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

Deliverable nº:	**D1.5**
Deliverable name:	**Final project report**
Version:	**1.0**
Release date:	**01/06/2018**
Dissemination level:	**Public**
Status:	**Submitted**
Author:	**SmartIO**
Contributors:	**Dieter Hirdes and WP leaders**

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 646476.

Document history:

Version	Date of issue	Content and changes	Edited by
0.1	01/06/2018	First draft version	Joseph Negreira
1.0	04/06/2018	Final submitted version	Dieter Hirdes

Table of contents

1 Executive summary and Conclusions ... 4

2 Project context ... 6

2.1 Objectives 7

2.2 Results achieved 8

3 Main scientific and technological results ... 11

3.1 WP2 main Scientific & Technical results 11

3.2 WP3 main Scientific & Technical results 17

3.3 WP4 main Scientific & Technical results 21

3.4 WP5 main Scientific & Technical results 25

3.5 WP6 main Scientific & Technical results 29

3.6 WP7 main Scientific & Technical results 32

4 Exploitation main results (WP8) ... 38

5 Communication and Dissemination results (WP9) ... 42

6 Socio-economic impact of the project ... 44

7 Exploitation ... 46

8 Communication and dissemination products ... 49

9 Annexes ... 52

1 Executive summary and Conclusions

The main objective of the EMPOWER project was to encourage and enable active end-user participation for local energy trading and related services in the distribution grid. A new market player role titled "Smart Energy Service Provider" (SESP) was defined. The SESP engages the local community, involves various agents towards energy and flexibility trading, optimizes market operations and creates value that can be translated to novel business models. SESP manages all its operations by means of an integrated cloud-based ICT platform that facilitates communication and trading between agents.

The EMPOWER project has been focused on:

- Defining a community for local trading of energy, flexibility and energy related services.
- Creating a trading system for continuous exchange of energy, flexibility and service contracts and any combinations of these.
- Designing a cloud-based ICT platform for operating local markets.
- Implementing and testing the ICT platform in three pilot sites.
- Offering communication services, like web access and mobile apps to participants to support their engagement to the ICT platform.

The ICT platform merged with the trading system allows neighbours from a community to participate in the local markets sending and receiving offers for their energy resources like photovoltaic panels and for flexibility based on flexible appliances and storage units.

The innovation in this project lies in the methodology and technology implemented by means of new IT tools that creates the foundation for sale of products and services related to both IT and energy. The aspect for innovation is that software will be a key requirement to further develop the power markets and utilize the new infrastructure introduced by Smart Grid and Internet of Things.

The main deliverable of the project is the ICT platform-based, market design and the rules for operating the local markets which are defined and implemented by the SESP. While projects similar to EMPOWER build on simulations, EMPOWER delivers a working ICT platform integrated with flexibility assets at pilot customer sites, enabling energy and flexibility trading between neighbours and towards the local distribution grid company.

The developments being performed cover two specific areas:

- The local smart grid area, with ICT extensions of the infrastructure, will lead to the participation of new actors in local energy markets and in development of new business models.
- The business-related area of the project, with the definition of the new players' role and involvement, and the design and development of the new local energy market.

The cloud-based trading platform being developed enhances participation of the market agents and the creation of submarkets in order to satisfy the community needs. Alternative economic models can coexist with classical business models, depending on their acceptance. From a solidarity perspective, the design of cooperative community markets and its effect on incentivizing cooperatives to promote transition to renewable energy generation that fosters climate solidarity has been outlined. Local and sustainable energy generation shields consumers from volatility of oil/gas prices and wholesale electricity markets and partially relives them from grid dependency. Furthermore, investment decisions of cooperatives into energy storage to increase their market options as well as to reach self-sustainability has been designed and implemented. Additional effects of the proposal beyond current state of the art are reduction in CO2 emissions, due to shift to renewable electricity generation, and prioritization of energy storage for sustainability. In order to quantify the impact of these effects, a life cycle analysis has been conducted.

The ICT platform was implemented in three pilot sites in Europe, in Germany, Malta and Norway, to demonstrate the EMPOWER platform support for several distribution grid management and services (for instance, decision-making, load forecasting, consumer profiling, load aggregation, demand-response programs, energy consumption and supply balancing, cost reduction). Existing equipment, available customers, and pilot use cases have been identified and after the deployment of systems and solutions was completed, the pilots were successfully validated and tested.

2 Project context

From the beginning of the 90's the European electricity markets were reorganized. The basic target was to increase efficiency in the electricity systems. A deregulation and reorganization process took place where organized market places were established, new types of market players came into the market and new rules and business models for the technical and economic interaction between the players were defined. One of the critical success factors were efficient development and implementation of ICT systems at the participant side (generators, retailers and large consumers) and at the market place side (power exchanges and transmission system operators). Companies in the NCE Smart Energy Markets' network were forerunners in this development. These changes mainly took place at the wholesale/high voltage side of the electricity market.

Nowadays we see a lot of changes going on at the retail/medium and low voltage side of the electricity market. These changes are driven by political goals, consumer engagement and technology developments. A lot of new technologies are under deployment including appliances for smart metering, distributed electricity generation, home automation/smart appliances/load control, distributed storage and finally electric vehicles. Such technologies create new challenges for the operation of the distribution networks, due to higher peaks, more dynamics and less predictability. Balancing supply and demand and maintaining power quality in the grid are some of the challenges. These challenges are local and must be solved at the local level. Traditionally such challenges have been met by investing in balancing facilities and grid enforcements.

At the same time, we observe a growing engagement from the consumers, who want to take a larger responsibility for a sustainable future regarding energy use. Some places groups of consumers self-organize to create co-operatives in order to be able to take such responsibility.

As described above, deployment of new technologies at retail side creates new challenges for the electricity system. On the other hand, the same technologies can also be a main contributor to solving these challenges. However, technological possibilities and consumer awareness are not enough to make this happen.

The consumers and prosumers must be provided with incentives (economic and other) to invest in new technology and to participate in self-generation, demand response programs and other programs that put a value at flexibility. This should be done by development of innovative business models. The contribution from each single consumer and prosumer might be small, so aggregation and coordination must be established efficiently. Such collective/coordinated regimes must ensure confidence for the consumers/prosumers as well as for the DSO in order to maximize potential and hence realize the benefits for the local electricity system, the local community and each participant.

Local market place(s) must be established to exchange the local resources aiming for solution of local challenges and ensuring local cost efficiency. We have proposed the definition of a new role in the local electricity market, the Smart Energy Service Provider (SESP), with the task to handle the operation of the market place, the coordination between the participants, economic settlement and offering of services for the market participants (including optimization, algo-trading, automation and control). The SESP role can be taken by incumbent roles (like the DSO) or by newcomers (like ESCOS, cooperatives, municipalities, or others). In any case the tasks and responsibilities for the different roles must be defined and the technical and economic interaction between them must be outlined.

This local reorganizing process has many parallels to the development at central level back in the 90's. Once more, the development of ICT tools and services to handle the new regime will be a critical success factor.

2.1 Objectives

The EMPOWER project represents a total perspective of the local electricity business organization and has the following overall objective:

"Develop and verify a local market place and innovative business models including operational methods to encourage micro-generation and active participation of prosumers to exploit the flexibility that this creates for the benefit of all connected to the local grid."

The overall objective is to be reached by the achievement of the following sub-objectives (**SO**s) and the different achievements obtained in the different work packages (**WP**s):

SO-1. Develop a new market design for local trading and involvement of the consumer/prosumer end of the distribution net by means of cloud-based ICT. This market design will be based on the micro-market concept and operate in conjunctions with other micro-markets also to form a neighbourhood market. The market design will adhere but will not be dependent on the structure of a micro-grid. In fact, we assume a design that can contribute to the lay-out of efficient micro-grids in the future. The market design will converge towards the design and development of a set of software agents customized for trading within a local market. The agents should be accommodated within the SESP control cloud.

SO-2. Develop prosumer-oriented business models relevant for the market design developed. In particular, we will seek to define the business concept for a role that we have called SESP and which cater for the local energy market. The SESP will enable the business transactions, the flow of communication, flow of energy and internal credit assignment. It monitors it and establishes trading channels with the central market or other local markets. The entity that controls the SESP role (i.e. the prosumer community, the local utility, a third-party service provider) will significantly influence the choice of business model.

SO-3. Develop an ICT based monitoring and management system that can be accommodated in the SESP control cloud. The control system will use prediction and big data analytics for market optimization to maintain grid balance within the SESP area by communicating demand response strategies to the local controllers.

SO-4. Develop full bidirectional and secure communication between the market and business part of the SESP control structure and the physical infrastructure below that controls the flow of energy according to the business exchanges defined at a given time and the actual energy generation.

SO-5. Integrate the different parts and demonstrate the viability of the concept created in at least two physical regions in Europe with different geography, demography, sociography and maturity in terms of prosumer activities, implementation of DER and new loads that call for efficient and intelligent demand-response programs.

2.2 Results achieved

Objective SO-1: Develop a new market design for local trading and involvement of the consumer/prosumer end of the distribution net by means of cloud-based ICT

A new design for a local market place, trade and involvement of local consumers and prosumers has been developed. A new network market concept for communities and new trade concepts, supported by novel ICT-technologies, have been explored. In contrast to comparable initiatives reported in the literature, the concept developed applies customizable long-term contracts inspired by financial securities. Non-continuous trading is advocated. The concept promotes an integrated market place were energy, flexibility, energy services and combination of these can be traded in different ways, opening for new business opportunities.

The proposed market and trade model developed for EMPOWER is able to support interactions with the DSO to support trade in different flexibility contracts including instant peak shaving, emergency support, "valley filling" and containment of local surplus. The market and trade concept aims to be adaptable and customizable for different price and regulatory regimes. It can be suited to both island mode operations (micro grid) and customized for support of local trade in a system fully connected to the central market.

Objective SO-2: Develop prosumer-oriented business models relevant for the market design

- Development of three distinct EMPOWER business models.
- Development of two EMPOWER business model prototypes.
- Collection of EMPOWER case studies with data from approx. 35 relevant benchmark business models and companies.
- Publication of one scientific paper in a prestigious Energy journal (Energy Policy, impact factor: 3.045).
- Additional publication of a scientific paper in a prestigious, peer-reviewed Energy journal (Energy Policy, impact factor: 4.140) on "prosumer flexibility" (in total WP2 has produced two publications in this leading Energy Innovation Journal: one on "flexibility-based business models" and one on "prosumer flexibility")
- Design of an executive education training program for business model development for EMPOWER.
- 10 workshops with >200 participants.
- Development and publication of a teaching case study (including a novel teaching process and tool for business model composition).

- Development of three working papers (business model quality, incumbent acceptance, business model composer).
- Multi-country study with 830 participants from four countries to measure prosumer acceptance and optimize business models (available here: https://www.alexandria.unisg.ch/252125/1/Broschuere_Empower_WEB.pdf)
- Near-site prosumer acceptance study to test business model design for cooperatives (available in Deliverable 2.3.)
- Acceptance study with three types of prosumers (battery, heat-pump and e-mobility; available here: https://www.alexandria.unisg.ch/253226/)
- EMPOWER partner eco-system has been developed, which outlines the different roles that project partners can play in implementing the EMPOWER concept
- Award-winning test of utility-based business model (preparation and participation at utility start-up competition)
- Production of four EMPOWER related videos.
- Development of a 4-phase concept for managing the implementation of EMPOWER business models in accordance with current and changing regulation

<u>Objective SO-3: Develop an ICT based monitoring and management system that can be accommodated in the SESP control cloud</u>

An ICT cloud-based monitoring and control platform for the SESP, the EMPOWER platform, has been developed. In addition, a SESP community member smart phone application, the SmartFlex app, was developed in relation to the end users (prosumers and consumers) of the EMPOWER platform. Communication between the EMPOWER platform and the pilot site installations has been successfully validated and tested. The platform includes functionality to generate control plans based on flexibility requests from a DSO and functionality to execute control commands sent to flexible loads at the pilot sites.

The EMPOWER platform contains functionality to support the SESP to handle energy-, flexibility- and energy service contracts, including all information about resources, sites and prosumers. This also includes handling of meter values and predictions at different aggregation levels and with different time resolutions.

Furthermore, economic settlement information was calculated for the various contract types.

Finally, machine learning algorithms were developed to generate predictions of consumption, production and available flexibility, in addition to optimization algorithms to generate optimal utilization of flexibility (control plans).

The EMPOWER platform has been integrated with equipment at the pilot sites and this has been successfully tested and verified in a Factory Acceptance Test (FAT).

<u>Objective SO-4: Develop full bidirectional and secure communication</u>

A user interface for controlling the communications between field devices and high-level systems, as the SESP, was implemented. Communication rules were established between the different actors involved, from the communication protocol at a physical device level to the communication method at a high level (web services) between the Communication Platform and the SESP.

A specification plan for the communications platform was defined with a list of the different communication protocols that can be used within each of the levels of the SGAM architecture of the EMPOWER platform. Different options were given for each step, always using standard protocols such as Modbus, IEC 104, DNP, as well as technologies of interconnection of data with the cloud, like web services.

All API functions (Web Services) that were necessary to connect the communications platform with the cloud systems (SESP Control Cloud) were developed. This should allow reading on demand or sending control commands to the different field devices as EV chargers, Battery Storages and PV panels.

A laboratory SCADA was used as the test environment. The SCADA was connected to a realistic DER emulator and to the SESP platform using the Event Hub Azure from Microsoft. Data were received from DER to SCADA and sent using web services to the SESP platform. The defined API functions were successfully tested, and the test results were documented.

A monitoring tool was designed in order to monitor every data received from field devices and from the SESP Control Cloud. A MODBUS field device simulator was developed and connected to the SCADA. The complete system was tested successfully, developing full bidirectional communication between Field devices and SESP platform, using an SCADA as a gateway between them.

Objective SO-5: Integrate the different parts and demonstrate the viability of the concept created in at least two physical regions in Europe

Three pilot sites have been chosen in the municipalities of Hvaler (Norway), Wolpertshausen (Germany) and Gozo (Malta). In Hvaler, there are two sub-pilots, Hvaler/Norderhaugveien and Hvaler/Sandbakken. In Sandbakken, EMPOWER developed Norway's first and only full-fledged microgrid, officially opened by the Minister of Petroleum and Energy in September 2017.

A set of seven different use cases were defined to be tested at the pilot sites. Different possibilities to test the defined use cases at the pilots were evaluated and chosen, to define the need of deployment, and to consider the existing products/equipment available at each pilot site.

The selected pilot sites reflect the deployment of technologies and were prepared for use case testing in the project, considering that each pilot is different from each other, with respect to technologies, functionalities and markets / regulatory assumptions. Thus, the set of use cases to be tested differed from pilot site to pilot site.

3 Main scientific and technological results

The project has been implemented in 9 WPs, interrelated in the following ways:

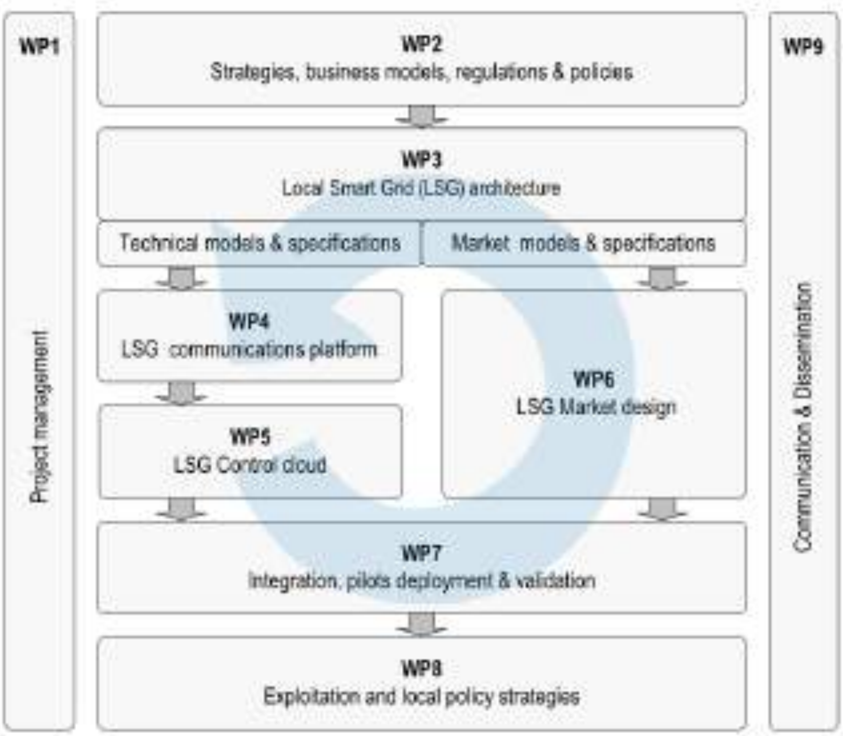


Figure 1: Work Package interdependencies

The Grant Agreement established that the ethics issues in the project will be gathered in a work package number WP10 - Ethics requirements.

3.1 WP2 main Scientific & Technical results

General achievements

The overall objective of WP2 was to develop business models that facilitate the diffusion and exploitation of the EMPOWER concept. In particular three EMPOWER –based business models have been developed that are able to utilize the market potential of the market design (as developed in WP6), the technological infrastructure (as developed in WP5) and the learnings from the demo-sides (WP7).

Overall, the development of business models was a core task of WP2 and has direct implications for the dissemination of the EMPOWER project. Business models enable European companies (start-ups and incumbent firms) to seize the EMPOWER concept and integrate it in their activities of value creation and value capture. The deliverables D2.1 and D2.2 of WP2 contain the conceptual development of the three generic business models for EMPOWER: 1) the "EMPOWER platform business models", 2) the "Our power business model" and 3) the "DSO local business model".

Figures 2-3-4 show the graphical representations of the three models.

Figure 2: Overview of the EMPOWER platform business models

Figure 3: Overview of the Our power business model

Figure 4: Overview of the DSO local business model

The conceptual business models have been further developed and integrated into "**Newtility**", which throughout the EMPOWER project has become an award-winning EMPOWER business model (preparation and participation at utility start-up competition).

In cooperation with SmartIO, the Newtility approach catering the utility-focused EMPOWER business model has been further developed to take part in a start-up competition which was organized by local utilities in Germany. The Newtility approach was awarded as the winner concept. A brand protection was filled and Newtility is now in the position to be realized on a commercial-level bringing the EMPOWER business model initiatives to the European markets.

A central element of this concept has been the development of a 4-phase concept for managing the implementation of EMPOWER business models in accordance with current and changing regulation. In a first-step the EMPOWER tools and services support the implementation and management of a local tariff that enables to offer local electricity tariffs.

Figure 5: Example of local electricity tariff

Within a step-wise approach the initial starting-offer helps to get utilities involved and then at later steps the offer and services increase complexity towards a full realization and implementation of the EMPOWER market design. The details of this approach and how it confirms with current and changing regulations has been outlined in D2.4.

WP2 conducted two studies:

- “Prosumer acceptance of different technological regimes”
- “Energy policy and management implications”.

The most salient achievements of those are summarized below.

The multi-country study and analysis with 830 participants from four countries to measure prosumer acceptance and optimize business models revealed important features of prosumer acceptance of the EMPOWER concept in different European countries. Based on this analysis, the EMPOWER approach and the EMPOWER business models have been confirmed and optimized. The study is available here: https://www.alexandria.unisg.ch/252125/1/Broschuere_Empower_WEB.pdf

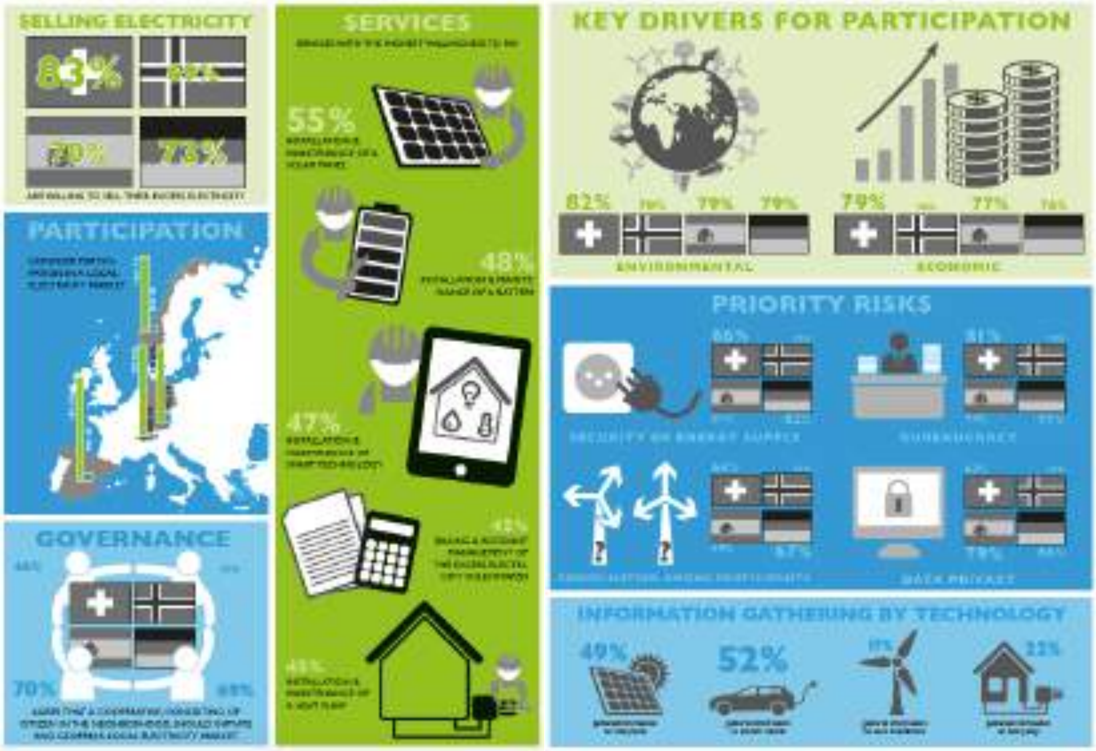


Figure 6: Study on prosumer acceptance of different technological regimes

The acceptance study with three types of prosumers (battery, heat-pump and e-mobility; available here: https://www.alexandria.unisg.ch/253226/). This study was developed towards an additional publication of one scientific paper in a prestigious Energy journal (Energy Policy, impact factor: 4.140) on “prosumer flexibility” (in total WP2 produced two publications in this leading Energy Innovation Journal: one on “flexibility-based business models” and one on “prosumer flexibility”). The paper on “prosumer flexibility” received coverage in social media and among researchers. It has been named an “important paper” and has been featured as a research highlight in the energy section of the journal Nature.

An important overall achievement of the work in WP2 and for the output of WP2 is the integration of rigorous scientific and practical impact. In such, WP2 established linkages with the business community (e.g. in workshops and conferences with professionals). However, WP2 at the same time produced scientific impact, such as through the already successful publication of papers in prestigious journals such as Energy Policy or on different conferences. Here is a selection of some important indicators for the output of WP2:

- Development of three distinct EMPOWER business models
- Development of two EMPOWER business model prototypes
- In-time submission of all deliverables (D2.1, D2.2, D2.3 and D2.4)
- Collection of EMPOWER case studies with data from approx. 35 relevant benchmark business models and companies
- Publication of one scientific paper in a prestigious Energy journal (Impact factor: 3.045)

- Design of an executive education training program for business model development for EMPOWER
- Production of a business model composer tool: http://businessmodelcomposer.com
- In total 10 workshops with >200 participants (only WP2 related workshop, additional workshops have been done for WPs 8+9)

Figure 7: Workshops with professionals

- Production of three EMPOWER related videos
- > 20 interviews with leading executives in the industry (14 different companies in Europe) 1. to develop the business models and 2. to identify criteria for the social acceptance of the business models (that will be further developed and tested from M13-32)
- Production of three EMPOWER related videos:

  Euresearch Services: Empower

  - https://www.youtube.com/watch?v=IlN7_zOX2wk&list=PLqYCCUDc43YkoIUoXZrdBE1DYQ1KOcbj7

  Business models for EMPOWER

  - https://www.youtube.com/watch?v=XhLFgJWnB7c&list=PLqYCCUDc43YkoIUoXZrdBE1DYQ1KOcbj7&index=3

  Our Power for EMPOWER

  - https://www.youtube.com/watch?v=5x0XyTpk9jA

- Development and publication of a teaching case study (including a novel teaching process and tool for business model composition):

  http://www.thecasecentre.org/educators/products/view?id=131609

- Development of three working papers (business model quality, incumbent acceptance, business model composer)
- Near-site prosumer acceptance study to test business model design for cooperatives (available in Deliverable 2.3.)
- Broad list of students contributing to EMPOWER resulting in a thesis related to EMPOWER (including BA thesis on Malta)
- Further development and application the executive education training program for business model development for EMPOWER.

- Multi-country study on regulations across European countries and how they fit EMPOWER
- 4 additional workshops (in total 10 workshops with >200 participants).
- EMPOWER partner eco-system has been developed, which outlines the different roles that project partners play in implementing the EMPOWER concept
- Follow-up projects: Advisory Board: https://quartier-strom.ch

An ongoing concern in cooperation of WP2 and WP 8 was to further increase business awareness. To support this ambition which was formulated in the DoA one important achievement was the production of a specific video, which outlines how EMPOWER insights are transferred to practice. The video is available here:

Prof. Wüstenhagen about the EMPOWER project (in German)

https://www.youtube.com/watch?v=pY08S8pX4SI.

Conclusions

Based on the work in WP2 EMPOWER specific business models are now available, which leverage the specifics of the EMPOWER concept. These EMPOWER specific business models have been evaluated against alternative business models and provide important advancements of how to create and capture economic and sustainable value with local power markets. A central concern of the EMPOWER based business models is that they put the prosumer preferences centre stage and accommodate the insights that have been developed in the prosumer acceptance studies that have been conducted in WP2. As a result, EMPOWER business models are now ready for implementation.

3.2 WP3 main Scientific & Technical results

General achievements

WP3 has settled the main specifications of the ICT platform designed and developed in the EMPOWER Project (SESP ICT platform). The characteristics of the architecture of the SESP ICT platform for local energy trading have been determined based on the application of the Smart Grid Architecture Model (SGAM). The actors intervening in the system and their relationships have been identified. The control and market interactions have been defined and the needed communications infrastructure has been detailed. Once the architecture of the platform has been described, the resilience and security of the SESP ICT platform have been evaluated and a Life Cycle Assessment has been performed.

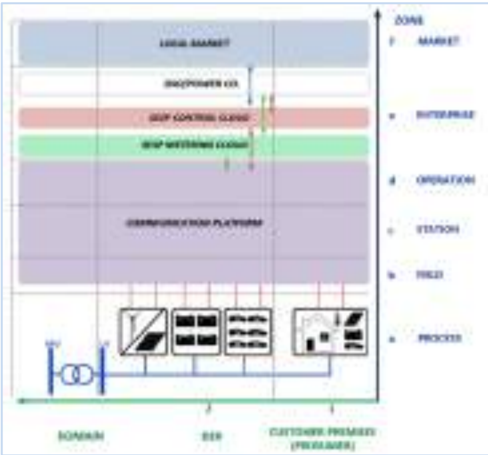


Figure 7: EMPOWER) Local Smart Grid Architecture (DoA)

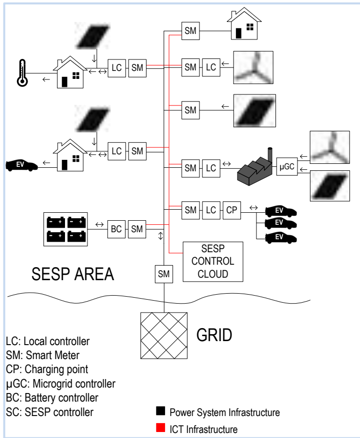


Figure 8: EMPOWER zones and domains in SGAM

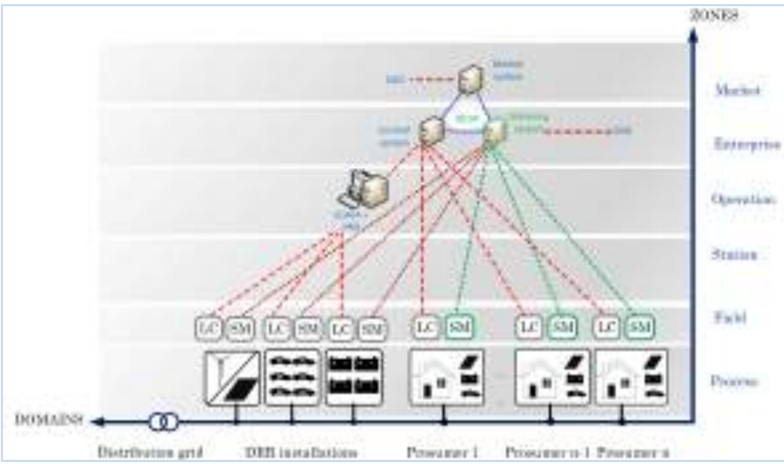


Figure 9: EMPOWER metering system

<u>Design of software architecture and platform of the control cloud.</u>

The control architecture needed for the management and secure operation of DERs and prosumers has been described. The architecture has been proposed based on the Smart Grid Architecture Model (SGAM) methodology. The control use cases have been established. From these, the function layer and component layer have been built. The main actors, functions and components were identified without constraining them to the available services and infrastructure in pilots. The outcomes of task T3.1 have been an input to WP5 Local Smart Grids Control Cloud and for WP7 Integration, Pilot deployment and validation, as they provide a general description of the control architecture, so that it was adapted easily to the specificities of each pilot site for implementation. All this has been reflected in deliverable D3.1 Control cloud technical architecture.

<u>Design of software architecture and platform of the market cloud.</u>

The relationship between market participants has been defined and the technical architecture of the market cloud integrated in the SESP platform has been detailed.

<u>Market use cases were identified and described.</u>

A market cloud architecture was proposed, including a description of potential relations with the wholesale market. All this has been reflected in deliverable D3.2 Market cloud technical architecture.

<u>Design of interfaces of the platform.</u>

The communication system architecture needed to exchange signals among the different zones of the EMPOWER system (from market to process, passing through enterprise, operation, station and field) and from the DER and prosumer domains has been defined. The communication protocols and information exchanges required have been identified. This has permitted to define the so-called information and communication layer, without constraining them to any available services or infrastructure existing in pilots. The outcomes of this task have been an input to WP4 Local Smart Grid Communications platform and WP5 Local Smart Grid Control Cloud in order to proceed with the implementation of the SESP platform and for WP7 Integration, Pilot deployment and validation. All this has been reflected in deliverable D3.3 Communications system.

<u>Evaluation of the rate of resilience and security.</u>

The focus of this task has been determination of the rate of resilience and security issues of the designed architectures. To do so, the existing smart grid solutions have been analyzed and key performance indicators have been proposed and evaluated in order to measure the impact of the Local Smart Grid (LSG) architecture. A methodology for the assessment of resiliency in ICT platforms was developed in D3.4 Index of resiliency and security. The application of this methodology has the drawback that it requires to have detailed information regarding the architecture. So, alternatively, some indicators were proposed to have a direct measure of resiliency of EMPOWER ICT platform implemented in each pilot site based on field information.

The indicators selected to evaluate the resiliency in Noderhaugveien, Wolpertshausen and Malta are the Packet Delivery Ratio, the Average end-to-end delay and the Operation Criticality Index. They have allowed to quantify the resilience of the ICT platform in the different pilots when metering and communicating the metered data.

The resiliency and security of the ICT platform (eSmart Systems Connected Grid) have also been examined from a broader perspective (without looking at the specific performance in pilot sites). Based on ISO/IEC 27001 Information Security, it is explained how eSmart Systems handles information security and requirements related to GDRP (General Data Protection Regulation). Finally, taking into consideration that the platform is based on Microsoft Azure, its Resiliency checklist is reviewed to check eSmart Systems Connected Grid application design, data management, security, testing, deployment, operations, telemetry, Azure Resources and Azure services. This work has been reflected in D3.6 Resiliency evaluation indices.

Furthermore, a Life Cycle Assessment has been performed so as to determine the potential environmental impacts of the whole local market structure. This study has been based on an iterative process, and as a result, a screening LCA of the EMPOWER Project has been achieved. A methodology for this assessment has been proposed, taking as a reference ISO 14040 and ISO 14044. GaBi software tool has been used to develop the simulation scenarios so as to assess the potential environmental impacts. Two scenarios have been assessed: one assuming the pilot site consumes energy from the main grid for one year. The other scenario has considered the EMPOWER structure to increase the total renewable energy mix and to lower the energy consumption from the electrical grid. Two pilot sites have been assessed, both located in Norway: Norderhaugveien and Sandbakken, due to their significant differences. Four impact categories have been chosen: Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP) and Ozone Depletion Potential (ODP). These indices have been evaluated in the two scenarios for each pilot site. This work has been reflected in D3.5 Life Cycle Analysis.

Conclusions

- The general architecture of the SESP ICT platform has been determined, enabling an easier characterization and relation identification of actors, components and functions of the system in each pilot site, according to its specificities.
- Regarding the resilience and security evaluation of the SESP ICT platform (based on Microsoft Azure), it has been shown how eSmart Systems handles information security and requirements related to GDRP (General Data Protection Regulation) and the Microsoft Azure Resiliency Checklist has been presented to review the corresponding application design, data management, security, testing, deployment, operations, telemetry, Azure Resources and Azure services. From an application design standpoint Connected Grid is highly resilient to failures.
- On the other hand, the SESP ICT platform shows, in general, resilient performance when monitoring and communicating the metered data in all the pilot sites, as reflected by the Packet Delivery Ratio, Average End-to-End Delay and Operation Criticality Index calculations. The Packet Delivery Ratio calculated for Wolpertshausen and Malta is very high (>99 %), showing a successful reception of the information sent. In Noderhaugveien, it is lower because of maintenance during some of the days when the measurements were being registered. The Average End-to-End delay, exceeds the expected 30 s in all the pilot sites and the Operation Criticality Index, which should be less than 1%, also surpasses this value in 4 of the meters evaluated. The Operation Criticality Index is successfully kept below 1 % in Norderhaugveien Consumption Meter 1 and in Malta water heater meter. The reason for the Average end-to-end delay and the Operation Criticality Index being outside the limits is that the ICT platform tested is running as a pilot and thus not operational on a daily basis. In an operational installation, there would be daily follow up and setup of notifications on low response and missing values.
- Regarding the Life Cycle Assessment, it has been shown that the scenario in which EMPOWER structure is deployed so as to lower the electrical consumption from

the main grid and promote the use of local renewable generation leads to environmental impact levels very close to the base scenario where all the electrical energy is consumed from the main grid. The reason for this is that the base scenario takes into consideration the Norwegian Energy mix, where close to 98 % is covered by hydro power sources. Taking this into account, the EMPOWER structure could be especially interesting for regions that have a high dependence on conventional generation and where the environmental impact of the fuel based electrical generation could be lowered very significantly.

3.3 WP4 main Scientific & Technical results

General achievements

The communications platform developed in the EMPOWER project allows a bidirectional communication between the SESP system and the field devices, for each pilot.

Without reliable communication between both ends it would not be possible to perform all the other functionalities at the business layer level.

It was essential to develop a stable platform that provides real-time data to the business layer, as it is extremely important for the flexibility operator to be able to send commands to different devices in order to reduce the load and balance the power grid according to the needs of each moment.

These objectives above mentioned required the Communication Platform (**CP**) to have a well-defined functional interface to all kinds of Distributed Energy Resources (DER) and any equipment connected to these DERs. There are 2 types of users defined in the pilots:

- Residential users
- Sandbakken Recycling plant

The CP allows reading any kind of sensors and meters and even sending control commands to some of these DER devices.

The CP is prepared for a big scale rollout and easily to integrate new devices and systems so it has been upgraded with multiple signals for Sandbakken use case.

Due to the singularity of the pilot in Sandbakken, a new monitoring software has been introduced for collecting all the data from the DER devices (SCADA). This SCADA acts as a gateway that collects the data from the DER on real time and sends these data to the SESP. Also allows receiving commands from SESP to DER devices.

The first step for the connectors was to describe the format messages for each client with SESP in the deliverable D4.2 (Functional and technical documentation of relevant API-functions).

- Distributed energy resources (DER) to SESP
- SESP to Distributed energy resources (DER)
- Local controller (gateway) to SESP
- SESP to local controller

For the integration between the SCADA and SESP, a Webpage was created to access in case of doubts, question of support:

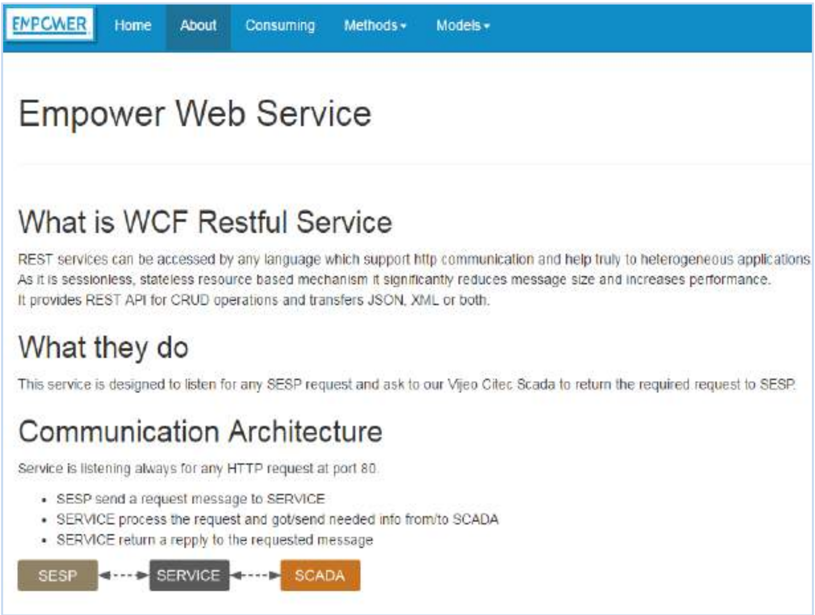


Figure 10: Web Page for Web Services Support

Multiple tests were performed over the API´s and CP platform in order to determine the optimal functionalities.

The results from these tests are documented in WP4 deliverable D4.5 “Communications Test Report”.

The bidirectional communication with SESP and the field devices installed in all the pilots has been a complete success.

This is an example of a test for a EV charger and a real time reading of every register on de EV charger in SCADA:

Figure 11: Real time reading of the EV charger

SESP ask for a value on real time, and SCADA connects to DER and send information to Event Hub from eSmart.

Following with the tests, the results in Event Hub in SESP Platform are shown in the next table:

Deviceid	Property	Format	Timezone	Unit	Starttime	Endtime	Value	Message	Receivedtime
EV.CPNw	ActivePower	Watts	UTC	Watts	6/7/2016 5:02:00 AM	6/7/2016 5:02:00 AM	33332.0	Get Result	6/7/2016 7:02:3
EV.CPNw	Active Power	Watts	UTC	Watts	6/7/2016 5:03:00 AM	6/7/2016 5:03:00 AM	33332.0	Get Result	6/7/2016 7:03:2

Figure 12: Results in SESP Platform

This indicates that data are been collecting from DER (EV) into SCADA and sending to the SESP automatically. So, it´s proved that there is a real communication between field devices and SESP.

To test bidirectional communications, SESP send commands to DER in order to change the state.

Figure 13: EV Charger, state

When an on/off charge command is sent from SESP to Scada, Scada will be responsible for sending a proper command to the DER controller after receiving a command from SESP.

The result of the operation is sent to SESP from SCADA.

It is shown in the figure the state (START/STOP) in the charging point.

EV.CPNw	Charge		UTC	Unknown	6/7/2016 11:11:38 AM	6/7/2016 11:11:38 AM	1.0	Charge Set to 1
EV.CPNw	Charging Point State		UTC	Unknown	6/7/2016 9:13:31 AM	6/7/2016 9:13:31 AM	1.0	Get Result
EV.CPNw	Charge		UTC	Unknown	6/7/2016 11:20:28 AM	6/7/2016 11:20:28 AM	0.0	Charge Set to 0
EV.CPNw	Charging Point State		UTC	Unknown	6/7/2016 9:20:53 AM	6/7/2016 9:20:53 AM	0.0	Get Result
EV.CPNw	Charge		UTC	Unknown	6/7/2016 11:28:50 AM	6/7/2016 11:28:50 AM	2.0	Charge Set to 2
EV.CPNw	Charging Point State		UTC	Unknown	6/7/2016 9:29:03 AM	6/7/2016 9:29:03 AM	1.0	Get Result

Figure 14: Charging State are changed after the command signal from SES

	Test in Lab	Test on Field	Test on Pilot in WP7
EV Periodic Reading		X	X
EV on-demand reading		X	X
EV Remote		X	X
Generation Periodic Reading		X	X
Generation on-demand Reading		X	X
Generation Remote Command		X	X
Storage Periodic Reading		X	X
Storage on-demand Reading		X	X
STO Remote control signal		X	X
Prosumer Periodic Reading		X	X
EV charger	X		X
Storage battery	X		X
Generators – Solar and Wind	X		X
SESP Clients	X		X

Figure 15: Final results, successful

At the end of the WP4, there were still no EV charging for testing on pilot site in the same way it was done with Storage and Wind generation (in WP7) to prove that the communications were totally bidirectional.

Conclusions

Developing a platform to connect the physical devices and the final system (SESP) has been a very important challenge, due to the different pilots and countries involved, but at the same time very helpful for the near future. The CP-API developed in the EMPOWER project is fully operational, running and ready for future opportunities.

For the near future, the platform could be updated to integrate new metering systems. One of the most important technologies that are currently being implemented is the DLMS-COSEM, and although it will be an arduous task since being an open and standard protocol, it would be a great opportunity to integrate a communications platform, not only based on intelligent devices, but also in AMI systems and MV / LV infrastructure.

3.4 WP5 main Scientific & Technical results

General achievements

According to the DoA, the overall objective with WP5 was to develop the control cloud system for the SESP. This system should use prediction and big data analytics for market optimization to maintain grid balance within the SESP area by communicating demand response strategies to the local controllers.

The main outcomes from WP5 have been the EMPOWER platform and the SmartFlex app. The EMPOWER platform is the software solution that supports the SESP with the tasks defined in the project, mainly to handle local energy, local flexibility and local services. The SmartFlex app is the solution for the SESP members, i.e. the consumers and prosumers, for the interaction with the SESP and for providing the SESP members with information.

The development of the EMPOWER platform and the SmartFlex app was based on a set of use cases, which were defined in close cooperation with the different partners in the EMPOWER project. Below, the uses cases are listed, with a brief explanation of the content. In sum, this presents at a more detailed level the results from WP5. The first five use cases describe the functionality in the EMPOWER platform, while the last describes the SmartFlex app.

UC5.1 – Manage master data and configurations

This use case covers the handling of structure information, i.e. information that is rarely changed. It is split into three:

1. UC5.1.1 – Collect resource technical characteristics and status. Information is needed about each of the devices and appliances that belong to each of the SESP members. The resources are split into generator resources, load resources, electric vehicles (EVs) and storages. Technical information for the resources are covered, like rated power or maximum energy content.
2. UC5.1.2 – Collect resource commercial characteristics and status. This is information about the flexibility contract related to each resource, and defines when, how often and other parameters for the activation of the flexibility, in addition to the compensation that the SESP member gets when activated.
3. UC5.1.3 – Manage configurations. This is information about relations and aggregation levels, for instance between the prosumer and each resource, the neighbourhoods (used for local renewable generation) and zones (used for the safe operation of the local grid).

Figure 16 - Screen shot illustrating the relation between prosumer and resources

<u>UC5.2 – Trading preparation</u>

This part covers functionality needed to prepare for trading and consists of three main areas.

1. Handle market parameters. A lot of calculations are needed to prepare for the later processes. This can be different types of aggregations of data, but the most important part is related to predictions. Machine learning methods were used to predict production (at generating resources) and consumption (at load and EV resources) down to the level of 15 minutes. Further, these predictions were combined with flexibility contract information to predict available flexibility.
2. Prepare data for market. Three main commodities were defined in the project: Local renewable energy, local flexibility and local services. Each of these parts were covered by contracts with some common features and some specific for each contract type. For instance, the energy contract defines how the prosumer will be paid from the SESP when selling local surplus electricity and how she will pay to the SESP when buying.
3. Market notification. Each of the contract types (energy, flexibility and service) will have an economic settlement between the SESP and the SESP members. This part calculates the economic figures which form the basis for invoicing.

<u>UC5.3 – Handle market results</u>

To maintain balance in the SESP area was one of the main objectives in WP5. This use case covers the core functionality in this respect.

1. Handle control request. In cases where the DSO has a challenge in the local grid, e.g. a substation overload or a voltage quality problem, the DSO will send a control request to the SESP. The control request is based on a flexibility contract and contains information about the location (which zone), when, how much and the direction of the flexibility that is requested. A web-interface was developed to enter this information by the DSO.
2. Create control plan. When the SESP receives a control request from the DSO, the task is to generate a control plan which fulfils the request (if possible), to the lowest possible cost and without violating any of the commercial (defined in the flexibility contracts) or technical constraints. This function combines information

from many of the other use cases. An advanced optimization algorithm was developed to handle this crucial part of the project. The creation of a control plan is illustrated in Figure 16. The control plan basically contains information about when and how to use each of the flexible resources.

Figure 17. Screen shot illustrating the control plan meeting a control request

UC5.4 – Control plan execution

When a control plan has been calculated, the output, which is the control command decisions must be sent to the relevant resources for activation. This is for instance decision to delay EV charging or to charge at lower power levels, to curtail load or generation resources or when to charge of discharge batteries. This information is sent to the local controllers in advance and activated according to the schedule in the control plan.

UC5.5 – Monitoring and logging

The main part of this use case is the reception and handling of data from meters and sensors. In the setup of the pilots, meter values for all controllable resources and other devices have been collected every 10 second. This information is the basis for aggregations in time (to 15 minutes, hours and days) and in space (to site, neighbourhood and zone) and is presented both in the EMPOWER platform and the SmartFlex app.

A smaller part of this use case covered the detection of overriding of control plan, which happens when a SESP member declines a control plan. This option is regulated in the flexibility contract. It might be related to an EV charging point that is planned disconnected and used in cases where the SESP member is in hurry for charging of the EV. A revised control must then be made.

UC 5.6 Customer communication

An important part of the EMPOWER project is the interaction between the SESP and the SESP members. This use case covered the functionality that was developed in the SmartFlex app.

1. Controllable units' status and overview. This is information at the site level (like purchased and sold electricity), at the resource level (like meter values for each

resource) and at the contract level (information about the contract terms and contract economy).

2. Controllable plan execution. This is information about the flexibility usage, e.g. when a resource is going to be disconnected. The possibility to decline a control request, as described above, is handled here.

A screen shot of the SmartFlex app is shown in Figure 17.

Figure 18: The Smart Flex app

Conclusion

Through the work in WP5 the EMPOWER platform for SESPs and the SmartFlex app for SESP members have been designed and developed. The systems cover functionality for the whole value chain from device configuration and the collection of real time meter values down to the level of 10 seconds, to advanced algorithms for prediction of available flexibility and optimal utilization to solve problems in the local grid. The solutions have been tested and demonstrated on real data from the EMPOWER pilot sites and deployed for the use in WP7.

3.5 WP6 main Scientific & Technical results

General achievements

The primary objective of this work package has been to explore the theories on the micro-market and capitalize on former research related to market design and trading in a smart grid setting. The general idea was to synthesize this into a whole and specify a concise market arena that can support trading at the user end of the supply chain in a full scale, real-time environment of prosumers and surrounding supply system.

- Simple personal apps for the use of community members. These apps support the trading process by means of software agents.
- A scheduling system to support the SESP in his operation with the DSO and the EMPOWER control cloud.
- A decision support system for optimizing flexibility operations with the DSO. Provisions have also been made in the design to extend this to central market operations and enable similar flexibility operations.
- A settlement module that communicates with the control cloud of the SESP and a standard billing system. The billing system will not be implemented by EMPOWER but provides an API that allows a bridge into existing billing systems, even PayPal.

The work package has completed its assigned 4 tasks. The primary objective specified for the work package has been realized and much publicized under the supervision of Work Package 9. An ICT-oriented market design for local markets has been proposed.

The market builds on the platform-based business models defined in WP2 and enables a "network market concept" for local trade. The trade aspect embraces:

- An energy part: A platform for trade in energy contracts based on templates defined by the SESP and customized for the community
- A flexibility part: Trade in flexibility whereby agreements with the DSO are auctioned out as tranches to the community members
- A service/product part: Trade of services/apps produced by community members themselves and professional third parties that are invited in and can offer community specific bargains.
- A trade in contracts combining the above and thus creating energy products
- A scheduling concept for coordination of local market operations with trade in external market places i.e. day-ahead spot market

The concepts defined can support trade within a local market that is fully disconnected from the central electricity system (e.g. microgrid) as well as a local trading place that is directly connected and under strong influence from developments in the central market. Close cooperation with other work packages, especially with WP2, has resulted in a concept that is duly accommodated supported by platform-based business models. The business model and trading platform is embraced by a strong community concept inspired by current drivers behind modern energy cooperatives, online trading systems like Amazon and shopping clubs. This implies a community-oriented market and trading system that defines the result as a platform-based network market. Efforts have been made to support the development of a trading system which is adaptable and that can be customized to different regulative and price regimes.

The local market is organized by an entity combining different roles and which is called a Smart Energy Service Provider (SESP). An important advantage with this is that long-term contracts creates a perspective that reduce risks associated with investments in renewable energy resources such as roof top PV panels. The aim thus was to encourage capacity increase in **DER**s (Distributed Energy Systems). Flexibility is used to manage short-term variations in demand and supply and ensure benefits for all taking part. In addition, increased self-consumption within the community was sought. To take advantage of the market power that a community with a common energy interest represents the energy and flexibility aspects of the market has been combined with a service and product part. This creates internal network reinforcement effect where community members formalize and offer each other in terms of maintenance by allowing third parties to enter the local market in a controlled form through the SESP a third revenue stream is created that can help to support the business case represented by the local market. This has proven especially important in regions were general energy prices are low.

Contract templates that can be customized and handle energy sales, flexibility and energy related services and combination of these have been specified. The ambition is to allow such contracts to be traded with identical "over –the-counter" and auction mechanisms and be managed by simple software agents or human controlled apps. Due concern has been made to so-called cross-market operations whereby the local market operator can benefit from its connection, directly or indirectly, with the day-ahead and balancing market. Similarly, due concerns have been made regarding flexibility trade for different purposes, including the support of the local DSO. Strong efforts have been invested in creating a viable and competitive market concept supported by viable business models that scale up and can be acknowledged by energy communities across Europe. Consequently, active dissemination of ideas and early concepts have been important. This integration yields market and business-related synergies which have been demonstrated in practice with real people and further developed by spin-offs/spin-outs from the project, constituting embryonic enterprises with local market management as their prime mission.

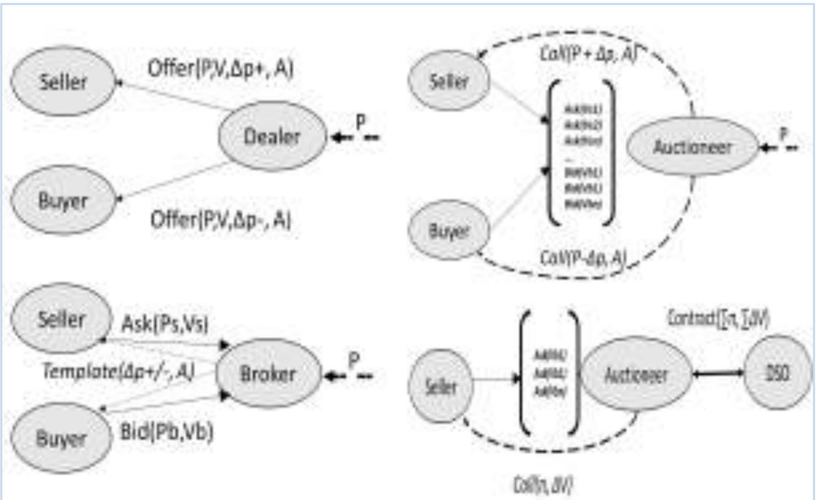


Figure 19: Trading concepts precipitated during the WP6 endeavour. Due to the need to kick start marketing activities and focus on long-term energy contracts and short-term flexibility the OTC related concepts above (left right and bottom) were primarily focused a

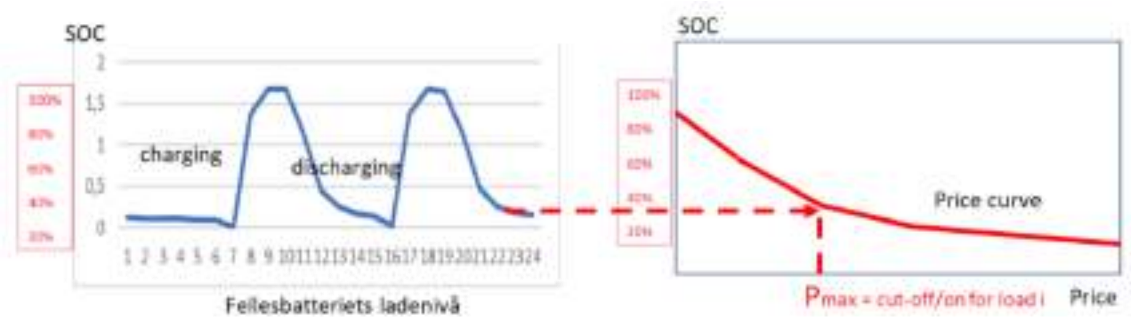


Figure 20: The SOC metering is hooked to the price curve for a community battery, typically in a microgrid setting. Price curve is established based on price limit bids or by the SESP itself. A load or consumer specifies the maximum price that it is willing to opt.

Conclusion

WP6 has successfully established a local energy market concept that can be quartered in a community setting. It is integrated with a set of generic business models defined in WP2. This constitute the basis for a network market model for energy. WP6 has thus actively contributed to the overall objective of the project, which was to develop a local market place and innovative business models, including operational methods to encourage micro-generation and active participation of prosumers to exploit the flexibility. Both the long-term contracts and the empirical data that is now emerging suggests that this contribution have been effective. The work package has explored the theories on the micro-market and capitalized on former research related to market design and trading in a smart grid setting. A synthesis of this effort in conjunction with the concepts derived in WP2 and the feedback produced by different stakeholders in WP8 have led to the final results documented in the various deliverables.

3.6 WP7 main Scientific & Technical results

General achievements

In EMPOWER we were facing pilots in three very different countries, within different regulatory regimes, and with very different price level on electrical energy. Despite of these differences, EMPOWER proved the value of using this common platform-concept for optimizing the consumption / production according to different purposes.

Figure 21 – Location of the pilots

Country-specific pilots were divided into sub-pilots for demonstrations of different Pilot Use Cases (PUCs) in different households and municipal buildings with different consumption/production -profiles. In Norway, we had 2 sub-pilots, one neighbourhood area with private households (Hvaler/Norderhaugveien), and one complete microgrid in a Municipal garbage sorting facility (Hvaler/Sandbakken).

In Germany and in Malta we defined sub-pilots consisting of private households, and of different municipal buildings. These sub-pilots were tested and supported by the same SESP-operator, and with the same equipment for meterdata-reading and for controlling the flexible loads.

<u>Norwegian Pilot</u>

Hvaler is a municipality in Norway, consisting several islands. Norgesnett is the DSO in the area that includes 6.800 electricity customers, 50 kV supply, one primary transformer station (30 MW) and 206 secondary stations. Norgesnett has implemented full scale smart meter infrastructure in the area, i.e. all 6.800 meters have been substituted with smart meters and communication infrastructure. Hvaler was thus the first large full-scale smart meter pilot in Norway.

Norway is currently experiencing an exponential growth in deployment of EVs. Although the electric energy (in kWh) needed to charge these vehicles are not very big, the peak situation in the distribution grid (in kW) is expected to be challenging within a few years. One specific objective for the Hvaler pilot have been to take advantage of the SESP role, the market design including incentives from innovative business models to relieve this situation and hence reduce the need for grid capacity investments, by smoothening out the charging demand and utilizing other types of flexibility available at Hvaler. A secondary objective has been to analyze the real-life impact to this challenge from dispersed intermittent power generation.

The pilot areas in the Norwegian pilot have been selected based on their feasibility to cover the Pilot Use Cases (PUC) 1-7. The pilot areas; Norderhaug and Sandbakken have very different characteristics. Norderhaug was selected because it is a typical Norwegian residential neighborhood including local energy production, electrical vehicle charging and energy storage. Sandbakken was selected because it is a totally new built site and consists of solar/wind production, energy storage and several charging stations for EV in addition to several operational buildings with considerable energy demand. The Sandbakken site is also constructed to run shorter period off-grid in, island mode.

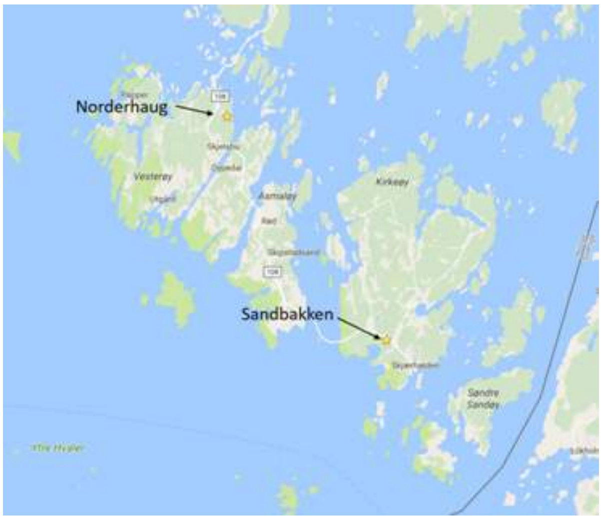


Figure 22: Pilot sites for EMPOWER in Norway

Through systematic run of test cases, it was demonstrated that the SESP platform fully worked according to design and in good interaction with the flexible energy resources that was available within the customer premises. For Norgesnett (DSO) it was very interesting to observe that the EMPOWER business model and the SESP operator demonstrated that the purchase of flexibility, primarily load reduction, is possible, and can serve as a good substitute to grid investments.

<u>German Pilot</u>

In the course of the EMPOWER project, the municipality of Wolpertshausen was selected as a pilot location for the implementation and realization of the EMPOWER project. The aim of the pilot location was to connect private and public buildings to the EMPOWER platform.


Figure 23: Wolpertshausen village and solar cells installed

The municipality of Wolpertshausen is located in the federal state of Baden-Württemberg in the district of Schwäbisch Hall. The municipality has approx. 2,150 citizens, who are spread over various districts. The structure of the village is mainly agricultural. Furthermore, several medium-sized companies are located in the municipality. Wolpertshausen has a strong economic position due to its connection to the A6 motorway and its proximity to the cities of Schwäbisch Hall and Crailsheim.

Wolpertshausen is a model municipality in the field of renewable energies and has been honoured as a bioenergy village. Several PV plants, biogas plants and wind energy plants are in operation on the municipal territory. Renewable energy covers 100% of the municipality's energy requirements. The municipality strives for 100% energy self-sufficiency with renewable energy. This is clearly supported and promoted by the citizens of the municipality. Many residential and communal buildings are equipped with PV systems and the energy produced in the municipality is to be used within the municipality. Since the beginning of 2000, a local heating network based on renewable energy his in operation in Wolpertshausen. Generating and using renewable energy locally is an important aspect for the community of Wolpertshausen.

Wolpertshausen's participation in the EMPOWER project was excellent. With the implementation and the implementation of the EMPOWER platform with SESP Control Cloud, the enormous potential of the Wolpertshausen municipality could be demonstrated. The very good interaction of the EMPOWER platform with the participants has clearly shown that the municipality can build up its own electricity market in the future on the basis of the EMPOWER idea. Flexibility management and the balance between supply and demand play a central role. Three public buildings and nine private households participated in the EMPOWER project, representing the entire community. The participants were equipped with control technology. In private households, the potential of flexible loads was greater than in public buildings. The DSO NetzeBW made the network typology data available to the project and installed smart meters in the public buildings. In future, the smart meter roll-out in Germany will also have to be implemented more effectively for private households. Due to regulatory requirements, the private participants in the EMPOWER project could not be equipped with smart meters. Here, the flexibility loads were connected directly to the devices via control devices. The participants were able to read their electricity and energy requirements directly via the APP developed by the EMPOWER project and thus optimise their energy behaviour.

The Energy Agency of the district of Schwäbisch Hall, which is owned by the Schwäbisch Hall Economic Development Corporation (WfG), advised the EMPOWER project on questions of energy efficiency and sensible energy use and possible local energy marketing. The local council, the citizens and the energy centre want to use the

EMPOWER guidelines and take a first step towards regional energy marketing. There is a strong political will at local level. The current Electricity Market Act in Germany must facilitate the implementation of new marketing models in the future. At present, the end consumer is burdened by excessively high taxes and fees.

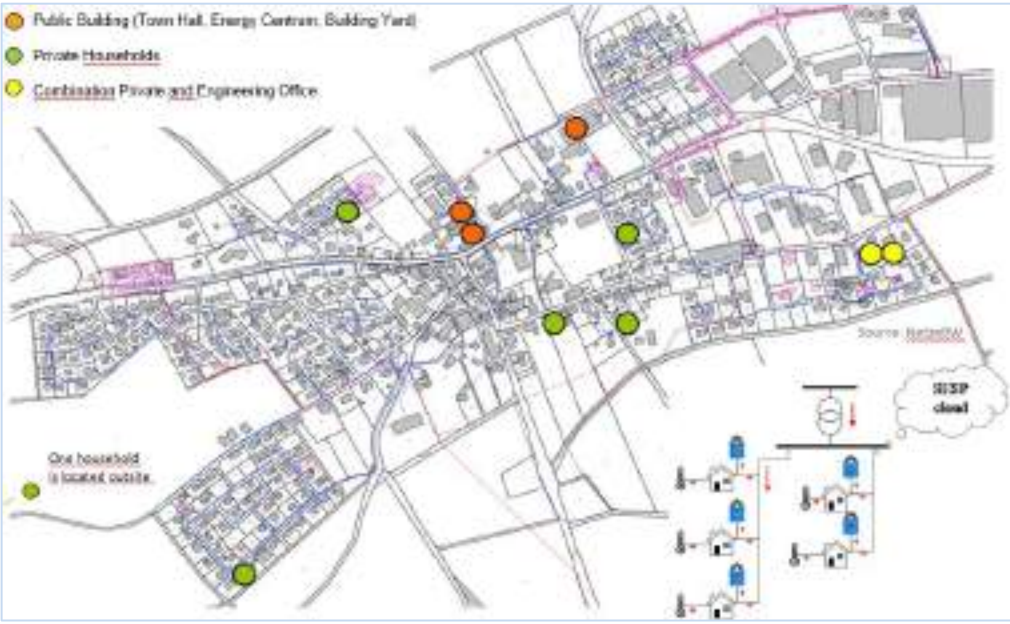


Figure 24: Grid structure Wolpertshausen / participants

The German market has not yet been liberalized to the point where flexibility can be traded that easily. However, in Germany more and more generator-owners are joining and developing concepts and business models in order to market their own generated electricity. At the moment, they market the electricity to the DSOs directly over the stock market or to end customers, which requires acting as an official electricity trader including all rights and obligations. This can be seen as a main obstacle for local cooperatives, since they are subject of the German energy law in this case and hence obliged to pay a high amount of taxes and surcharges reducing considerably their competitiveness. Located close to the pilot-site, there is an agricultural cooperative, founded in 1988. It has 1.450 members and may be suitable for a future SESP beyond the EMPOWER project frame. As soon as the German feed-in tariff system ends successively (beginning in 2021), there is an opportunity for the cooperative to buy and sell electricity made by member-owned facilities.

It can be concluded, that the implementation of the EMPOWER concept has very good chances in the future German energy market design. The pilot site Wolpertshausen has demonstrated flexibility loads very well and perfectly described which regulatory obstacles must be removed in the future so that the liberalisation of a decentralised energy market can be successfully implemented in Germany. The legal framework and regulatory framework must be reorganised so that energy marketing can be implemented on a non-discriminatory basis. The competitive challenge is great, especially when large fossil and nuclear power plants are promoted by politicians. On this point, the European Commission and the Federal Government must guarantee fair and sustainable competition for the regional energy market places. The citizens and the municipality of Wolpertshausen represent the majority of German municipalities for a future decentralised energy market based on the EMPOWER concept and structure.

Malta Pilot

MIEMA implemented the local pilot action on the island of Gozo. This second island of the Maltese archipelago has a population of 31,000, constituting almost 12,000 households and covers a total surface area of 67 square km. The island attracts a fair share of the close to two million tourists who visit Malta throughout the year. Recognized as a region at NUTS 3 level, the island has a dedicated Minister, as well as a Regional Committee composed of the island's 14 municipalities, or Local Councils. The ten sites of the Malta pilot, consisting of both consumers and prosumers, were all located in Victoria the capital city of Gozo. Victoria itself has a population of 7,000 residents and is the most important city of Malta's sister island.

Figure 25: Pilot site for EMPOWER in Malta

Gozo is considered to be vulnerable due to its 'double insularity' condition, which also applies to its reliance on the energy supply from Malta's power station. Its rural character presents a different challenge to that offered by Malta as a whole. At the early stages of the Empower project, 97% of the Gozitan energy consumers had just had a smart meter installed, as part of a national initiative to replace all traditional electricity meters with the selected smart meter model.

The selection of having the pilot site in Gozo was related to the strategy call EcoGozo which has been drawn up as a holistic vision covering all aspects of development in Gozo, with energy generation placed as a central issue of this vision. The results of the Empower pilot action were in fact presented to the EcoGozo Directorate with a view to facilitate the implementation of smart grid initiatives.

One of the main objectives of the pilot action was to support the position of prosumers in the distribution chain. It is necessary to assess whether it is economically viable to feed all the energy produced from RES into the grid at fixed feed-in tariffs or explore options related to self-consumption and energy trading between prosumers within a community. Presently the national power generation and distribution network in the Maltese islands is operated by Enemalta and all energy produced from RES (mainly PV installations) has to be sold to the sole energy provider.

The implementation of testing with respect to pilot use cases (PUCs) was very important for the pilot implementation since it showed that consumption and generation could be predicted which would in turn allow for decision-making with respect to potential energy trade. Another important factor was the definition of flexibility with respect to controllable loads located at the pilot sites. The project results are considered very useful particularly in relation to the changing scenario of Malta's energy consumption patterns, as well as the multiplication of the number of prosumers in Gozo. Energy monitoring allowed for a definition of specific generation and consumption profiles which are very important in order to consider the integration of energy storage systems and promote the uptake of electric vehicle and implement and vehicle-to-grid concept. The pilot action also served to educate energy consumers and to study the impact of real time monitoring on energy saving.

Conclusions

All equipment for reading meters and switching/controlling flexible loads were successfully integrated with the EMPOWER cloud platform. Even though available equipment on the market suffers from proprietary solutions and lack of interoperability, we were able to test all PUCs successfully. For the Norwegian sub-pilot Hvaler/Sandbakken, we had to add specific web-services for reading/controlling all DERs through both a microgrid-controller, two SCADA-systems, and further to the EMPOWER control-cloud. For the internet-connection in Malta/Gozo it was necessary to establish a separate GSM SIM-modem, to mitigate for instable internet connections.

All the tests, for the different pilots, have largely been successful. Although some needs for improvement have been uncovered during these tests. Smart home equipment need some robustification with better stability, before large scale roll-out.

The PUCs 1-6 have all been tested extensively, with promising results. This proves and demonstrates the strength and innovation part of the EMPOWER project. For the microgrid at Sandbakken, all PUCs have been demonstrated, although with some challenges. Since Sandbakken sub-pilot is controlled through both scada-systems and Microgrid-controllers, we had to develop dedicated web-services to send and receive values and control signals. However, the Sandbakken sub-pilot, realised through EMPOWER, will be a Norwegian living lab in years to come. Sandbakken will provide state of the art knowledge for microgrid-research and island mode operations in the years to come.

4 Exploitation main results (WP8)

General achievements

The main goal of WP8 was to measure the success of the project. While dissemination has to create the awareness of the stakeholders about the new scenario, exploitation must make business models real

This work package has facilitated business development among partners and others to meet the objectives defined. Close interaction with managers and top-level business developers and stakeholders associated with these have been carried out. Close collaboration with WP9 and WP2 has ensured tangible and lasting results related to business as well as social and regulatory impact. All of this have been documented in the various deliverables produced.

In accordance to the EMPOWER DoA the work has been structured around the following tasks:

- Market review and business context analysis to identify pertinent stakeholders and trends
- Development of an exploitation plan for the project results and each partner
- Test business models for relevant stakeholders including partners. The results here were based on test of business concepts and the exploitation plan with professional co-players. Emphasis was placed on contact with the stakeholders. Input regarding potential opportunities with new business models were investigated.

Two major achievements must be especially highlighted, namely the start-ups that base their venture on the EMPOWER experience and results.

→ **Smart Energi**: The spin-out from Fredrikstad Energi, Smart Energi, has provided a very important testing ground for the market concept and the SESP role. With its commercial focus and good contact with people this start-up has also catered for a very proper test arena throughout the project. This small, but customer-oriented organization has been receptive to ideas and provided valuable feedback to many aspects of the project. Smart Energi has during the course of the project, seized a position as a SESP and ecosystem developer and builds a market position in Norway for this purpose under the brand "Smart nbolag" (In English: Smart Neighbourhood)

Figure 26: Promotional campaign of Smart Energi

→ **Newtility**: the spin-off from SmartIO and UNISG, which has set forth to pursue a slightly modified SESP role and build an ecosystem in the German speaking market of Europe based on the EMPOWER findings. Although it is an early venture it has stirred interest among a group of German DSOs who see the Newtility approach as both useful and innovative. This has already earned the initiative an award exciting future prospect. Now, firm evidence can be established that the initiative has found very high market appreciation and also strong support of EMPOWER key partners (e.g. eSmart Systems).

Behind these the most innovative and promising innovations from the project, based on the level of ongoing exploitation efforts and interest from various stakeholders can be listed too:

- The ICT-platform has shown that it is possible to deliver a whole new type of services and support from prosumers and consumers alike and to unite and leverage their collective market power to attract different stakeholders and make an impact in the retailer part of the energy market. The technology partner, eSmart Systems has taken a lead here - based on the work that has been done. plan to go internationally with this, and since the termination of the project, has done so.
- Empirical data harvested and the ripple effects that the local market endeavour has generated, strongly suggests that long-term contracts with type of value focus, the way this has been defined in EMPOWER, stimulates residential owners to invest in micro-generation facilities.
- Both during the project and after we see that EMPOWER has made a lasting impact on energy users and stimulated increased engagement. This is especially true for Wolperthausen and not least Hvaler.

- The impact on DSOs' planning and operations is still pending. Trade in flexibility as an alternative to the introduction of power tariffs or capital demanding upgrades is still an issue. Some of this scepticism can be attributed to current regulations. But energy associations such as the Danish Energy Association and ENTSO-E have taken an interest in the concepts developed in the project.
- The CEO of eSmart Systems has recently taken an initiative, together with top leaders in Schneider Electric, Norway to present an industrialized version of the EMPOWER platform for European DSOs and other stakeholders on August 17, 2018 to boost exploitation effects and promote their part of the findings.
- The Norwegian regulator, NVE has vouched to cater for local flexibility markets, but wants to be compliant with other European initiatives. NVE has been in contact with the project coordinator about these multiple times. The call for future cooperation between the Norwegian TSO, Nordpool and major European utilities to dive deeper into the substance created by EMPOWER has been accelerated after the termination of the project.
- In EMPOWER it has also been shown that it is technically possible to operate as a SESP independently of geographical distance and national borders. However, current tariff regimes and regulations largely inhibit a "a one size fits all" business approach. A degree of customization is required. However, we see that the basic principles derived are applicable across borders. Smart Energi and Newtiltity are strong evidence of that. This is also currently supplemented by the Norwegian utility, Skagerrak, which is currently creating its own local market associated with a football stadium in the city of Skien.
- Linkages and potential of different partner business models within an effective and working eco-system have been confirmed and endorsed. Business models for the EMPOWER partners are highly appreciated from the business community. The short-term benefit has been increased media focus and increased awareness of the potentially disruptive concept that the EMPOWER results represent. This part has been injected into the H2020 INVADE project to pursue a more consolidated ecosystem for trade in flexibility in different ways.
- We have seen that the workshops held have also generated ripple effects beyond the project consortium. The endorsement of the EMPOWER concept and business model by Lyse and KIC Innoenergy are two firm examples of that. Others follow suit (see below)

Future plans

The exploitation effort has triggered business, social and product development beyond the project. The project has inspired multiple parties external to the project. They have initiated efforts on their own. This includes Agder Energi and Nordpool Otovo, Skagerak Energi and Lyse in Norway. Malling is a Nordic company which has announced efforts to create local market hubs. KIC Innoenergy in Sweden has used EMPOWER results to ramp up a full-scale demo at Øbo outside Stockholm. TNO and University of Eindhoven have used EMPOWER to cater for local energy markets in the Netherlands. Hvaler commune who owns and hosts the Sandbakken Microgrid is currently planning an extension to the steering and storage concept. The municipality will explore related market concepts for this. It has also been instrumental in Q4, 2017 and Q1, 2018 in selling the concept to other municipalities in Norway and Sweden. Skagerrak, which is mentioned above, is one case in point. Others include the Swedish island of Orust and the municipalities of Bø and Sauherad. Attention has also been raised in India where a delegation, including members of the project and Hvaler municipality, was invited. Currently new business opportunities based in part on the EMPOWER experience is being set up there.

Evidence that ideas and tangible findings from EMPOWER has infused new research activities can be found with the ERA-Net initiative, E-Regio and INVADE.

Conclusions

Work Package has carved out strategies for exploiting the R&D results of EMPOWER together with business leaders of each partner organization and by actively involving other stakeholders in pertinent workshops and in peer-to-peer dialogs. This work has led to an early spin-out from Norgesnett, namely Smart Energi. This company was engaged and supported early to pursue the local market concept created in EMPOWER for different neighbourhoods in the eastern part of Norway. The EMPOWER concept, with the technical platform, is now being marketed under the brand "Smart Nabolag".

Another spin-out from the project is Newtility, a small venture with project members from SmartIO and UNISG. It is cultivating the market and business concept developed in EMPOWER and is currently achieving success in the German grid market. They are supported by eSmart Systems. eSmart Systems has continued to develop the EMPOWER platform and is currently marketing this under the name "Connected Prosumer". August 17, 2018, they will launch a full-scale event for DSOs. Other business partners and research partners have also documented cultivation of EMPOWER take-away. The market and business concepts developed are further developed in major project like ERegio (ERA-Net SG) and INVADE (H2020). Political and social impacts have been generated. Here, WP8 has profited from dissemination activities organized by WP9. At least three of the pilot sites serve as models for similar initiatives in different European countries. The municipalities of Wolperthausen and Hvaler and consumers/prosumers there are sharing their thoughts and experiences harvested from EMPOWER with other communities across Europe. The Norwegian regulator, together with the Danish and Swedish energy authorities have picked up ideas, through close interaction with the project to pioneer new regulations to stimulate the creation of local flexibility markets. Nordpool, the Nordic Power Exchange, has also moved forward on a similar note.

5 Communication and Dissemination results (WP9)

General achievements

The main achievements of WP9 have been the dissemination and communication of the project insights, in parallel to the caption of attention of stakeholders. Dissemination and communication are key in H2020 projects. Dissemination is needed to broadcast the results of the project while communication focuses on divulging the project (not necessarily its results) so as to reach a specific audience. The main goal of communication and dissemination is to strategically inform/at all project stages, always keeping or widening the attention of the public and stakeholders (governments, authorities, public & private funding entities, students, etc.).

<u>Instruments for dissemination and communication</u>

Being aware of the large influence Internet has nowadays, a large effort has been put to update the webpage of the project with news and connecting it to the social networks. In addition, several events have been organized and other communication channels like conferences, workshops, magazines, newsletters and journals have been used to publish EMPOWER vision, objectives and results.

For encouraging the dissemination of EMPOWER and reaching potential stakeholders, the project has been presented at several events and flyers have been distributed. Additionally, the Technical Advisory Group (TAG), which was created during the first year of the project, has been expanded. All these communication and dissemination activities have been complemented with the release of videos explaining the project insights. All these instruments have had a significant impact in the awareness creation and results exploitation.

The objectives of EMPOWER dissemination and communication results have also been possible thanks to coordinated actions in 3 domains: technology transfer (led by UPC), citizens awareness (led by SmartIO), and business creation (led by St. Gallen University), coordinated by the Work Package Leader (UPC).

Technology transfer (UPC)

- To disseminate the technology developed related to Power electronics developers, microgrid developers, energy service providers and energy research community.
- To promote the awareness of the stakeholders.
- To harvest pertinent feedback.
- To prepare the local stakeholders situated at or close to the test sites.
- To inspire and trigger similar initiatives to create a broad momentum.
- To highlight new scientific results and outstanding issues and to show how historic research has been applied and conveys this to the international research community to trigger continued scientific efforts.

<u>Citizens awareness (SmartIO)</u>

- To prepare the locale stakeholders situated at or close to the test sites and conditions the parties being affected for the purpose at hand.

- To promote the SESP role and the micro-market for inclusion in regular business operations. Especially the value propositions that can be associated with this are important to convey.
- To stimulate social and environmental mind-shifts and trigger practical initiatives among based on the EMPOWER experience.
- To promote the necessary actions in order to facilitate the birth of new business models.

Business creation (UNISG)

- To disseminate the knowledge to the business community with publications in management journals. Specially focused on energy industry and business models for local electricity retail markets.
- To implement an in-house-training program for incumbents to implement new business models of local electricity retail markets for prosumer smart grid power services. To participate in the European Academy of Management (EURAM) and European Group of Organization studies (EGOS); in particular organization of two research workshops to engage fellow European researchers in management to focus on energy innovation.
- To participate in the UK-based European network on business model innovation management practice community in higher education: publication of a teaching case study for business model development of local electricity retail markets for prosumer smart grid power services that can be used for higher education management research community: Active participation and dissemination within the European Academy of Management (EURAM) and active participation and dissemination within European Group of Organization studies (EGOS); in particular organization of two research workshops to engage fellow European researchers in management to focus on energy innovation, and in particular publication in management journals (e.g. Research Policy and Organizational Studies).

Specific achievements

A total number of 6 video releases, 47 publications and 84 events (including conferences and workshops in which the project partners have either participated or organized) have been reached. Furthermore, a book to be published by Wiley during 2019 with focus on local electricity markets is under development. In December 2017, the “EMPOWER concept” video accumulated 607 views in YouTube; the” EMPOWER whiteboard animation” video received 373 views the” Business model composer” video was watched 106 times and “The central role of business models video” gathered 74 views. Therefore, all the released videos have led to more than 1000 views up to December 2017. Additionally, regarding publications, 6 high-level articles in leading peer-review journals (5 published and one currently under review) and 10 conference papers have been written, as well as 20 press releases and 13 non-scientific publications. Furthermore, EMPOWER has been involved in 84 events.

6 Socio-economic impact of the project

The EMPOWER project affects a number of core stakeholders from the electricity industry and creates an impact for them. To name a few these are electricity consumers (increased choice and lower electricity bills), local electricity suppliers (higher self-sustainability of their previous clients), distribution system operators (partial take-over of their previous tasks by prosumers; change of their business model towards a Smart Energy Service Provider (SESP); increased competition in the domain area due to market entry of independent service providers), electricity exchanges (potential small-scale implementation of their current wholesale market task), regulatory bodies (design of new market roles, implementation of new market structures and rules).

EMPOWER implementation impacts for electricity consumers are monetary savings. Simply through shifting parts of consumption to low-cost periods during demand response pilots, savings have in some cases exceeded 10% of electricity bills [1]. As demand side management is a basic tool that is built into the EMPOWER project, at least the same monetary savings will be achieved in the residential consumers segment. The aforementioned savings come along with a supportive mechanism to reach EU climate objectives. Capgemini [2] concludes that compared to the EU 20-20-20 goal up to 50% of energy saving and 25% of CO2 emission reduction targets can be met by demand response actions.

Equally important as monetary savings is the potential of demand response to reduce the total generation capacity needed in peak hours. It is estimated that the volume of controllable load in the EU is at least 60 GW – shifting this load from peak times to other periods can reduce peak-generation needs in the EU by about 10% [3]. This is comparable to the total installed generation capacity of two mid-size Member States or about one-third of all EU gas-fired power generation. The consortium expects that the EMPOWER implementation will result at least in a 12% peak load reduction during the pilot phase according to the characteristics of the pilot implementation sites. On the household level in Norway, the project will significantly increase the current load control potential for shifting 0,5 kWh/h per household demand for electricity for hot water heaters [4] as additional appliances and storage will be integrated into the pilot sites.

Furthermore, significantly more intermittent wind and solar generation will be integrated into the market [5]. As EMPOWER will integrate local, decentralized electricity storage

---

[1] VaasaETT: The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison, Short name: Empower Demand I, 2011. Downloadable at: http://esmig.eu/sites/default/files/2011.10.12_empower_demand_report_final.pdf

[2] Capgemini: Demand Response: a decisive breakthrough for Europe, 2008.

[3] Styczynski, Zbigniew et al.: VDE Study Demand Side Integration – Lastverschiebungspotenziale in Deutschland, 2012. This study outlines a theoretical DR-potential of 25 GW in 2010 (to be doubled by 2030), of which 8,5 GW are technical/economical potential in Germany only. This result is confirmed by the dena-Netzstudie II: Deutsche Energie Agentur: dena-Netzstudie II. Integration erneuerbarer Energien in die deutsche Stromversorgung im Zeitraum 2015 – 2020 mit Ausblick 2025, Berlin 2010.

[4] Saele, H. and O. S. Grande: "Demand Response From Household Customers: Experiences From a Pilot Study in Norway." Smart Grid, IEEE Transactions 2(1), 2011: p. 102-109.

[5] SMART-A project estimated that the broad use of smart appliances could yield an increased uptake of wind power in the system of up to 70% and a reduction of fossil fuel consumption of up to 6% for 2025. Ref.: Timpe, Christof: Smart Domestic Appliances Supporting the System Integration of Renewable

units into the system architecture, an increased uptake of intermittent generation by 40% compared to the status quo at the pilot sites is to be expected. This expectation is in line with conclusions from Hao, Middelkoop et al. [6]. They estimate that up to half of the need for balancing power in the USA may be provided by controlling heat, ventilation and cooling in commercial buildings.

The potential export potential of smart electricity solutions can e.g. be derived from the expected, massive impact of smart grid technologies in the US. A recent report estimates that the functional elements of a smart grid, which include cost reduction, enhanced reliability, improved power quality, increased national productivity and enhanced electricity service, will generate a benefit of 1294 (low scenario) and 2028 billion (high scenario) US dollar [7].

The smart grid, combined with a portfolio of generation and end-use options, could reduce 2030 overall CO2 emissions from the electric sector by 58% relative to 2005 emissions [8]. It is estimated that the emissions reduction impact of a Smart Grid is 60 to 211 million metric tons of CO2 per year in 2030 [9]. To reach these positive impacts as soon as possible, it will be helpful for international investors to implement the EMPOWER ICT in their home markets as soon as it is commercially available.

Other studies have estimated the cost of power disturbances across all business sectors in the U.S. at between $104 billion and $164 billion a year as a result of outages and another $15 billion to $24 billion due to power quality (PQ) phenomena [10]. Based on the micro-market approach used in the EMPOWER project also this cost component will be significantly reduced.

Energy – SMART-A, Final Report, 2009. For Germany, VDE estimates for 2030 a controllable amount of electricity of 43 TWh, accommodating electricity generation from 20 GW onshore wind installed capacity in the grid. Reference: Styczynski, Zbigniew et al.: VDE Studie: Demand Side Integration – Lastverschiebungspotenziale in Deutschland, 2012.

[6] Hao, H., et al.: How demand response from commercial buildings will provide the regulation needs of the grid. 2012 50th Annual Allerton Conference on Communication, Control, and Computing, 2013.

[7] Electric Power Research Institute: Estimating the Costs and Benefits of the Smart Grid – A Preliminary Estimate of the Investment Requirements and the Resultant Benefits of a Fully Functioning Smart Grid, Final Technical Report 2011, Palo Alto, United States.

[8] Electric Power Research Institute: The Power to Reduce CO2 Emissions: The Full Portfolio, Final Technical Report 2009, Palo Alto, United States, 2009.

[9] Electric Power Research Institute: The Green Grid: Energy Savings and Carbon Emissions Reductions Enabled by a Smart Grid, Palo Alto, United States, 2008.

[10] Electric Power Research Institute: The Cost of Power Disturbances to Industrial and Digital Economy Companies, Palo Alto, United States, 2009.

7 Exploitation

Innovations for future exploitation

The most innovative and promising innovations from the project based on the level of ongoing exploitation efforts and interest from various stakeholders was also listed:

- The EMPOWER ecosystem and community concept
- The hybrid network market concept developed in WP6 that shows that it is possible and economically sustainable to operate a local market with an open channel towards the central market. It requires a value focus rather than a price focus, which is currently demonstrated by Smart Energi and Newtility start-ups.
- The SESP concept and the associated business models created in WP2 that underpins this composite role.
- The technical architecture and ICT based infrastructure constituting what we have labelled “IoT for Smart Grids”.
- The forecasting modules and apps supporting this which are based on modern data science and machine learning

This and other achievements had at the termination of the project created the following impact:

- The ICT-platform has shown that it is possible to deliver a whole new type of services and support from prosumers and consumers alike and to unite and leverage their collective market power to attract different stakeholders and make an impact in the retailer part of the energy market. eSmart Systems has taken a lead here based on the work that has been done. As explained earlier they plan to go internationally with this and since the termination of the project, has done so.
- Newtility is a spin-off from EMPOWER in Germany. It is a new start-up incorporating the business aspects from WP2 and the market aspects from WP6. They are currently involved with a number of German utilities.
- Based on records from at least one pilot area and the ripple effects that the local market endeavour has had, strongly suggests that long-term contracts with value focus the way this has been defined in EMPOWER stimulates residential owners to invest in micro-generation facilities.
- Both during the project and after we see that EMPOWER has made a lasting impact on energy users and stimulated increased engagement. This is especially true for Wolperthausen and not least Hvaler.
- The impact on DSOs’ planning and operations is still pending. Trade in flexibility as an alternative to the introduction of power tariffs or capital demanding upgrades is still an issue. Some of this scepticism can be attributed to current regulations. But energy associations such as the Danish Energy Association and ENTSO-E have taken an interest in the project.
- The CEO of eSmart Systems has recently taken an initiative together with top leaders in Schneider Electric, Norway to present an industrialized version of the EMPOWER platform for European DSOs and other stakeholders on August 17, 2018

- The Norwegian regulator, NVE has vouched to cater for local flexibility markets, but wants to be compliant with other European initiatives. NVE has been in contact with the project coordinator about this multiple time. The call for future cooperation between the Norwegian TSO, Nordpool and major European utilities to dive deeper into the substance created by EMPOWER has been accelerated after the termination of the project.
- In EMPOWER it has also been shown that it is technically possible to operate as a SESP independently of geographical distance and national borders. However, current tariff regimes and regulations largely inhibit a “a one size fits all” business approach. A degree of customization is required. However, we see that the basic principles derived are applicable across borders. Smart Energi and Newtiltity are strong evidence of that. This is also currently supplemented by the Norwegian utility, Skagerak, which is currently creating its own local market associated with a football stadium in the city of Skien.
- eSmart Systems could have taken the SESP position but has declined and is comfortable with the role as a software and platform provider for the ecosystem (software as a service). Currently, the company is putting a lot effort into business development and marketing based on EMPOWER. Their commitment to massive exploitation of the EMPOWER result was stressed by the company’s CMO for energy markets during her presentation at the last exploitation workshop in Halden in October 2017.
- Linkages and potential of different partner business models within an effective and working eco-system have been confirmed and endorsed. Business models for the EMPOWER partners are highly appreciated from the business community. The short-term benefit has been increased media focus and increased awareness of the potentially disruptive concept that the EMPOWER results represent. This part has been injected into the H2020 INVADE project to pursue a more consolidated ecosystem for trade in flexibility in different ways.
- We have seen that the workshops held have also generated ripple effects beyond the project consortium. The endorsement of the EMPOWER concept and business model by Lyse and KIC Innoenergy are two firm examples of that. Others follow suit (see below)

Future plans

The exploitation effort has triggered business, social and product development beyond the project. The project has inspired multiple parties external to the project. They have initiated efforts on their own. This includes Agder Energi and Nordpool Otovo, Skagerak Energi and Lyse in Norway. Malling is a Nordic company which has announced efforts to create local market hubs. KIC Innoenergy in Sweden has used EMPOWER results to ramp up a full-scale demo at Øbo outside Stockholm. TNO and University of Eindhoven have used EMPOWER to cater for local energy markets in the Netherlands. Hvaler commune who owns and hosts the Sandbakken Microgrid is currently planning an extension to the steering and storage concept. The municipality will explore related market concepts for this. It has also been instrumental in Q4, 2017 and Q1, 2018 in selling the concept to other municipalities in Norway and Sweden. Skagerak, which is mentioned above, is one case in point. Others include the Swedish island of Orust, Bø and Sauherad. Attention has also been raised in India where a delegation, including members of the project and Hvaler municipality, was invited. Currently new business opportunities based in part on the EMPOWER experience is being set up there.

Evidence that ideas and tangible findings from EMPOWER has infused new research activities can be found with the ERA-Net initiative, E-Regio and INVADE.

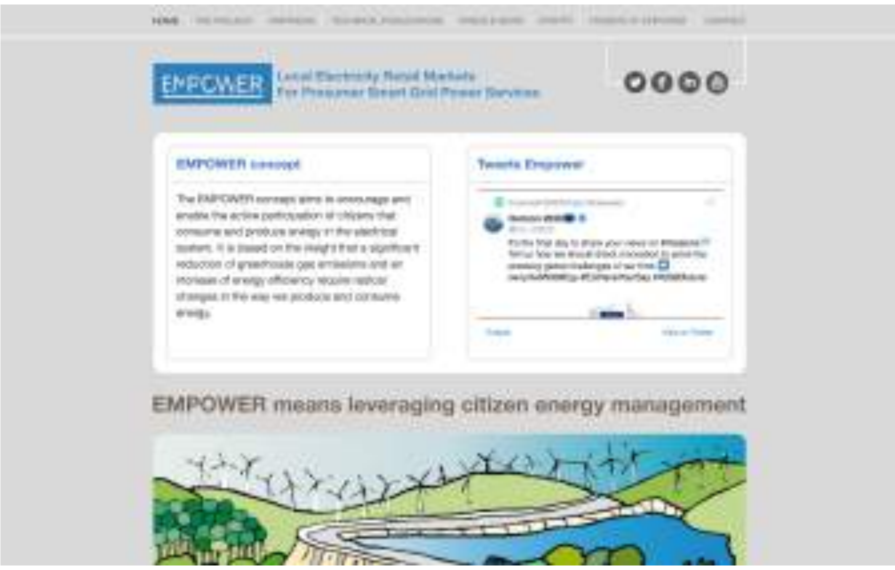
Conclusions of the exploitation of results

Work Package has carved out strategies for exploiting the R&D results of EMPOWER together with business leaders of each partner organization and by actively involving other stakeholders in pertinent workshops and in peer-to-peer dialogs. This work has led to an early spin-out from Norgesnett, namely Smart Energi. This company was engaged and supported early to pursue the local market concept created in EMPOWER for different neighborhoods in the eastern part of Norway. The EMPOWER concept, with the technical platform, is now being marketed under the brand “Smart Nabolag”. Another spin-out from the project is Newtility, a small venture with project members from SmartIO and UNISG. It is cultivating the market and business concept developed in EMPOWER and is currently achieving success in the German grid market. They are supported by eSmart Systems. eSmart Systems has continued to develop the EMPOWER platform and is currently marketing this under the name “Connected Prosumer”. August 17, 2018, they will launch a full-scale event for DSOs.

Other business partners and research partners have also documented cultivation of EMPOWER take-away. The market and business concepts developed are further developed in major project like ERegio (ERA-Net SG) and INVADE (H2020). Political and social impacts have been generated. Here, WP8 has profited from dissemination activities organized by WP9. At least three of the pilot sites serve as models for similar initiatives in different European countries. The municipalities of Wolperthausen and Hvaler and consumers/prosumers there are sharing their thoughts and experiences harvested from EMPOWER with other communities across Europe. The Norwegian regulator, together with the Danish and Swedish energy authorities have picked up ideas, through close interaction with the project to pioneer new regulations to stimulate the creation of local flexibility markets. Nordpool, the Nordic Power Exchange, has also moved forward on a similar not

8 Communication and dissemination products

- Web page of the EMPOWER H2020 project: http://empowerh2020.eu



- Logo:

- Project Videos: https://www.youtube.com/channel/UCsTRAP13mzIkOiGJIpjUFfA

  Euresearch Services: Empower

  - https://www.youtube.com/watch?v=IIN7_zOX2wk&list=PLqYCCUDc43YkoIUoXZrdBE1DYQ1KOcbj7

  Business models for EMPOWER

  - https://www.youtube.com/watch?v=XhLFgJWnB7c&list=PLqYCCUDc43YkoIUoXZrdBE1DYQ1KOcbj7&index=3

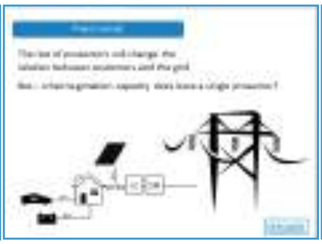
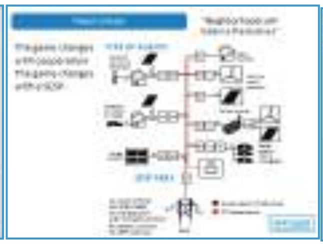
  Our Power for EMPOWER

  - https://www.youtube.com/watch?v=5x0XyTpk9jA

  Prof. Wüstenhagen about the EMPOWER project (in German)

  - https://www.youtube.com/watch?v=pY08S8pX4SI

- Stakeholders presentation

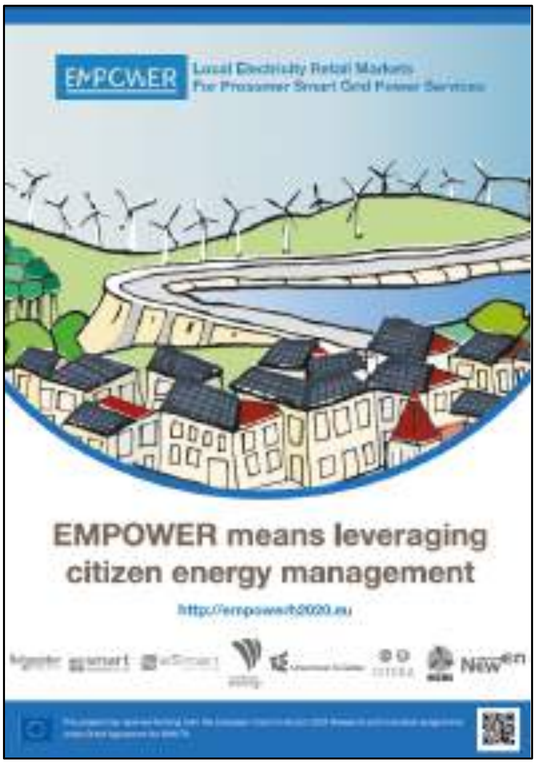




- Project Newsletter

- Project Flyers




- Project Poster



9 Annexes

Table A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.

No.	Title	Main authors	Type of publication	Publisher	Year of publication	Relevant pages	Permanent identifier (if available)	Is/will open access be provided?
1	Timing-based business models for flexibility creation in the electric power sector	Thorsten Helms, Moritz Loock, Rene Bohnsack	Journal article	Energy Policy	May 2016	348-358, Volume 92	https://www.sciencedirect.com/science/article/pii/S0301421516300763	YES
2	Multi market bidding strategies for demand side flexibility aggregators in electricity markets	Stig Ødegaard Ottesen	Journal article	Energy (&NTNU, Doctoral Thesis ISBN 978-82-326-216-3)	March 2017	120-134, Volume 149	https://www.sciencedirect.com/science/article/pii/S0360544218302159	YES
3	Optimization problem for meeting distribution system operator requests in local flexibility markets with distributed energy resources	Pol Olivella-Rosell; Eduard Bullich-Massagué; Mònica Aragüés-Peñalba; Andreas Sumper; Stig Ottesen; Josep-Andreu Vidal-Clos; Roberto Villafafila-Robles	Journal article	Applied Energy	August 2017	881-895, Volume 110	https://www.sciencedirect.com/science/article/pii/S0306261917311522	YES
4	The flexible prosumer: Measuring the willingness to co-create distributed flexibility	Kubli, Loock & Wüstenhagen	Journal article	Energy Policy	2017	540-548, Volume 114	https://www.sciencedirect.com/science/article/pii/S0301421517308704	YES
5	Methodology for the Evaluation of Resilience of ICT Systems for Smart Distribution Grids	Pau Lloret-Gallego, Mònica Aragüés-Peñalba, Lien Van Schepdael, Eduard Bullich-Massagué, Pol Olivella-Rosell and Andreas Sumper	Journal article	Energies	August 2017	1287, Volume 10	http://www.mdpi.com/1996-1073/10/9/1287	YES

6	Business model quality: towards an ecological rationality view	Moritz Loock	Journal article	working paper in preparation for review	July 2016		not available	YES
7	Frame sequences and rule dynamics: Evidence from corporate venture processes in the power sector	Moritz Loock, Emma Reuter, Daniel Bartl	Journal article	working paper in preparation for review	June 2016		not available	YES
8	EMPOWER: A network market approach for local energy trade	Bernt Bremdal, Pol Olivella, Jayaprakash Rajasekharan	Conference paper	IEEE PowerTech 2017	June 2017		https://smartgrids.no/wp-content/uploads/sites/4/2017/05/EMPOWER-local-energy-markets.pdf	YES
9	Creating a local energy market	Bernt Bremdal, Pol Olivella, Jayaprakash Rajasekharan, Iliana Ilieva	Conference paper	CIRED 2017	June 2017		http://digital-library.theiet.org/content/journals/10.1049/oap-cired.2017.0730?crawler=true&mimetype=application/pdf	YES
10	Day-ahead micro-market design for distributed energy resources	Pol Olivella	Conference paper	IEEE ENERGYCON 2016	April 2016	001-006	https://ieeexplore.ieee.org/abstract/document/7513961/	YES
11	Scaling novel business models	Loock, Bartl and Reuter	Conference paper	EGOS conference, Athens	June 2015		https://www.alexandria.unisg.ch/239897/	YES
12	Design and Operational Characteristics of Local Energy and Flexibility Markets in the Distribution Grid	Pol Olivella, Jayaprakash Rajasekharan, Bernt Bremdal	Conference paper	SET PLAN 2016 - CEEC X	December 2016		http://www.setplan2016.sk/dat/poster/10.SET_Plan_Poster_Jay.pdf	YES
13	New markets and business models in microgrids: EMPOWER project	Pol Olivella Rosell, Rafael Pacheco Bubí, Roberto Villafáfila Robles, Andreas Sumper Antoni, Sudrià-Andreu	Conference paper	Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo (CYTED).	December 2015		not available	YES
14	The flexible prosumer: Customer co-creation of ancillary services in smart grids	Kubli, Loock & Wüstenhagen	Conference paper	IAEE Vienna	2017		https://www.eeg.tuwien.ac.at/conference/iaee2017/files/abstract/640_Kubli_abstract_2017-04-01_19-32.pdf	YES

15	Multi-Period Power Management Optimization for Operating Isolated Hybrid Microgrids	Marc Galceran, Mònica Aragüés, Eduard Bulich, Oriol Gomis	Conference paper	IEEE explore 2017 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe)	2017	001-006	https://ieeexplore.ieee.org/abstract/document/8260208/	YES
16	Architecture definition and operation testing of local electricity markets. The EMPOWER project	E. Bullich-Massagué, M. Aragüés-Peñalba, P. Olivella-Rosell, P. Lloret-Gallego, J. A. Vidal-Clos and A. Sumper	Conference paper	IEEE explore 2017 International Conference on Modern Power Systems (MPS)	2017	001-005	https://ieeexplore.ieee.org/document/7974447/	YES
17	Empowering Local Electricity Markets: A survey study from Switzerland, Norway, Spain and Germany	Reuter, Emma; Loock, Moritz	Report	HSG	October 2017		https://www.alexandria.unisg.ch/252125/	YES
18	V2G: Measuring electric vehicle drivers' willingness to co-create flexibility for smart grids	Kubli, Loock & Wüstenhagen	Research poster	St. Gallen University	2017		https://www.sccer-mobility.ch/export/sites/sccer-mobility/p_supporting_measures/Annual-Conferences/AC2017/dwn_conference_150917/53_PRINT_Poster_Kubli_Loock_Wustenhagen_V2G-Willingness-to-co-create-flexibility_v3.pdf	YES

Table A2: List of written dissemination activities.

No.	Title	Main authors	Type of publication	Publisher	Year of publication
1	For energy conversion	Dieter Hirdes	Divulgation article	European Commission (CORDIS)	2015
2	Getting smarter and smarter	Estabanell Energia	Article	Blog of Estabanell Energia	April 2015
3	Local Electricity Retail Markets for Prosumer Smart Grid Power Services	Moritz Loock	Project description on UNISG homepage	UNISG webpage	April 2015
4	EMPOWER H2020	Mònica Aragüés , Emmanuelle Reuterand Dieter Hirdes	Article	BRIDGE	April 2017
5	Energy solutions for the future	EGI-HSG	Press release	UNISG webpage	August 2015
6	Vil flytte markedsdmakt	Atle Albensen	Article	Energiteknikk (Norwegian Energy Technology Magazine) page 42	December 2014
7	Empowering local electricity retail markets through business modelling	Loock, Bohnsack, Reuter and Kunze	Teaching Case	ECCH	December 2015
8	How to use the business model composer for EMPOWER business modeling	Moritz Loock, Rene Bohnsack	Brochure	St. Gallen University	December 2015
9	Norway is pushing the development of innovative smart grid solutions	Dieter Hirdes	Article	GTAI, Germany Trade & Invest	December 2016
10	Facilitating homeowners to be able to create their own energy	NRK- Østfold (Hilde Erlingsen and Odd Skjerdal)	Article	NRK - Østfold	February 2015
11	Solar cells and wind turbines will provide power at the eastern Hvaler	John Johansen	Article	Fredrikstad Blad	February 2015
12	Unique environmental project in Southern Sandøya will make cabins self-powered. Recieving 16 environmental millions	John Johansen	Article	Fredrikstad Blad	February 2015
13	Strategic Transformation in the German Energy Industry	Emma Reuter, Moritz Loock	Workshop description	St. Gallen University	February 2016
14	Empower 2020: towards a collaborative electric business model	Cristina Bernabeu	Divulgation article	Info PLC++	February 2017
15	Choose your partners wisely	Claude R. Olsen	Press release	Forskningsradet webpage	January 2015
16	The real value of Smart Grids and Microgrids	Andreas Sumper	Press release	Automática e Instrumentación, num. 469	January 2015
17	New concecpts in microgrids for the distribution of electrical energy	Francesc Girbau, Mónica Aragüés, Andreas Sumper	Divulgation article	Automática e Instrumentación, num. 469	January 2015

18	Europe's electricity becomes intelligent! Also in Wolpertshausen	Henrik Steinert	Press release	Bürgermeisteramt Wolpertshausen	January 2016
19	Strategic Innovation in the Energy Industry	Emma Reuter, Moritz Loock	Workshop description	St. Gallen University	January 2016
20	EMPOWER H2020	Emmanuelle Reuter	Article	BRIDGE	January 2017
21	Fredrikstad Energi preparing for the future	Fredrikstad Energi	Press release	Energibransjen.no	March 2015
22	The concept of prosumer	Mònica Aragüés	Press release	CIT UPC	March 2015
23	Promising Smart Grid Business Models	Moritz Loock	Workshop description	UNISG webpage, conference brochure	March 2015
24	Local Electricity Retail Markets for Prosumer Smart Grid Power Services	Henriette Forsetlund	Project description on eSmart homepage	eSmart webpage	March 2015
25	eSmart Systems partner in a new EU project that will revolutionize the energy market	Henriette Forsetlund	Press release	eSmart webpage	March 2015
26	NCE Smart leads new 50 million EU project which will revolutionize the energy market	Dieter Hirdes, Bernt A. Bremdal, Knut H. Johansen	Press release	NCE Smart Energy Markets webpage	October 2014
27	Multi market bidding strategies for demand side flexibility aggregators in electricity markets	Stig Ødegaard Ottesen	Journal article	Energy (&NTNU, Doctoral Thesis ISBN 978-82-326-216-3)	March 2017
28	A green electricity tariff for Wolpertshausen	Henrik Steinert	Press release	Bürgermeisteramt Wolpertshausen	July 2017
29	Optimization problem for meeting distribution system operator requests in local flexibility markets with distributed energy resources	Pol Olivella-Rosell; Eduard Bullich-Massagué; Mònica Aragüés-Peñalba; Andreas Sumper; Stig Ottesen; Josep-Andreu Vidal-Clos; Roberto Villafafila-Robles	Journal article	Applied Energy	August 2017

Table 3: List of oral dissemination activities.

No.	Title	Type of activities[4]	Main leader	Date of publication	Place
1	Local Electricity Retail Markets for Prosumer Smart Grid Power Services	Presentation	Dieter Hirdes (SIN)	21-22.05.2015	Brussels
2	Promising Smart Grid Business Models	Presentation	Dieter Hirdes (SIN)	2015	St. Gallen
3	Business Modeling in the Energy Sector	Presentation	Dieter Hirdes (SIN)	18-21-05.2015	St. Gallen
4	Novel grid developments, novel business models	Presentation	Dieter Hirdes (SIN)	2015	Lausanne
5	New energy business models	Presentation	Dieter Hirdes (SIN)	2015	Falera
6	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	21/5/15	Brussels 1st workshop SmartGrids Brussels
7	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	16/6/15	Malta demo site
8	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	17/6/15	Statsbygg
9	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	18/6/15	Verdiskapingsforum Østfold
10	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	13/8/15	TrønderEnergi
11	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	14/8/15	Stavanger
12	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	28/8/15	Hvaler, OE Minister visit
13	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	28/8/15	Ringeriks-Kraft Halden
14	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	2015	Lyse
15	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	10/9/15	Wolpertshausen
16	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	22/9/15	SRG meeting Dublin
17	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	1/10/15	FlexNett project meeting
18	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	8/10/15	BANCAGE Bulgaria
19	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	9/10/15	Østfold fylkeskommunes Internasjonale Forum
20	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	13/10/15	TrønderEnergi
21	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	14/10/15	Haugaland Kraft
22	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	22/10/15	German-Norwegian Energy Forum Berlin
23	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	3/11/15	FME CEI Halden
24	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	4/11/15	Nettalliansen
25	EMPOWER H2020	Presentation	Dieter Hirdes (SIN)	6/11/15	Energi Norge

No.	Title	Type of activities[4]	Main leader	Date of publication	Place
26	Motivated Learning and the Origins of Experience: How New Ventures Develop Heuristic Portfolios	paper presentation	Reuter and Loock (St. Gallen University)	03-10-2015	Denver, US
27	Research project presentation	research project presentation	Reuter (St. Gallen University)	03-03-2016	Amherst, Massachussets
28	TAG Workshop in "7th St. Gallen Forum for Management of Renewable Energies"	panel discussion	Reuter and Loock (St. Gallen University)	27-05-2016	St Gallen
29	7th St.Gallen Forum for Management of Renewable Energies	Not applicable	Rolf Wüstenhagen	26-27,05,2016	St Gallen
30	Reinventing the Utility: Successful Strategic Renewal in the Energy Industry	panel discussion	Reuter and Loock (St. Gallen University)	27-05-2016	St Gallen
31	Electricity micromarkets with community electricity storage	Presentation	Pol Olivella (CITCEA-UPC)	09-02-2016	Berlin
32	The vision of EMPOWER H2020 project: Storage needs of Smart Energy Service Providers	Presentation	Pol Olivella (CITCEA-UPC)	02-05-2016	Aachen
33	Day-ahead micro-market design for distributed energy resources	Presentation	Pol Olivella (CITCEA-UPC)	April 2016	Leuven
33	Performance of micro-markets for distributed energy resources	Presentation	Pol Olivella (CITCEA-UPC)	December 2015	London
34	Preconference St. Gallen Forum for Management of Renewable Energies	Presentation	Knut H. Johansen (eSmart) (eSmart)	26.05.16	St. Gallen
35	TAG Workshop in "7th St. Gallen Forum for Management of Renewable Energies"	Speaker at Workshop 7 EMPOWER to the people	Knut H. Johansen (eSmart)	27-05-2016	St Gallen
36	Strategic Innovation in the Energy Industry	presentations/ workshop	Emma Reuter, Moritz Loock (St. Gallen University) (St. Gallen University)	May 2016	Berlin
37	Optimization problem for meeting distribution system operator requests in local flexibility markets with distributed energy resources	presentations/ workshop	Emma Reuter, Moritz Loock (St. Gallen University) (St. Gallen University)	September 2016	St. Gallen
38	the EMPOWER project	video	Moritz Loock (St. Gallen University) (St. Gallen University)	April 2016	online
39	business models for EMPWOER	video	Emma Reuter/ Moritz Loock (St. Gallen University) (St. Gallen University)	July 2016	online

No.	Title	Type of activities[4]	Main leader	Date of publication	Place
40	using the business model composer for EMOWER	video	Moritz Loock (St. Gallen University) (St. Gallen University)	July 2016	online
41	Total upheaval in the energy industry?	Speaker/Presentation	Knut H. Johansen (eSmart)	31.05-01.06.2016	Røros, Norway
42	The flexible prosumer: Measuring the willingness to co-create distributed flexibility	Speaker/Presentation	Knut H. Johansen (eSmart)	02.06.2016	Oslo, Norway
43	Multi-Period Power Management Optimization for Operating Isolated Hybrid Microgrids	Presentation	Knut H. Johansen (eSmart)	2016	Barcelona, Spain
44	Local market design workshop	Panel discussion	Bernt (SIN), Jay (SIN) and Pol (CITCEA-UPC)	2016	Oslo, Norway
45	Micro-markets and EMPOWER project	Webinar	Pol Olivella (CITCEA-UPC) (CITCEA-UPC)	02.11.2016	
46	EMPOWER project	Panel discussion	Mònica Aragüés, Pau Lloret, Andreas Sumper, Roberto Villafáfila (CITCEA-UPC)	15.11.2016-17.11.2016	Barcelona, Spain
47	EMPOWER project	Panel discussion	Mònica Aragüés, Pau Lloret, Andreas Sumper, Roberto Villafáfila (CITCEA-UPC)	15.11.2016-17.11.2016	Barcelona, Spain
48	EMPOWER project	Panel discussion	eSmart	15.11.2016-17.11.2016	Barcelona, Spain
49	EMPOWER project expained to Smart Grids Working Group of COEIC	Presentation	Roberto Villafáfila (CITCEA-UPC)	07.02.2017	Barcelona, Spain
50	EMPOWER project explained in the Energy Congress of Catalonia	Presentation	Roberto Villafáfila (CITCEA-UPC)	15.02.2017	Barcelona, Spain
51	EMPOWER project explained in COEIC	Presentation	Roberto Villafáfila (CITCEA-UPC)	04.04.2017	Barcelona, Spain
52	EMPOWER project	BRIDGE Meeting	Emmanuelle Reuter (St. Gallen University)	17.-18.01.2017	Brussels
53	Power to the People: Generating Cleaner Energy from Smart Grids - Trends, developments and new models	Presentation		07.06.2017	Zürich
54	EMPOWER project	University-level seminar	Emmanuelle Reuter (St. Gallen University)	25.09.2017	Oberwesel
55	EMPOWER case study	University-level seminar	Emmanuelle Reuter (St. Gallen University)	4.-8.9.2017	St. Gallen

No.	Title	Type of activities[4]	Main leader	Date of publication	Place
56	EMPOWER project	University-level seminar	Emmanuelle Reuter (St. Gallen University)	27.06.2017	Zürich
57	EMPOWER project	Presentation in a meeting	Emmanuelle Reuter (St. Gallen University)	26/6/17	Luxembourg
58	EMPOWER project	Presentation in a meeting	Emmanuelle Reuter (St. Gallen University)	30.05.2017	Frick
59	EMPOWER project	Presentation in a meeting	Emmanuelle Reuter (St. Gallen University)	31/5/17	Ittigen
60	EMPOWER project	Presentation in a meeting	Mònica Aragüés (CITCEA-UPC)	16/05/2017	Girona
61	Local flexibility markets: From EMPOWER to INVADE	Participation to a Workshop	Pol Olivella (CITCEA-UPC)	11/07/2017	Barcelona
62	Machine Learning in the Energy Sector	Participation to a Workshop	Davide Roverso (eSmart)	25/10/17	Oslo, Norway
62	Machine Learning in the Energy Sector	Participation to a Workshop	Davide Roverso (eSmart)	6/11/17	Copenhagen, Denmark
63	Machine Learning in the Energy Sector	Participation to a Conference	Davide Roverso (eSmart)	26/9/17	Stavanger, Norway
63	Machine Learning in the Energy Sector	Participation to a Conference	Davide Roverso (eSmart)	9/11/17	Oslo, Norway
64	Machine Learning in the Energy Sector	Participation to a Conference	Davide Roverso (eSmart)	12/9/17	Trondheim, Norway
64	Machine Learning in the Energy Sector	Participation to a Conference	Davide Roverso (eSmart)	26/10/17	Kristiansand, Norway
65	Machine Learning in the Energy Sector	Presentation in a meeting	Davide Roverso (eSmart)	2/11/17	Halden, Norway
65	Machine Learning in the Energy Sector	Presentation in a meeting	Davide Roverso (eSmart)	21/9/17	Halden, Norway
66	Machine Learning in the Energy Sector	Participation to a Conference	Davide Roverso (eSmart)	7/9/17	Hønefoss, Norway
66	Machine Learning in the Energy Sector	Presentation in a meeting	Davide Roverso (eSmart)	30/8/17	Halden, Norway
67	Machine Learning in the Energy Sector	Presentation in a meeting	Davide Roverso (eSmart)	12/6/17	Oslo, Norway
67	Machine Learning in the Energy Sector	Presentation in a meeting	Davide Roverso (eSmart)	2/6/17	Halden, Norway
68	Machine Learning in the Energy Sector	Presentation in a meeting	Davide Roverso (eSmart)	20/2/17	Fredericia, Denmark
68	Machine Learning in the Energy Sector	Presentation in a meeting	Davide Roverso (eSmart)	23/1/17	Halden, Norway
69	Machine Learning in the Energy Sector	Presentation in a meeting	Davide Roverso (eSmart)	15/1/17	Bellevue, WA, USA
70	Empower Project	Presentation	Diane Cassar (MIEMA)	15/07/2017	Gozo, Malta
71	Empower Project	Presentation	Diane Cassar (MIEMA)	11/9/17	Nicosia, Cyprus
72	Smart Meters and Smart Grid - learning from piloting	Presentation	Vidar Kristoffersen (FEN)	29/1/15	Halden, Norway
73	DSO trade with flexibility - a substitute for grid investments?	Presentation	Vidar Kristoffersen (FEN)	19/10/17	Halden, Norway

No.	Title	Type of activities[4]	Main leader	Date of publication	Place
74	Innovation spinning with EMPOWER based business models	Presentation	Moritz Loock (St. Gallen University)	4/5/17	GEM, Grenoble, France
75	The role of EMPOWER based business modeling in sustainability transitions	Presentation	Moritz Loock (St. Gallen University)	1/9/17	EAWAG, Zurich Switzerland
76	Preferences of flexibility prosumers in EMPOWER market places	Presentation	Moritz Loock (St. Gallen University)	10/11/17	GEM Grenoble, France
77	Efficient digital prosumer	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
78	EMPOWER - an example of an alternate DER marketplace	Presentation	Tina M. Skagen (eSmart)	2017	
79	The connection between smart charging stations and energy demand in neighbourhoods	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
80	Smart Grids and Business Models	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
81	Energy Markets and Demand Side Flexibility	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
82	Demand side flexibility and its role for DSOs and TSOs	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
83	EMPOWER, Smart Energy Hvaler and Statkraft	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
84	Aggregation of prosumer flexibility as a service to the DSOs	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
85	Demand side flexibility	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
86	Demand side flexibility and activities in eSmart	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
87	Smart Grids – on how energy and it technology together with market models can contribute to a more efficient power system	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
88	How innovative business models can contribute to solving power challenges in distribution grids	Presentation	Stig Ødegaard Ottesen (eSmart)	2017	
89	Novel grid developments and business models	Presentation	Moritz Loock	2016	Lausanne
90	Novel grid developments and business models	Presentation	Moritz Loock	2017	Lausanne
91	A business model based on EMPOWER	Presentation	Moritz Loock / Christian Kunze	2017	Düsseldorf

Table A4: List of applications for patents, trademarks, registered designs, etc

Type of Exploitable Foreground	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable, commercial or any other use	Patents or other IPR exploitation (licenses)	Owner & Other Beneficiary(s) involved
Commercial exploitation of R&D results	The full EMPOWER suite for local flexibility & energy trade	No	None	Software based on WP6, WP7, WP8	Energy	2018	Protection for the brand has been filed	B1: eSmartSystems company B2: Grid companies, prosumers, energy cooperatives B3: Newtility, Smart Energi, Hvaler municipality
Commercial exploitation of R&D results	Web and app based software for German consumers based on EMPOWER & blockchain	No	None	Software based on WP2, WP6 and WP7 results	Energy	2018	Protection for the brand Newtility has been filed	B1: Newtility company (spin-off from UNISG and SmartIO) B2: Grid companies B3: eSmart Systems supporting them
Commercial exploitation of R&D results	Web based software and energy community concept based on EMPOWER	No	None	Software based on WP2, WP6 and WP7 results	Energy, ICT	2017	Protection for the brand “Smart Nabolag” (Smart Neighbourhood) has been filed	B1: Smart Energi (spin-out from FEN) B2: Prosumers, consumers organized in communities B3: eSmart Systems supporting them.

Type of Exploitable Foreground	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable, commercial or any other use	Patents or other IPR exploitation (licenses)	Owner & Other Beneficiary(s) involved
Commercial exploitation of R&D results	Marketing and sales material	No	None	Sandbakken microgrid concept as demonstrated in pilot	Energy, ICT	2017		Schneider Electronics
Commercial exploitation of R&D results	New business models from EMPOWER	No	None	Business concepts developed in WP2	Energy	2017		B1: NewEn B2: Energy cooperatives
Commercial exploitation of R&D results	Business modeller	No	None	Tool to design new business concepts in WP2	???	2018		
Exploitation of results through (social) innovation.	The use of Sandbakken microgrid as a local and Nordic symbol/model of a "green society"	No	None	Sandbakken microgrid and market concept	??	2017		B1: Hvaler municipality B2: Hvaler population B3: Nordic municipalities B4: eSmart Systems providing the operational software, Schneider Electric harvesting long term experiences with microgrids
Exploitation of results through (social) innovation.	The use of the community concept	No	None	Apps, knowledge of trade, knowledge of how	Energy	2016		B1: Prosumers at Hvaler and in the region beyond B2: Smart Energi

Type of Exploitable Foreground	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable, commercial or any other use	Patents or other IPR exploitation (licenses)	Owner & Other Beneficiary(s) involved
	at demo site "Norderhaugsveie"			to organize a local market				B3: Nordic municipalities B4: eSmart Systems providing app
Exploitation of results through (social) innovation.	The use of the community concept at demo site "Norderhaugsveie"	No	None	Apps, knowledge of trade, knowledge of how to organize a local market	Energy	2016		B1: Municipality of Wolperthausen B2: NewEn, Newtility B3: Other German municipalities/coops
General advancement of knowledge	Knowledge applied for further research in local energy markets	No	No	Local market and trade concepts and software from EMPOWER	Energy, Research	2017		B1: SmartIO, eSmart Systems B2: Other research projects, other research communities, the NCE network of energy/ICT industries
General advancement of knowledge	Knowledge applied for further research & education in local energy markets and microgrids	No	No	Local market and trade concepts and software from EMPOWER	Energy, Research, Education	2017		B1: UPC/CITCEA B2: Master and PhD students, other research communities

Type of Exploitable Foreground	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable, commercial or any other use	Patents or other IPR exploitation (licenses)	Owner & Other Beneficiary(s) involved
General advancement of knowledge	Knowledge applied for further research & education in novel business models for renewables	No	No	Business models developed in WP2	Energy, Research, Education	2017		B1: UNISG B2: MBA and PhD students, other research communities
General advancement of knowledge	Knowledge applied for further research in agent-based technologies	No	No	Distributed and IoT related ICT concepts combined with multi-agent technologies	ICT, Research, Education	2017		B1: UiT- The Arctic Univ. of Norway B2: Master and PhD students, other research communities, Nordic industry
Exploitation of R&D results via standards	Commercial operation of batteries in communities. Organization of local energy communities for local trade	No	No	Recommendations for regulations of organized energy communities and the use of batteries	Policies, regulations	2017		B1: SmartIO B2: NVE, ENTSO-E, interest organizations for utilities (Energi Norge, GEODE)