2025

MINT e-book

VERSION 2.0

EN

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Date	Version	Description of Changes	Status	Author
13-11-2024	0.1	Concept	Draft	Marco Cicarelli
16-01-2025	2.0	Release	Release	Frederik Leempoels

1 Introduction

MINT is a self-learning and self-managing energy management system that connects and aligns all energy assets to continuously maintain the balance between a local installation and the electricity grid.

Instead of focusing on how much energy is needed (demand), it shifts the focus to what is available (supply) and tries to plan the energy demand to match these moments. The MINT energy management system distributes the available energy over time, based on the needs of the users, allowing to maximise the use of locally produced and renewable energy, limit peak consumption and avoid power cuts. While doing this, it considers both manageable consumers, such as electrical cars or batteries, and unpredictable ones, like production processes or the daily consumption of a company building (lighting, IT infrastructure, HVAC, etc.), which are more difficult to manage.

The MINT System is built on two platforms, the MINT Core PLC program and the MINT DataHub Cloud platform. The MINT Core is the heart of the system that ensures the basic functionalities like power control. It is built in layers (modules) and is installed on a local MINT controller. The MINT DataHub uses the DataGateway from the local controller, which secures communication to the MINT Cloud and offers advanced features like the Optimiser and Reporting.

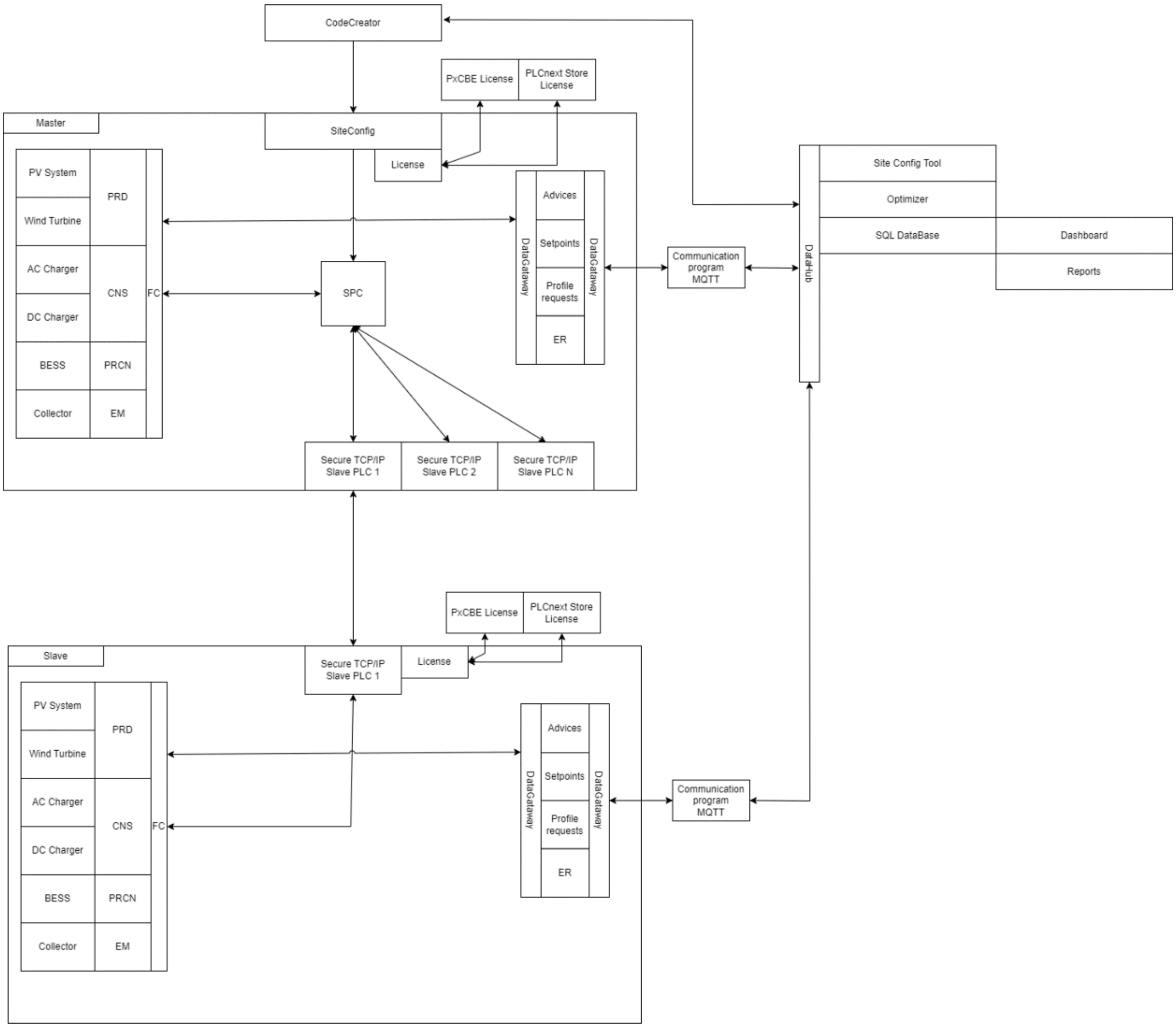

Figure 1: MINT system

MINT is a solution where multiple applications work together as one ecosystem to enable the transition to an "All electrical society".

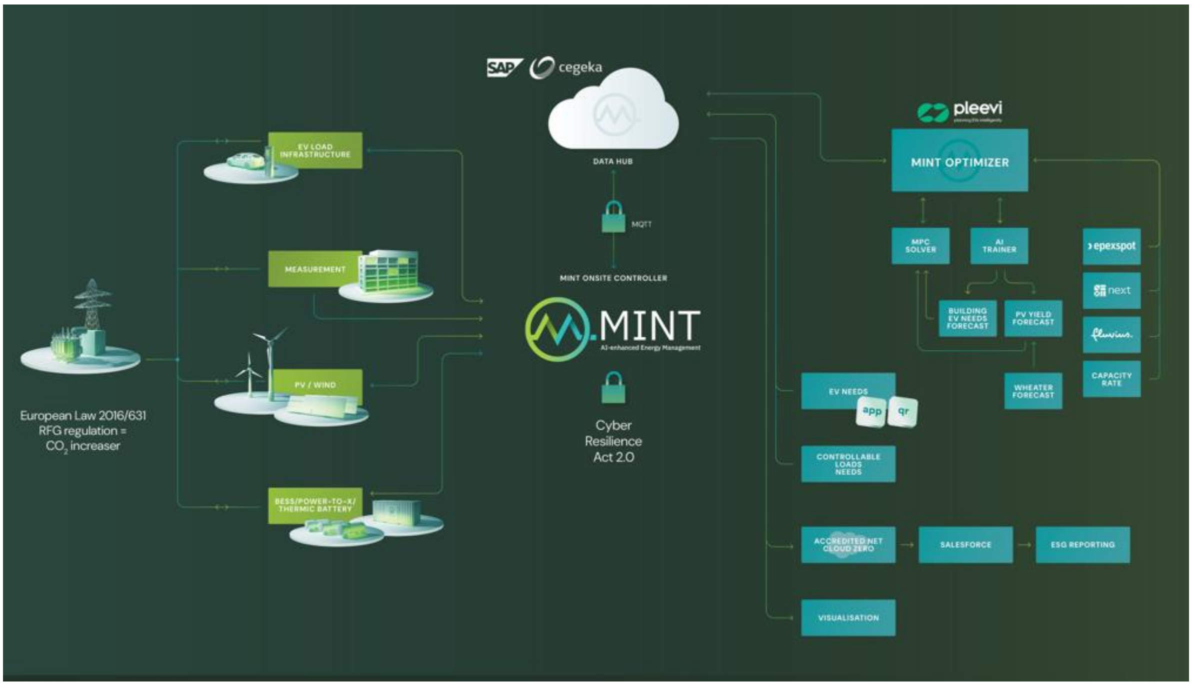

Figure 2: MINT ecosystem

1.1 Objectives

MINT has the following objectives:

- Meet the needs of the EV user, so the vehicle is charged at the requested time.
- Reduce the total load on the electrical system as much as possible and consider self-generated energy or dynamic prices.
- Predict the required amount of energy a car needs. Since every charging session can be different (number of kWh, departure time, ...), we need to read the RFID badge to link the user/vehicle to a standard departure time and, hence, the required amount of energy. As an alternative, the user profile can be transmitted via the MINT DataHub, and optionally, the user will be able to modify a charging session through a smartphone application.
- Consider additional data to optimise the software:
  - Charging on 1, 2 or 3 phases.
  - The phase rotation in the cabling or distribution boards.
  - The maximum payload of the vehicle.
  - The maximum current in each part of the electrical installation.

Depending on all incoming measurement data and preferences, an optimal curve is calculated for each charging point. To respond to changing conditions, this calculation is repeated every 15 minutes. All measurements and corresponding corrections are carried out continuously, and occasionally, to prioritise others, a vehicle may temporarily not even be charged.

1.2 Advantages

Using MINT has these important advantages:

- Maximum user comfort. Vehicles are charged in a timely manner, considering all charging sessions and conditions.
- Greatly reduced load on the electrical system. It may be possible to avoid an additional investment.
- Maximum car consumption if applicable.
- Reduced costs, among other things, through peak shaving.

1.3 Requirements

Both AC and DC chargers should have Modbus RTU RS485 or, preferably, Modbus TCP/IP. Furthermore, all chargers require...

... Read access to:

- The current per phase of each charging point / connector.[1]
- The status of a charging session (A1, B1, B2, C1, C2, F and E, or alternatively, 0-Available, 1-Preparing_TagId_Ready, 2-Preparing_EV_Ready, 3-Charging, 4-SuspendedEV, 5-SuspendedEVSE, 6-Finishing, 7-Reserved, 8-Unavailable, 9-UnavailableFwUpdate, 10-Faulted, 11-UnavailableConnObj).
- The RFID of the associated badge that changed the status of the charge point to initialise an active charging session (B2). In short, the RFID code that activated the charging session.
- The total energy counter, the voltage and the power on each phase and the total power.[2]

... Write access to:

- Set the maximum charging current of each charging point / connector.
- Temporarily interrupt a charging session by writing 0A.[3]
- End a charging session by sending a deactivation command.
- Set the watchdog timer, which will refresh on all registers after each write command.
- Set a fallback current.

Furthermore, if the charge point is compliant with ISO15118, read access to the following registers is useful:

- The vehicle ID connected to each charge point / connector.[4]
- State of Charge (SOC).
- Battery capacity.
- ...

And finally, if it works transparently and does not apply its own logic, a communication gateway can be used.

[1] Current per phase if the charging point does not work 3-phase.
[2] Additional electrical values are nice to have, not mandatory.
[3] If the charging point does not support 0A, it will be reduced to 6A.
[4] Optional.

2 MINT Core

MINT Core is the local PLC controller that integrates all your energy assets and manages them in real-time. By default, you can integrate solar panels, charging stations, batteries and grid power. No matter what extensions are involved, MINT Core always remains in charge of your energy management and ensures that your energy flows are never interrupted. It is the controller that ultimately sends the commands to your energy assets. MINT Core consists of the following modules.

2.1 Site Config (SC) module

The Site Config (SC) module contains the site configuration which can be generated by a cloud-based configuration tool. The configurator creates a file that can be imported in our Code Creator which, on its turn, automatically generates the MINT Core program that should be downloaded on the Controller.

The SC module is licensed based. This license contains the site configuration, asset counters and optional functionalities which will limit the Site Power Control (SPC), so no misuse is possible.

Per PLC, master or slave, or, in a multi-PLC approach, per full site, the following limitations apply.

2.1.1 Per PLC

Per PLC, there is a maximum of...

- 5 collector levels (fuses)[5]
- 1 parallel zone[6]
- 20 collectors to protect in the SPC[7]
- 50 charge points
- 5 BESS connections
- 5 PV systems

2.1.2 Per full site

- 5 collector levels (fuses)
- 1 parallel zones
- 200 collectors (fuses)[8]
- 1000 charge points (both AC and DC)
- 10 BESS connections (Modbus server connections)
- 25 solar fields (Modbus server connections)

[5] Excluding the grid. The grid is always included as the top level of the installation, so it will be considered as Level 0, not as the first collector level.
[6] MINT Core is designed to handle 1 grid connection. This can be a real meter or a virtual meter, summing all the meters of the next level.
[7] 200 when monitoring only is configured.
[8] AC charge points with a shared fuse are not counted in this 200.

2.2 Field Control (FC) module

The Field Control (FC) module will allow the Site Power Control (SPC) to connect to different assets in the field through standardised communication structures. These structures will send the data to specific asset types e.g. AC charging points, BESS and others. The following communication structures are foreseen.

Producers (PRD)

- Solar inverters
- Windmill inverters
- CHP
- ...

Consumers (CNS)

- AC Charge points
- DC Charge points
- Heat pumps
- E-boilers
- ...

Producer Consumer (PRCN)

- BESS
- Thermic ESS

Energy measurement (EM) devices

- Uncontrollable Load (UCL) measurement / calculation
- Building measurement

2.3 Site Power Control (SPC) module

The Site Power Control (SPC) module will calculate the available power for the local site through an algorithm and distribute the setpoints to the FC module. The algorithm will take the power strategy into account, which can be tailored to local needs, and will consider both local rules and the structure of the site's electrical installation from the SC module. It will calculate power and distribute power and amperage to all modules, which enables to protect the fuses in every collector level based on the amperage of each phase, and to protect the transformation stations based on their available power.

2.3.1 SPC rules

2.3.1.1 Peak shaving

Both pro- and reactive peak shaving are built-in in the SPC. Charge points will always start at 6A and smoothly ramp up to their setpoint. Proactive peak shaving will avoid unexpected peaks and gives the system time to calculate the total available power. On top of this, reactive peak shaving means MINT can also receive an active power limit per collector. The setpoint can be variable and set in multiple ways.

2.3.1.2 Dynamic load management

Considering the wide variety of 1, 2 and 3-phase vehicles in the market, we don not distribute equally on current. Instead, our distribution calculation is based on equal active power and not on the PWM signal. We assume that every vehicle needs the same amount of energy to drive the same distance, approximately 20 kWh / 100 km.

Every charging session starts at 6A and the PWM signal will be increased by 1A every minute. The PWM signal is maximum 5A higher than the actual value. Some manufacturers implement a higher offset than others. This gives freedom to the software of the vehicle. In case of an event, the decrease process is not time delayed.

Example

The control signal is 12A and the real measured value is 10,8A. Each vehicle can behave in a different way.

2.3.1.2.1 Dynamic reserve

To make sure the charging process can start without recalculation, a dynamic reserve is set. This will be determined by the number of cars that are not connected, multiplied by 6A on each phase. Apart from disabling, it is possible to select 1, 2 or 3 free connectors. By consequence, the maximum dynamic reserve will be 18A (3 x 6A). The control system is always fast enough, even with an electronical fuse. Please note that this feature also needs to be implemented for the higher-level fuses.

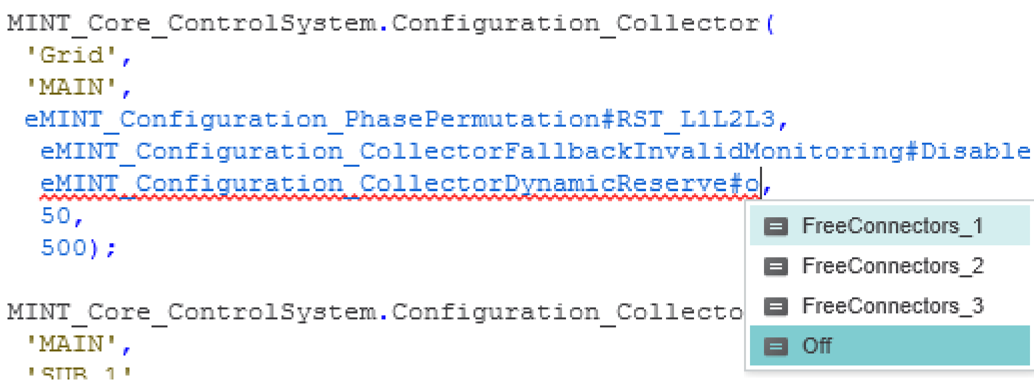

Figure 3: Dynamic reserve

Example

If the fuse is 100A, there are 10 connectors available, the Dynamic reserve is set to 3 free connectors and 7 cars are charging, the limit is 100A – 18A. If then, 3 cars connect at the same time, the remaining 18A can be used directly without a recalculation.

2.3.1.2.2 Fixed reserve

Depending on the fuse characteristics, the recalculation process can be too slow. A fixed offset or reserve will “catch” these uncontrollable loads.

Example

If there is a recalculation in 1 second, but the AC charger only reacts after 15 seconds, the total process is too slow, even if you recalculate in 1ms.

2.3.1.2.3 Total reserve

The Total reserve is the maximum value of the Dynamic and the Fixed reserve.

Example

If the Dynamic reserve is 12A and the Fixed reserve is 50A, the Total reserve is 50A.

2.3.1.3 Fallback system

The Fallback system limits assets to a default setpoint based on temporary electrical limits. There are 2 options, “Disable” or set to a minimum value. That way, if no advice for these specific assets is received, they can switch to rule-based SPC. A timeout value can be configured, the default is 30 seconds.

Example

Set all Consumers (CNS) behind Collector 1 on level 2 to 6A if the energy meter of this collector is not responsive. Or, set all chargers of Collector 3 to 0A if the grid meter is not responsive.

```
MINT_Core_ControlSystem.Configuration_Collector(
 'Grid',
 'MAIN',
 eMINT_Configuration_PhasePermutation#RST_L1L2L3,
  eMINT_Configuration_CollectorFallbackInvalidMonitoring#d,
  eMINT_Configuration_CollectorDynamicReserve#Off,
  50,
  500);
```

Figure 4: Fallback system

2.3.1.4 Variable collector limits

A variable collector limit is a limit to change the maximum power value during operations in a live system. The setpoint can be both positive and negative and can be given through a local eHMI or a cloud input.

Example

Limit the grid consumption to 100kW or no injection allowed.

2.3.1.5 Variable collector targets

A variable collector target is a target value for one or more collectors. Depending on the collector level, all connected assets will work together to reach this setpoint, which can be sent through our DataHub.

Example

Aim for a grid consumption of 100kW or an injection value of 120kW.

2.3.2 Consumer power control

2.3.2.1 AC charger control

A Power Test will determine the minimum and maximum power of the AC Charger, and there are 3 modes to control the power supply of an AC Charger: manual, rule-based or advice-based.

Manual

A setpoint is manually sent to the charger.

Rule-based

The connected car will charge as fast as possible taking all SPC rules like peak shaving and variable limits into consideration. When there is no power available for al sessions, the SPC will distribute a 0A command to a charger based on the maximum power the vehicle can take and the already charged energy. This will be recalculated every 15 minutes. Consequently, it is possible that even if a 1-phase car has already charged 20kWh and a 3-phase car only 15kWh, the 3-phase car stops charging, because a 1-phase care needs more time to charge the same amount of energy. So, at the end all cars will be charged equally.

Advice-based

The connected car will start charging at 6A and follow the advice once it is received. It will ramp up by using Rule-based charging but will switch automatically between Rule- and Advice-based if a network error occurs. The SPC will wait 20 minutes for a new advice and resets automatically after receiving a new advice.

Example

The example below shows a target of 60W. The yellow line shows the measured active power of the car. The blue line indicates the target active power, which is calculated by the optimisation engine. When the power value is higher than 0W, the PLC application will give 6A as a setpoint.

Figure 5: Advice-based

2.3.2.2 DC charger control

A DC charging session always starts at 5kW. This value is increased as fast as possible, until the car stops, or the maximum is reached. The charger always receives a value that is 7kW (10A on each phase) higher than the current value.

2.3.3 Producer power control

Producer power control is case specific, for example, it might be based on FCR (Frequency Containment Reserve) or the imbalance market, maximised auto consumption or PV curtailment for day-ahead invoicing or commands from the grid operators.

2.3.3.1 Injection limitation

The injection will be limited to a specified energy value. This can be based on price limits from day-ahead pricing, or on fixed limits from the grid connection.

2.3.3.2 Cos φ compensation / Reactive power control

With MINT you can compensate your cos φ by sending reactive power setpoints to your solar inverters.

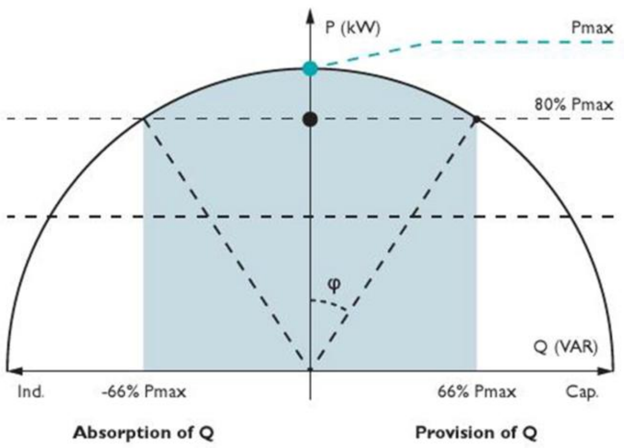

Figure 6: Cos φ compensation / Reactive power control

2.3.4 Producer – consumer power control

Assets that can both produce and consume, like a Battery Energy Storage System (BESS), can be set to peak shaving or advice charging mode. Producer – consumer power control is case specific, for example, it might be based on FCR[9] or the imbalance market, maximised auto consumption or PV curtailment for day-ahead invoicing or commands from the grid operators.

2.3.4.1 Peak shaving

Eliminate demand spikes by reducing electricity consumption.

2.3.4.2 Advice charging

Produce or consume based energy on the received advice.

[9] Frequency Containment Reserve.

2.3.5 Collector power control

A collector is the optional measured fuse point where multiple sub collectors or assets are combined and where a fuse needs to be protected. This point can be measured by an energy metering device or calculated by adding the values of all sub assets and collectors called a virtual Collector.

2.3.5.1 Virtual Collector

In a virtual collector there can be only one unmeasured point. Each virtual collector needs at least the current of each phase.

2.3.6 Forecaster measurements

These measurements will be sent to forecasting mechanisms to predict specific energy flows of a system. For each collector, the following total parameters will be calculated:

- Uncontrollable loads as UCL_SUM.
- Solar panels as PV_SUM.
- AC chargers as AC_SUM.
- DC chargers as DC_SUM.
- Battery Energy Storage Systems as BESS_SUM.

2.4 DataGateway

The DataGateway allows to send and receive raw data to and from external services in a predefined structure, e.g. the DataHub (see section 4.1). It connects to the DataHub through an MQTT communication program and enables master and slave(s) to process advice, receive setpoints, recognise profile requests and other information.

Based on the IO standardisation in the PCU cabinet, which can be delivered by Phoenix Contact Belgium, the defined in- and output structures of the PCU library easily integrate communication protocols of the Belgian grid utility operators.

2.4.1 Outgoing data

Here is a list of parameters that will be sent by the DataGateway to the Cloud based DataHub

2.4.1.1 For energy reports

From Collectors

- UCL_SUM "p1 p2 p3"
- PV_SUM
- AC_SUM
- DC_SUM
- BESS_SUM
- …

From AC chargers

- Mode

- ChargeTransactions
  - Started
  - Updated
  - SuspendedEV
  - Ended
- Energy values
- Error Codes

From DC chargers

- Mode
- E values
- Error Codes

From BESS

-

From PV systems

-

From Combined Heat and Power (CHP)

-

From Wind

-

2.4.1.2 For other purposes

For Remote Terminal Units (RTU)

-

For profile requests

-

For logging

-

For boot messages

-

For alarming

-

2.4.2 Incoming data

For advice

- AdviceChargerAC (60 minutes)
- AdviceChargeDC
- AdviceBESS (100 seconds)

UserProfile

- **TBD**

DayAhead

- **TBD**

RTU

- Command

CollectorTarget

- Pos and neg value minute based

CollectorLimit

- Pos and neg value minute based

2.5 Multi-PLC approach

This chapter describes how the multi-PLC approach is designed, and which modules are included in each master and / or slave PLC.

2.5.1 Design

In a multiple PLC approach, there is only one master and at least one slave. The master PLC's Site Power Control (SPC) module provides a secure TCP/IP connection to each slave PLC. As mentioned in section 2.1.2, the Site Config (SC) module includes a license for every PLC based on the site configuration and asset counters.

Every slave has a separate Field Control (FC) module to connect to Producers (PRD), Consumers (CNS), Producer Consumers (PRCN) and / or Energy Management (EM) devices, and a DataGateway to connect to the DataHub through an MQTT communication program.

2.5.2 Modules

2.5.2.1 Master

- Site Config (SC) module (see section 2.1)
- Field Control (FC) module (see section 2.2)
- Site Power Control (SPC) module (see section 2.3)
- DataGateway (see section 2.4)

2.5.2.2 Slave

- Field Control (FC) module (see section 2.2)
- DataGateway (see section 2.4)

2.6 PLC settings

Navigate to the WBM environment of the PLC to configure the settings.

2.6.1 Firmware settings

The firmware version can be found in the top right corner (FW: YYYY.X.X LTS) and should match the software version, which can be found in the change notes of the library that is being used. To update the firmware, select “Firmware Update” from the main menu.

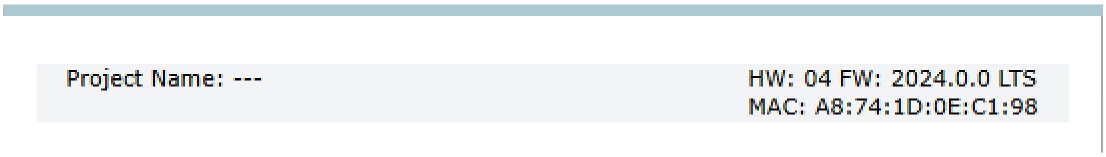

Figure 7: Firmware settings

2.6.2 System services

Select “System Services” from the main menu and check if these settings are deactivated:

- DATALOGGER
- ETHERNET IP
- OPCUA
- PROFINET CONTROLLER
- PROFINET DEVICE
- TRACING

If they are activated, unmark the tick box in the Activation column to deactivate them, and click “Apply and reboot” to finalise.

Configuration

System Services

Service ID	Service Name	Factory Default	Activation
APP MANAGER	App Manager	☑	☑
DATALOGGER	Data Logger	☑	☐
EHMI	PLCnext Engineer HMI	☑	☑
ETHERNET IP	EtherNet/IP (slave device)	☑	☐
FWM	Firewall Manager	☑	☑
GRPC LOCAL SERVER	gRPC Remote Procedure Calls (Local)	☑	☑
IEC	IEC 61131-3 Runtime for PLCnext Engineer	☑	☑
LINUX SYSLOG	PLCnext Syslog adapter	☑	☑
NETLOAD LIMITER	Netload Limiter	☑	☑
OPCUA	OPC UA Server	☑	☐
OPCUA CLIENT	OPC UA Client	☐	☐
OPCUA PUBSUB	OPC UA PubSub	☐	☐
PLCNEXT STORE	PLCnext Store Connector	☑	☑
PROFICLOUD	Proficloud	☑	☑
PROFINET CONTROLLER	Profinet Controller	☑	☑
PROFINET DEVICE	Profinet Device	☑	☐
SOFTWARE UPDATE	Software Update via Device and Update Management	☐	☐
TRACING	Trace Controller	☑	☐

Discard | Apply and reboot

Figure 8: System services

2.6.3 Firewall settings

Select “Firewall” from the main menu and check if the firewall has started in the General Configuration. If not, mark the Activation tick box to start the firewall.

In the Basic Rules of the Basic Configuration, change the Action column of the last 4 items (Seq. 6, 7, 8 and 9) to “Reject”.

Click “Apply” to confirm.

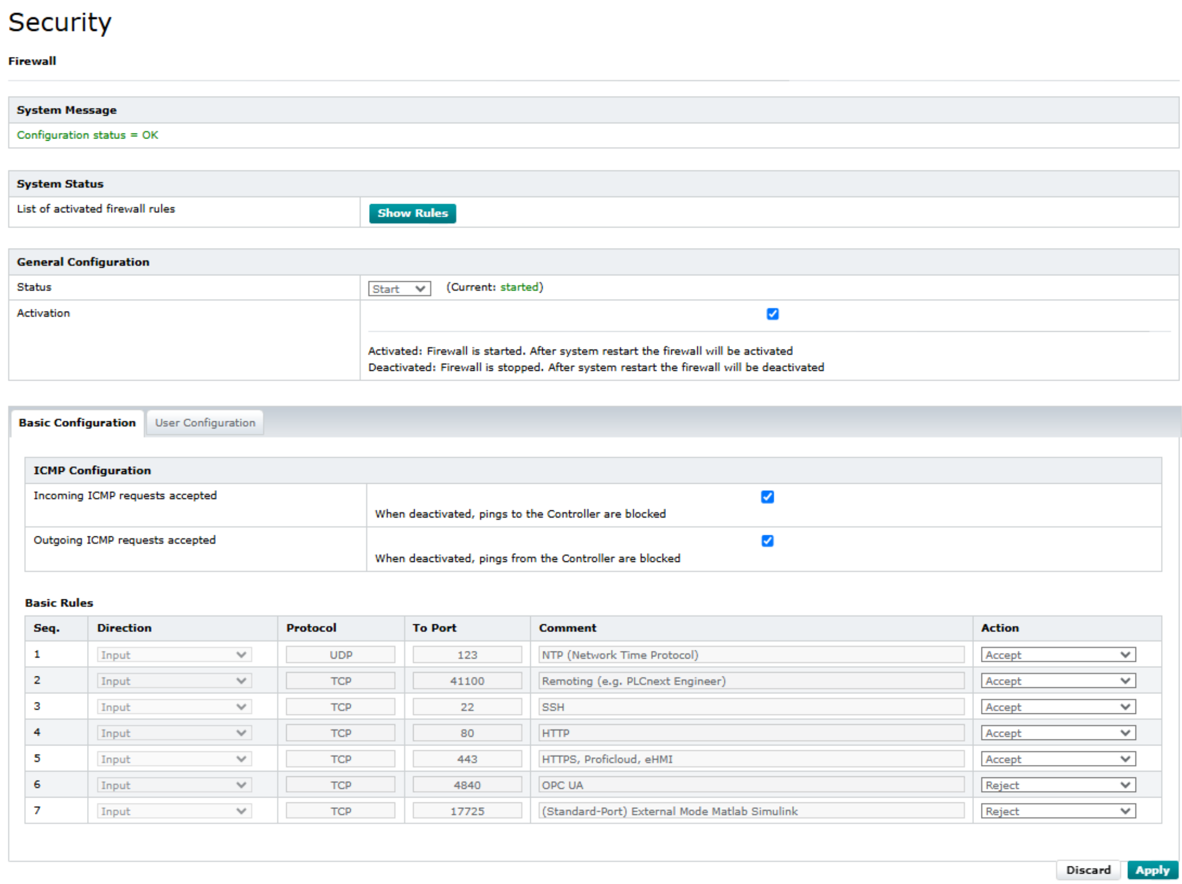

Figure 9: Firewall settings

2.6.4 Network Time Protocol (NTP) clock synchronisation

Select “Date and Time” from the main menu and make sure all server hostnames (0.pool.ntp.org, 1.be.pool.ntp.org, and 2.europe.pool.ntp.org) have a minimum polling time of 1 minute and 4 seconds, and a maximum polling time of 36 hours, 24 minutes and 32 seconds applied. To change the polling interval, click the pencil icon on the right of each server hostname, modify the “Min. polling time” and/or “Max. polling time” and click “OK”. Finally, click “Apply” to confirm.

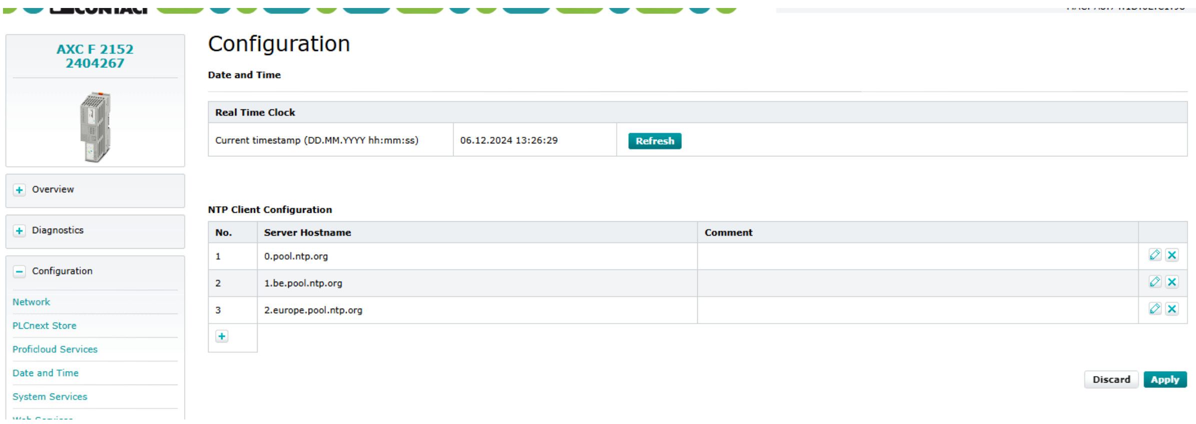

Figure 10: NTP clock synchronisation

2.6.4.1 Troubleshooting

Follow these steps if the synchronisation does not work.

To setup the NTP, the PLC needs internet access to the NTP server. Open an SSH tunnel to the Linux core of the PLC, for example with PuTTY, and use the following command to check the connection:

ping 8.8.8.8

Create a root user in Linux and set the password to[10]:

sudo passwd root

And enter the root user mode:

su

Set the date and time to the correct UTC time, either by using a command, or by configuring it in the PLC:

date -s "YYYY-MM-DD hh:mm:ss"

Now, edit the settings of the NTP server:

cd / etc

…

nano ntp.conf

And add the following line:

tos maxdist 20

[10] The password can be modified, but unless there is a good reason to change it, using this one is preferred. If the password is changed, please make sure to remember it.

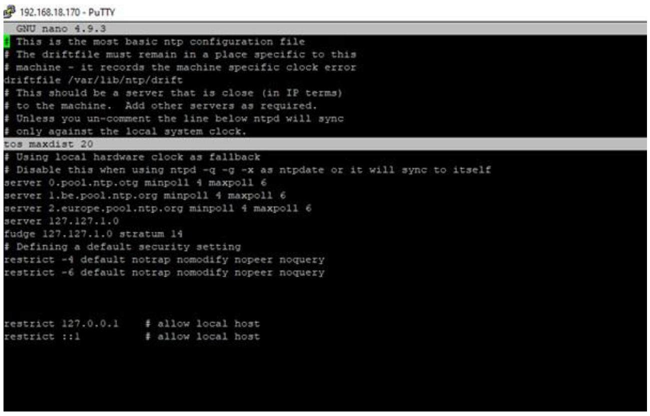

Figure 11: PuTTY

Press Ctrl + S and Ctrl + X in the WBM to restart the NTP daemon and click “Apply” in the previously opened Date and Time window. Wait 2 minutes and open the inquiry program.

ntpq –q

The ntpq -p command queries the NTP daemon (ntpd) on a Linux system, to retrieve information about its synchronised peers. Running ntpq -p displays a table-like output with detailed columns:

- **remote**: Hostname or IP address of each NTP peer.
- **refid**: Reference ID used by the NTP peer for synchronisation.
- **st**: Stratum level of the NTP peer.
- **t**: Type of peer (l for local, u for unicast, b for broadcast).
- **when**: Time in seconds since last successful communication.
- **poll**: Interval in seconds between NTP queries.
- **reach**: Octal representation of success/failure history.
- **delay**: Round-trip delay time to the peer (ms).
- **offset**: Time difference between system’s clock and peer’s clock (ms).
- **jitter**: Variability in round-trip times (ms).

Symbols like *, +, -, # denote the synchronisation status: * preferred, + candidate, - viable but not selected, # rejected.

Example

remote	refid	st	t	when	poll	reach	delay	offset	jitter
===========	===========	===	===	====	====	====	=====	=====	=====
LOCAL(0)	.LOCL.	14	l	462	64	200	0.000	+0.000	0.002
*ntp2.belbone.be	10.0.0.5	2	u	63	64	377	5.789	+1.020	0.914
+vps-7d02b399.vp	152.78.229.49	2	u	3	64	377	12.236	-1.561	0.577

This output indicates the local clock (LOCAL(0)), a selected NTP peer (*ntp2.belbone.be), and a candidate peer (+vps-7d02b399.vp). In summary, the presence of a selected (*) peer ensures continuous clock synchronisation through the NTP protocol in a Linux environment. You can test this by changing the internal clock, wait a few minutes, and check the time using:

date

3 MINT Power Control Unit (PCU)

3.1 DSO/TSO

Grid or system operators are key players in the energy industry. They are responsible for maintaining the reliable and secure operation of the electrical grid. To ensure it operates within its capacity, they constantly monitor the grid's performance, balancing electricity demand and supply. In Europe, grid operators are divided into transmission and distribution system operators. A Transmission System Operator (TSO) is responsible for the transmission of electricity from generation plants to regional or local electricity distribution operators. A Distribution System Operator (DSO) manages the local and regional energy distribution networks that transport electricity to end users.

In a new decentralised energy landscape, DSOs have additional responsibilities. The increasing popularity of local energy assets, such as electric vehicles (EVs), photovoltaic (PV) systems and heat pumps generate new challenges. TSOs' limited insights into their activity and the lack of transparency about the utilisation of grids, especially in low voltage networks, can result in inaccuracies in load and generation predictions. Substantial electricity pulls during peak demand, for example, could impact the system's balance of supply and demand. So, to avoid grid congestion, a capacity tariff was introduced, enforcing stakeholders to spread their energy consumption as much as possible.

And that is where MINT comes in, to effectively oversee and regulate assets, ensuring their optimal and grid-friendly behaviour. Incorporating forecasts, consumption patterns and asset performance into an energy management system, MINT seamlessly links all energy assets together and allows producers and consumers to communicate and match the demand to the available supply. It is a smart, self-managing energy management system that keeps the balance of all your energy assets.

3.2 PCU

Combining standardised code elements (Function blocks) and methods to ensure maximum flexibility and operational reliability, the PLC library easily integrates the control of power production assets (PV, Wind, CHP, ...) into a program to make sure the demands of power distribution companies (Fluvius, ORES, Sibelga, ...) are met.

Depending on the PCU's ability to communicate with them, the architecture is compatible with several devices and brands, allowing it to control all kinds of assets with their specific function. The default way of communicating is Modbus TCP or RTU, but other ways are possible.

For distributed power control (multiple electrical cabinets), multiple PLCs in a Master-Slave configuration can be used. In that case, the master PLC will control the slave(s), the power of the site considering a hierarchy, and oversee the connection to the utility company. This is crucial to meet all the requirements of the grid operator and have a reliable system that can perform multiple roles. Connecting to the DataHub and the master, slave controllers have a limited configuration, they do not have the ability to connect to RTU and battery interfaces. Master and slave(s) will communicate over a secure TCP connection and at least one PLC should be configured as a master. The MQTT connection to the DataHub enables visualisation of the power production in the MINT Portal or advice-based injection, but also injection limitation, which can be enabled, disabled, or controlled based on ENTSO-e day-ahead pricing. Connecting to a battery, allows for imbalance control to regulate the flow of energy to and from the grid based on imbalance pricing.

The PCU architecture is also universally compatible with libraries and other custom-made software, such as Code Creator to communicate with specific devices, and Solarworkx[11] to communicate and control various PV inverters.

More details on the PCU (control functions, configuration methods, interfaces, …) and clear instructions on how to configure the PCU can be found in *MINT_PCU_EN.pdf*.

[11] Solarworkx requires an additional license.

4 MINT Cloud

4.1 DataHub

As mentioned in section 2.4, an MQTT communication program connects the DataGateway to the DataHub. It consists of three major parts: One that handles incoming data, one that sets up the client, and one that handles outgoing data. To establish a connection with the DataHub and use the MINT Cloud capabilities, the MQTT driver program, which can be found in the MINT Core template, needs to be configured together with a certificate that enables the secure connection to the DataHub. The procedure to install the certificate is found in *MINT_Certificates_EN.pdf*.
In the PLC next program you can add the SaaS token to enable the connection to the DataHub.

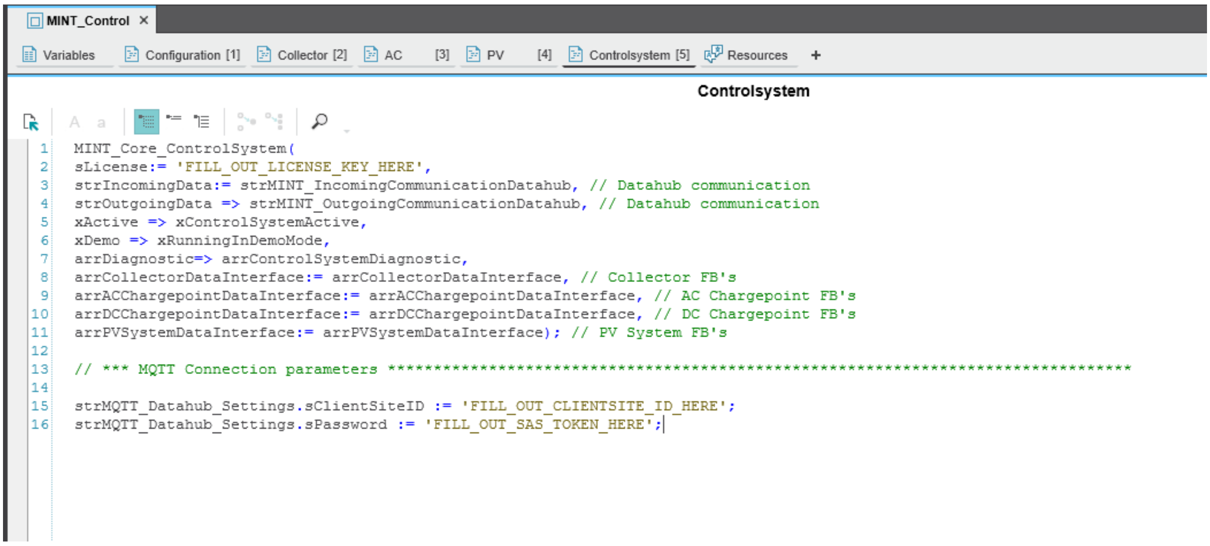

Figure 12: DataHub credentials

The MINT DataHub is set up as a stateless data processing service, which means that data will be forwarded to the PLC on-site or pushed from the PLC to external parties. All communication parameters are set inside the control logic of the MINT library. Clear instructions on how to configure the PCU or MINT controller so it can connect to the DataHub can be found in *MINT_PCU_EN.pdf*. Once the connection is established, data between the MQTT broker and the MINT DataHub can start flowing.

4.2 Portal

The portal is the frontend application, which allows customers and administrators to manage their MINT DataHub environment. Here they can manage the drivers, MINT controllers, site configs, controller SaaS tokens, external services and monitor their site through dashboards.

4.2.1 User management

The portal is accessible with credentials and has different user levels, which can be managed in the portal.

4.2.2 Site management

The site management page is to manage all necessary settings to connect, monitor and maintain a MINT connected site. Here they can import site details using the site configuration tool, manage the PLC connections, check which data connections are active, and much more.

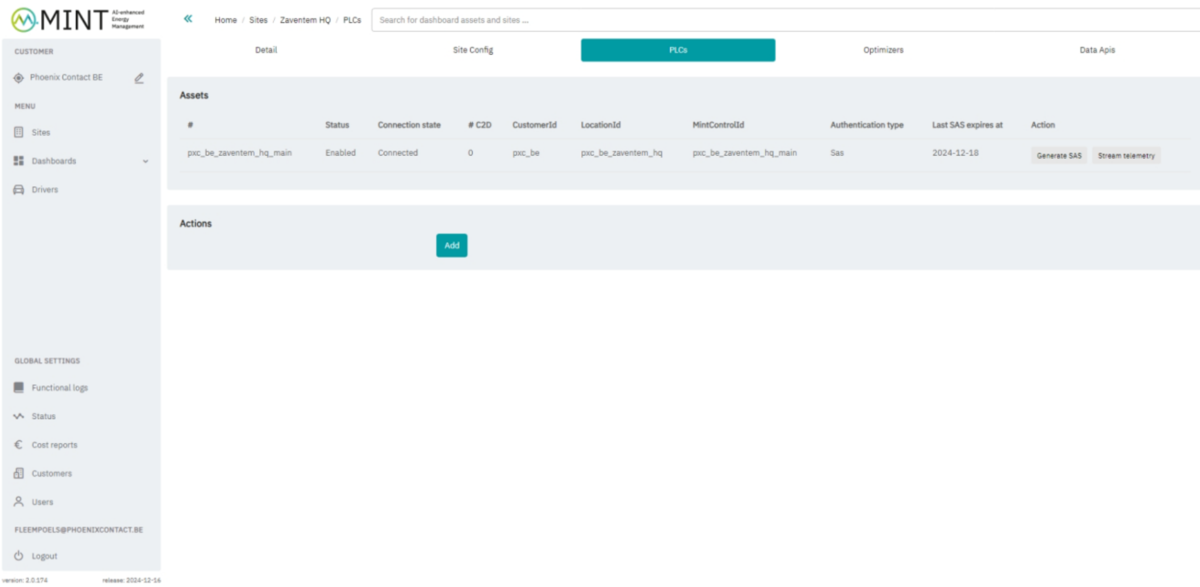

Figure 13: Portal site management

4.2.3 Driver pool management

The Driver pool is a list of users that received access to the MINT tenant through the MyCapacity app. It will allow users to update their departure time and requested energy to get an optimised charging session. The driver pool is an API to the Capacity environment and will not store personal data in the MINT DataHub. For GDPR policy we refer to the GDPR documentation of Cegeka.

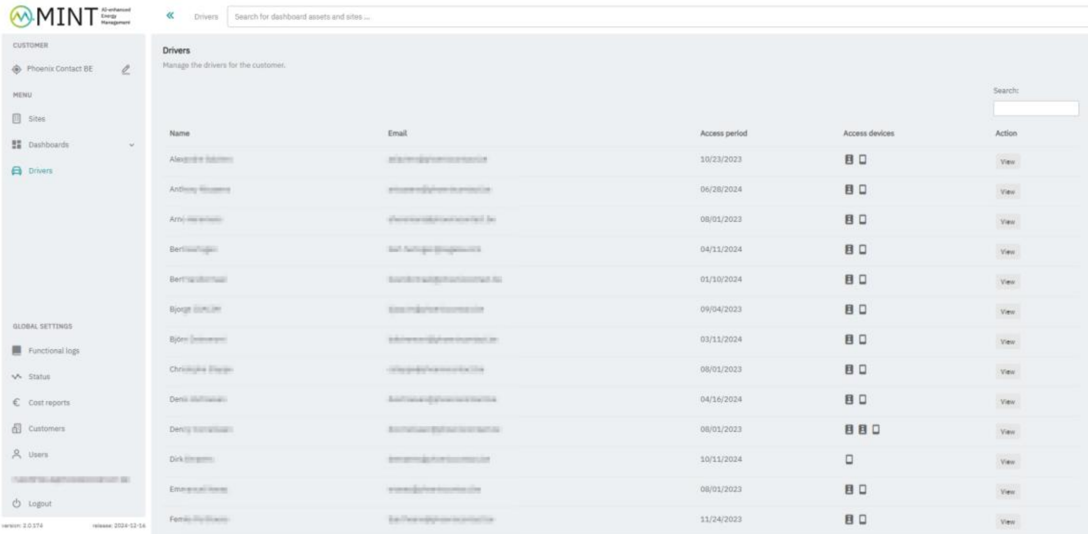

Figure 14: Driver pool management

4.3 Dashboarding

A centralised and cloud-based dashboard allows users to visualise and monitor energy flows of several sites at the same time. The default templates are detected automatically and will be visualised based on the site structure drawn in the site configuration tool.

These are the default templates.

4.3.1 AC charger

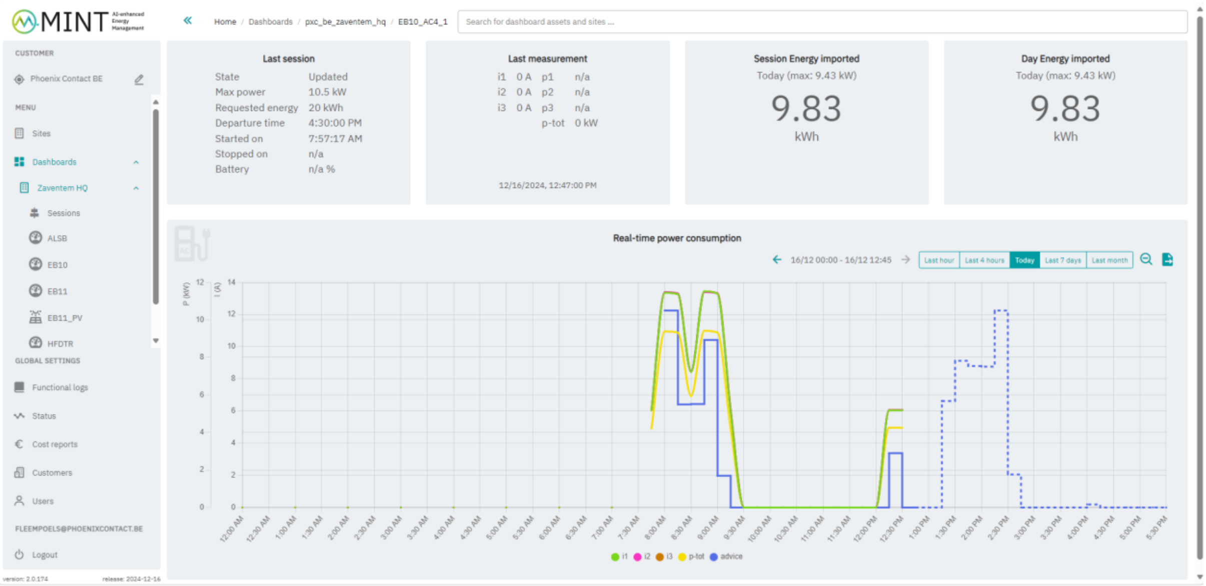

Figure 15: Dashboard AC charger

4.3.2 DC charger

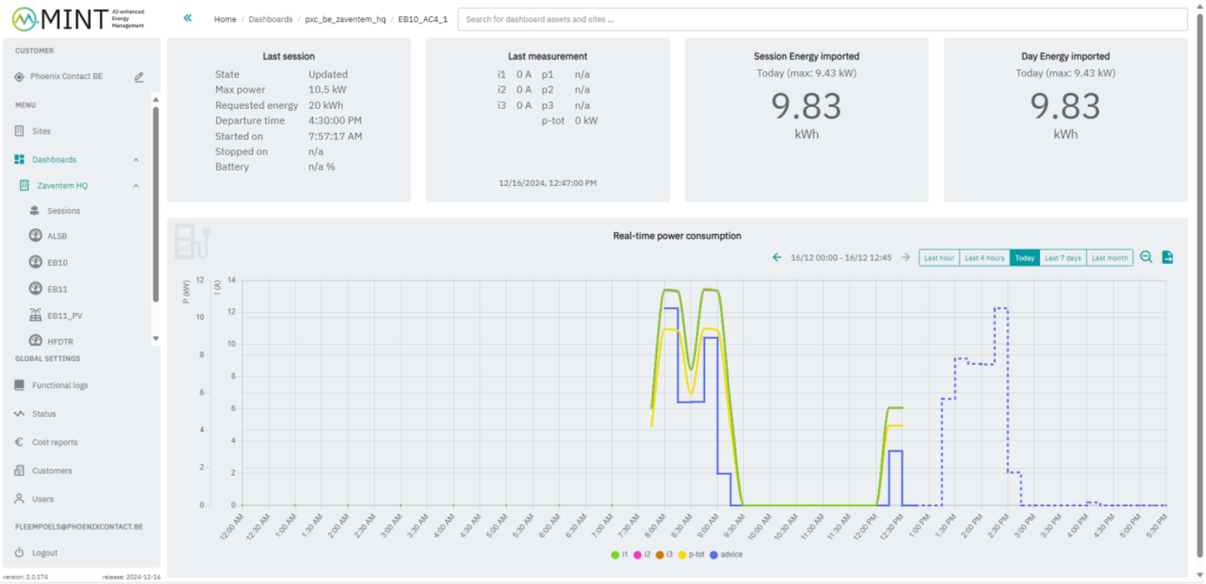

Figure 16: Dashboard DC charger

4.3.3 Solar

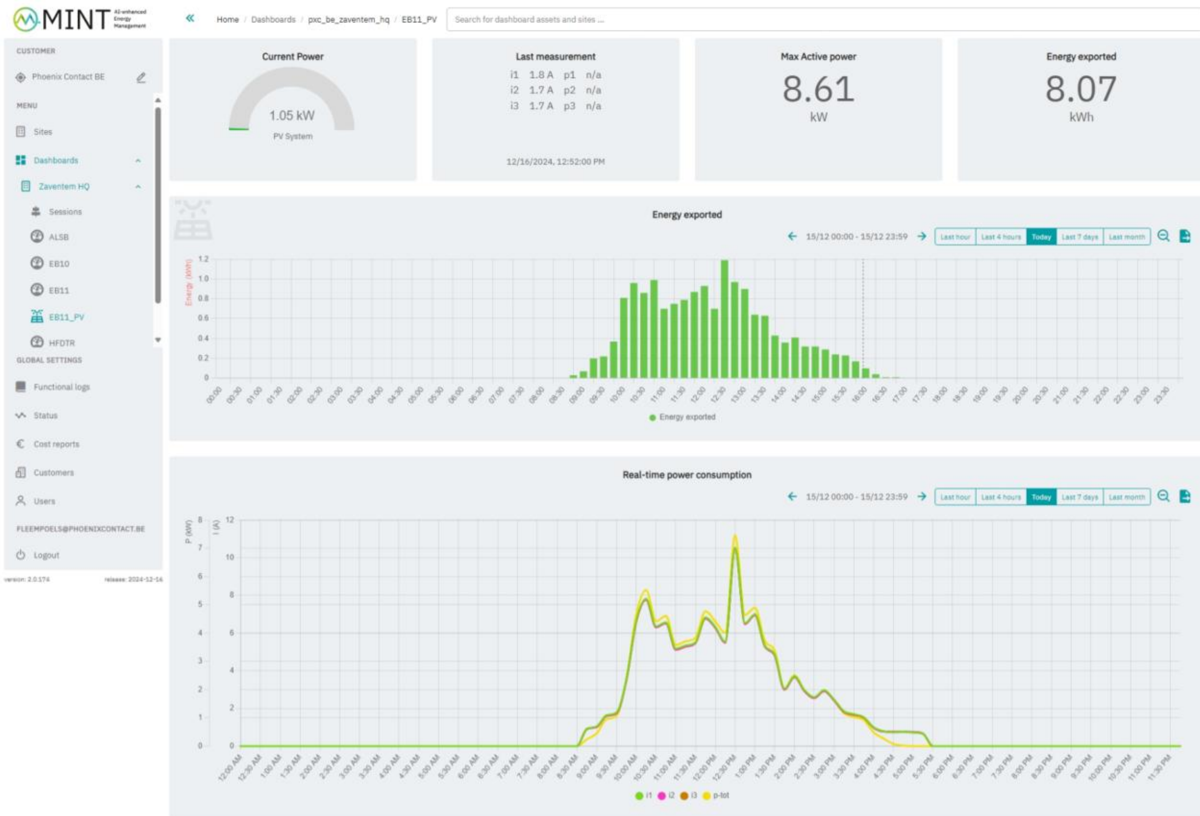

Figure 17: Dashboard solar

4.3.4 Battery

In development.

4.3.5 Collector

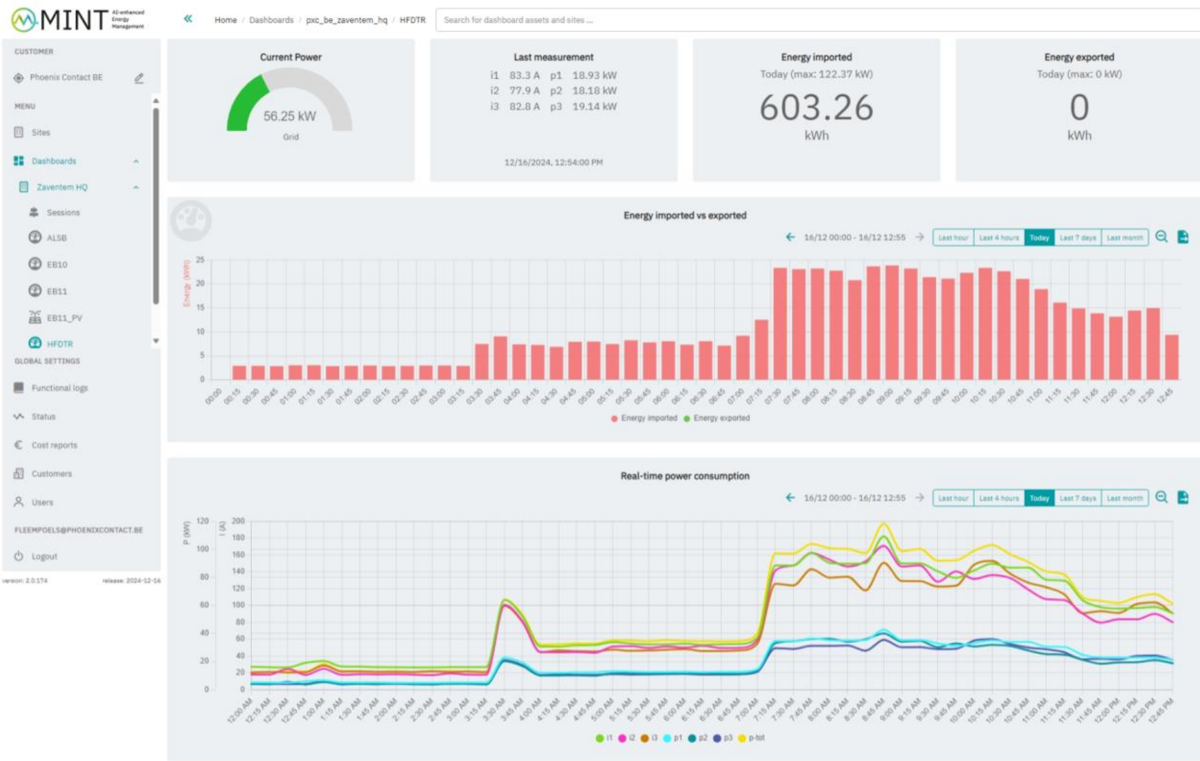

Figure 18: Dashboard collector

4.3.6 Site main page

Figure 19: Dashboard site main page

4.3.7 Session page

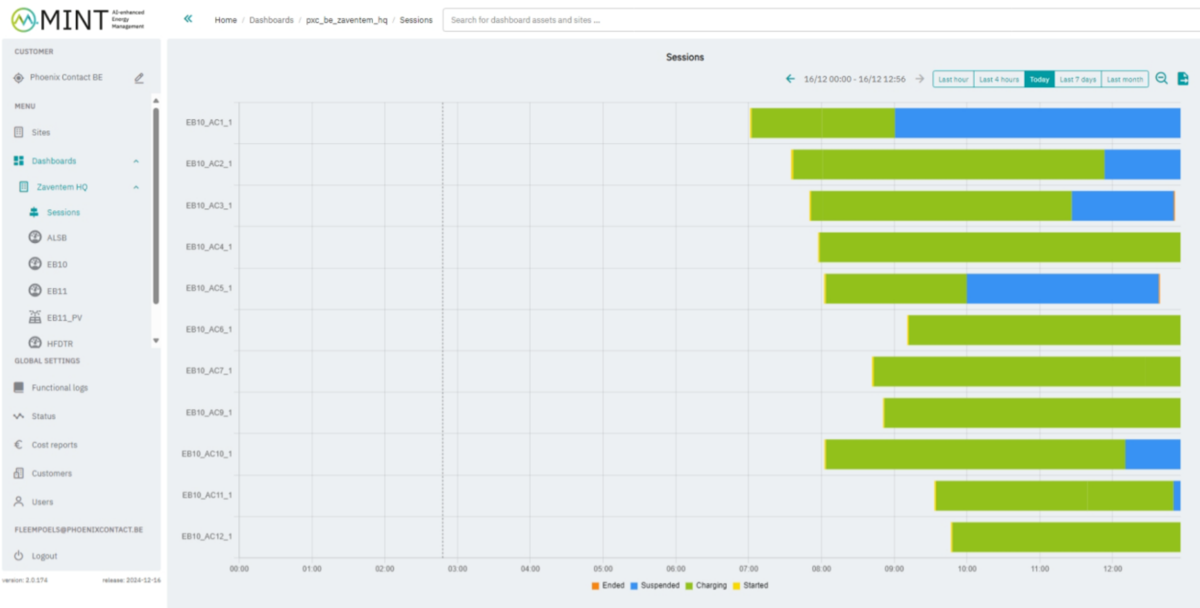

Figure 20: Dashboard session page

4.4 Reporting[12]

The MINT Reporting tool will analyse historical data and deliver a report in which CO2 reduction, price shifting and peak shaving results are documented and printed in a readable document.

4.5 Advanced

MINT Advanced is the AI layer on top of MINT Core that optimises your power management. Using data from several sources, such as energy prices, weather forecasts and user preferences, it advises the local controller on how to store or deploy the available energy in the most economical and ecological way.

Taking priorities into consideration, the goal of MINT Advanced is always optimal comfort for all end users, without wasting energy or overcharging. Thanks to the knowledge about the available energy and the user profiles from the app, this also applies to EV users, who can set their preferences on when their car should be charged.

Moreover, the AI will learn consumption patterns and become more precise.

4.5.1 Optimiser

The MINT Optimiser is an external service that will receive all measurement data from the MINT Controller. Based on forecasters and multiple data inputs, it calculates the most economical and ecological way to consume kWh. For now, the Optimiser is limited to cars and batteries, but it can be extended to optimise all electrical controllable assets.

There are different types of forecasters.

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[12] Under construction.

4.5.1.1 PV prediction in the AI algorithm

This shows the last PV prediction (green), the measured PV production (yellow), and the PV prediction for the next 15 Minutes (blue).

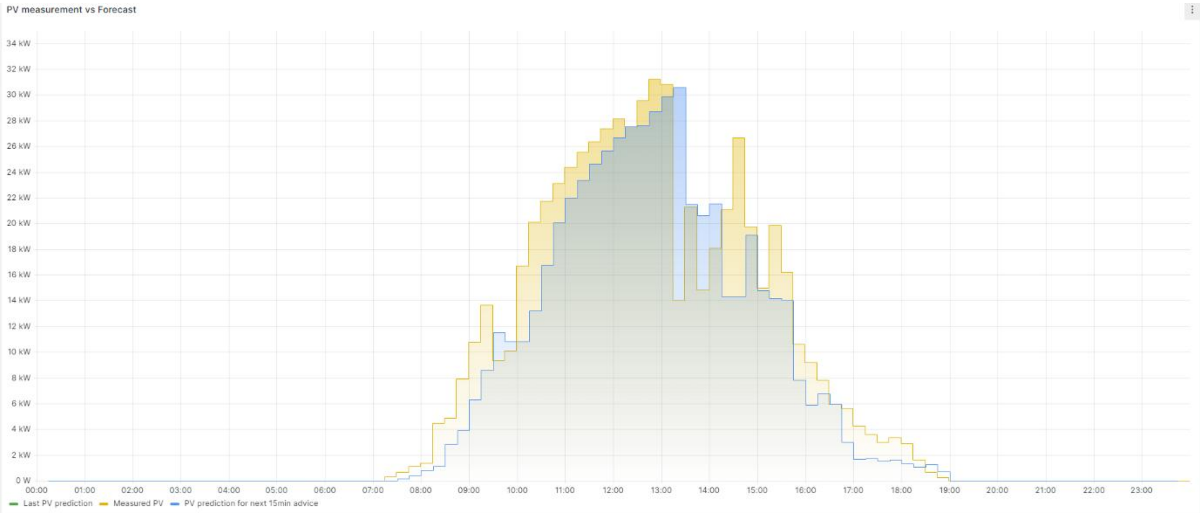

Figure 21: PV prediction in the AI algorithm

4.5.1.2 PV prediction of multiple solar fields in the AI algorithm

This shows the PV prediction of multiple solar fields behind one EAN number in the AI algorithm.

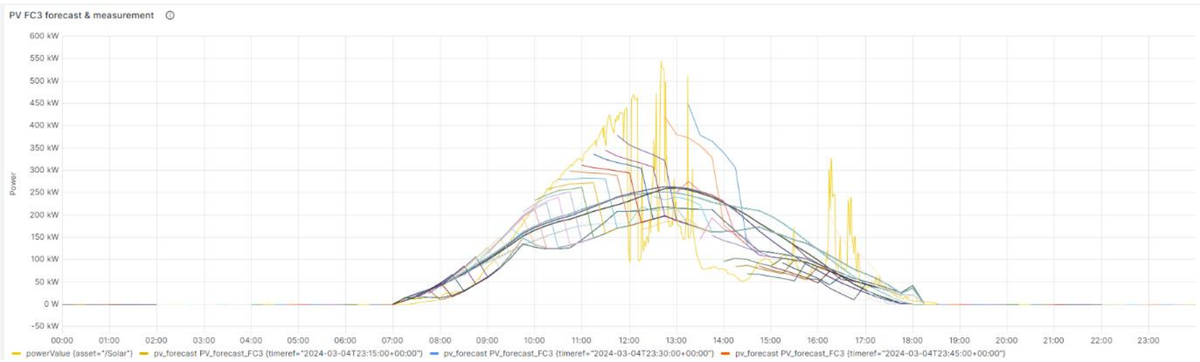

Figure 22: PV prediction of multiple solar fields in the AI algorithm

4.5.1.3 Uncontrollable load of the plant

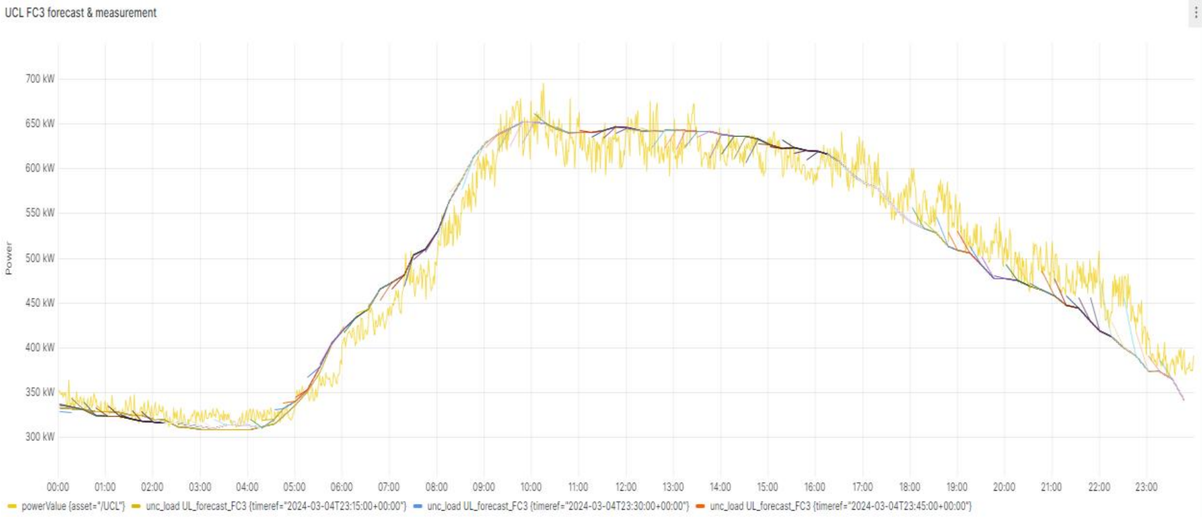

Figure 23: Uncontrollable load

To optimise cars, the Optimiser needs information like departure time and requested energy from the end user. This info can be collected in multiple ways.

4.5.2 RFID

Drivers and their associated RFID badge[13] can be added in the MINT portal. The RFID badge will identify users to activate the My Capacity app on their mobile phones.

There are multiple ways to identify the RFID badge in the MINT System.

4.5.2.1 Modbus protocol

Via the Modbus protocol, directly in the MINT controller. This is the most preferable way, but it requires a compatible charger where the RFID badge is part of the Modbus registers.

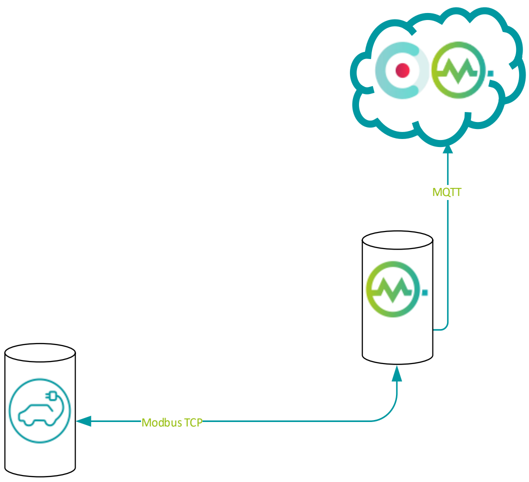

Figure 24: RFID via Modbus protocol

[13] The RFID badge will be used to start charging sessions over OCPP on the CPO platform.

4.5.2.2 CPO platform

Via the OCPI interface from an integrated CPO platform[14] to the MINT DataHub. When activating a session on a MINT Advanced controlled car park, the CPO sends the RFID badge number to the MINT DataHub to identify the user.

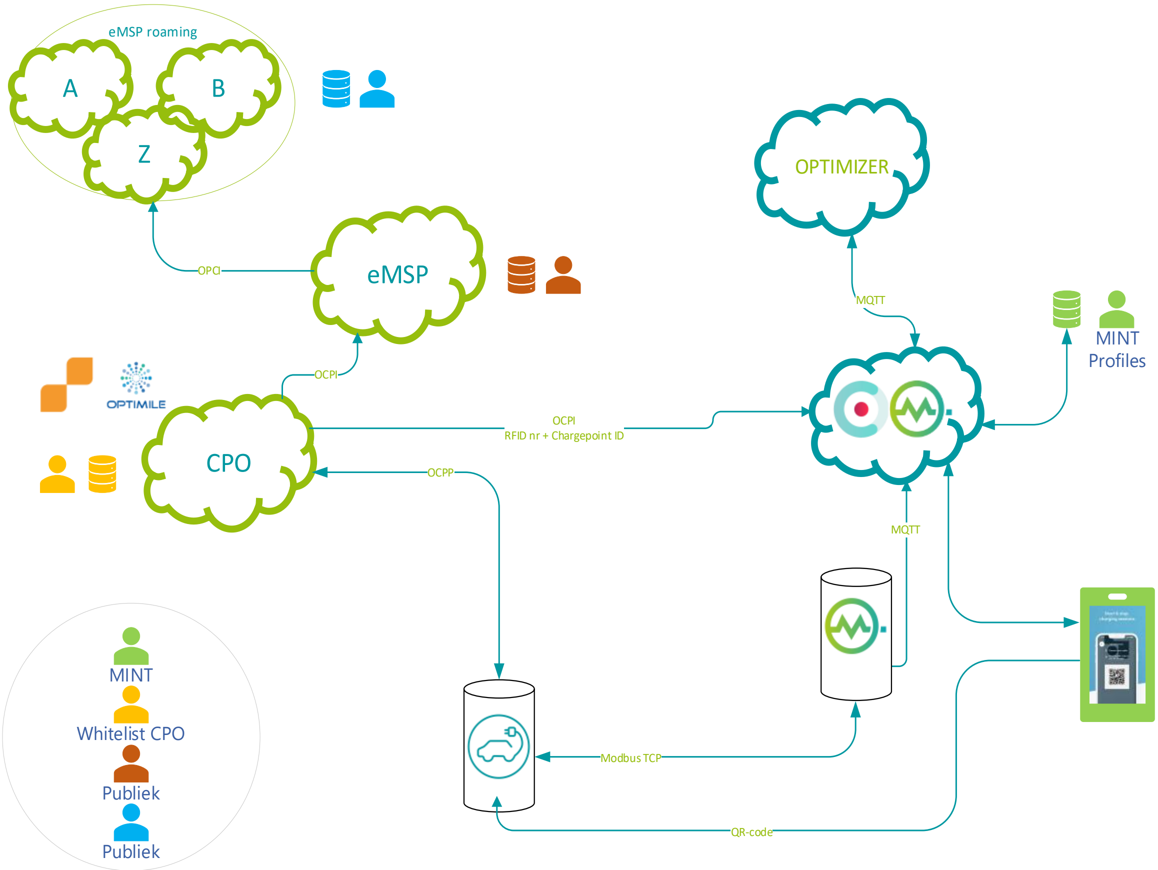

Figure 25: RFID via CPO platform

4.5.2.3 Broker

Via an OCPI interface to a partner platform (broker) between the charger and the CPO platform. The broker will act like the CPO and send all messages to the original CPO platform. If a charging activation message is sent, the broker will send a copy to the MINT DataHub to identify the user and, if it is a known MINT user, send a notification in the app.

[14] Optimile and white labels.

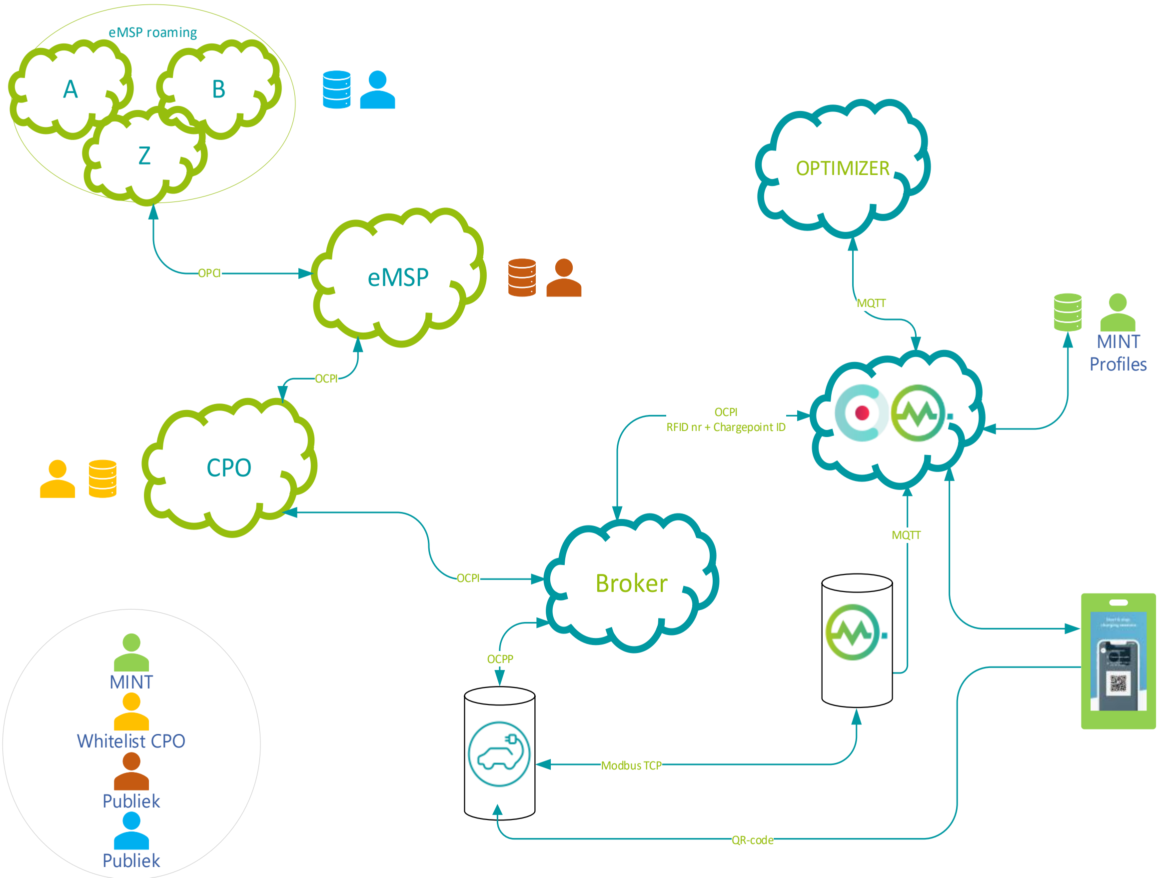

Figure 26: RFID via broker

4.5.3 App

The app can be used to modify a loading schedule. It will send a notification if a known RFID badge logs an active session in the MINT DataHub. This will initiate the user's default schedule that will be sent to the Optimiser. Thanks to the notification however, the user can modify this schedule and override the departure time and/or the requested energy. This can be done for every session, but for every new session, the default profile will reapply.

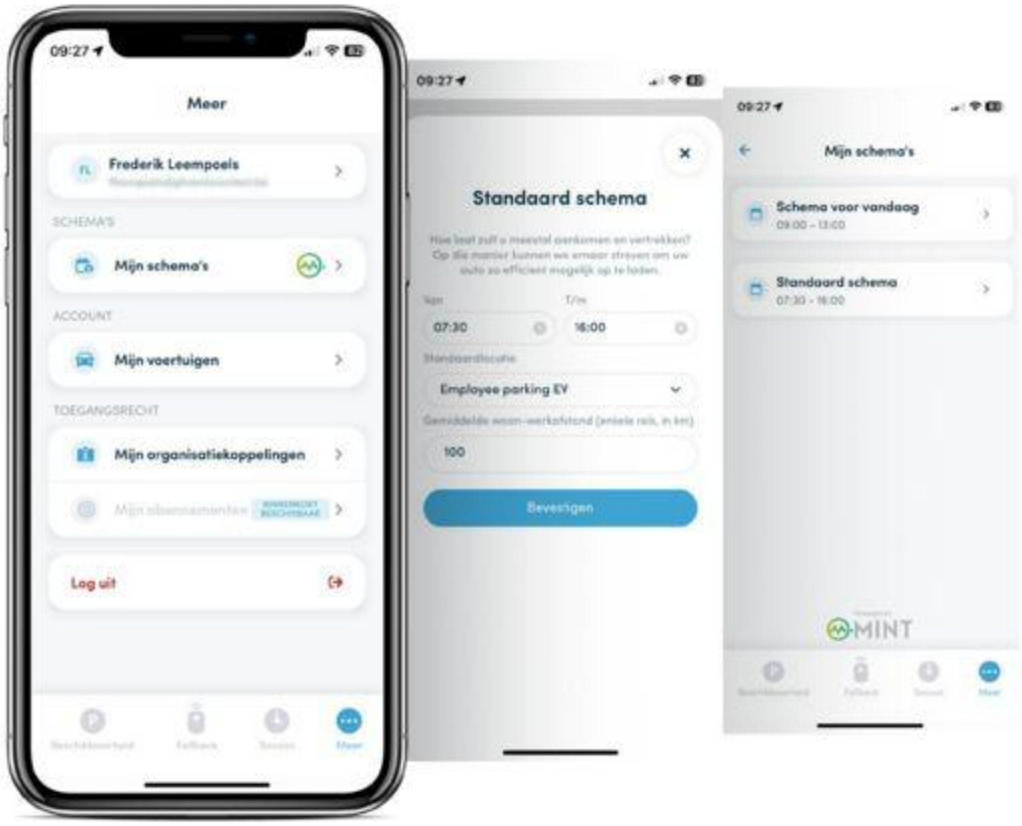

Figure 27: App

4.5.4 QR code

By scanning a QR code, a user can be redirected to a visitor portal of the MINT DataHub. It allows them to update their departure time and requested energy without sharing any personal information. To prevent misuse, the visitor portal will check for active charging sessions that have started less than 2 minutes earlier.

The QR code can be generated in the MINT Portal, and is linked to the equipment ID, which is used to identify the charge point in the MINT system. This means that every charging point has a unique QR code. For a charging point with two connectors, an additional question will identify which one is being used.

If a mobile device is linked to an open web page of the visitor portal, it is possible to access and update the values of the session.

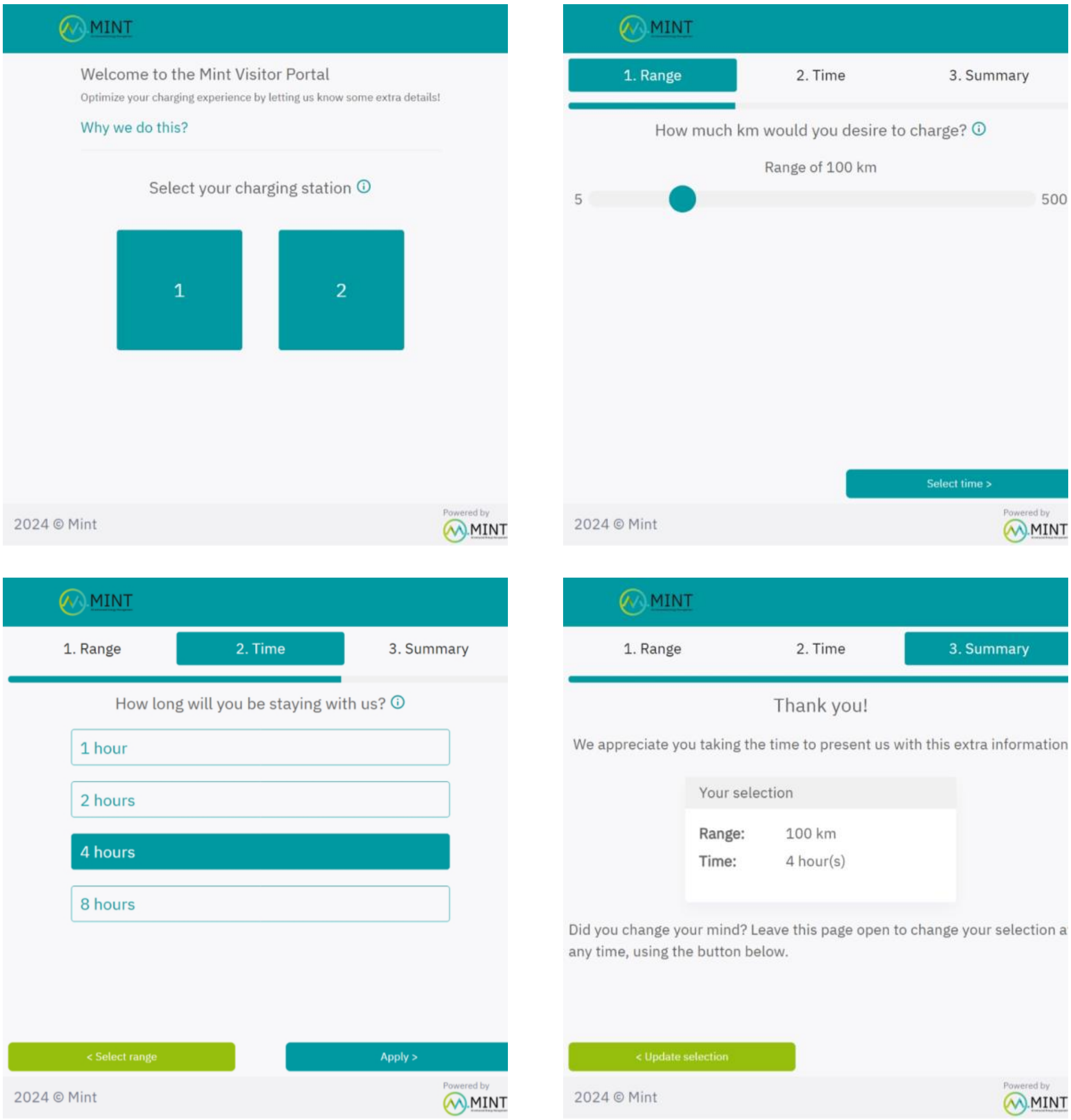

Figure 28: QR code

The visitor portal can be customised by changing the logo and colours.

5 MINT Integrations

The MINT Integrations are extensions of the MINT platform, allowing external parties to send data to the MINT platform and to receive data from sites in the field.

5.1 API

To integrate a MINT API into an application, a client ID and secret to send data or provide at least one API endpoint to receive data should be provided.

The necessary credentials to connect to the API can be requested through a local Phoenix Contact subsidiary. In the first stage, credentials for the test environment will be provided. At a later stage, after validation by your subsidiary, production credentials can be provided as well.

The next step is to start integrating with the API or to provide the endpoint details to a Phoenix Contact subsidiary, so that the process to enable the integration on the MINT DataHub can be initialised.

The Advice API provides the following endpoints:

- Advice (AC Charger)
- Advice (Battery)
- Droop (Battery)
- Command

The Planning API provides the following endpoints:

- Plan

The Data API messages you can receive on your endpoint(s) are Charge transaction and Energy report from:

- AC Charger
- Collector
- PV
- Battery
- DC Charger

To setup these API integrations, we refer to separate documentation:

- *MINT_Advice API_EN.pdf* on how to send advice data to the MINT platform.
- *MINT_Planning API_EN.pdf* on how to send plans to the MINT platform.
- *MINT_Data API_EN.pdf* on how to receive data from the MINT platform.

In the documentation, every aspect of the API will be described. Read it carefully, since all of it is important to setup a working integration. For any other integrations, please get in touch with a local Phoenix Contact subsidiary for the right documentation.

5.2 FTP

To connect an application to MINT through FTP, setup on the side of the external party will be required before any integration can be set up in the MINT DataHub. This can be a single location for all data, or separate locations for each data type. Considering some requirements, the external party is completely free in deciding how the FTP integration is set up.

The next step is for the external party to provide the FTP connection details to their Phoenix Contact intermediary, so that the process to enable the integration on the MINT DataHub to start sending data can be initialised.

The messages you can receive through the FTP integration are Energy reports from:

- AC Charger
- Collector
- PV System
- RTU

To setup this FTP integration, we refer to separate documentation: *MINT_Data FTP Connection_EN.pdf*. In the documentation, every aspect of the FTP integration will be described. Read it carefully, since all of it is important to setup a working integration. For any other integrations, please get in touch with a local Phoenix Contact subsidiary for the right documentation.

6 Data & Security

All information about data & security can be found in separate documentation: *MINT_Data policy 2025_EN.pdf*.

6.1 Firewall setting

The configuration of the firewall (or routers) should allow the connection ports to reach each other. Clear instructions on how to configure the firewall settings can be found in section 2.6.3.

7 Code Creator

The Code Creator generates PLCnext Engineer code to setup a Modbus RTU or Modbus TCP connection to an asset in the field. The expected input like Modbus registers, function codes and transformations needed to compile this code is provided by device packages. Code Creator enables users to add read values automatically to a PLC program for interpretation, which saves time and reduces the risk for errors. To link the devices' outputs in the program, users can just import a zip file with the required information. How to create this file is explained in the documentation on the download page.