topic: "ax/ei/L1-1/L2-1/L3-1/L4-1/L5-1/L6-1/L7-1/L8-1/L9-1/ee/electric-mp1"
```

Topic structure example:

ax/ei/Country/Site/Hall/Floor/Segment/Workgroup/Line/Station/Substation/ee/electricsensor

- The frequency for the ingest data on the MQTT broker must be 10 Hz for both pneumatic and electric sensors. If the data is ingested on a lower frequency-rate, this will have impact on the following topics:
  - Model training: As the amount of the training data for the initial model training is fix, the timespan for the collection of the training data will increase. Furthermore, as the model uses caches, the size of the caches should be adjusted accordingly within the model parameters:
    - cp\_min\_size: default 1000 for 10 Hz, e.g. set to 100 at 1 Hz
    - cp\_step: default 100 at 10 Hz, e.g. set to 10 at 1 HzWarning: Changing the cache sizes will affect the accuracy of the model in is therefore not recommendet!
  - Aggregation: If energy consumption is calculated based on the energy flow (e.g. rawAirFlow for pneumatic sensors), this may affect the accuracy of the calculated energy consumption value

## 4.2 Initial Training

Before the anomaly detection is active, a first initial training has to be finished. Therefore, a scheduled training is configured by default. You can check the progress in the asset settings.

AX ENI needs at least 864.000 “good” data points for initialization. “Good” means, the pneumatic or electric consumption must be in a good condition working in its usual behavior. This is the “baseline” for the ongoing anomaly detection. With a frequency of data ingestion of 10 Hz, this equals to 24 hours of data.

The screenshot shows the configuration page for 'electric-mp1'. Under the 'Models' section, the 'Scheduled trainings' tab is active. It displays a table with the following data:

Model name	Status	Next run	Recording progress	Stop date
ENI-electric-mp1	Active and waiting for trigger	9/25/25, 10:34	Datasamples: 78740 of 864000	9/16/55, 13:37

Below this table, two other models are listed:

No.	Model name	Type	Format	Training samples	Current version	Linked Model	Active	Status
2	ENI-Postprocessing	Anomaly detection	Custom Java Model	-	v2 (Sep 23, 2025, 13:35:16)	ENI-Classification-EE	On	✓
3	ENI-Classification-EE	Classification	Custom Java Model	-	v1 (Sep 23, 2025, 13:35:16)	-	On	✓



### Note

**The model of Festo AX Energy Insights is designed to detect changes in the consumption over a longer period of time. Therefore, it might take some time until results from the anomaly detection and aggregated data are displayed, as the caches of the systems need to be filled.**

## 4.3 Model-Finetuning

Here is a brief overview over how the model works:

- Model detects *implicit system states* in the training phase.
- During inference, an assignment of new data to the implicit system states takes place. For the anomaly detection, the behavior of the new data is compared with its assigned implicit system state.
- Relevant parameters for the anomaly detection are
  - *min\_anomaly\_threshold*: Sets a threshold value for the deviation from the new data to its assigned implicit system state, under which an anomaly is never reported
    - For positive values the threshold is set as an absolute value measured in program-specific units, e.g. l/sec or V
    - For negative values the threshold is set as a proportion of the assigned implicit system states mean value
  - *max\_anomaly\_threshold*: Sets a threshold value for the deviation from the new data to its assigned implicit system state, above which an anomaly is always reported
    - Positive and negative values behave as above
- The other parameters are relevant for detecting the system states and should only be changed with caution and with deeper understanding.

Troubleshooting:

*The process produces too many anomalies (too many false positives). How do I reduce the rate?*

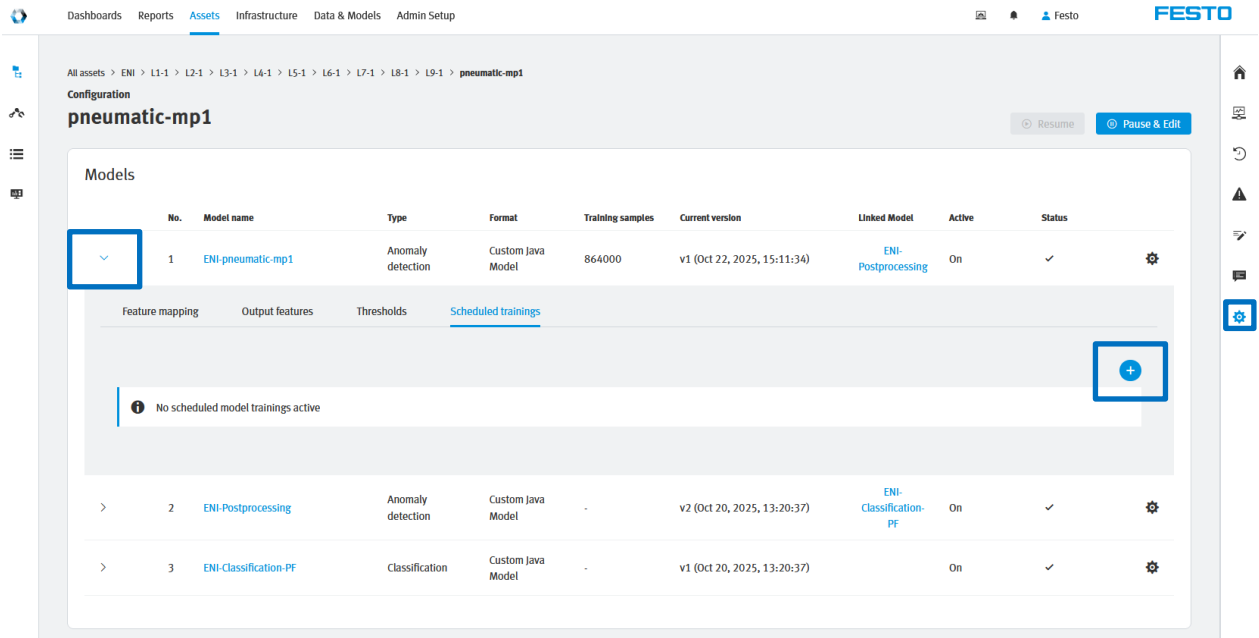
- If false anomalies occur by small sensor values (e.g. during standby), then the best way is to increase `min_anomaly_threshold` parameter, by setting either a greater positive value or a greater negative value.
- If false anomalies occur by large sensor values (e.g. during production), the best way is to increase `max_anomaly_threshold` parameter, analogously to `min_anomaly_threshold` (see above).

*The process does not detect anomalies when expected (too many false negatives). What do I do?*

- Try decreasing `min_anomaly_threshold` resp. `max_anomaly_threshold` accordingly.

To retrain an existing model with new hyper-parameters you can do the following steps.

- Open the model of the asset and configure a “Scheduled training”



- Set the “Datasamples” and the hyper-parameters and click “ok”

Model: ENI-pneumatic-mp1 ×

### Add scheduled retraining

Datasamples: 86400      Scheduler stop date: Nov 20, 2025      Scheduler stop time: 9:40

**Advanced settings**

Model activation ▼

**Workflow** ▲

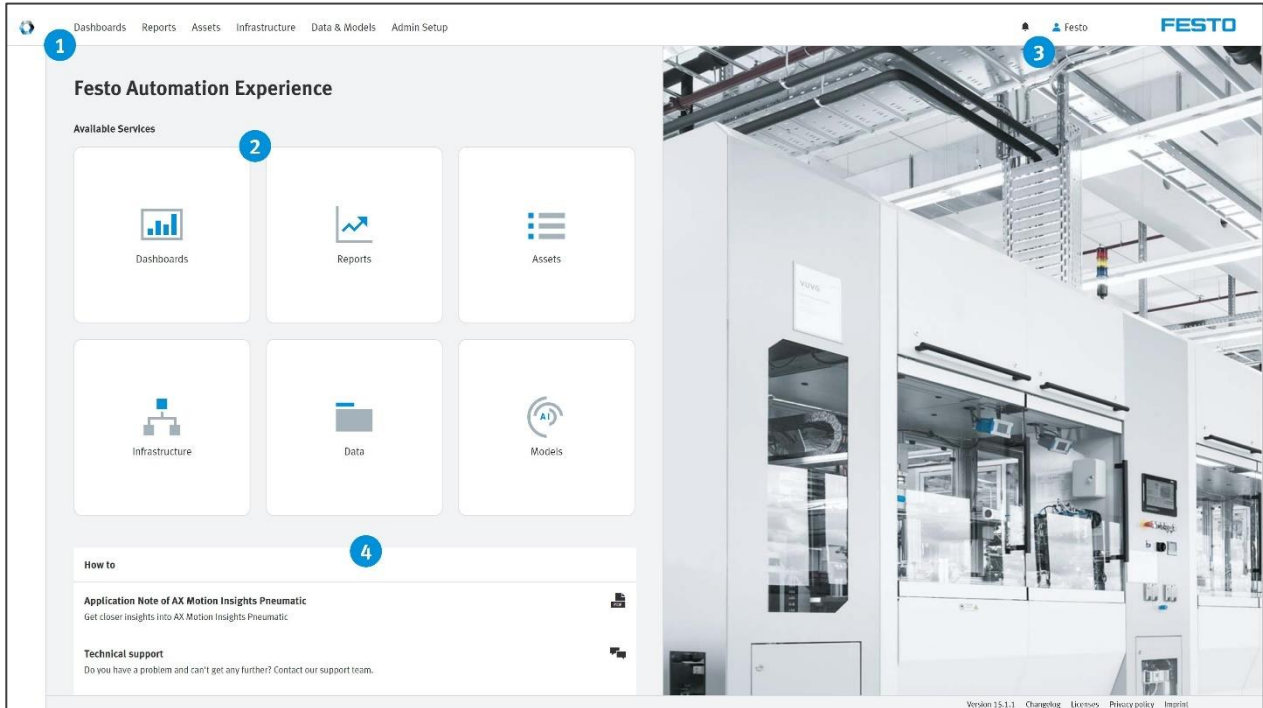
Augmentations ?	ID,CHANGE_RATE
Clipping ?	5
Cp Min Size ?	1000
Cp Step ?	100
Evaluation frequency ?	60
Evaluation interval ?	300
Granularity ?	10
Gravity ?	10
Max Anomaly Threshold ?	-.25
Min Anomaly Threshold ?	5
Random Seed ?	-1
Sensitivity ?	-1
Tolerance ?	-1

Cancel Reschedule

## 5 When the application is running

### 5.1 UI Walkthrough

After logging into the application, the user is greeted with the app's start screen. As user with the role "ADMIN", the start screen looks as following:



When the application is running

### 5.1.1 Main Menu (1)

On the top you'll find the main menu starting from the left, that will bring you to the sub sections of the app. It includes:

Menu point	Description	Remark
<b>Dashboards</b>	Access to build customized dashboards from a selection of widgets with the data coming from onboarded assets with their data points/features.	Only users with ADMIN role
<b>Reports</b>	Access to reports to get dedicated views on events and data in retrospective. First report is "Hierarchical Report" to gain overview of anomalies that have occurred in a specific time range.	All users
<b>Assets</b>	Access to all onboarded assets (here: pneumatic cylinders) with their dedicated dashboards for each asset for live view on the asset state.  An asset tree allows for easy navigation in hierarchical structure.	All users
<b>Infrastructure</b>	Expert setting screen to adjust inbound and outbound MQTT broker and other settings.	Only users with ADMIN role
<b>Data&amp;Models</b>	Expert setting screen to work with data sets and trigger new trainings on models.	Only users with ADMIN role
<b>Admin Setup</b>	Access to event log, onboarding settings, general tenant settings, user management and system settings.  Furthermore access to license settings to activate new licenses and gain overview about existing license setting.	Only users with ADMIN role

Table 5.1: Menu functions descriptions

### 5.1.2 Quick Access Buttons (2)

The buttons copy the functionality from the main menu for fast access.

### 5.1.3 Notifications and User Profile (3)

The bell icon gives you access to the notification dialog. Here users will be notified about two types of events:

1. Anomaly events
2. Onboarding events

**Anomaly events:** All anomaly events that occur on the onboarded assets are being triggered as a notification and shown here for direct access.

**Onboarding events:** Once a new asset has been onboarded to the application, a notification is triggered and shown here. This is especially helpful in the onboarding process.

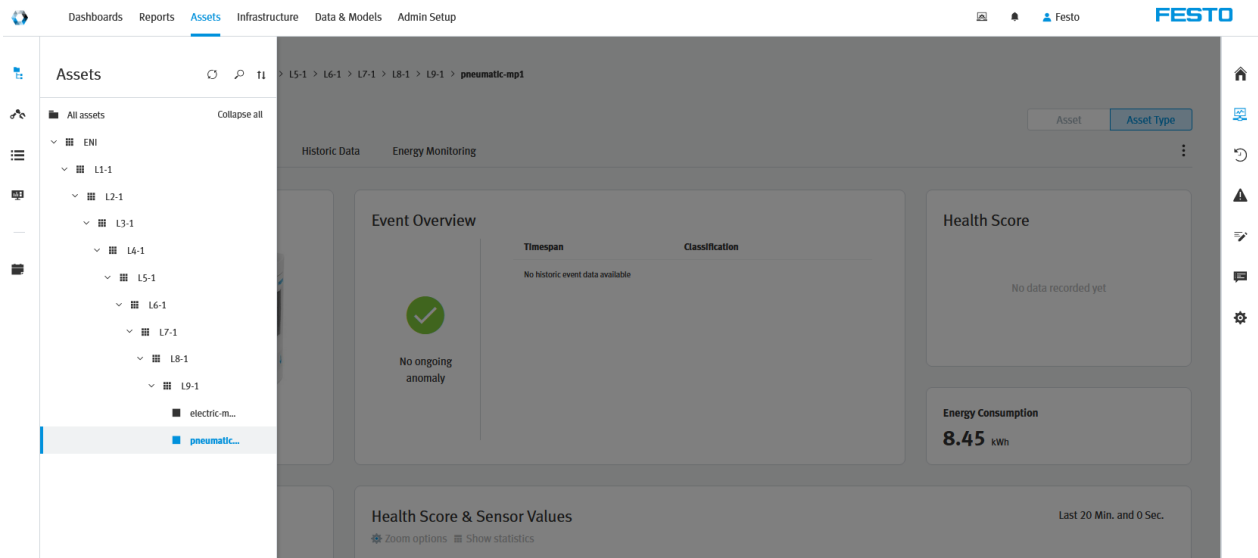
## 5.2 Asset Dashboard Walkthrough

Clicking on “Assets” guides you to the assets section that represents one of the core parts of the application. This section gives you structured access to the live data for all onboarded assets.

### 5.2.1 Asset Tree

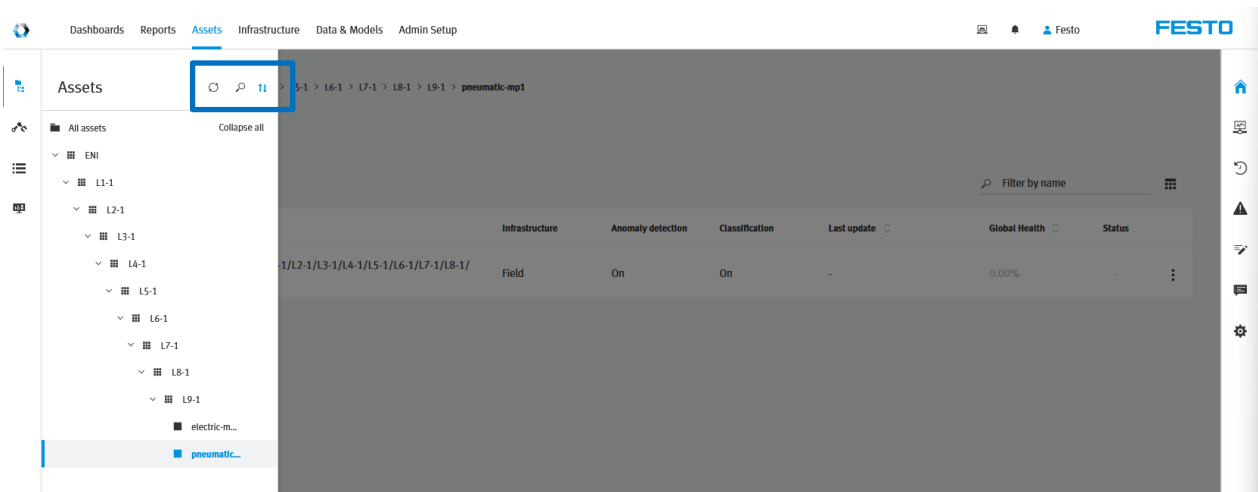
The asset tree represents the hierarchical structure of your monitored machine or subsystem.

Clicking on the asset name will bring you to the detail screen for the asset.



### 5.2.2 Asset Tree Controls

These buttons allow you to reload the asset tree structure (can be helpful in onboarding phase) and to search for a specific one (helpful in scenarios with many assets).

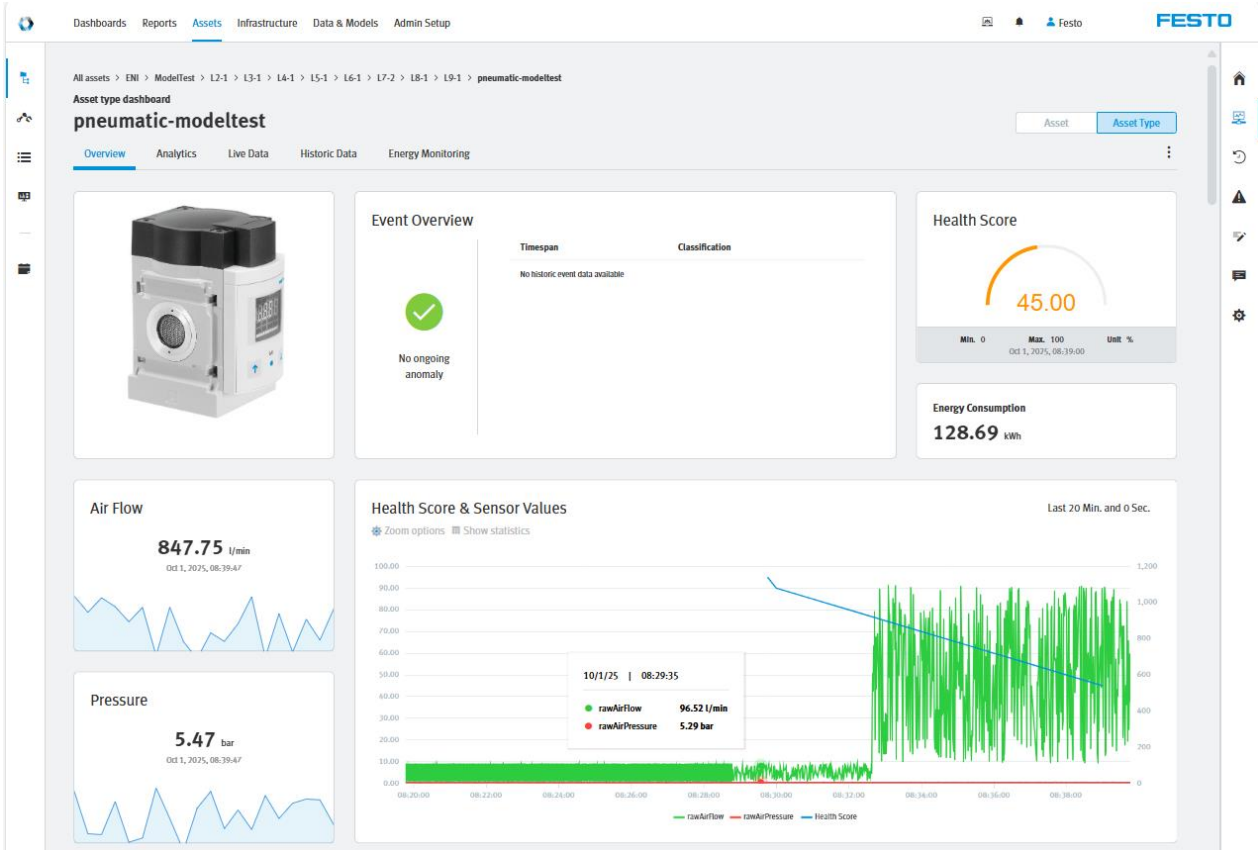


When the application is running

### 5.2.3 Asset View Pneumatic Sensor & Electric Sensor

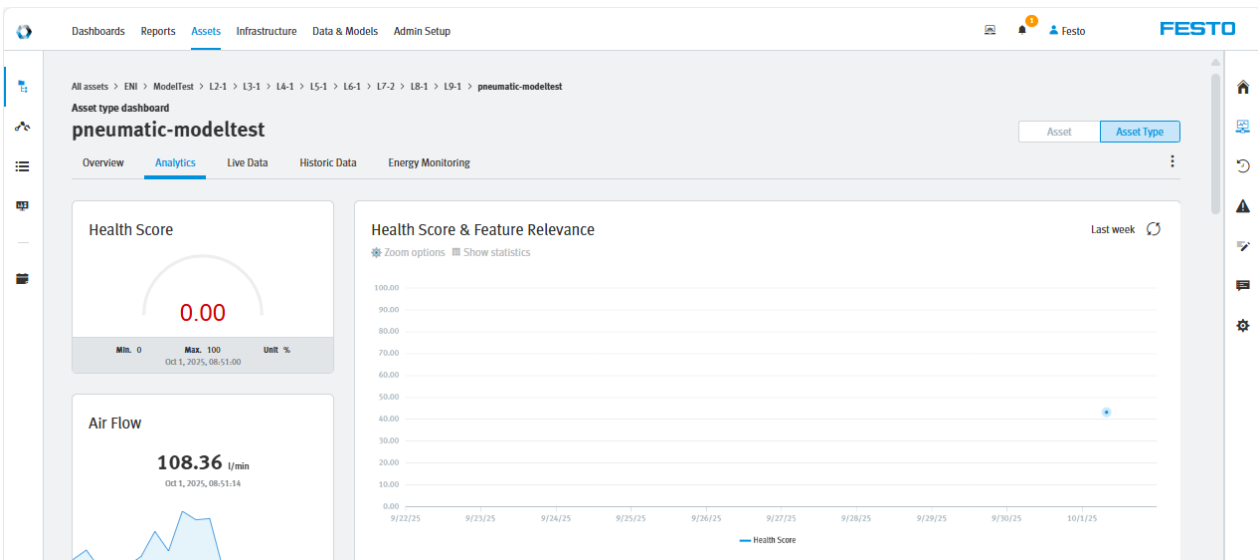
#### 5.2.3.1 Overview

The Overview tab displays information about the health score and classification, along with the primary measurement data and total energy consumption. It provides a concise summary of all critical information related to the measurement point.



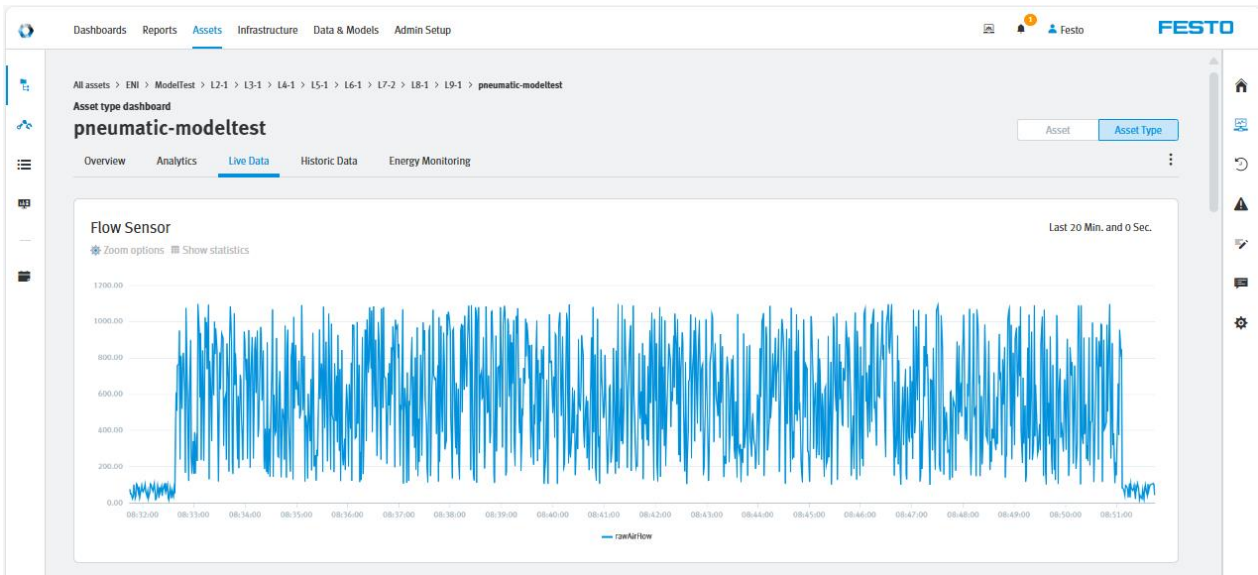
#### 5.2.3.2 Analytics

The Analytics tab contains all relevant information regarding the health score. It also includes a historical data view that displays the health score trend over the past week.



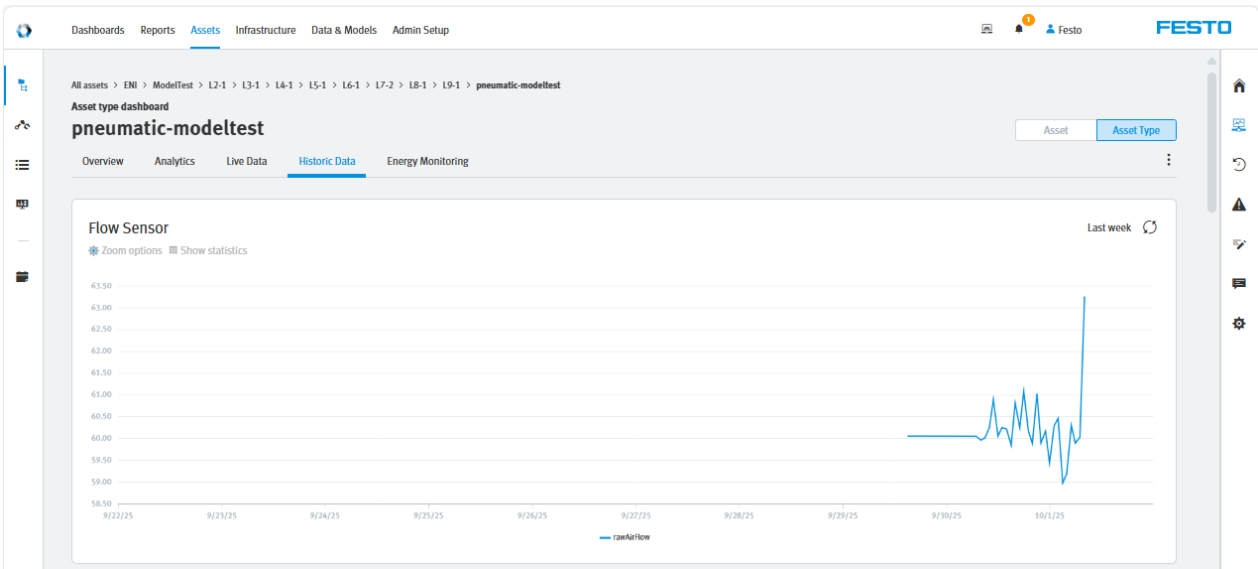
### 5.2.3.3 Live Data

The live data view displays the measurement data from the last 20 minutes. The data is aggregated as the mean value over one-second intervals.



### 5.2.3.4 Historic Data

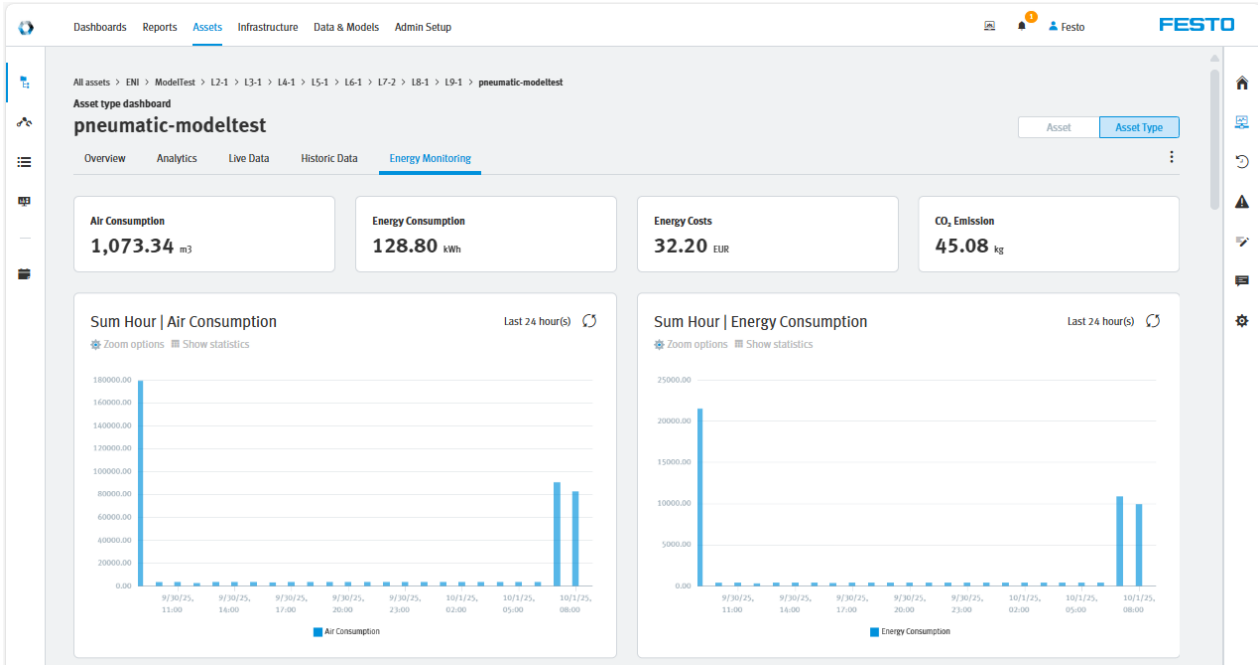
The historic data from the past week displays all measurement data, aggregated as mean values over one-hour intervals.



When the application is running

### 5.2.3.5 Energy Monitoring

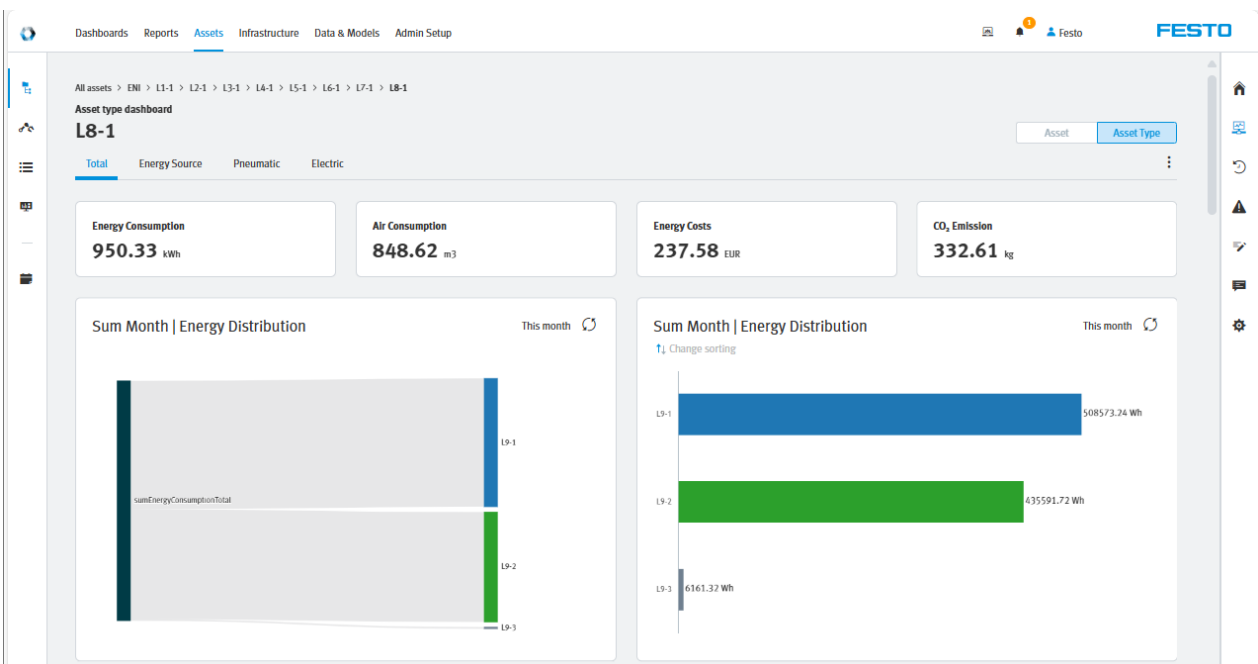
The energy monitoring view displays the total energy consumption, cost, and emissions since the onboarding of the measurement points. Additionally, historical data views show the energy data for the last 24 hours and the last 31 days.



### 5.2.4 Asset View Hierarchy Levels

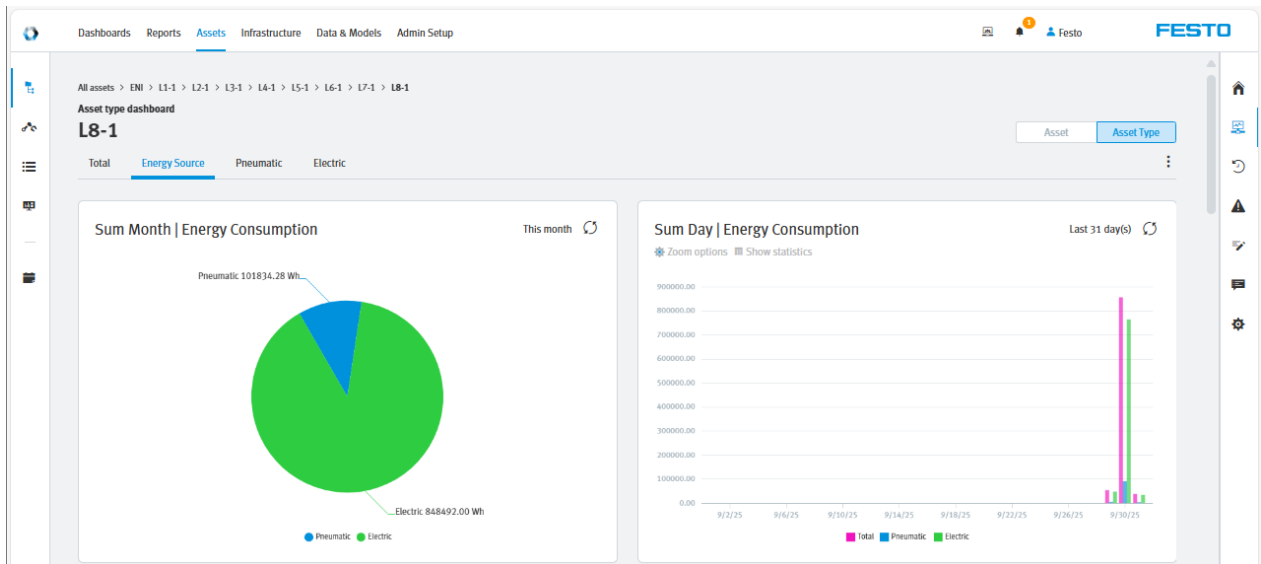
#### 5.2.4.1 Total

The “Total” view displays the total energy consumption, cost, and emissions for the selected hierarchy level. All energy data from the underlying assets are automatically aggregated. Additionally, historical data views present information for the last 31 days. A Sankey diagram and sorted bar charts further assist in identifying the assets with the highest energy consumption.



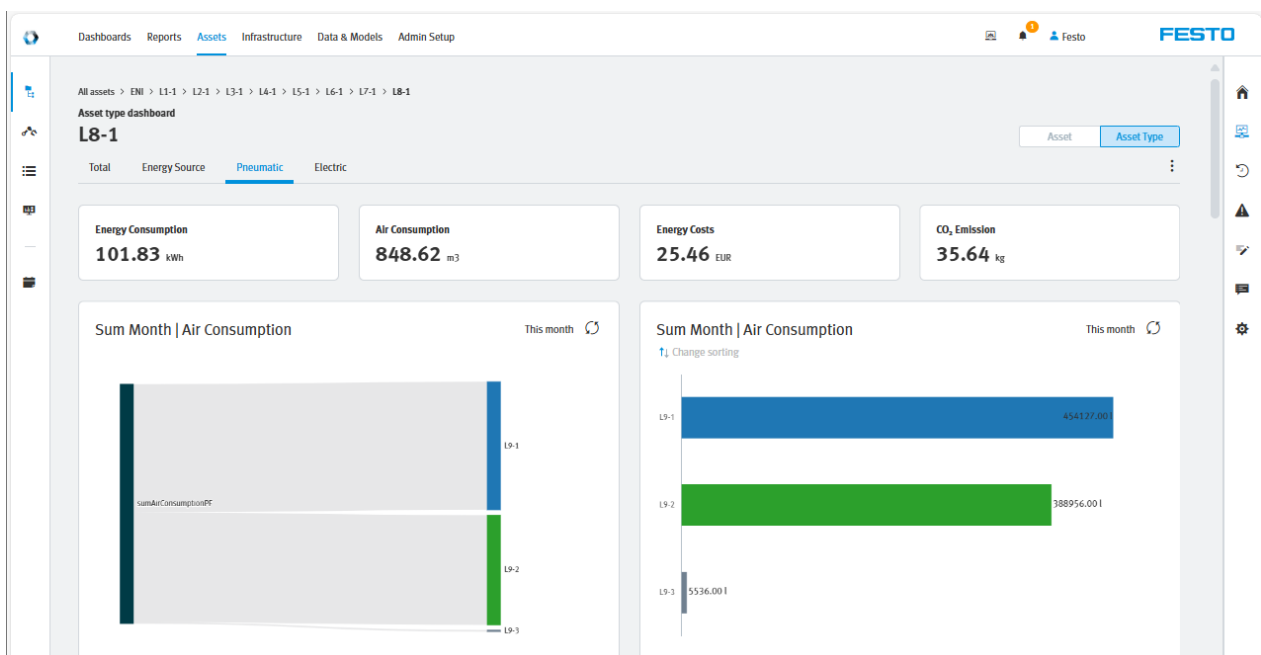
### 5.2.4.2 Energy Source

The “Energy Source” view displays pneumatic and electric energy consumption. This view is designed to support the breakdown of energy consumption, costs, and emissions by energy source. Additionally, historical data views over the past 31 days provide insight into the historical trends.



### 5.2.4.3 Pneumatic

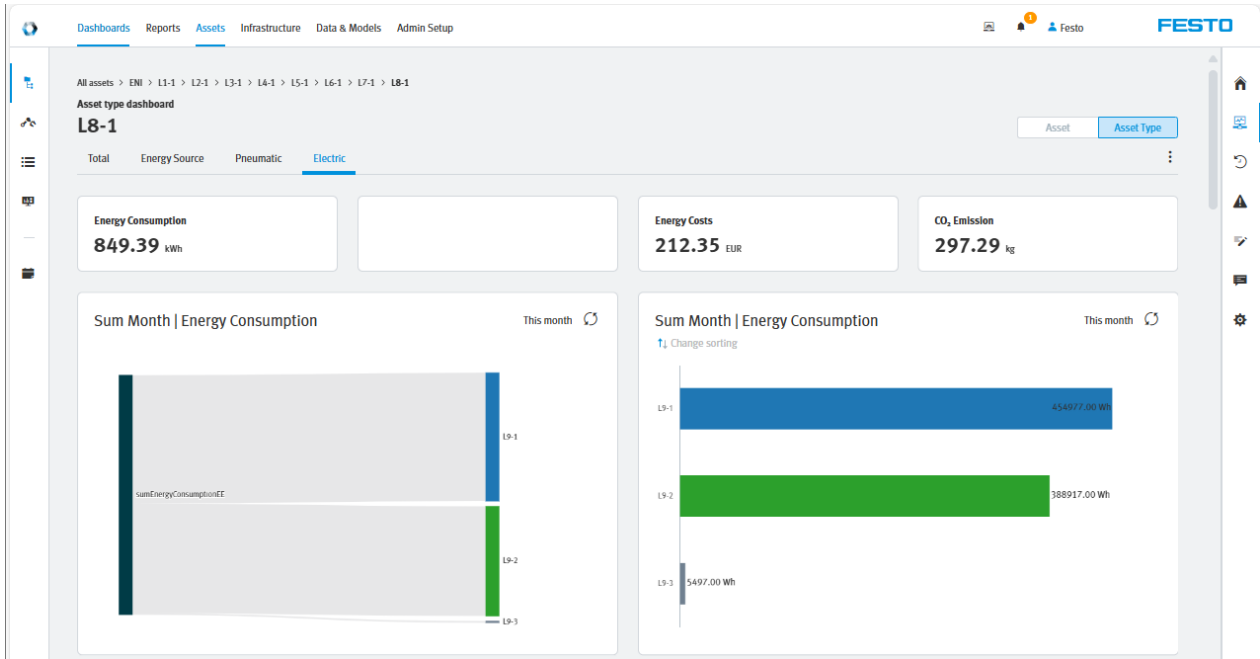
The “Pneumatic” view displays the pneumatic energy consumption, cost, and emissions for the selected hierarchy level. All energy data from the underlying assets are automatically aggregated. Additionally, historical data views present information for the last 31 days. A Sankey diagram and sorted bar charts further assist in identifying the assets with the highest pneumatic energy consumption.



When the application is running

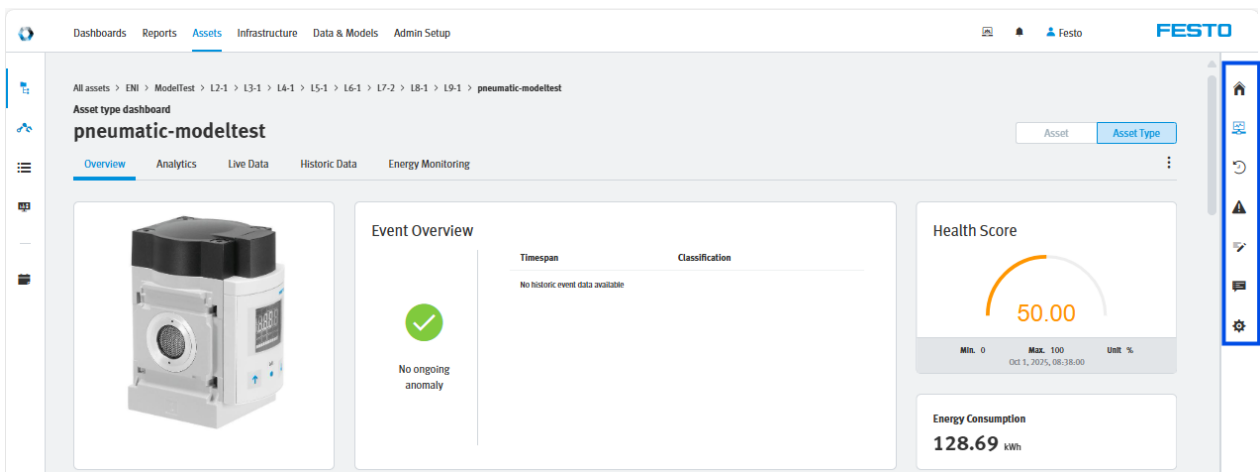
#### 5.2.4.4 Electric

The “Electric” view displays the pneumatic energy consumption, cost, and emissions for the selected hierarchy level. All energy data from the underlying assets are automatically aggregated. Additionally, historical data views present information for the last 31 days. A Sankey diagram and sorted bar charts further assist in identifying the assets with the highest electric energy consumption.



#### 5.2.5 Asset Tree Controls

The sub menu on the right side controls section to show for the asset selected by the asset tree.








Icons	Descriptions
	Home Screen for the asset. Contains an overview including the current health score for the asset (or group of assets when a node is selected in the tree).
	<p><b>The dashboard for the asset.</b></p> <p>There is two sections: the general dashboard that is derived from the asset's asset type and a dashboard for the individual asset. The latter can be designed individually by the user. The first one gives a great overview and already contains a lot of information about the current state of the asset as well as a look back for a certain time period.</p>
	Access to historic data of the asset. Further offers to export the data selection as csv or to create a new data set in AX from it to train a model with it.
	Event log for an asset. Here all events for the asset, such as anomalies, are collected.
	Upon anomalies, annotation can be added to an event to use in future events.
	<p>Model overview for an asset. Allows for fine tuning of a model and to schedule new trainings, e.g. after component replacement.</p> <p>Expert section.</p>

Table 5.2: Asset icons with descriptions

When the application is running

### 5.3 Inviting New Users

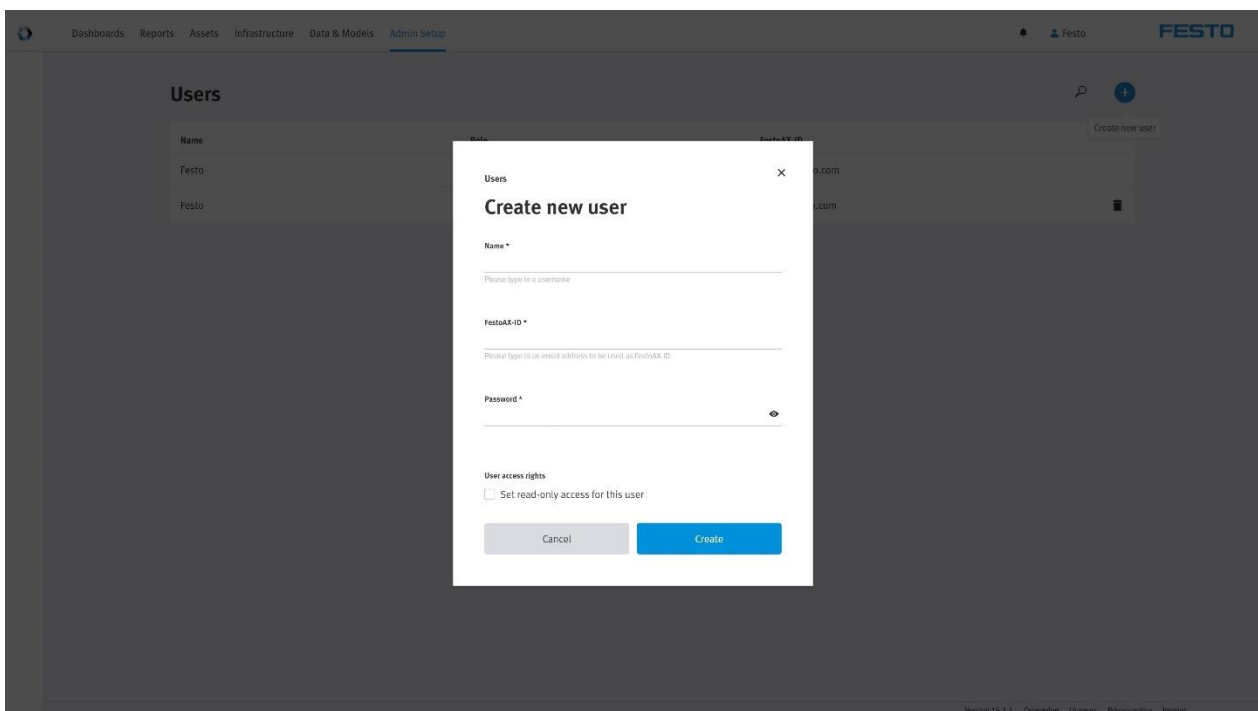
User with role “ADMIN” can invite new users. There is currently no logical limit to users added to the application. New users are added through the “Users” screen. It is reached through

Admin Setup > User Settings > (+) *New User*

Three things are needed for a new user:

- Name: a non-unique name to label the user
- FestoAX-ID: E-Mail address to uniquely identify user (also used for login)
- Password: The password to authenticate the user.

The new user can be set to “read-only”. This allows for accounts that can only view the data but not make amendments.

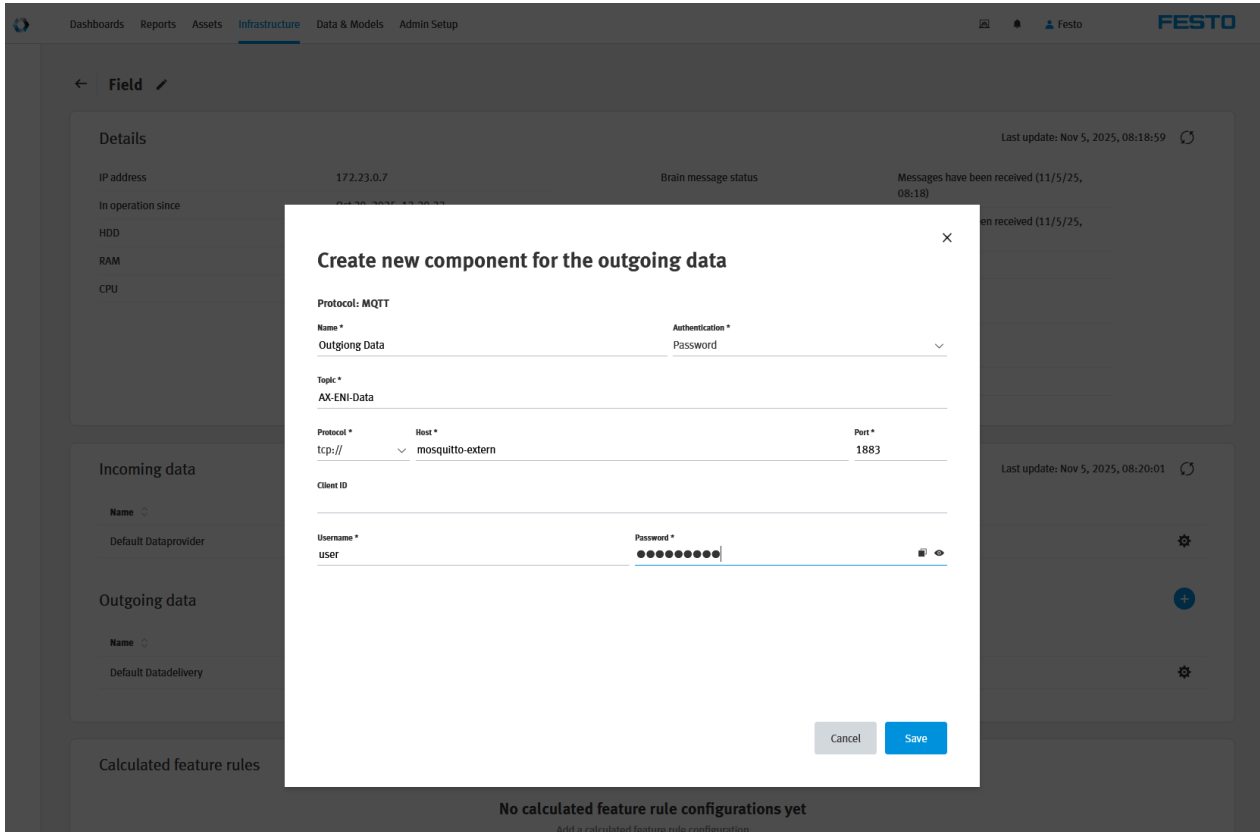


## 5.4 Outbound MQTT Data Delivery

To use model results like anomaly score or anomaly event in 3<sup>rd</sup> party systems, an outbound connection via MQTT can be configured. It is reached through

Infrastructure > Field > Outgoing data > Default Datadelivery > (+) *New Component*

The same broker like for the incoming data, which is part of the docker-compose.yml, can be used:



To get results being sent out, the “Field to External (F2E)” forwarding gate has to be activated for the features needed:

When the application is running

- For the according asset, choose the settings and pause the anomaly detection model (ENI-Post):

The screenshot shows the 'Configuration' page for the asset 'pneumatic-mp1'. The breadcrumb navigation is 'All assets > ENI > L1-1 > L2-1 > L3-1 > L4-1 > L5-1 > L6-1 > L7-1 > L8-1 > L9-1 > pneumatic-mp1'. The page title is 'Configuration pneumatic-mp1'. There are two buttons: 'Resume' and 'Pause & Edit'. The 'Pause & Edit' button is highlighted with a red box and labeled '2'. Below the buttons is a 'Models' table with the following data:

No.	Model name	Type	Format	Training samples	Current version	Linked Model	Active	Status
1	ENI-pneumatic-mp1	Anomaly detection	Custom Java Model	864000	v1 (Oct 22, 2025, 15:11:34)	ENI-Postprocessing	On	✓

Below the table are tabs for 'Feature mapping', 'Output features', 'Thresholds', and 'Scheduled trainings'. The 'Output features' tab is selected and highlighted with a red box and labeled '3'. It contains a table with the following data:

Feature name	Information type	Data type	Timeseries settings	Active forwarding gates
Anomaly Score	Anomaly score	Numeric	0	⊘
Anomaly Score Raw	Anomaly score (raw)	Numeric	0	⊘

A settings gear icon is highlighted with a red box and labeled '1'.

- After pausing the model, the forwarding gates can be adjusted and the anomaly detection model can be resumed:

The screenshot shows the 'Configuration' page for the asset 'pneumatic-mp1'. The breadcrumb navigation is 'All assets > ENI > L1-1 > L2-1 > L3-1 > L4-1 > L5-1 > L6-1 > L7-1 > L8-1 > L9-1 > pneumatic-mp1'. The page title is 'Configuration pneumatic-mp1'. There are two buttons: 'Resume' and 'Pause & Edit'. The 'Resume' button is highlighted with a red box and labeled '2'. Below the buttons is a 'Models' table with the following data:

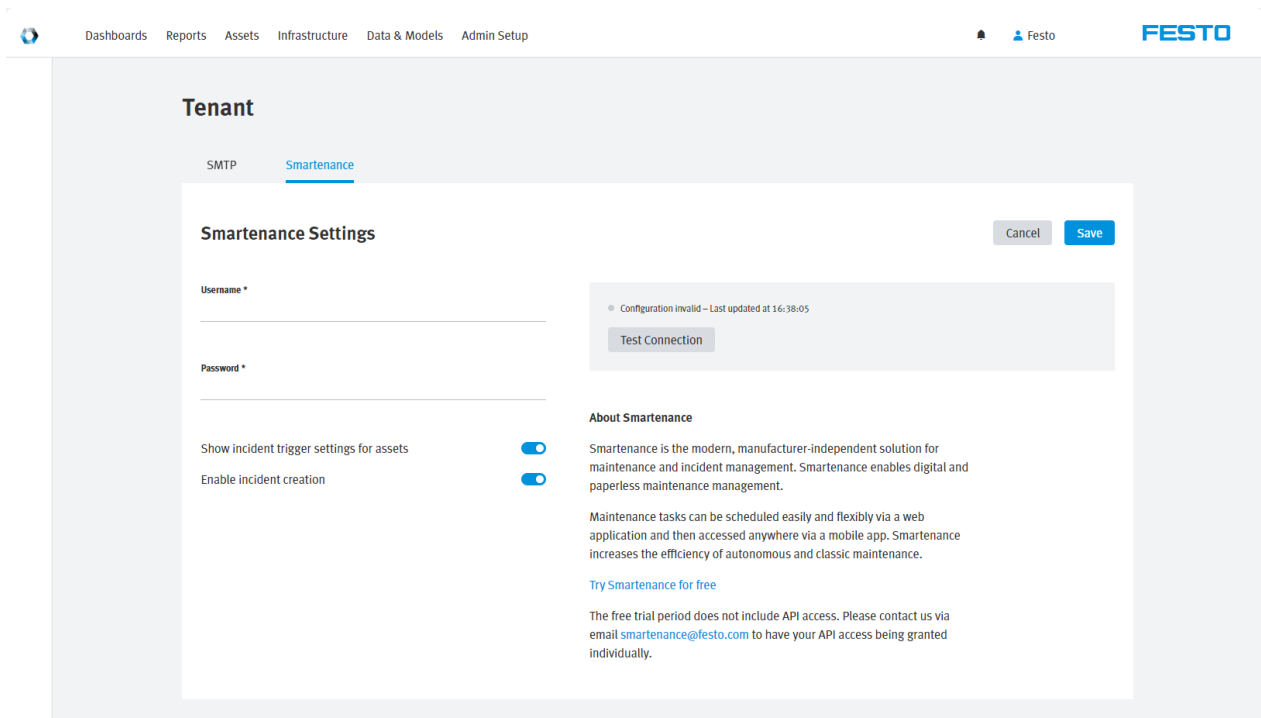
No.	Model name	Type	Format	Training samples	Current version	Linked Model	Active	Status
1	ENI-pneumatic-mp1	Anomaly detection	Custom Java Model	864000	v1 (Oct 22, 2025, 15:11:34)	ENI-Postprocessing	Off	✓

Below the table are tabs for 'Feature mapping', 'Output features', 'Thresholds', and 'Scheduled trainings'. The 'Output features' tab is selected. A dropdown menu is open, showing 'All (6)', 'F2B' (checked), 'F2E', 'B2D X', and 'F2B X'. The 'F2E' option is highlighted with a red box and labeled '1'.

## 5.5 Connecting Festo AX Smartenance

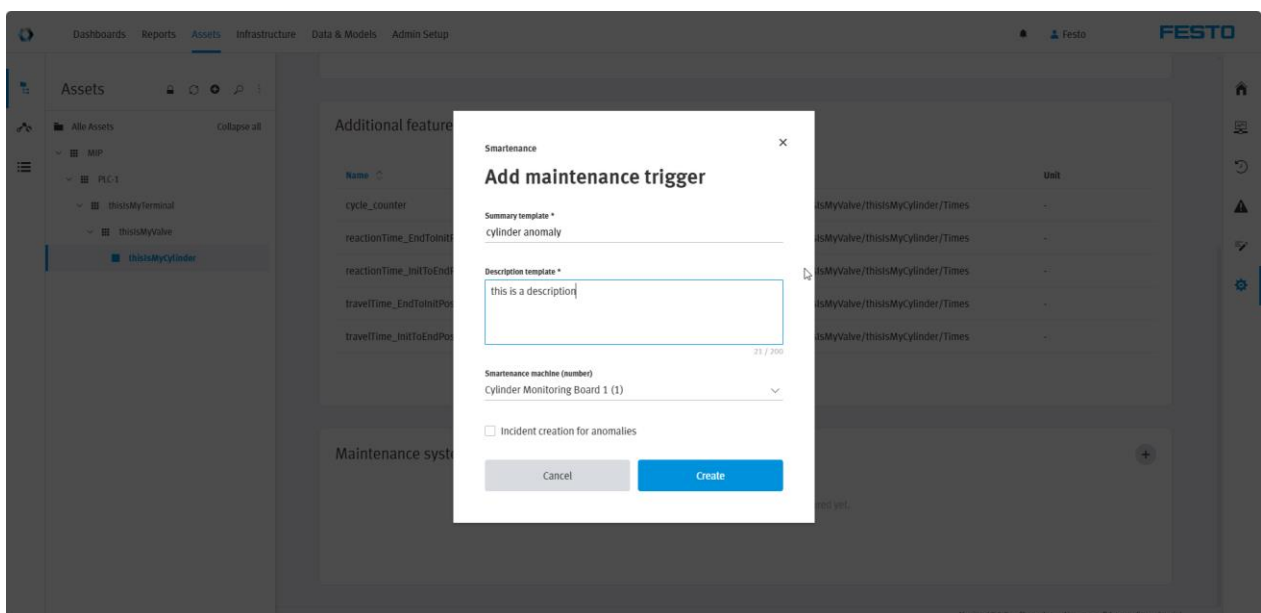
To be able to trigger incidents for specific assets, a premium account for Festo AX Smartenance is needed. Then the API credentials to connect both systems can be added in Festo AX Motion Electric Insights here:

Admin Setup > Settings > Smartenance



After establishing the connection, each asset can be configured to trigger an according incident in Smartenance:

Asset Tree Controls > Asset configuration > Maintenance system triggers > (+) *Add maintenance trigger*



When the application is running

## **5.6 Deletion of data**

Recorded data is deleted when the database has reached a maximum of 250 million recorded values as a default deletion task. This can be changed by adding a new task and deleting the existing default task:

Admin Setup > System Tasks

The deletion task does not delete the aggregated data.

## 6 Frequently Asked Questions

➤ **How many cycles do I need to fine-tune the model initially?**

860000 data points are needed to fine-tune the model. These cycles should include all possible variants of the process (e.g. different weights or movements).

➤ **What pneumatic/electric sensor does Festo AX ENI support?**

All pneumatic sensors that provide at least an air flow value are supported. Additionally, all energy meters that provide at least active power values are supported. Missing measurement data will result in empty dashboard widgets.

➤ **What happens when a measurement point is replaced by a new one or reset?**

If the measurement point is replaced with a new one or the energy meter readings are reset, no action is required in Festo AX.

➤ **I have specific questions. How can I get in contact?**

Get in contact with your Festo contact person or through [www.festo.com/contact](http://www.festo.com/contact)

➤ **The machine is running but I don't see any data or anomaly score calculated. What is the reason?**

There's different reason why no anomaly score is calculated and no data received although everything seems to be set up correctly and machine is running.

- Check MQTT status
- Check MQTT statistics
- Check Device connection status