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Deliverable 1.3.1 EMS analysis: Asset types and integration mapping

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Date	Version	Person
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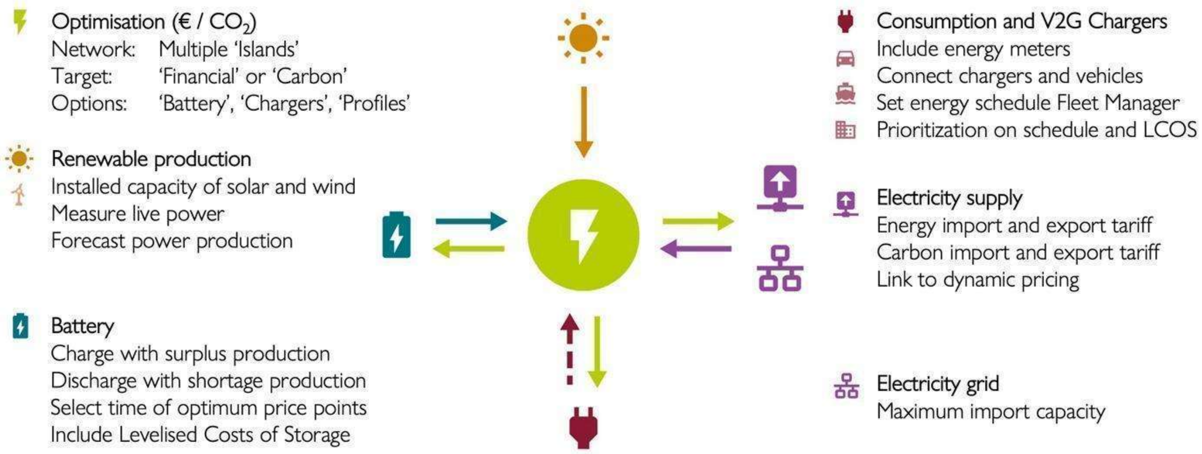
Contents

1. Introduction

1.1 Technical aspects of the EMS

The technical aspects of the Energy Management System (EMS) for Local Energy Communities will be detailed in this activity (1.3). An EMS is intended to monitor and optimise a network of energy objects towards maximising self-consumption and/or minimising costs.



The EMS for a community connects the energy objects within a community with the intention to monitor and optimise them towards highest self-consumption or minimum costs. Indicated are the elements which make up the EMS.

This first report covers the results of the first deliverable 1.3.1. It includes a gap analysis between the currently existing open source EMS and the technical challenges and requirements for the pilot solutions. The gap analysis focusses on four types of technical requirements:

- Energy optimisation requirements
- Installation and maintenance requirements
- Monitoring and KPI requirements
- End user requirements

Due to time order reasons, the initial reference will be the Arnhem pilot, complimented with initial feedback by stakeholders of the Fourmies and Brugge pilots, as well as partner Veolia. The complete end user needs (*D.1.1.2*), as well as the technical analysis and KPI's (*D.1.2.1*) will only be available after period 2. In the deliverables 1.3.2 and 1.3.3 we will revisit the user needs, technical analysis and defined KPI's and adjust or expand when required, based on the additional requirements from the pilots.

1.2 The Arnhem pilot

Saksen Weimar is a newly built and renovated residential district mainly with large private houses with solar panels. There are 373 households in the district, of which 170 are social housing apartments and the rest are privately owned. Within the district there is a large installed base of solar (estimated between 500-1,000 kWp) and between 20 -30 owners of electric vehicles. The amount of heat pumps is still restricted but expected to grow as are the number of EV owners. This growth is expected to cause net congestion problems within the next 5-10 years.

The objective of the pilot is to maximise self-consumption within the district by organising an energy collective, supported by an EMS. Using the energy within the district when it's produced is expected to offer a financial benefit to all members through a fair pricing method for energy sharing. Secondly, energy sharing reduces net congestion which is expected to lead to lower network costs for residents. Finally, there is a shared and articulated interest by residents to become less dependent on energy supplier as well as become more sustainable. The EMS is expected to support all individual residents to consume energy at the most optimum times at the lowest integral cost. Some of that can be done through automation, but the vast majority has to be informed and stimulated to adjust consumption to benefit.

To further increase self-consumption, a collective heat storage system (expected capacity 300,000~600,000 kWh) will be implemented locally accompanied by extra solar production capacity. By adding this storage the still existing surplus of energy production (on sunny days, during late morning early afternoon) will be stored as heat. The heat will be redistributed on colder cloudy days in spring, autumn or winter. The additional benefit of this seasonal storage is that the amount of heat based on natural gas will be reduced. To maximise self consumption and optimise costs, the EMS is expected to include the optimisation of the storage and redistributing as heat.

This infrastructure development and integration work will initially be led by the local government contracting the several elements of the energy system, with the plan to transfer management of the energy system to the local energy collective. During development integrators need tools to connect and configure the EMS. The energy collective will, moving forward, be responsible for operating and maintaining the energy system, including the EMS. The Energy collective therefore need the EMS to offer the insights in performance as well as maintenance of the energy system.

1.3 The Fourmies and Brugge pilots

The additional Fourmies and Brugge use cases, and the impact on the EMS requirements will be evaluated in period 2 (as part of deliverable 1.3.2 and 1.3.3), after user needs (D 1.1.2) and technical requirements (D 1.2.1) are complete.

Two distinctions are already worth mentioning here. For Fourmies, also electric batteries are considered as part of the energy mix. Therefore, they need to be taken into account in the EMS. In addition individual residents in Fourmies are not perse expected to organise themselves in a collective.

For Brugge, the role of the energy collective is (partially) filled in by the housing cooperation Vivendo. At this stage it's not yet clear how that will impact additional requirements for the EMS.

2. Gap analysis for technical requirements

2.1 Introduction

In this section we will initially take the Arnhem pilot as reference for defining the functional and technical requirements for the EMS, using the four categories:

- Energy optimisation requirements
- Installation and maintenance requirements
- Monitoring and KPI requirements
- End user requirements

Once user needs (D 1.2) and technical system requirements (D 1.2.1) are ready, we will compliment requirements for the EMS in deliverable 1.3.2 and 1.3.3.

2.2 Energy optimisation requirements

Asset types

For an Energy Management System to work all parts of the system are represented by standardised data models (called asset types with attributes). The benefit of the standardised data models is that any other part of the EMS as well as users can recognise these models, avoiding confusion or errors.

What asset types are available in the current open source EMS OpenRemote

- Electricity producers: solar and wind
- Electric battery
- Electric vehicle and electric charger
- Electricity supplier (to include contractual data, such as prices)
- Electricity meters

What's missing for asset types

First of all, two asset types are missing: one representing heat storage and one representing an electric heat pump. In addition, however we observe that the exact definition of asset types is different per location, due to many factors. First and foremost, as there are no generally adopted standards and therefore manufacturers and integrators all use their own definitions. So next to additional asset types we require a solution for integrators to adjust or create asset types per use case.

Forecasting methods

For an energy management system to optimise those objects which can be controlled, like EV charging, a heatpump or storage devices, a lot of energy data has to be forecasted.

What forecasting methods are available in the current open source EMS OpenRemote

- Forecasting of e.g. consumption based on 'weighted exponential averaging', which is using past data at the same time of the same day as most likely value
- Solar power forecasting, based on weather forecast and specifications and orientation of installed solar panels
- Wind power forecasting, based on weather forecast, and specifications of installed turbines

What's missing for forecasting

In general forecasting needs more advanced models which not just take into account the historical behaviour but also the influence of multiple other attributes, which are non linear and interdependent. Examples are

- Solar and wind power forecasting, corrected with the actual measured data
- Forecasting of EPEX prices ahead of them being published
- Forecasting of consumption as influenced by e.g. temperature, wind.

Optimisation methods

Optimisation has multiple challenges. First of all, what to optimise for, secondly for whom, and thirdly how.

What optimisation methods are available in the current open source EMS OpenRemote

- At individual level optimising on costs, considering dynamic energy tariffs

What's missing on optimisation

Referring to the 'what', 'for whom' and 'how', there are a couple of elements missing:

- Optimise both on dynamic energy tariffs as well as dynamic capacity limits as set by grid operators, which adds also a time order challenge.
- Optimise energy sharing across modalities, from electricity to heat
- Motivate and incentivise residents to manually change their behaviour ad hoc as well as structural (optimise human behaviour)
- Optimise an energy system at two levels, both at individual household level as well as at district level with shared energy assets (e.g. district storage)

2.3 Installation and maintenance requirements

For an energy management system to be successful also the installation effort and flexibility is relevant as well the requirements from maintenance point of view. It will be a system integrator which initially support the development and configuration of the EMS. Also the maintenance of the full energy system is most of the time done by a system integrator. Based on the feedback of existing system integrators who use OpenRemote as well as the Partner Veolia in this project, we have identified the following gaps, which require additions or improvements.

What's missing or can be improved on Flexibility

- Create your own asset types
- Method for integrators to add their own services, e.g. for optimisation or forecasting

What's missing or can be improved on Workflow integration

- Extend alarms with option to define notifications methods and frequency
- Reporting functionality with a schedule
- Monitoring device connectivity

What's missing or can be improved on Integrations

- Modbus (locally via gateway)
- Cloud based energy assets: Enode
- Integration of OpenRemote as gateway including hardware OTA updates
- Integration Open source Home automation: Home Assistant, OpenHAB
- Integration with Energy markets

What's missing or can be improved on security

- Secure access of gateways through tunnelling
- Data access restriction methods

2.4 Monitoring and KPI requirements

For monitoring similar requirements are needed as indicated for maintenance requirements as indicated in 2.3. In addition, there are performance related requirements for the effectiveness and quality of the EMS. The following KPI's are proposed for this purpose:

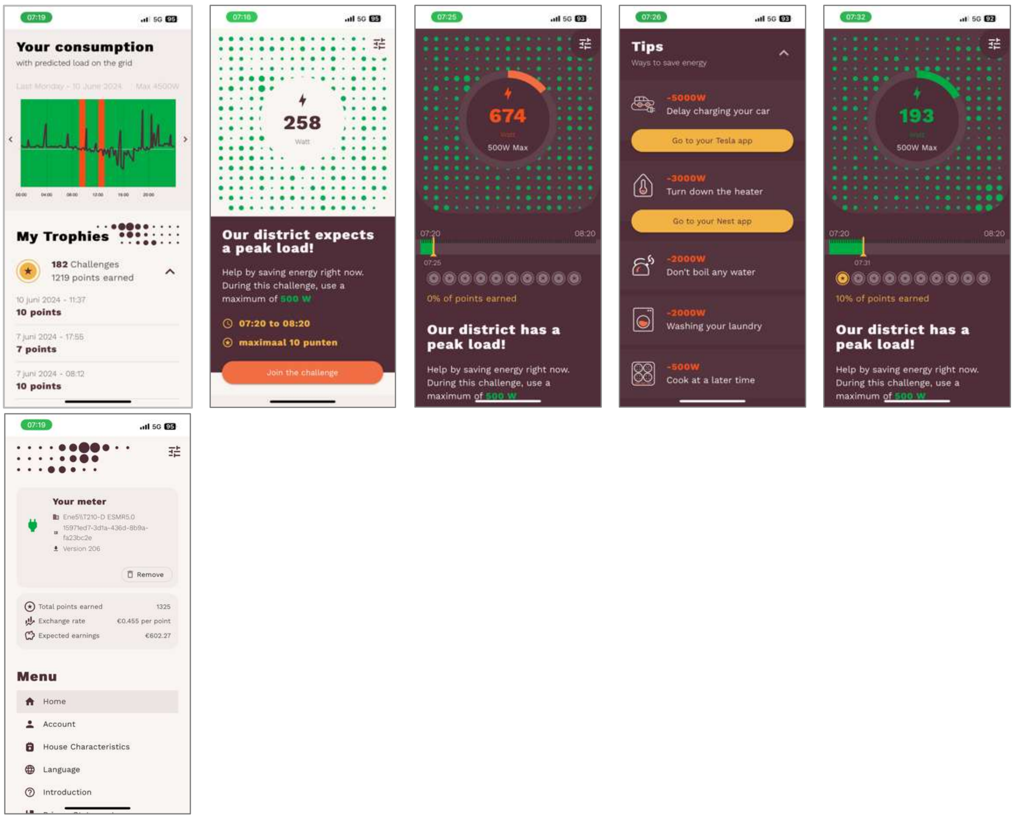
- ***Self-consumption:*** the percentage of produced energy which is immediately consumed (or temporarily stored) within the energy community.
- ***Renewable Energy Share Electric:*** the percentage of the overall electricity consumption which is locally produced.
- ***Renewable Energy Share:*** the percentage of the overall energy consumption (electricity, gas, heat) which is locally produced.
- ***Optimisation savings:*** the financial savings as realised by the EMS, by increasing self-consumption within the district.

What's missing or can be improved for monitoring and KPI's

- Method for integrators or cooperations to define and calculate KPI's similar as those above in a flexible manner.

2.5 End user requirements

The EMS includes a means to communicate with end users, engage them, and be motivated to adjust their behaviour in line with the set optimisation goals within the EMS. At the start of the project, the open source EMS from OpenRemote already included an end user app with this purpose, called OurGrid.



Screenshots of the OurGrid app for users as part of the already existing EMS. From left to right: real-time insight in current consumption of user as well as indication of district transformer by green/red background (1); When critical load is expected on district transformer, users receive a challenge (2-4); personalised tips are given linked to the users home situation (5); meter can be set as well as home settings, and earned points can be tracked (6).

What's missing or can be improved for the end user

To improve the OurGrid app to fit within the requirements of the Arnhem case, the OurGrid app needs to facilitate the foreseen extensions on the optimisation as shared earlier. The main elements which are missing are

- The ability as a user to take into account optimisation on dynamic energy tariffs as well as the requests received by the grid operator.
- The ability as a user to optimise your energy consumption, using an energy sharing method between participants
- The ability as a user to optimise energy sharing across, from electricity to heat
- The ability as a user to integrate heatpumps, EV or batteries for automated control

3. Summarising and next steps

3.1 Summary of gaps

Summarising from the earlier analysis the requirements for the use case revealed the following gaps in the existing open source EMS from OpenRemote, need to be addressed:

Energy optimisation

- Two additional asset types heat storage and electric heat pump.
- A forecasting method which takes into account the influence of multiple other attributes, which are non linear and interdependent.
- Optimisation based on both on dynamic energy tariffs as well as dynamic capacity limits as set by grid operators, with the additional time order challenge.
- Optimisation of energy sharing across modalities, from electricity to heat
- A method to motivate and incentivise residents to manually change their behaviour ad hoc as well as structural (optimise human behaviour) in conjunction with automatic control
- Optimisation of an energy system at two levels, both at individual household level as well as at district level with shared energy assets (e.g. district storage)

Installation and maintenance

- A solution for integrators to adjust or create asset types per use case.
- Method for integrators to add their own services, e.g. for optimisation or forecasting
- Extend alarms with option to define notifications methods and frequency
- Reporting functionality with a schedule
- Monitoring device connectivity
- Integration Modbus, Enode, OpenRemote as gateway, Home Assistant, OpenHAB
- Integration with Energy markets
- Secure access of gateways through tunnelling
- Data access restriction methods

Monitoring and standard KPI's

- Method to define and calculate KPI's similar as those above in a flexible manner.

The end user OurGrid app

- Optimisation on dynamic energy tariffs as well as the requests by the grid operator.
- Optimise energy consumption, using an energy sharing method among participants
- Optimise energy sharing across, from electricity to heat
- Integrate heat pumps, EV or batteries for automated control

3.2. The next steps

In Period 2 we will define detailed requirements and implement the EMS optimisation requirements (deliverable 1.3.2), the required integrator tools (deliverable 1.3.3) and the procurement and implementation guide for an EMS (deliverable 1.3.5).

In period 3 we will further enhance the end user energy app specifically towards further increasing of self-consumption by storing or consuming heat, the incentive model behind it, as well as a method to configure their individual optimisation routines (deliverable 1.3.4).