*local **E**lectricity retail **M**arkets for **P**rosumer smart grid p**OWER** services*

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Abbreviations and Acronyms

Acronym	Description
CA	Consortium Agreement
DoA	Description of Action (annex I of the Grant Agreement)
EC	European Commission
GA	Grant Agreement
PC-A	Project Coordinator-Administrative
PC-T	Project Coordinator-Technical
PMC	Project Management Committee
PO	Project Officer
QM	Quality Management
TMT	Technical Management Team
ToC	Table of Contents
WP	Work Package
WPL	Work Package Leader

Tables

Figures

Executive summary

This document describes the results of the feasibility analysis and the field devices integration work between field devices and the SESP, starting from the SGAM architecture defined in other work packages and deliverables.

It has been studied and analyzed different elements involved in communications platform from field devices to business layer.

In later chapters, it is documented different preconditions and future upgrades for the systems involved:

- Customer Communications Interface – related to SESP members status and control plan execution
- External information Providers – regarding flexibility on demand and metering data from DSO
- Field devices – related to SESP members and DER devices

From the SGAM architecture established in other WP´s it has been decided the best way to exchange data between SESP and field devices is using both an SCADA form the case of Norwegian Pilot where it is involved Generation and Storage and also using smart gateway in case of households in the rest of use cases for Malta, Germany and smart Homes in Norway.

1 Introduction

The objective of this document will be to define the minimum viable product (MVP), a product that has just enough features to gather validated learning about the product and its continued development.

2 System description

Before starting talking about the devices and systems studied, let´s start with a brief description of the whole EMPOWER system, to obtain the different parts that will be described in the following sections.

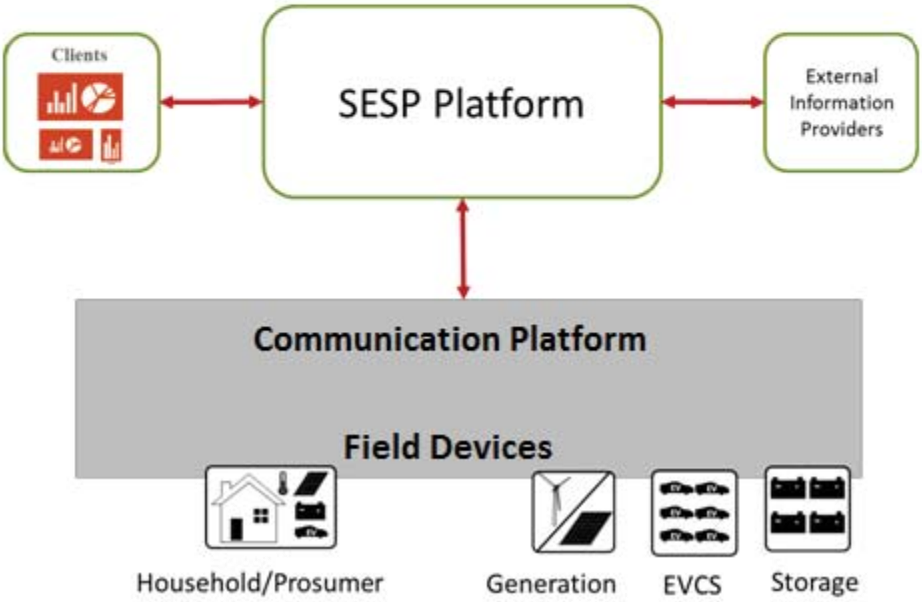

Figure 1.SESP Overview

As already mentioned in previous deliverables (D4.1, D4.2), the Communication Platform is divided into two types of systems.

- Household local controller systems
- DER Control System (SCADA)

In order to provide a two-way communication between field devices and BPL layer, where the SESP receives all the information from field devices as well as information from applications located in the business layer, various methods have been evaluated.

1. In the case of the system referred to the devices, located in household sites.

For each one of the pilots defined in the project, SESP system will receive data from each smart energy device installed in households.

It will be installed smart devices in Norway, Malta and Germany in order to obtain periodically meter readings of each customer, using an optical probe and a gateway device to send consumption information to the system SESP directly.

Participants in the EMPOWER project at each pilot site, will have to install a local controller with an optical reader to monitor the AMI meter.

Here are the specifications of these smart devices:

Squid.link Gateway – Technical specifications

General	
Dimensions (W x H x D)	102 x 102 x 28 mm
Power supply	External netadapter 5v DC, 2 AMp
Power conumpstion	Typical: 1.2 W // Max: 2.5 W
Ethernet	10 / 100 MHz
Environment	IP class: IP20. Operation temperature 0 – 50C
Wireless communication	
ZIGBEE	
Frequency	2.4 GHZ
Protocol	ZigBee SE11, HA1.2
WIRELESS M-BUS / SUB 1 GHZ RADIO	
Frequency	868MHz (315-955 MHz on request)
Protocol	Wireless M-Bus C1, T1, T2
Z-WAVE	
Frequency	868/908/921MHz, etc. (depending on region)
Protocol	Z.Wave Puls
WLAN	
Frequency	2.4 GHZ
Protocol	80211 b/g/n (Access Point and/or Station)
CELLULAR MODULE	
Frequency	GSM 900/1800MHz, UMS 900/2100MHz
Protocol	GSM 900/1800, UMTS 900/2100

Certifications	
RADIO	ETSI EN 300 328 V1.9.1 (2015-02)
	ETSI EN 300 220-2 V2.4.1 (2012-05)
	FCC Part 15.247
	Industry Canada RSS-247, Issue 1
SAFETY	IEC 60950-1:2005 (Second Edition) + Am 1:2009 + Am 2:2013
	EN 61000-3-2: 2006 +A1: 2009 +A2:2009
	EN 61000-3-3: 2008
	UL 60065
EMC	EN 301 489-01 (V1.9.2) EN 301 489-03 (V1.6.1)
	EN 301 489-07 (V1.3.1) EN 301 489-17 (V2.2.1)
	EN 301 489-24 (V1.5.1) EN 55022 (2010)
	EN 55024 (2010)
	FCC Part 15, subpart B
	Industry Canada RSS-310, Issue 4

External meter interface

Technical specifications

General	
Dimensions (W x H x D)	115 x 35 x 70 mm
Power supply	Battery 3 x AA alkaline batteries, exchangeable
Power consumption	Battery life: 2 years, updating every 5 seconds
Environment	IP class: IP22. Operation temperature -20 + 60C

Communication	
WIRELESS PROTOCOL	ZigBee Home Automation 1.2 Supports IE62056-21 compliant electricity meters Supports LED/IR pulse
Certifications	
	RoHS compliant according to the EU Directive 2002/95/EC

Table 1.*Smart Home devices*

These devices provide a reliable and rapid reading and communication between the meter and the SESP system about households' network consumptions.

2. In the case of Norway Pilot, it has to be distinguished between to operation areas:

One based on households, with the technology exposed above, and another area based on Sandbakken and Hvaler Municipality, that are related to DER devices integration: Generation, Electric Vehicle, Storage and Communication with SESP client simulator located in the laboratories of the UPC using a SCADA software designed specifically for Empower Project.

For these DER cases,there are 2 locations:

- Municipality Area – EV (installing EV chargers)
- Recycling Plant Area – EV, Generation and Storage

In addition, using the SCADA, it will be used for connecting the SESP platform to the SESP member emulators from UPC remotely.

In later chapters, functionalities and data exchanged between systems for each case will be updated.

In order to perform bidirectional communication between DER devices and the SESP control cloud, there has been developed a SCADA software and a group of web services that enable real-time communication between BPL and DER devices.

This SCADA system is critical because it is the system in charge of receiving all data from each one of the devices installed in both Sandbakken and Hvaler Municipality.

In addition to this software that has been developed a range of services based on APIs defined in deliverable D4.2 which allow a full connection between SCADA and SESP.

From all the technologies that were mentioned and discussed in Deliverable D4.1 it was decided that all field devices must be connected via Modbus protocol with the SCADA system that will act as a gateway between SESP system and the DER devices.

3 Customer communication interface

3.1 SESP member – controllable units' status and overview

Through the Local Controller / SCADA the SESP monitors and logs all activity integrated with the Local Controller / SCADA

Definition of controllable units' status is the current status of the controllable unit, and whether the unit is ON (default) or turned OFF (either manually by the SESP member or by the SESP due to control plan execution).

Controllable units will be presented in the app indicating current status:

- Generation: production
- Load: Consumption
- Charging point: Consumption
- If the unit is ON/Off

3.1.1 MVP – SESP v2.0: Controllable units' status and overview

- Presenting real time consumption, overall and pr. unit
- Presenting real time generation, pr. unit
- Presenting if the unit is ON/OFF

3.1.1.1 Later versions:

- Presenting real time storage and current storage level
- Presenting historical and predicted generation/consumption

3.2 SESP member – Control plan execution

If a SESP member has a unit which will be engaged in a control plan executed by the SESP Control Cloud this will be notified and presented with an overview over date and time interval when the controllable unite is part of a control plan e.g.:

Scheduled disconnection

- Unit: Floor Heater
- Date: June 30th 2016
- Time interval: Kl 15:15-15:30

When the execution plan is ACTIVE the SESP member's controllable units' status will be updated with ON/OFF or current operation level. Later, the SESP member will be able to see a units' historical disconnections that have been executed (Disconnection Log).

3.2.1 MVP – SESP Control Cloud v2.0: Control plan execution

- Receiving push notification in app regarding control plan execution, containing: unit, time and date for execution of control command
- Presenting unit status "ON/OFF" when engaged in a SESP control plan.

3.2.1.1 Later versions

- Presenting historical disconnections pr. unit in a disconnection log
- Decline option. A SESP member will have the option to manually decline the control plan notification when the notification is sent to the SESP member through the app.
- When the unit is under control, the app will indicate whether it is controlled by a SESP control plan or manually by the SESP member.

3.3 Preconditions

- The app requires a smart phone - either iOS or Android.

- Units have to be integrated with a Local Controller to be able to send and receive control commands to and from the SESP Control Cloud
- The customer must be a SESP member

4 External information providers

4.1 Metering data from DSO

Metering data from DSO requires firstly that the DSO allows the SESP to receive this information, and secondly that the SESP can integrate to this system. In EMPOWER this has not been possible, as the only DSO represented as a project partner (Fredrikstad Nett) is prevented by national law to share this information with any third parties [see: 5.1.1]

For those customers who have a contract with a SESP, it should not be a problem of sharing metering data. In the future, this data will also be available through the national metering data hub. The main problem of using DSO metering data is time resolution and availability. DSO metering data will only be available as an update once a day.

4.2 Handle control request (Flexibility demand from DSO)

As WP 6 LSG Market Design is yet to be finalized, the only control request the system will experience is from a DSO.

The DSO will send a flexibility request to the SESP Control Cloud through a defined website. The flexibility demand will be represented as a time series with 15 minutes' resolution and will be valid for one or multiple zones. Further, the request will either be for reservation or for activation.

The request can be positive or negative. Positive values are defined according to up-regulation in the wholesale market, namely - increase in generation or decrease in load. Discharging of batteries also fall into this category. Negative values correspond to down-regulation, namely - decrease in generation, increase in load including batteries charging.

4.2.1 MVP – SESP v2.0: Flexibility demand from DSO

- Presenting a website where a DSO can post flexibility requests, which will be received by the SESP Control Cloud based on fixed parameters.

4.2.1.1 Preconditions

Specified contract between SESP and DSO (WP 6).

Grid topology is not available to the SESP, as this is exclusive information handled by the DSO. The DSO and SESP will mutually agree on a zone system of metering points that will form the basis for requests sent by the DSO.

DSO will send requests based on DSO's own analysis, thus the reasoning behind request is irrelevant for the SESP.

4.3 External forecasting data: weather, etc.

Future expected external forecasting is

- Weather forecast and temperature observations
- Add solar observations and predictions
- Add wind observations and predictions

4.3.1.1 Preconditions

- Relevant external forecasting systems exist and will be able to integrate towards.

5 Field devices

5.1 SESP member – (Actor with a contract with SESP)

5.1.1 Metering data from smart meters

The SESP control cloud will receive metering data from the Local Controller through an Optical reader / EMI sensor reading signals directly from the Smart meter. This data will then be sent to the Azure Event Hub in the SESP Control Cloud

5.1.1.1 Preconditions

- The customer is a SESP member
- The EMI sensor transfers metering data to the Local Controller and routes this to the SESP Control Cloud.

5.1.2 Meter data and event signals from SESP member household

The SESP control cloud will receive metering data and event signals from the Local Controller into the Azure Event Hub through either:

A. Optical reader / EMI sensor reading signals directly from a Smart meter (generation/consumption)

B. Smart plug / rely

5.1.2.1 Preconditions

- The customer is a SESP member
- The EMI sensor / smart plug / rely transfers metering data and event signals to the Local Controller and routes this to the SESP Control Cloud.

5.2 DER field devices

As discussed in previous deliverables the possibility of making different tasks of integration between different systems involved in the project has been studied.

To integrate field devices, there has been carried out development tasks and interface software to adapt the drivers for these devices to the SCADA system via Modbus protocol.

As this is a standard protocol, the SCADA system has integrated a connector to "understand" the information coming from the different field devices (controllers).

If instead of using standard protocols it is decided to use private protocols, this would lead to develop new connectors for each of the chosen controllers.

In addition, by utilizing a standard protocol future developments and integrations will be easier to adapt and export which should again be more economical.

Main functionalities needed

For all field devices (EV Chargers, Storage, Generation) the same main functionality is required

SCADA is connected in real time with every device controller and SESP.

The main functionalities required are:

- Bidirectional communication in real time between the SESP and field devices.
- Periodic sending of electrical measurements

- Real time Command from SESP to DER devices
- Energy values reading on demand, as state of charge, energy, power, etc.
- Minimum logical intelligence within the communication platform
- Operator monitoring tool for smart grid.

Minimum data exchanged between SESP and SCADA DER devices:

- Active Power,
- Reactive Power
- Voltage
- Current
- State of charge
- State

Different measurement technologies, media and communication possibilities have been discussed in previous deliverables (such as D4.1 and D4.2) aiming to establish guidelines for a stable and reliable communication between the SESP system and SCADA field devices.

Among the possible technologies available on the market, the final choice fell on implementing the SCADA called Vijeo Citec as a basis for the communication platform on which one has developed different connectors that connect the SESP system with the DER devices.

Different DER devices are connected to the SCADA communication platform using Modbus TCP.

Within the SCADA they have developed a series of WEB connectors (web services) to communicate in real time with the SESP system using the communication bus Event Hub Azure from Microsoft.

All data sent from the SCADA system to the SESP Control Cloud will go through this communication bus.

After tests at laboratory level between these systems, both SESP and SCADA and emulators simulating DER´s, the results obtained have been successful from both sending commands from SESP to DER´s devices and sending periodically data from DER´s to SESP platform.

For these pilots, it has been assumed that each DER device incorporates its own local controller to communicate with the SCADA system (as it was described in deliverable D4.2).

In the case of the electric vehicle, it has been assumed that the charger will have the controller embedded.

On the other hand, in the case of pilot in Sandbakken, the architecture is defined as follows:

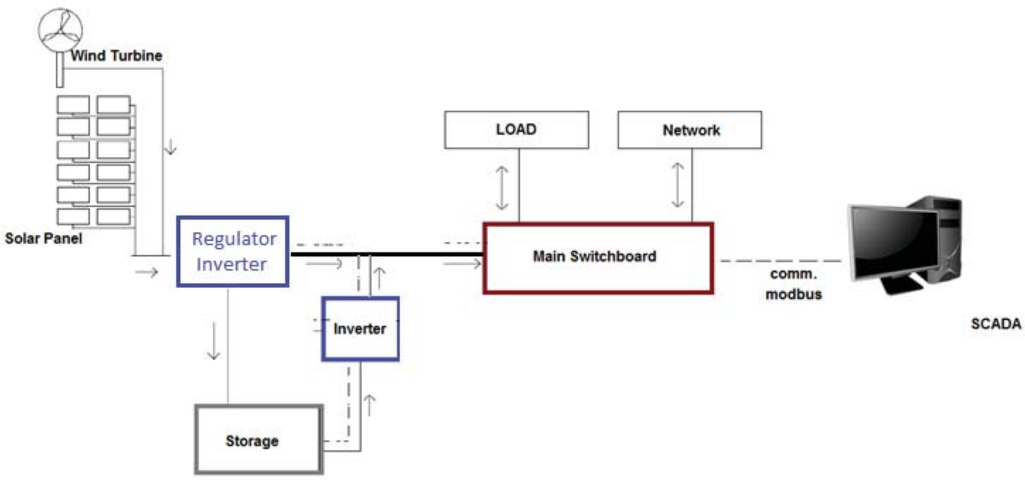

Figure 2.Sandbakken Renewable Station, Norwegian Pilot

Each wind turbine and solar panel is connected to a connection device (controller) which is connected to a voltage regulator/converter that communicates with an DC/AC inverter.

All these devices must be remotely controlled, meaning there must be communication with each one of these devices to carry out the tasks of energy measurement, state of charge (battery), etc.

In addition, remote control is needed to able to perform the appropriate actions for commands sent from SESP to this DER devices trough SCADA system.

6 Conclusions

The aim of Deliverable 4.4 Feasibility Report is to describe and document that the methods of communication and integration between the SESP and the SESP member's – households with Local Controller's and facilities with an appropriate SCADA system, respectively – have high reliability and are secure, and thus further supporting the chosen communication and integration methods in the EMPOWER project.

The executed tests have been done in a laboratory environment, all with successful results regarding the correct exchange of meter data and the sending and receiving of control commands to designated DER's from the SESP platform. All the data will in a periodically matter go from SCADA / Local Controllers, in addition to on demand requests from the SESP.

At household level, all controllable DER's are directly linked to a Local Controller serving as a gateway. This Local Controller will send and receive data directly to and from the SESP Control Cloud through the selected protocols and existing infrastructure.

Regarding larger facilities, to manage and facilitate a larger system with multiple DER's and larger volumes a SCADA software system will serve as a gateway between the SESP member and the SESP. As such, the SCADA and the Local Controller serve the same objective, but at different levels. Both manage the interface between SESP and SESP member. All commands from the SESP, and all data from DER's will go through either a Local Controller or a SCADA system.

7 References

- Empower Project - Deliverable D4.2: Functional and technical documentation of relevant API-functions
- Azure Event Hub (azure.microsoft.com)
- Azure IoT Hub (azure.microsoft.com)
- Protocol Specification for Modbus exchanges between external system and charging Station – www.Schneider-electric.com
- Technical Note – unSpec Logging in SolarEdge Inverters (Susnpec Alliance) - www.sunspec.org/