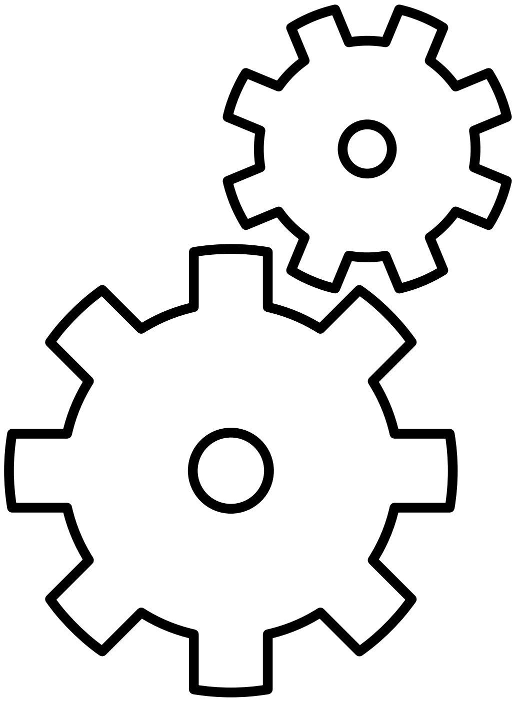
Configuration Guide

Pixii EV Charger Integration

Shaping the power of the future



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Revision	Date	Comment
0.1	2022-09-02	Initial draft
1.0	2022-12-16	First release
1.1	2023-01-05	Small corrections

1 Introduction

This document explains the different ways to integrate the Pixii PowerShaper systems with EV chargers. There are two main options:

1. Communication-less integration: There is no communication between the EV chargers and the PowerShaper. The PowerShaper relies on the Peak Shaving functionality to provide power when the consumption exceeds a discharge threshold and charges the battery when the consumption goes below a charge threshold.
2. The PowerShaper system is controlled by the EV charger system by communication and may use the Peak Shaving functionality as a fallback mechanism for discharge and charge. Alternatively, the idle charge power may be used to put the system in charge mode up to the idle SoC if the demand response signal is stopped.

NOTE:
This document only explains the control/operational aspects of EV charging integration. The electrical characteristics of each site and the EV charger need to be evaluated for e.g. high THD and other disturbances and limitations. Corrective equipment such as transformers and filters may need to be installed. That is outside the scope of the Pixii delivery.

1.1 Relevant documentation

Common for both solutions, please refer to the following documents:

- Pixii PowerShaper Service Priorities and Scheduler
- Pixii PowerShaper Peak Shaving
- Pixii PowerShaper Meter Setup
- Pixii PowerShaper Multicabinet Meter Sharing
- Pixii PowerShaper Multicabinet Peak Shaving
- Pixii PowerShaper Multicabinet Common Setup

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2 Communication-less integration

2.1 Concept

In this approach, there is no communication between the EV chargers and the Pixii PowerShapers. The PowerShapers are connected to a meter, reading the load, and using the Peak Shaving functionality to discharge when the load exceeds a set discharge limit, and charges when the load goes below a set charge limit.
The advantage with this approach is that no communication integration is needed.
The disadvantage is that if the battery is depleted, the EV charger system will not know that it should stop charging if it has no meter readings, which may result in tripping the circuit breaker. Usually, the discharge power will start derating somewhat when reaching the min SoC.
The EV charger system should then in this option read the load from a meter and throttle the charge power if the breaker trip limit is exceeded. In this case, the systems can work autonomously.

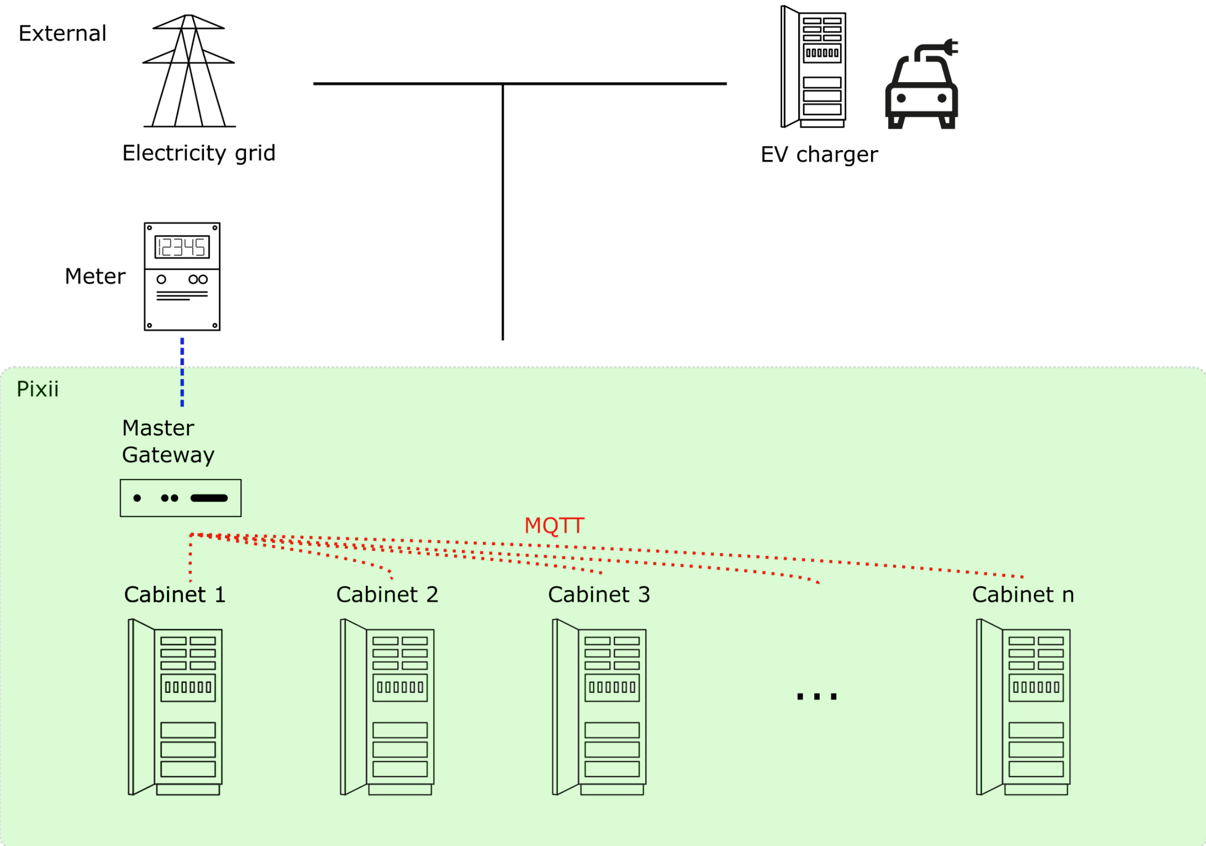

Figure 2.1 Communication-less integration

2.2 Implementation details

The system is configured using the peak shaving functionality, please see the list in the relevant documentation chapter.
A meter is connected to the Master Gateway in the PowerShaper system. The meter needs to be selected from the list of supported manufacturers. The active power is read once per 1 – 10 seconds, depending on the meter type. It is advised to use a meter that supports update rates of 1 seconds to be able to react quickly to the changes in power demand.
The charge and discharge limits are programmed in the PowerShaper system according to the limitations of the electrical breaker with some margin, and the expected energy cycling of the system.
Figure 2.2 shows a suggestion for the service settings, where the PowerShaper will discharge up to 50 kW if the meter reading goes above 150 kW, trying to keep the meter at 150 kW, and charges with up to 50 kW if the meter reading goes below 50 kW, trying to keep the meter below 50 kW while charging.

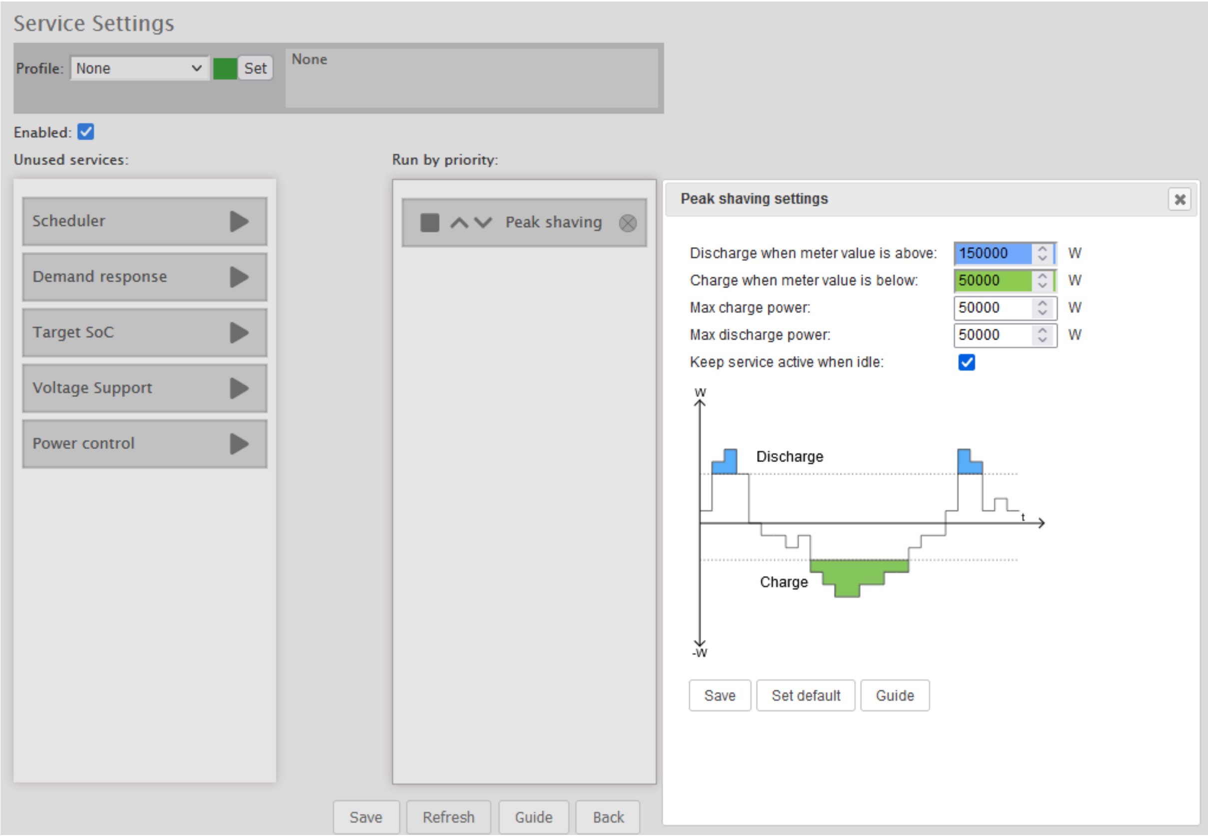

Figure 2.2 Peak shaving settings

2.3 Relevant documentation

See *"1.1 Relevant documentation"*.

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3 Communication-based integration

3.1 Concept

In this approach, there is established a communication between the EV chargers and the Pixii PowerShapers. The options are either MQTT or Modbus. MQTT is recommended.
The PowerShapers are by default passive in this configuration and will not discharge any power unless commanded. It is the EV charger system (denoted by “Energy Management System” in the illustration below) that is responsible for commanding discharge when needed. It may also command charging, however that is usually not needed.
The PowerShapers are connected to a meter, reading the AC load of the site. It will use the Peak Shaving functionality to charge the battery when the load goes below a set charge limit, in this relieving the EV charger system from ensuring that the batteries are charged when there are no vehicles needing charging.
Alternatively, the “idle charge power” may be used to ensure the system is charged up to the idle state of charge when not receiving discharge commands from the EV charger system.

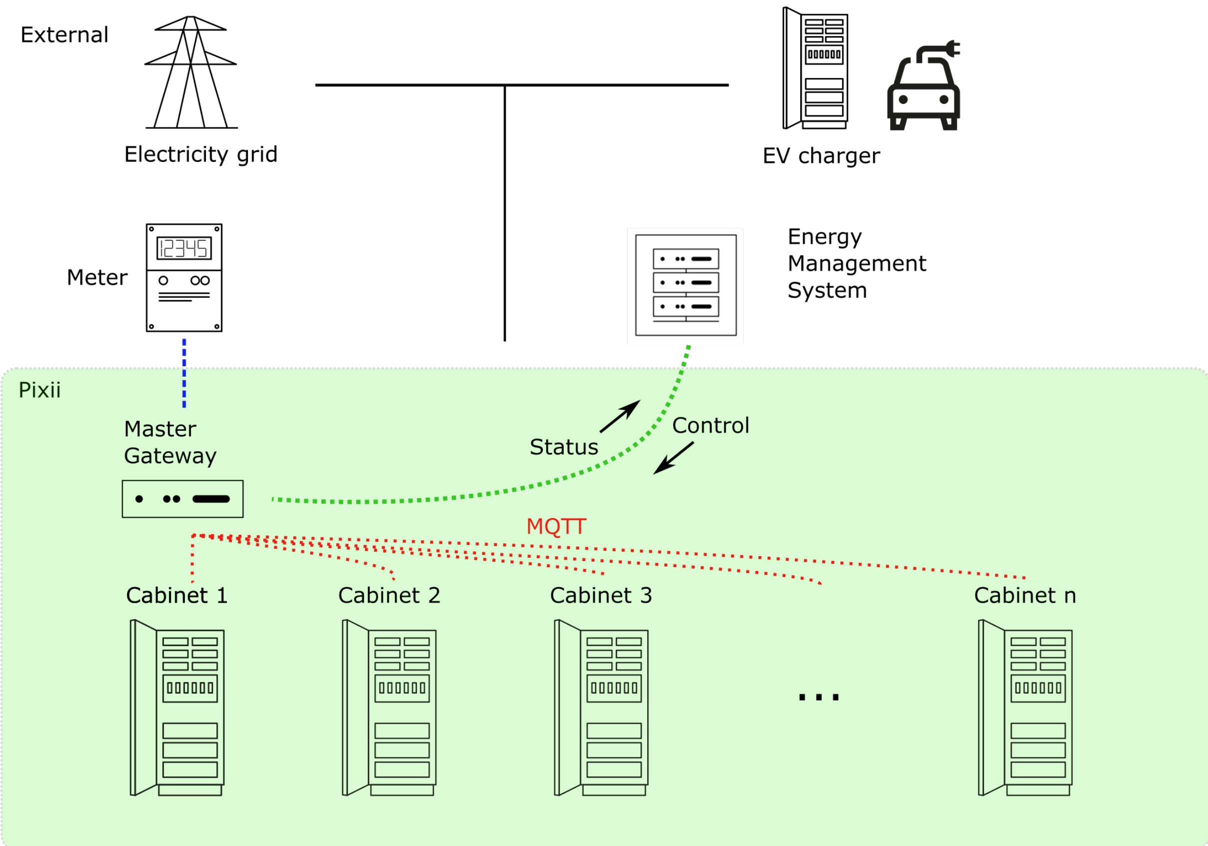

Figure 3.1 Communication structure between the EV charger system and the PowerShapers

The advantage with this approach is more granular control for discharging the system when needed, and that the status of the PowerShapers will be known which can be used to keep the charging power within safe limits.
It will also open for using the PowerShaper system for other services.

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3.2 Implementation details

The EV charger control system will use the Demand response service to command a discharge reference when power from the PowerShaper system is required; i.e. when an EV is to be charged.
The EV charger control system and the PowerShapers will need to be on the same network/ connected to the same network switch when using MQTT or Modbus TCP.
The EV charger control system can get the PowerShaper power output value and status, and use this to determine if the EV charger may allow increasing the power usage for charging the EV's.
Using MQTT, the PowerShapers will individually publish the "core" and "battery" status topics. The publish rates can be configured, but 1 s publish rates is recommended. The "ac_w" value may be used to check the amount of power the PowerShaper system is discharging or charging, while the "grid_cap_w_n" (n = 1, 2 and 3) values indicate how much power capacity is available.
The "batt_soc" in the battery topic will indicate the state of charge of the battery, while the "batt_soc_min" and "batt_soc_max" values are the lower and upper operation limits of the battery. When the "batt_soc" reaches the min and max limits, the PowerShaper system will stop discharging and charging, respectively. The EV charger system should thus leave some margin (1 - 2 %) to the min and max values since the SoC is an estimated value coming from the battery manufacturers' BMS and may be suddenly changed as a result of a recalculation.
The PowerShaper system uses the active power readings from the meter, and report the active power for control. The breakers are rated by AC amperage, which need to be taken into consideration. The same considerations need to be made for the EV charger limitation method (AC amperage or power), and the expected AC-DC conversion losses to the EV.
The configuration options from the EV charger should include:

- The grid amperage/power limit (breaker/transformer) limitations.
- Power margin to the grid limit.
- Power increase step size for when the EV requests more power.
- Power decrease step size for when less power is used than discharged by the PowerShaper system.

> **NOTE:**
> It is highly adviced to leave some room of margin between the charging power and the breaker limit + the discharge power from the PowerShapers.

The suggested control flow diagram is illustrated in *Figure 3.2*:

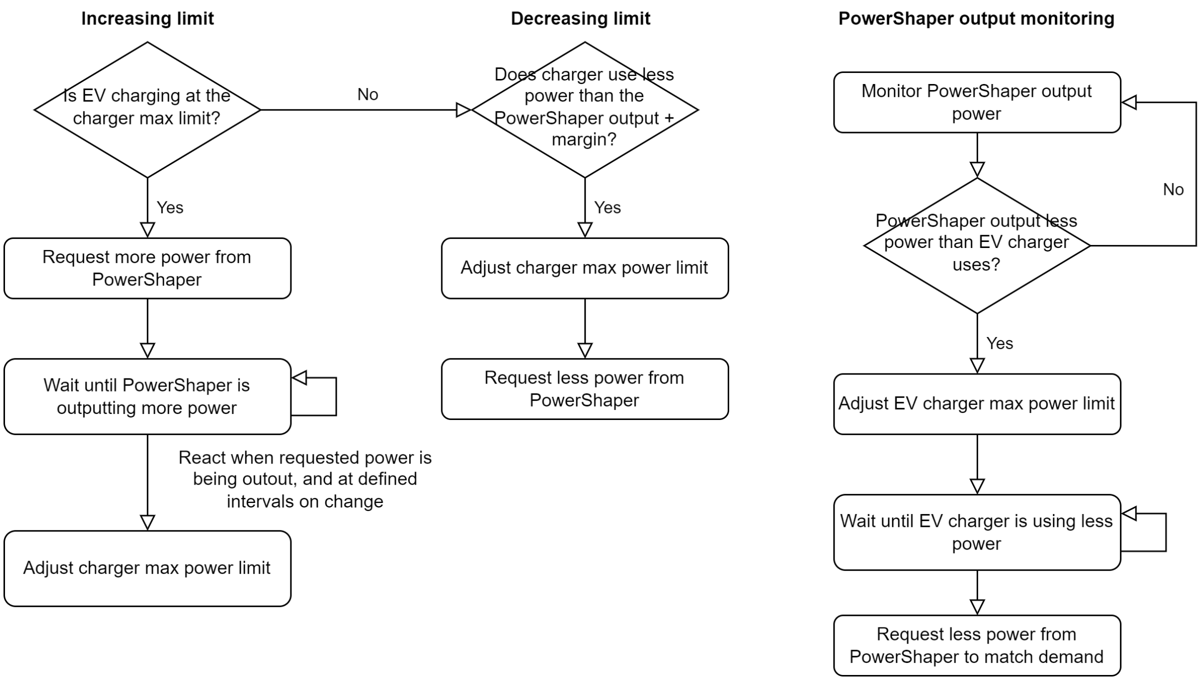

Figure 3.2 Control flow diagram

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The operation is best explained with a simplified example:
In this case, the breaker limit is 100 kW (= grid power limit), and there is a 100 kW PowerShaper system (two cabinets):

1. There are no EV's connected to the charger, and the batteries are at max SoC, 90 %.
2. An EV is connected to the system, and charging starts with 95 kW (5 kW = grid power margin).
3. The EV charger requests the PowerShaper to output 10 kW more (5 kW from each cabinet, = 10 kW total power increase step size)
4. The PowerShapers output 5 kW each, and reports that in the "ac_w" values. The EV charger may now allow the EV to charge with 105 kW, leaving some margin.
5. The EV increases its' charging power to 105 kW.
6. Steps 3 – 5 are repeated until the EV cannot take any more power, or the PowerShapers are not able to discharge more.
7. When the EV charger notices that the EV is taking less power than available, the EV charger should request the battery system to lower the output (using the power decrease step size), and lower the maximum charge limit to the EV.
8. When no power is needed from the battery system, the EV charger must stop requesting power, so that the PowerShapers may enter either Peak Shaving or idle mode, to charge the batteries.

The typical service settings is illustrated in *Figure 3.3*.

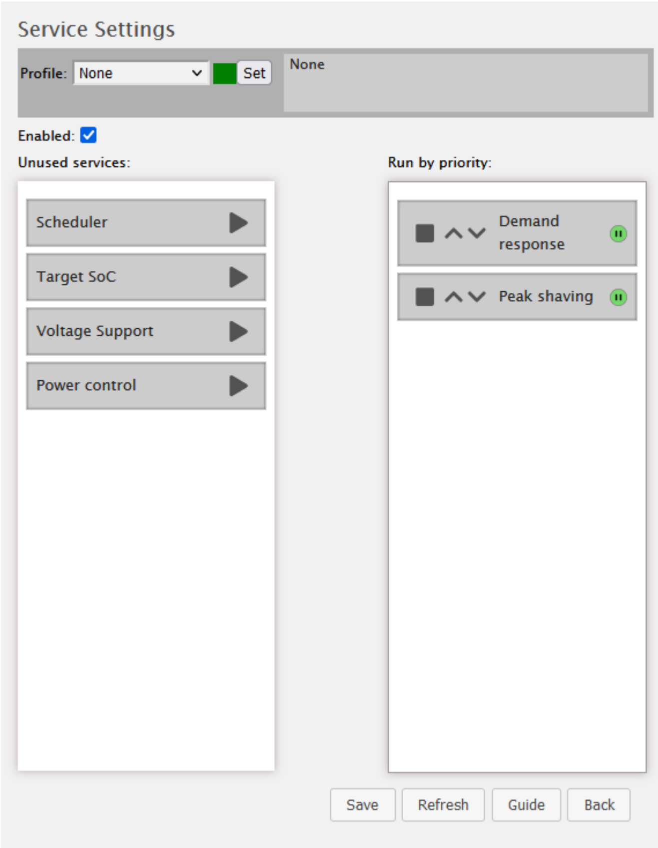

Figure 3.3 Service settings for communication based control

The PowerShapers may also publish the meter reading in the "meter" status topic that may be consumed by the EV charger.

3.3 Relevant documentation

See *"1.1 Relevant documentation"* and:

- Pixii PowerShaper Demand Response
- Pixii PowerShaper Communication and Control Integration Guidelines
- Pixii PowerShaper MQTT monitoring and control
- Pixii PowerShaper Modbus Control
- Pixii Powershaper Modbus Mapping

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