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Second Report: Business Models Issues

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Executive Summary

After a first activity report released to the European Commission early 2017, the BRIDGE Business Models Working Group (BM WG) re-structured internally so as to better tackle specific issues identified by its members related to Business Models in the different BRIDGE projects. This restructuration of the BM WG generated the following 4 Sub Working Groups (SWGs):

- Business models aspects in Regulated Activities;
- Business models for Local Energy Management;
- Business models for Energy Storage;
- Business models for Demand Response.

Based on this new structure, the members of each SWG have delivered a first version of main findings/recommendations and action plans for the year 2018 described in the upcoming sections of this report.

Business Model aspects in Regulated Activities

The objective of the SWG related to “Business Models aspect in regulated activities” is to assess business model conditions related to regulated grid activities and including: new grid devices and the involvement of flexibilities for grid planning, operation and control. Within the SWG, 5 main issues have been determined, each of them raising a specific challenge.

The first issue deals with the **incentives provided to operators and market players in order to facilitate the development of a positive business case for smart equipment**. The main recommendations defined are based on the work already achieved within the UPGRID project which addresses risks with investment and operation in/of smart technologies. As an example, one recommendation to tackle the risk related to investment in smart technologies is the adoption of a stochastic distribution network planning approach when a recommendation to tackle the risk related to operation of smart technologies is the reduction of operational uncertainty of smart technologies through enhanced testing and trials. During 2018, the main action will be related to the Cost Benefit Analysis conducted by UPGRID within the context of the deployment of these technologies across the DSO network of each participating country. It is also stressed that the potential of funneling greater resources available for innovation funding should be considered.

Furthermore, the SWG focused on **market design so as to meet efficiency and scalability demands**. The aim is to define a methodology and a tool that will be circulated across the different projects involved to internationalize energy organizations. Along 2018, a methodology will be built to mainly analyse and develop patterns for the energy industry as well as develop education module for practitioners. The work on the tool will be based on the already existing inteGRIDy tool: this tool, aiming at helping the business modelling for future cities and technologies, will be assessed and improved so as to better tackle the issue.

The next challenge of the SWG is linked **to data and financial flow-organization for the different players** (excluding issues related to transitive energy management and data management already dealt in other groups). The main recommendation highlighted is to list and analyse what are the data required to enable the business models (aggregated load curve, aggregated generation curve, installed generation capacity, constraints measurements by the DSO, etc.). The action for 2018 will be to disseminate a questionnaire within the projects to provide a matrix of the analysis of the type of data required (relevance for BM, owner, etc.) and to identify the differences between the projects and countries.

Then, the SWG targeted **market design for the use of flexibility by the Distribution System Operator (DSO)** for planning or operation purposes. The main recommendation aims at raising market design questions by interviewing DSOs in different European countries to understand how they deal with them. During 2018, interviews with DSOs will be carried out based on the specific questionnaire developed by the SWG (see part 2.5.3) to provide benchmark between projects and countries.

Finally, the SWG dealt with **local Flexibility Market** related to the previous issue since the DSO is expected to be the main beneficial of this market. The main recommendation is to challenge the project deliverables as well as existing pilots to define clearly the concept of “Local flexibility Market”. The plan for 2018 will be to list and analyse the existing projects describing and demonstrating local flexibility markets. This work will be based on a dedicated list of questions (see part 2.6.3).

In conclusion, the work of the SWG will be based on 3 main actions: **surveys**, **tool** and **deliverable challenges between SWG.**

Business Models for Local Energy Management

The SWG related to “Business models for Local Energy Management” analyses the scope for business models revolving around consuming self-generated electricity (prosumage) in two perspectives: individual and collective self-consumption as home owners, Small-Medium Enterprises and cooperatives have a more active role in the energy system and self-consumption was more associated with a financial loss rather than be more financially interesting for prosumers.

Regarding **Individual self-consumption**, this BM SW states that in most countries, the cost per kWh of residential systems is lower than the retail price and that taxes and levies on electricity play an important role for prosumage so as financial support is still required towards this aim. Moreover, that technological progress and smart devices (e.g. smart meters, storage devices, smart-home controllers…) are fundamental to optimise prosumage. The SWG emphasizes that not all candidate prosumers judge purely on financial terms; some of them place significant value on their ecological footprint. Something that should be targeted by Governments companies and projects when dealing with this activities.

For instance, findings expressed by this SWG state that benefits from individual self-consumption are important when high retail prices are present, solar irradiation is available, usual demand of buildings exceeds production (i.e. offices) or buildings have temporal overlaps of production and load curves (such as residents with pensioners), etc. Furthermore, when third-party entities can achieve significant cost savings due to economies of scale, such as ESCOs and RESCOs or these entities are involved in the dimensioning, financing and possibly managing of the excess energy. Last but not least, benefits could be achieved also when production is combined with storage systems (e.g., batteries). It is highly recommended that regulators regularly update supporting policies (e.g., as in Germany) to be cost-efficient and provide the appropriate investment signals, without distorting the market. Furthermore, prosumers would need to participate in a fair manner to the network expansion and management costs, e.g., by introducing capacity-based network tariffs (instead of those that are purely based on energy volume) so as regulated players, like DSOs would need to provide transparent, localized and up-to-date information to facilitate prosumage.

Moreover, the SWG focused on **collective self-consumption** business models in presence of low government support which are characterized by complex legal rights and management issues. They conclude that wherever the building is owned by one entity and inhabited by tenants, then policy makers would need to provide clear regulatory frameworks and standards for shared investments. A carefully designed regulation would allow households to become prosumers easily.

During 2018, this SWG foresees to enrich the description and recommendations of the issues related to Local Energy Management enlisted in this document and to identify new issues related to these topics providing recommendations and characterizing these new issues identified.

Business Models for Energy Storage

The ”BM SWG working on **Storage”** related issues has confirmed that storage devices would favour self-consumption in countries with high retail prices (such as Germany) without sophisticated business models using VPPs technologies. The development of a clear and favourable regulatory framework encouraging the development of flexible hybrid power plants (RES + storage) at generation side is needed at national and European levels. In this same direction, the increment of financial incentives for operators of distributed storage would need to take part in coordinated schemes (such as VPPs).

It has been emphasized that ICT and technology providers must be considered when designing BM dealing with storage applications in connection with RES and DR technologies. In addition, in some cases when multiple storage devices are deployed the role of an ESCO or a third party would be useful and facilitate the identification of revenue streams.

Regarding batteries, it is recommended that financial instruments (including public subsidy) and regulatory framework would need to evolve in order to encourage the development of BESS. If a massive deployment of BESS occurs, effective stimulation of battery market would lead on to investment of accompanying technologies (software and hardware), decreasing prices and favouring their market penetration. Lack of investors and "regulated" investment in storage might prevent other type of storage and type of actors to become competitive. Also, the risk for battery storage is the competition with potentially less expensive flexibilities, and/or other energy careers storage. The SWG highlights that it is important to continue to invest in new technologies at national and European levels, and to define public policies that will facilitate innovative battery technologies to get to the market.

In order to foster the development of a flexibility market, the SWG specialised in storage issues recommends that centralized batteries shouldn't be allowed to participate to any flexibility market if they belong to a regulated entity, because if regulated entities own and operate the flexibilities (batteries included) then there will be no room for any flexibility market. Customers, aggregators might have difficulties to get correct ROI and even adequate payment for their services. This issue would be right in the centre of the iterations towards the validation of the Winter Package proposals aiming at having the "customer at the centre of the energy system".

However, there would be a risk that inflexible conventional power generation is distorting the market, so flexible sources cannot be operated profitably. Regulatory barriers changes, new alternative technologies, high energy storage costs, etc. pose a risk leading to unclear scenarios for decision makers. The use of tool to support decision making would be fundamental to better choose scenarios in different BMs.

Traditional business cases insufficiently imply stakeholder analysis, externalities, and the spatial optimality given the existing electricity grid and gas grid. Therefore, a new generation of business models will need to be developed, capturing all these elements. Indeed, more research is still needed on conversion and storage options with respect to intermittent renewable power production, and in particular what adjustments in the grid and in appliances may be needed to make them suitable for syngases.

Finally, life cycle analysis (LCA) and estimation of the socio-economic impacts must be taken into account when assessing business models in general. From storage technologies perspective, the lack of these analysis may lead to sub-optimal storage investment from societal perspective while the design of a robust cost-benefit model taking into account these externalities in storage systems may provide more elements to value the importance of storage and favours its deployment.

At this stage, this SWG has mostly worked on the characterisation of issues related to storage within the projects of the BRIDGE initiative. More recommendations for Storage BM are to be provided in the next report update by the end of 2018.

Business Models for Demand Response

The objective of the SWG dealing with demand response is to assess business models conditions related to a change in the power consumption for a better management of microgrids, by involving more the end-users and by working on the flexibility services and costs. Within the SWG, 4 main issues have been defined.

The first issue deals with the **allocation of 5G spectrum by telco operators for managing microgrids**. This issue is relevant since it impacts anyone who manages a microgrid e.g. energy cooperatives, energy companies, DSOs, mobile network operators, large local energy consumers (industrial, public services e.g. hospitals, commercial). Independently of the regulatory issues the main recommendation focuses on the need to introduce local micro licensing and allocate spectrum resources for managing smart grids.

Then, the SWG focused on **how to engage consumers?** Experiences from RealValue and SMILE are considered and it is stressed that the greatest risk to engagement is the lack of interest or understanding on the part of consumers and / or lack of willingness to understand. An example of recommendation within the SWG is to gain a thorough understanding of what is required to engage specific consumer categories i.e. gather feedback from large cohorts of consumers from diverse demographics to identify what would be the most efficient. During 2018, specific actions will be taken for the SMILE and RealValue projects (see part 5.3.3). On a higher level, it will be investigated the possibility of organising a stakeholder event at EUSEW involving potential smart loads / small-scale domestic RES/EES appliance manufacturers to study business models/ESCOs / regulation to facilitate the acceptability of the recommendations identified.

The next issue targets the **enabling of a fair and open market framework for flexibility services**. The aim is to address the need for adequate measures to ensure market uptake of innovative technological solutions and services. The issue can be addressed by implementing the Winter Package directives into MS regulation based on dedicated recommendations related to specific dimensions: demand response access to markets, service providers' access to markets, product requirements and measurement and verification, payments and penalties. During 2018, the main actions to be implemented will be focusing on the preparation of an EC/ACER implementation guidelines for different stakeholders (TSO, DSO, BRP, aggregators), the development of an implementation roadmap, the design and monitoring of KPI related to that matter.

Finally, the SWG worked on **revenues, costs & ROI of demand response.** To address this issue, it is reminded that there is a requirement for collaboration with TSOs/DSOs to ascertain higher values for flexibility and provide longer term contracts to encourage more investment and technology adoption. To illustrate this point of view, an example of recommendation is to create a forum of EU DSM players to collectively develop standard guidelines and operational standards. For 2018, the action plan will include several steps: design and develop an industry survey on approaches to revenue budgets and mechanisms for auction / win contracts, conduct the survey to encompass all EU Member States, and disseminate the findings and results.

Business Models tools

Within the Business Models Working Group, 3 main Business Models tools have been introduced to support the work of the working group:

The **Nobel Grid tool** proposed scenarios for the techno-economic evaluation of innovative smart grid technologies and associated business models. Then, the **Technofi tool** aimed at calculating key performance indicators (KPIs) to shape the socio-economic impacts of use cases/business models of smart grids and energy storage solutions. Two BRIDGE projects, NAIADES and REAL VALUE have tested the Technofi tool and provided relevant outcomes. As an example, NAIADES stressed that the tool would fit the parameters, function and characteristics of the batteries deployed in the project after studying a specific use case aiming at assessing the different costs (i.e. installation) of the batteries used in the NAIADES project compared with those already commercialised by different companies. One of the main recommendation raised by the project is related to the possibility for the tool to provide different charging and discharging hours for the batteries. Finally, the **inteGRIDy tool** which aims at helping the business modelling for future cities and technologies, is already part of the action plan dedicated to the SWG related to Regulated activities.

Collaboration between those 3 tools based on a wider sharing between the different BRIDGE Business Models projects will be further investigated during 2018 so as to better identify potential improvements for each of them.

What are the next steps?

The next step for the BM WG will be to foster synergies between the BM subgroups and the topics they have identified with the other BRIDGE WG (Regulations, Data Management and Customer Engagement) to provide more recommendations in a holistic perspective and a structured view of all the hot topics assessed within the BRIDGE initiative to the European Commission.

1. Introduction

BRIDGE is a European Commission initiative which unites Smart-Grid and Storage, Research and Innovation projects involving four cross-cutting issues related to Business Models, Consumer Engagement, Data Management and Regulations. The BRIDGE process implements continuous knowledge sharing amongst projects thus allowing them to deliver with a single voice conclusions and recommendations about the future exploitation of the project results, according to the four areas of interest of the Working Groups.

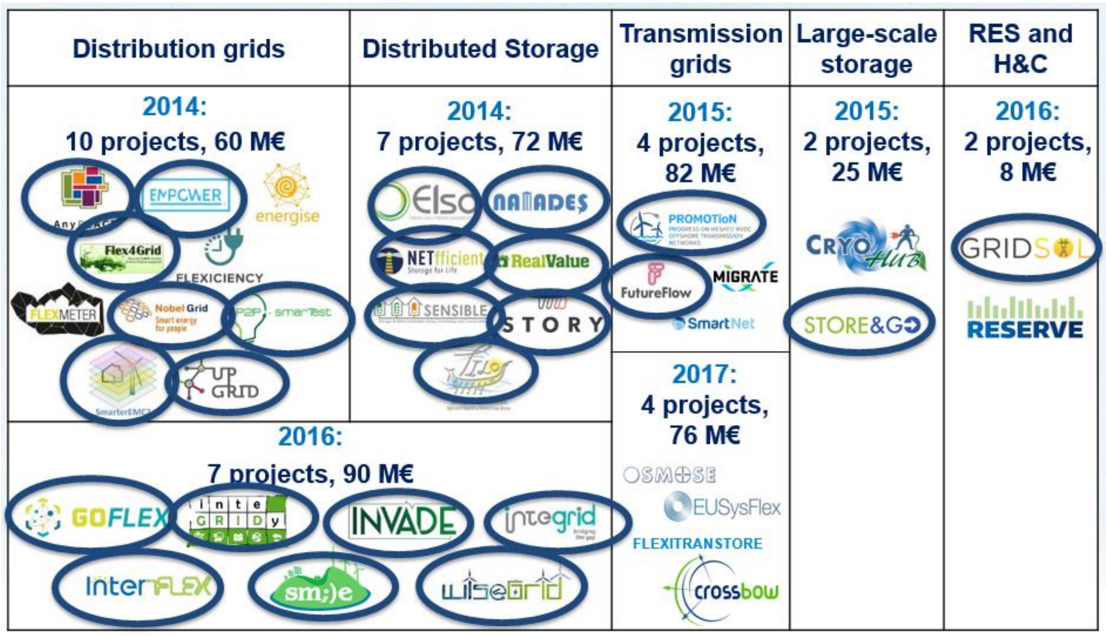
In particular, the Working Group related to Business Models (BM WG) aims at:

· Defining common language and frameworks around business model description, characterisation and valuation;

· Identifying and evaluating existing and new or innovative business models from the project demonstrations or use cases in order to provide recommendations to remove the barriers or issues identified towards their deployment;

· The development of tools allowing the comparison of the different business models applicable to smart grids and energy storage solutions.

The BM WG is composed by 25 projects (from 36 that compose the BRIDGE initiative) as shown in the scheme below:



This report gathers the issues identified by the members of the BM WG related to the use cases they are dealing with in their different projects. These issues and main findings are detailed in the upcoming chapters of this deliverable. To better structure the content and recommendations to be provided by the WG, it has been decided to structure the BM WG in four Sub Working Groups (SWGs) as follows:

- Business Models aspects in Regulated Activities;
- Business Models for Local Energy Management;
- Business Models for Energy Storage;
- Business Models for Demand Response.

2. Business Model aspects in Regulated Activities

2.1 Context

The Sub-working group (SWG) dedicated to **regulated activities** aims at **assessing business model conditions related to grid activities, which are regulated**. This encompasses the business models related to **new grid devices**, as well as the **involvement of flexibilities** for grid planning, operation and control.

The list of members of the Sub-working group is the following (the leaders being in bold font):

Table 1. Participants of the SWG in regulated activities

First name	Last name	Company	Project
Thomas	**DRIZARD**	**Enedis**	**INTERFLEX**
Guillaume	**LEHEC**	**ENGIE**	**INTERFLEX**
Spyros	GIANNELOS	Imperial College	UPGRID
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Ilias	LAMPRINOS	Intracom Telecom	Smarter EMC2
Tapani	RYYNANEM	VTT	FLEX4GRID
Rui	BERNARDO	EDP Distribucao	INTEGRID
Raphael	HOLLINGER	Fraunhofer ISE	Netficient
René	BOHNSACK	UCP	inteGRIDy

The table below gives an overview of the issues raised by the projects of this subgroup before meeting at the November 2017 BM workshop:

Table 2. Original issues of the SWG dedicated to regulated activities

Business Models Issues	Sub topics proposal
Which incentives to Distribution System Operator (DSO) and Transmission System Operators (TSO) to make the networks smarter, in a rate of return environment?	Service oriented business model
	Market design to meet efficiency and scalability demands
Which business models for Data Management?	Data and financial flow organization for the different players
Which procurement rules for small players?	Role of smaller consumers and local / national markets
Flexibility services: which business models?	Market design for the use of flexibility by DSO
	Local flexibility Market
	Keys to incentivize flexibility

The workshop has allowed to find methodologies to tackle the issues. Three ways have been identified:

- **Deliverable challenge between SWG members**. In the projects, some deliverables and extract of deliverables will be shared among the SWG members, in order to get feedback and to build a common deliverable;
- **Tool challenge**. Some projects (e.g. inteGRIDy) have developed analytical tools that can be used for other projects. The feedback on these tools will allow to tackle some of the issues.
- **Survey**. For some subjects, a survey, used as basis for interviews, will be built in order to provide benchmark between projects or countries, especially in the market design field.

The table below shows the final list of issues identified by the members of this SWG during the November 2017 BM workshop and that are to be assessed in this report and during 2018:

Table 3. Final issues identified by the SWG dedicated to regulated activities

Issues
Issue 1 - Service-oriented business model: incentives to operators/market players in order to make easier the BM of smart equipment
Issue 2 - Market design to meet efficiency and scalability demands
Issue 3 - Data and financial flow organization for the different players
Issue 4 - Role of smaller consumers and local / national markets
Issue 5 - Market design for the use of flexibility by Distribution System Operator (DSO)
Issue 6 - Local Flexibility Market

Issue 4 will not be analysed in 2018 and will be tackled during 2019 instead. Synergies with the "Local energy Management" subgroup will be discussed regarding this issue.

2.2 Issue 1 – Service-oriented Business Model: incentives to operators/market players to make easier the BM of smart equipment

2.2.1 Definition and characterisation

This issue deals with the incentives for facilitating wide-scale deployment of flexible technologies. It consists in assessing the incentives provided to operators and market players in order to facilitate the development of a positive business case for smart equipment.

Smart Technologies consist of the equipment deployed in a power system that assist in actively meeting system constraints at a smaller cost.

Examples include:

- Demand Side Response, whereby consumers can shift their load depending on system conditions. One potential benefit can include conventional network deferral or avoidance.
- Active Power Generation Curtailment, whereby distributed renewable systems can be asked to curtail their output in order to help meeting a system constraint.
- Low Voltage Network Management System, whereby field crews are provided with a real time view of the LV network diagram to manage and solve LV network incidents more rapidly than in the traditional way where no network visibility existed.

2.2.2 Recommendations

UPGRID project has resulted in a series of recommendations that aim to facilitate the wide roll out of smart technologies. Prior to providing these recommendations it is important to recognize the risks associated with investment in these technologies. These are as follows.

a. **Risk of sub-optimal investment decisions / stranded assets when long-term uncertainty in network planning is neglected**; This risk is introduced when network planning is conducted using traditional planning approaches based on individual projected scenarios on uncertain amount/timing/location of future load/Distributed Generation (DG) connections.

b. **Risk of not recovering the investment cost of smart technologies due to their low life span**; Such technologies (monitoring and control equipment, voltage regulators, Low Voltage NMS etc.) have lower life span than the typical forty-year life span of conventional ones, meaning that there is a shorter period of time to recover the initial investment cost.

c. **Risk of not recovering the cost of investment in Demand Side Response (DSR) due to low consumers' participation**; Despite investment in DSR technology, the eventual participation of consumers is uncertain and it may turn out to be not sufficient for generating system benefits, thereby essentially causing the associated initial investment costs to not be fully recovered.

Recommendations to address the risks associated with investment in smart technologies include:

a. **Adoption of a stochastic distribution network planning approach in order to** account for uncertainties on future demand / DG.

b. **Consideration of differences in life span of various technologies;** In setting the return on investment for DSOs, differences in life span of different types of technologies need to be considered so as to be able to recover the associated investment cost within the planning timeframe.

c. **Ensuring reduced uncertainty on consumers participation prior to DSR investments**; Actions to address the risk associated with reduced consumers participation involve: i) effective communication of potential benefits that consumers can access from their participation in DSR schemes, ii) the intensification of efforts related to R&D on DSR towards achieving user – friendliness and sustaining consumer comfort and iii) conducting incremental investments in the planned DSR infrastructure based on actual system needs, so as to reduce the chance of stranded assets that ultimately affect the consumers.

Risks associated with operation of smart technologies include:

a. **Risk of unpredictable behaviour of new flexible technologies**; The novelty of such technologies (e.g. Smart transformer) may lead to behaviour that DSOs did not expect on the outset.

b. **Risk of high load peaks resulting from uncoordinated Electric Vehicle (EV) operation**; This risk is related to potential peaky demand profiles in distribution networks by the envisaged penetration of EV. The emerging high demand peaks may result in higher reinforcement costs.

c. **Risk of decreased utilisation of Distributed Generation (DG);** Extensive curtailment of DG output involves risk of causing under-utilization of installed Distributed Renewable Energy Source (DRES) units. This, in turn may have an effect on many different stakeholders.

Recommendations to address the risks associated with operation of smart technologies are:

a. **Reduction of operational uncertainty of smart technologies through enhanced testing and trials;** Investments in smart technologies should follow significant testing and trial to make sure any uncertainty concerning their operational behaviour is minimized.

b. **Application of smart control of EV charging;** Smart charging and Vehicle to generation (V2G) approaches can avoid new demand peaks created by the EV.

c. **Maintaining high DRES utilization in a cost-effective manner;** benefits of DRES curtailment (e.g. achieving operation within thermal and voltage constraints) should be diligently compared to its costs (e.g. under-utilization of DG assets could affect current owners of DG units and discourage future deployment of these assets).

2.2.3 Action Plan for 2018

Some generic comments stemming from UPGRID related to the Cost Benefit Analysis (CBA) conducted within the context of the deployment of smart technologies across the DSO network of each country participating in UPGRID are as follows.

- The Cost Benefit Analysis (CBA) results indicate that the implementation of each of the examined UPGRID functionalities at each of the four Demos yields a positive business case i.e. the achieved economic benefits are higher than the associated enabling costs. This highlights the important potential of solutions trialled in UPGRID.
- Due to the wide diversity of the physical characteristics of the distribution networks and the regulatory framework in different European countries, the required methodologies and the results of the CBA are country- and network-specific. This implies the need for further detailed analysis in the context of a wide roll-out of UPGRID solutions in Europe.
- Innovation funding is necessary for advancing the technical capabilities and reducing the enabling costs of equipment supporting the examined functionalities.

Hence, the Action Plan should include the potential of funneling greater resources available for innovation funding. Additionally, any form of incentives should be provided only to boost innovation and not necessary the deployment of smart technologies; their deployment should always be dictated on a case-by-case basis in order to achieve satisfaction of system constraints at minimum cost.

2.3 Issue 2 – Market design to meet efficiency and scalability demands

2.3.1 Definition and characterisation

This issue deals with the market design to meet efficiency and scalability demands. How can business models account for different market designs to meet efficiency and scalability demands? The problem is that market design is different in each country and organizations that would like to offer their services and products across borders will have to adapt their business model.

In this issue, we will analyse the problem and create a methodology and a tool to enable energy organizations to internationalize.

2.3.2 Recommendations

A recommendation is that – once ready – the methodology and the tool are circulated across projects so that all can benefit from the knowledge.

2.3.3 Action Plan for 2018

For 2018 we propose to develop the methodology and the tool as well as create a dissemination plan.

Actions for the methodology includes:

- Analyse the challenges and required translation on a generic level (done)
- Analyse and develop patterns for the energy industry (kick off in summer 2018)
- Develop education module for practitioners

Actions for the tool includes:

- Develop a methodology for an online module, currently this is coined the "Market design canvas" (starting summer 2018)
- Assess tool in inteGRIDy project (starting in summer 2018)
- Create an education module online (like a mooc)
- Present the tool in a webinar (in July 2018)

Supporting information:

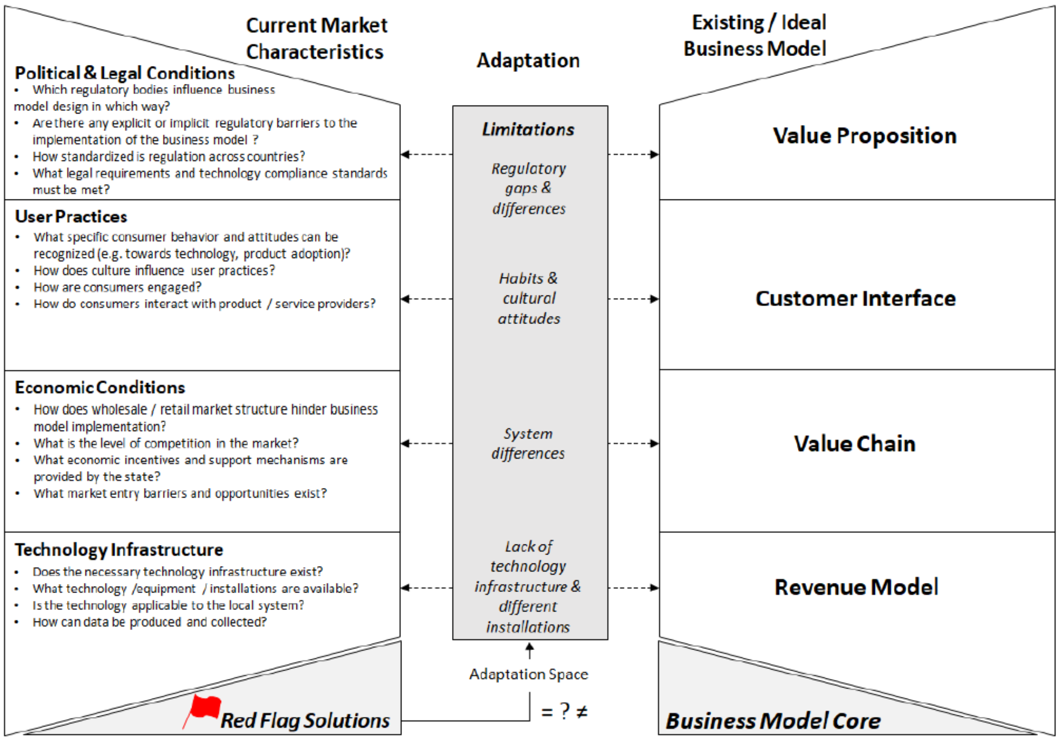

Figure 1: Market design canvas

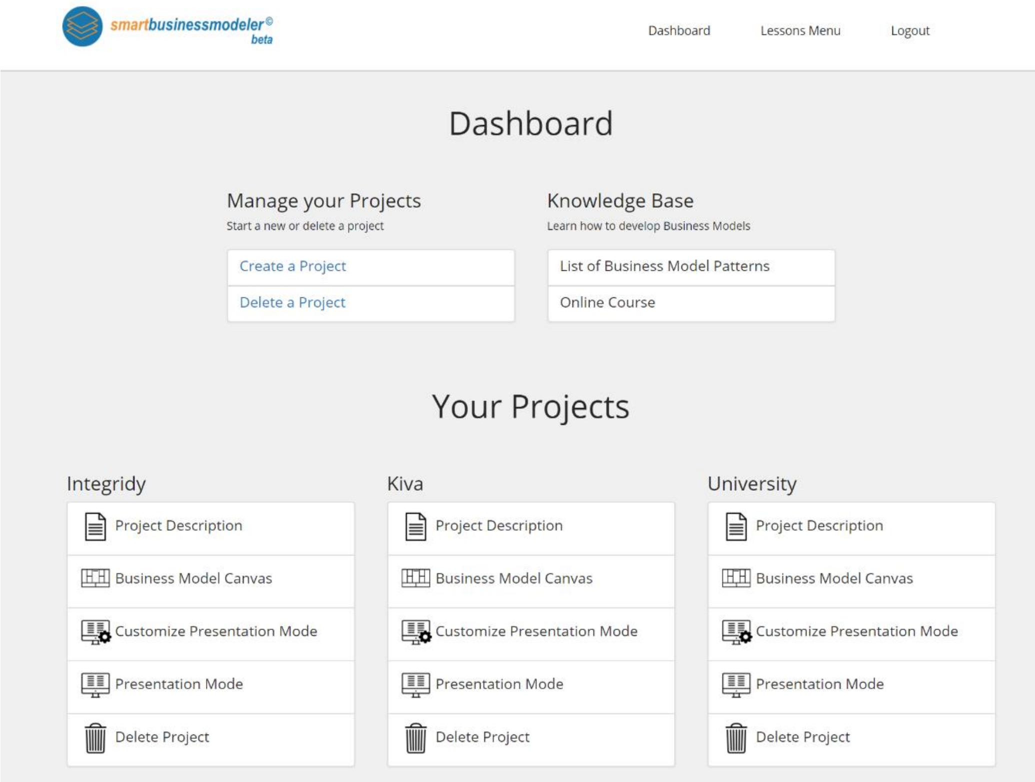

Figure 2. Business Model Tool inteGRIDy project

2.4 Issue 3 – Data and financial flow organization for the different players

2.4.1 Definition and characterisation

This issue deals with the data as basis for business models. This issue will focus only on data enabling business models but will exclude the issues related to transitive energy management (dealt in another SWG) and data management (dealt in another WG).

As currently there is no mechanism at the distribution level for balancing services or more generally services to the DSO, there is no framework for data exchange between the different players at the local level. Such local data are required to identify where local flexibility is required and what is its current value depending on the place where it is developed.

This local transparency has to deal with a confidentiality issue due to a lack of depth and liquidity of such local mechanisms at the beginning and shouldn't allow an access to the cost of a player which is a competitive data not to be disclosed.

2.4.2 Recommendations

Listing and analysing what are the data required to enable the business models, such as aggregated load curve, aggregated generation curve, installed generation capacity, constraints measurements by the DSO, average flexibility price at local level, etc.

2.4.3 Action Plan for 2018

The SWG will list and provide a matrix of the analysis of the type of data: relevance for business models, availability, owner... within different projects contributing to the business model WG.

The following questionnaire will be addressed by July 2018:

- What are the data and the data flow currently used in your project to develop and operate local flexibility?
- What are the data required to identify a place where local flexibility is required?
- What are the data required to operate the local flexibility from a DSO and an aggregator point of view?
- What are the data required to develop a healthy competition between flexibility providers at the local level?
- What would be the obstacle to data sharing between the local players?

Then an analysis will be performed in order to synthesize the answers and explain the potential differences between the projects and countries.

2.5 Issue 5 – Market design for the use of flexibility by the DSO

2.5.1 Definition and characterisation

This issue deals with the use of flexibility by the DSO for planning or operation purposes.

Flexibility represents any active means of load, storage or production management, able to temporarily modulate their load curves to serve electric system purposes.

An aggregator is an entity that combines the flexibility offer from multiple loads and/or generators and/or storage systems. It first prospects for the flexibility potentials in a given area, recruits these flexibilities and installs the necessary equipment. It then operates the flexibility through an aggregation platform to serve electric system purposes

Example of flexibility use case for DSO

Leveraging flexibility for real time voltage control: In this use case, flexibility assets (DERs, Loads and Storage) are leveraged to provide ancillary services to the distribution grid, and more specifically voltage support. We assume that the various flexibility assets form a *Virtual Power Plant (VPP)*. While a VPP may include assets in different parts of the distribution grid, only “co-located” assets of a VPP are considered in this use case. This means that we focus on that part of the VPP that includes various types of units connected on the same bus or different buses of the same distribution grid. These units are considered to participate in the wholesale and day ahead market with the VPP, but if voltage violations are detected, the VPP must be able to participate in voltage support together with other Distribution Grid components (other VPPs, DR Aggregators, independent DERs and Storage Systems, on-load tap changer (OLTC), Automatic voltage regulator (AVRs) etc.). All components provide their flexibilities to the Distribution Management System (DMS), responsible for calculating the optimal dispatch in a centralized manner in order to solve the voltage problems. The DMS then sends optimal operation points to the VPP Operator for the assets under its control. The VPP Operator, will then have to dispatch its units (if dispatch is in fact possible) in an optimal way. Dispatch is possible in the case where a number of VPP assets (DER/Load Owners) are connected on the same bus (for example group of buildings that include loads, DERs and storage system).

Leveraging flexibility for congestion management: The DSO is responsible for the reliable and efficient operation of the distribution grid (DG). An alternative solution for solving congestion problems in the DG, to the ordinary solution of field equipment control actions, is managing flexible loads. Harvesting the flexibility provided by Smart Consumers or DR Aggregators, the DSO can manage the network more efficiently and postpone costly network upgrades. This flexibility can be provided either through bilateral agreements (DR contracts) or through offerings in a dedicated energy market. Flexibility can be deployed in day-ahead planning, for mid-term management, or in intraday planning for short-term management of the grid. The latter requires short response times, not greater than 15min.

Practically, the DSO uses smart meter information and substation data gathered from SCADA systems to monitor the state of the grid. Other systems such as the Distribution Management System (DMS), utilized for managing the distribution grid, are responsible for operational planning; analysing meter data to conduct network simulations and project constraints, achieving optimal scheduling of switching actions and/or power imports. When a problem (congestion) that requires immediate action is detected or projected in the distribution network by the DMS, a request for available flexibility is issued. The request contains a set of parameters regarding the required flexibility: grid location(s), time and duration of the congestion, power or energy required and priority. The gathered flexibility information will be used by the DMS to solve the congestion through optimal management of flows, whilst other parameters, such as cost, could be considered as well.

Ancillary services

The fowling questions must be assessed:

- Which use cases for flexibility use for the DSO?
- which compensation scheme? Which market design? Which procurement rules? Which product standardisation?
- Which interaction with the TSO?

2.5.2 Recommendations

The SWG aims at raising market design questions and interviewing DSOs in different European countries to understand how they deal with them. Analysing existing pilots or commercial scale flexibility projects will bring also some elements of answers.

2.5.3 Action Plan for 2018

The action plan for 2018 will be to organise interviews with DSOs based on the following questionnaire:

Questionnaire related to market design for the use of flexibility by the DSO (part 1)

TOPIC 1: Technical use cases for the DSO

Local flexibilities may create value for the Distribution System Operator (DSO) either by postponing grid investment or by solving grid's constraints. In the first scenario, flexibilities may allow grid reinforcement measures to be done at a later time. In the second scenario, using flexibilities to solve grid constraints, flexibilities may be used to keep the quality of the distributed energy even when incidents or last-minute works on the grid are necessary.

1.1 Flexibility use on the MV level

- *Do you already use or planning to use flexibility for use cases of the MV level? Which use cases associated?*
- *Are these use cases are pilot tested or deployed at large scale?*
- *Which barriers do you identify for use case implementation? (e.g. power flow computation for need estimation, investment computation, contractual principles, lack of flexibility offer, no actual need for flexibility due the current level of renewable generation/EV)*

1.2 Flexibility use on the LV level

The LV level is now characterized by a lower observability for the DSO, due to less sensors, as well as the low reliability of forecasting tools at this reduced scale.

- *Do you already use or planning to use flexibility for use cases of the LV level? Which use cases associated?*
- *Are these use cases are pilot tested or deployed at large scale?*
- *Which approach are you using or planning to use on the LV grid: flexibilities managed remotely or local enslavement? Or a hybrid approach?*
- *Which barriers do you identify for use case implementation? (e.g. power flow computation for need estimation, investment computation, contractual principles, lack of flexibility offer, no actual need for flexibility due the current level of renewable generation/EV)*

1.3 Type of flexibility used

Flexibility can be retrieved from several means, such as demand side management.

- *What type of flexibility are you already operating or planning to operate for local purposes?*
- *Are you leveraging or planning to leverage other energy networks (gas, heat networks…) to provide local flexibility, and if yes, for which use cases?*

TOPIC 2: Procurement strategies

The procurement of flexibilities by the DSO may be made either through over the counter (OTC) agreements or through an organized market. OTC agreements can be adapted to flexibilities that cannot or would not be part of the national flexibility market. When the potential flexibility volume allows, OTC agreements should be part of a market-based process.

- *In your views, who should manage flexibilities for solving distribution grid constraints? The DSO directly by contracting with customers or the DSO through an aggregator contracting with clients?*
- *If any, which approach are you testing? OTC agreements or market approaches?*

TOPIC 3: Local market

On the local scale, flexibility can be used by the TSO or the DSO to relieve grid constraints, but also by other stakeholders to foster self-consumption.

- *In your views, does a local market make sense?*
- *In your views, are you thinking of a local energy market, in the sense of commodity, or local flexibility market, in term of services, or an hybrid approach?*
- *If yes, who in your view should operate such a market platform? Should such a local market platform be opened to other*

Questionnaire related to market design for the use of flexibility by the DSO (part 2)

TOPIC 4: Market design and compensation

These flexibilities could be remunerated on both the capacity and energy or on energy only. The first option is more adapted to cases in which the activation of the flexibility is unsure. Penalties can be introduced in order to incentivize flexibility reliability

- *Are you already compensating some flexibilities?*
- *If yes, how do you assess or measure the value of local flexibility services? How do you price such services?*
- *If no, how would you price such services?*
- *Which contractual approach would you propose?*

TOPIC 5: Product Standardization

The TSO products for balancing for example are already standardized. The DSO products are more specific to the location and the type of the grid.

- *Did you already standardize some flexibility products for the DSO use?*
- *If no, which barriers are you identifying?*

TOPIC6: TSO-DSO Interaction

In many countries, the flexibility is already used by the TSO to serve balancing purposes.

6.1 Impact on the distribution grid of flexibilities activated for the TSO

- *Did you perform studies to assess the potential negative impacts on the distribution grid of flexibilities activated for the TSO or national markets?*
- *In your views, the activation of flexibility connected on the distribution grid for national markets/mechanism could have negative impact for the DSO operation?*

6.2 Flexibility exchanges at DSO/TSO interfaces

- *Do you have an interface to exchange flexibilities with the TSO at DSO-TSO interfaces?*
- *Which use cases are you testing in association with the TSO? (e.g. reactive power at TSO/DSO interfaces, active power to relieve the upstream HV line…)*

2.6 Issue 6 – Local Flexibility Market

2.6.1 Definition and characterisation

This issue deals with the concept of **local flexibility markets** and the stakeholders involved in such local markets.

In a future system based on renewable energy generation which is mainly taking place in the distribution grid, flexibility which is locally available becomes more and more important. This chapter assess the concept to **trade** local flexibility on **local flexibility markets**.

Flexibility can be defined as the ability of the electricity system to respond to fluctuations of supply and demand while, at the same time, maintaining system reliability. Flexibility is the modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) in order to provide a service within the energy system. The parameters used to characterise flexibility include the amount of power modulation, the duration, the rate of change, the response time, the location, etc.

Flexibility needs to be considered as tradeable product separate from energy products. Today there are markets for flexibility for TSOs and Balance Responsible Party (BRPs) (reserve markets, capacity markets, spot markets) but not on local or regional level.

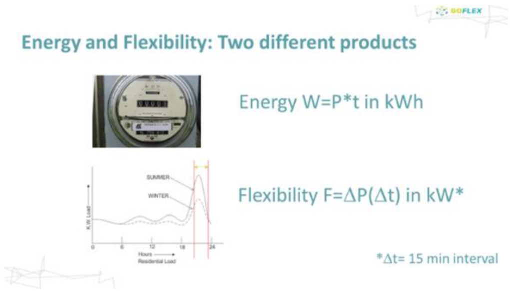

Figure 3. Energy Flexibility: Two different products

Local flexibility markets are supposed to handle local constraints, which are impacting the DSO but also the TSO. Aggregators have possibly a key role in such markets.

Possible users of local flexibilities could be DSOs, TSOs and BRPs, but also Microgrid Operators or local Energy communities.

The task is very much related to Issue 5 “Market design for the use of flexibility by the Distribution System Operator (DSO)” since the DSO is regarded as the main beneficial of a local flexibility market.

2.6.2 Recommendations

The SWG recommends defining clearly the concept related to local flexibility markets, and exploring the issues raised in the previous section by challenging projects deliverables as well as existing pilots. It recommends finding projects which demonstrate local market applications and compares the different approaches and assess its chances to succeed now and in a time frame of 10 years.

2.6.3 Action Plan for 2018

For 2018, the SWG will establish the definitions of the concept and challenge them among the WG dedicated to business models.

The SWG will list the existing projects describing and demonstrating local flexibility markets and analyse some of them.

The following questions will be raised:

- Under which circumstances does a local flexibility market make sense (in comparison to other measure to utilise local flexibility)?
- Who would benefit most?
- What kind of energy/flexibility products could be traded on such a market?
- What kind of pricing models are possible?
- How can the transactions be automatized?
- Which stakeholders should operate such markets?
- Which business model would attract enough flexibility supply and demand to be traded (in a multi-sided platform model)?
- Which stakeholder coordination (especially TSO-DSO) needs to be installed on such markets?
- How does current regulation affect the concept?

Synergies with the “Local energy management”, “Storage” and “Demand response” sub-working groups and the BRIDGE Data Management WG will be further investigated during 2018.

3. Business Models for Local Energy Management

3.1 Context

The Sub-working group (SWG) dedicated to “Business models for Local Energy Management” aims at analysing the scope for business models revolving around consuming self-generated electricity, also referred to as prosumage, in two perspectives: individual and collective self-consumption.

The list of the members of the Sub-working group is the following (the leader being in bold font):

Table 4. Participants of the SWG for Local Energy Management

First name	Last name	Company	Project
Lola	**ALACREU**	**ETRA**	**Nobel Grid**
Costas	KALOGIROS	AUEB	Wise Grid
Nolan	RITTER	DIW	Real Value
Jutta	HILDENBRAND	Swerea	NETfficent

Within this SWG, 2 main issues have been identified.

Table 5. Issues business model for Local Energy Management

Issues
Issue 1 - Business Model for individual self-consumption
Issue 2 - Business Model for collective self-consumption

3.2 Issue 1 – Business Model for individual self-consumption

The Sub-Working Group on Local Energy Management is tasked with analysing the scope for business models revolving around consuming self-generated electricity, also referred to as prosumage. This section focuses on individual self-consumption, while the next section is on collective self-consumption.

The analysis of individual self-consumption follows a two-pronged approach. First, two generic and mutually exclusive cases are discussed. The first case discusses the consequences of too little support, while the second case does the same for when there is too much. Second, it is shown how in Germany the incentive structure has shifted completely between 2009 and today. In 2009, home owners who generated electricity by PV modules faced the incentive to sell all self-generated electricity to the grid. Self-consumption was associated with a financial loss. Instead, it was financially sound to sell the self-generated electricity and at the same time consume electricity from the grid. Because of changes in taxes and because of the declining level of feed-in tariffs, it is now beneficial to consume self-generated electricity.

3.2.1 Definition and characterisation

During the last decades renewable energy sources have become an integral part of the energy policy due to several reasons, including increasing retail prices, potential effects of climate change and depletion of fossil fuels. Perhaps the most interesting aspect is the energy democratization; Photovoltaics (PV), wind turbines and other technologies are adopted not only by large-scale generators, but consumers as well. In the latter case, home owners, Small-medium enterprises and cooperatives have a more active role in the energy system. By becoming prosumers these entities can produce energy locally and perform load management, i.e., decide how much to consume or inject to the grid.

In this section we will analyse the effects of different levels of government support and environmental awareness of customers on the financial attractiveness and low environmental impact of grid-connected prosumer models.

What are the characteristics of the issue?

1. Renewable energy sources (RES) based technologies are mature enough and due to their worldwide massive deployment and the resulting economies of scale, the up-front costs have dropped considerably (especially in Germany & Italy) and, in most countries, the cost per kWh of residential systems is lower than the retail price. This indicates that taxes and levies on electricity play an important role for prosumage.
2. RES output is stochastic, but generally varies with location (e.g., solar irradiation, wind profile) and technology (e.g., efficiency) and is less-controllable compared to traditional technologies.
3. Local demand can be rescheduled to better match local-production and/or (dynamic) prices:
   - Smart meters, together with 3rd party applications (e.g., energy monitoring and analytics) or services (e.g., recommendation services), can help consumers/prosumers better understand their consumption/production profile and adjust their consumption patterns.
   - Complementary technologies (e.g., storage, smart-home controllers) can help prosumers reduce the energy bought from the grid or provide ancillary services (e.g., DR campaigns) to the grid and be compensated for their contribution.
4. Unless local production can meet sufficient local demand, financial support is still required to be financially attractive.
5. Not all candidate prosumers judge purely on financial terms; some of them place significant value on their ecological footprint. Reducing the consumption of fossil fuels and emission of carbon dioxide, which in European grid mixes is roughly 0.5 g CO_2 eq/kWh is appreciated as a benefit. On the other hand, producing equipment such as PV cells, power electronics and storage results in up front "social" costs, similar to capital. Thus, a complementary calculation of environmental impacts would result in the selection of technology that is both profitable and environmentally beneficial.
6. While intrinsic motivation may be an important determinant of prosumage or self-consumption, the impact of monetary incentives should not be underestimated. For example, German operators of solar modules receive a fixed feed-in-tariff for each kWh of electricity produced. This rate is below the price of electricity that households are charged because it includes taxes and levies such as congestion charges. Thus, from the perspective of solar electricity generators, it might be more beneficial to forego the feed-in-tariffs and instead avoid taxes and levies by prosumage. The intuition behind this is laid out in detail below. Most often, prosumage revolves around using batteries for storage. However, it is also possible to convert electricity to heat. Therein may lie a viable business model.

What are the consequences of the issue?

In the following we will focus on the effects of the governmental financial support for renewable energies and the ecological attitude of consumers to the grid and later examine resulting risks to different stakeholders. We can identify three cases:

A. **Too low support and/or low ecological attitude of population**

In this case, the energy policy does not provide enough financial incentives or individuals are not sensitive to climate change, resulting in **limited** new RES installed capacity every year. Consequently, energy mix is mostly from fossil-fuels, which pollute environment and have high operational expenditures due to the fossil fuels that are needed as input.

B. Too high support and/or high ecological attitude of population

In contrast to the previous case, the energy policy gives high compensation to prosumers and/or a large share of the society is very sensitive to climate change, resulting in **significant** new RES capacity additions every year. This has the following issues/effects:

i. High reverse power flows and congestion during periods of increased RES production and low local demand (in particular if storage technology is not provided and/or self-consumption are less profitable compared to energy injection).

ii. Traditional sources are used less often, but when these are needed the reaction time is very important (the so called “Duck curve”) and the capacity on stand-by is still substantial.

iii. Forecasting of production and load (and thus weather) becomes very important for power system operations.

Furthermore, eco-friendly consumers may become prosumers by adopting a green technology not only based on efficiency or financial attractiveness, but also based on the lowest environmental impact. This may imply that they prefer local manufacturers who use RES in the production of their own goods and services, minimize transportation or minimize production eco footprints using recycling. To enable them to do that, prosumers need access to information, for example environmental product declarations (EPDs), which are based on life cycle assessment methodology.

C. Monetary incentives for prosumage

Case C indicates how a transition from too little support for prosumage (2009) turned into strong incentives (2016). Altogether, this transition can be traced to a combination of changes in policy measures. The viability of business models revolving around self-consumption or prosumage depend not only on the level of support and incentives but also on the way these are applied. Taxes and levies, for example, may have a considerable impact on whether and to the extent that households consume their self-produced electricity (prosumage). The Figure below lays out the incentive structure and how it has changed between 2009 and 2016 for the German example.

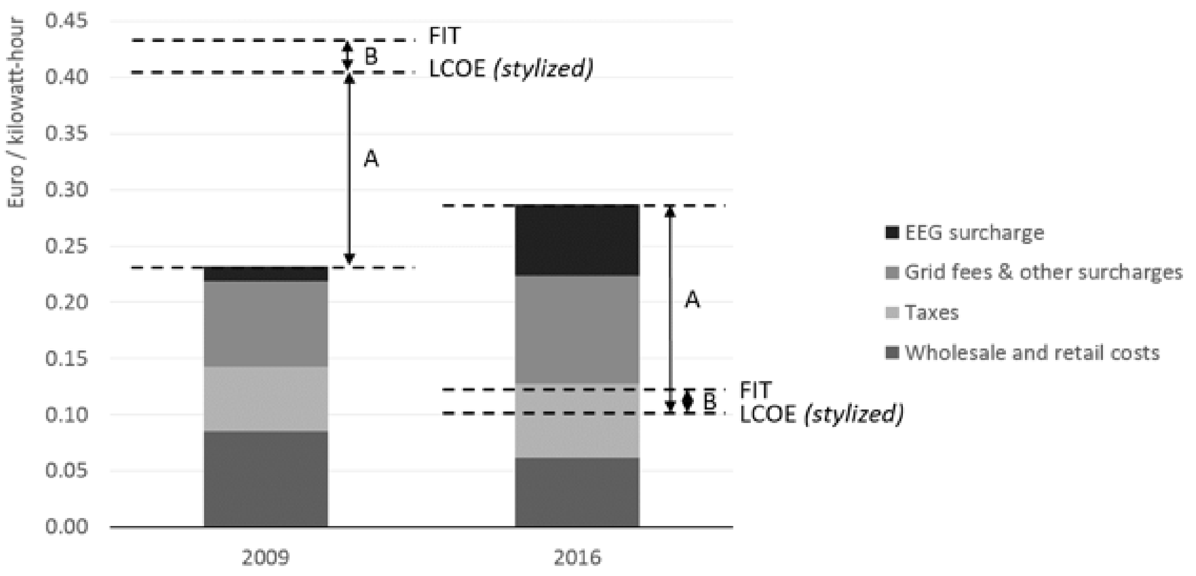

Figure 4. Electricity prices, taxes, levies, and Incentives for prosumage

The figure above indicates the level of the electricity price by its individual components from the perspective of the end user. In 2009 (left bar), the average price for 1 kWh of electricity was around 23 cents. Wholesale and retail costs accounted for about 8 to 9 cents or roughly a third. At the same time, the level of feed-in tariffs was about 43 cents per kwh. The levelized costs of electricity generation (LCOE) is assumed to have been around 40 cents per kwh. In 2009, self-consumption implied a loss on the order of 40 - 23 = 17 cents per kwh because electricity could be bought cheaper from the grid. This difference is indicated by the arrow labelled A. Instead, it was better to sell the generated electricity for a profit of about 43 - 40 = 3 cents per kwh. This is indicated by the arrow labelled B.

In 2016 (right bar), the incentive structure has reversed for several reasons. First, the electricity price that the end-user faces has increased to 28 cents per kwh, although wholesale and retail costs have declined to about 6 cents per kwh. Second, the level of feed-in tariffs has decreased considerably. The same applies to the levelized costs of electricity generation. For the purpose of demonstration, it was assumed that feed-in tariffs and levelized costs decreased by the same amount, so that the profit from selling electricity remains constant at 3 cents per kwh. In comparison, households can save a larger amount by consuming the self-generated electricity because the electricity cost from the grid exceeds the levelized costs of self-generation.

What are the risks of the issue?

In **case A**, namely “too low support and/or low ecological attitude of population”, we can identify the main risks as follows:

- The goal of transitioning to renewable energies is to mitigate global warming and its potential consequences such as extreme weather conditions. The allocation of too few resources jeopardizes achieving the intended climate goals.
- EU energy targets will not be met, such as 20% share of RES by 2020, which affects governments and other policy makers;
- The growing share of intermittent renewable sources into the electricity mix is expected to increase the volatility of electricity prices. Retailers are unable to pass on these costs to their consumers in case that fixed pricing schemes were negotiated. Residential consumers may experience excessively high prices because of dynamic pricing schemes. Altogether, this may impact the acceptance of price signals for residential customers.
- Households turning prosumer can shield themselves from the increased volatility. However, many households cannot become prosumers for a variety of reasons, including the lack of funds. This might imply that these households have to bear a higher burden from distribution and transmission costs.

On the other hand, in the **case B** (Too high support and/or high ecological attitude of population), the following risks may arise:

- Grid instability due to reverse power flows, congestion, etc. that affects DSO/TSO (linked to issue B.i)
- High prices for ancillary services that affects generators, TSO, consumers (linked to issue B.ii)
- Grid instability and outages due to failures in forecasting load and production, which affects DSO/TSO, consumers (linked to issue B.iii)
- Less revenues under existing tariff schemes (affects DSOs, retailers). This risk is related to issue B.ii, leading to an increase in retail prices and consequently making the Prosumer BM attractive to a wider set of consumers (the so called “death spiral”, which can eventually hamper grid reliability and thus affect the whole society)

In **case C (Monetary incentives for prosumage)**. Altogether, a potential model for business might be to organize prosumage for households with a solar module. The next figure indicates how battery storage might be used. One of the projects in the Business models working group analyses how smart electric thermal storage heaters may be used instead of batteries. The intuition is that storage heaters can store energy at cheaper rates compared to batteries.

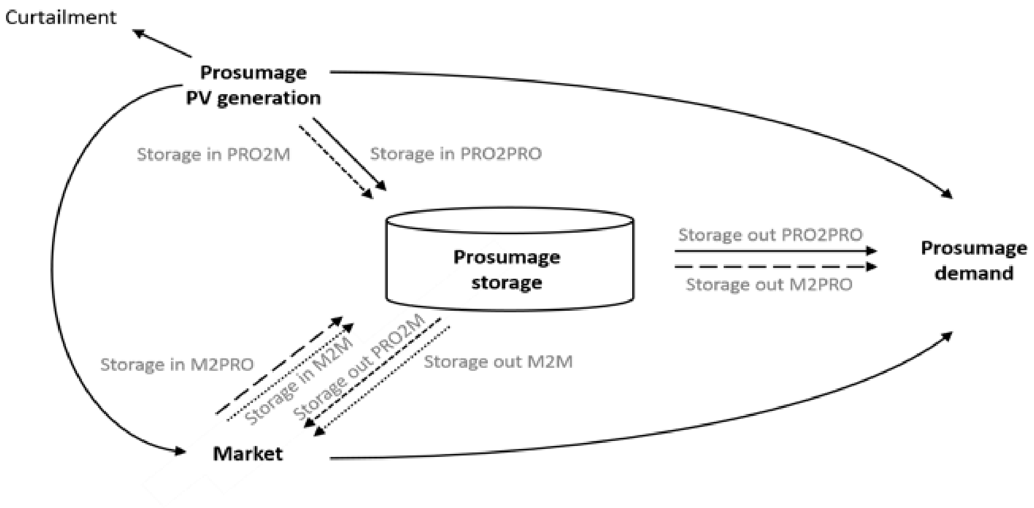

Figure 5. Prosumage business model overview

The business model represented above has a battery storage at its heart. This is the most common setup to organize prosumage. The battery can be used to store electricity either from self-generated PV electricity or from the market. On the one hand, this offers the possibility to align production and consumption profiles at the level of the household. But it also offers the potential for electricity arbitrage if households should have access to wholesale market prices. Households would charge the battery at times of cheap electricity and discharge the electricity back into the grid at higher price levels. Altogether, electricity can either be procured or provided to the market (M) or generated and consumed by the prosumer (PRO). To clarify the flows of electricity, the graph uses combines of M and PRO. PRO2PRO would indicate that self-generated electricity is consumed by the prosumer.

The project at hand substitutes the battery with heat storage. While conventional electric storage heaters are charged at night times, the smart storage is charged whenever electricity is cheapest. Before the integration of intermittent renewables into the electricity market, both charging concepts were identical. Unlike in the case of battery storage, smart storage heaters cannot discharge electricity back into the grid. The value generated by heat storages accrues in the form of a lower electricity price for the electricity consumed by households. The project at hand provides for tentative estimates in its reports. Savings from energy arbitrage are between 1.92 Euro per square meter and year up to about 3.50 Euro per square meter of dwelling exclusively heated by means of electric storage heaters. Specific information is laid out in project report D6.3 of the RealValue project which is available free of charge upon request. The article “Prosumage of solar electricity: pros, cons, and the system perspective” by Schill, Zerrahn, and Kunz (2017)[1] provides the basis for most of the information laid out here. Additional estimates for heat storages are based on the work of Schill (2017).

For the case of battery storage, the estimated costs are for a scenario in which about 15 GW of solar electricity is used for prosumage. In their analysis, varying shares of prosumage in the produced solar electricity are assumed to gauge their impact on costs.

[1] “Prosumage of solar electricity: pros, cons, and the system perspective” Wolf-Peter Schill, Alexander Zerrahn and Friedrich Kunz. © DIW Berlin, 2017. http://www.diw.de/discussionpapers

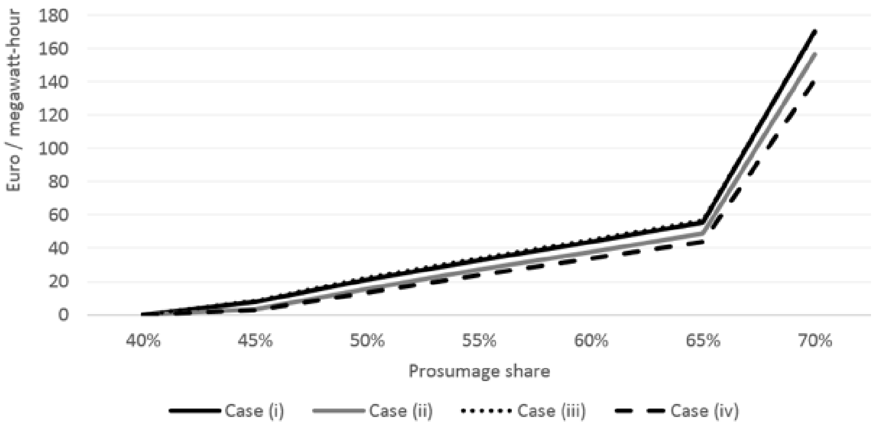

Figure 6. Costs for prosumage from scenario analysis

The figure 5 indicates the storage costs for 4 different options. In case (i), the storage is only to align self-generation and self-consumption with no option to charge or discharge electricity to and from the grid. Case (ii) assumes that the storage can additionally charge from the grid. In case (iii), the storage can additionally only be used to discharge self-generated electricity into the grid, while in case (iv), the storage can additionally charge/discharge from and to the grid.

Under this set of assumptions, the average additional cost to the system increases with the share of prosumage in electricity generation. The intuition behind this finding is that aligning the profile of self-generated solar electricity with self-consumption becomes increasingly more costly as the share of prosumage increases. This is because the dimension of the battery increases disproportionately when the share of prosumage reaches 65%.

Schill (2017) updates this cost assessment for power-to-heat storage (Figure 6). To this end, he assumes that households use additional smart electric thermal storage heaters to increase self-consumption. The heat demand profiles (Figure 7) indicate the amount of heat that households demand across the year. The green bars indicate the demand level for energy efficient buildings, while the blue bars indicate the energy consumption in inefficient buildings.

By assumption, storage heaters are operated on self-generated solar electricity. The major upside of this approach is that heat can be more cheaply stored compared to electricity.

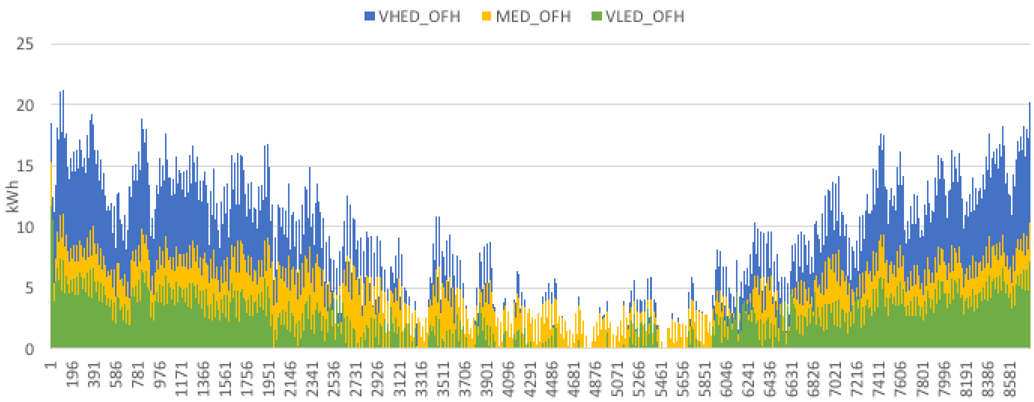

Figure 7. Heat demand profiles

The appeal of using heat storage or combined battery and heat storages becomes apparent when scrutinizing the results (Figure 8). As before, increasing shares of prosumage in self-generated electricity, lead to increasing system costs. However, when storing energy in the form of heat, the cost increase beyond a prosumage share of 65% is considerably lower compared to battery only storage.

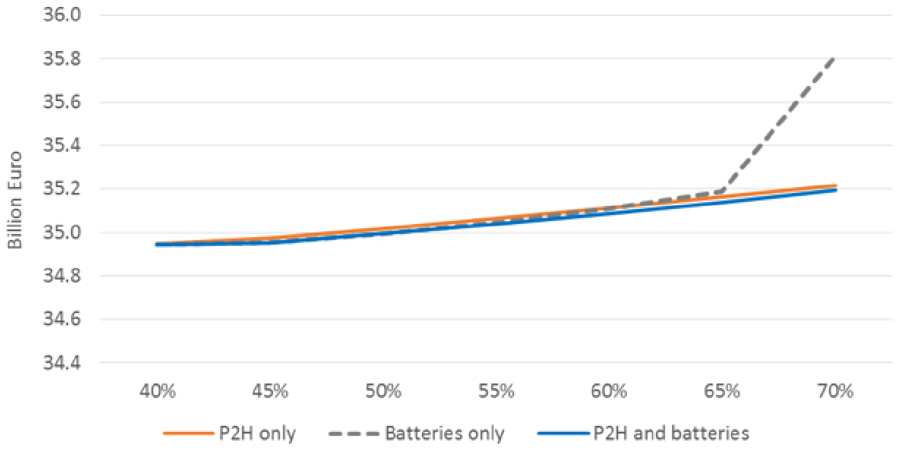

Figure 8. Additional system costs using battery and heat storage

What is the status of the issue at this time?

As evident from the previous subsection, both cases A and B pose significant risks to the energy ecosystem, which makes it harder for national authorities to set a long-term policy, one that was, for example, successful in another country.

We can observe that as RES capital expenditures shrink, traditional governmental energy financial support schemes fade out as well. Nevertheless, in most countries (e.g. Spain being the exception), policy makers recognise the need for gradual RES capacity addition, so governments do not penalize RES development by consumers. For example, they regularly update the energy policy so that feed-in tariffs are reduced or replaced by feed-in premiums, self-consumption schemes, or tax reductions. In that way, policy makers can strike a balance between the two extreme cases.

Issues from Case C: Figure 4 indicated the incentive structure and the shift towards prosumage because of market price changes mostly driven by energy taxes and the declining level of feed-in tariffs between 2009 and 2016. The viability of a business models revolving around prosumage obviously depends on policy decisions, especially how feed-in tariffs are set. Because it might take years before prosumers can amortize their investment, some potential prosumers may be reluctant to invest fearing that new policy decisions again reverse the incentives for prosumage. Altogether, policy makers may address this reluctance by indicating a time frame during which no changes to newly implemented regulations are intended.

Who is concerned by this issue and interested in the results?

By default, prosumers are concerned by this issue – private households, small and medium enterprises and cooperatives who are potential candidates to implement the technology and use it for self-consumption. The potential risk of grid instability and extended use of fossil fuels, as explained above, means that wider society (private consumers without option/interest to become a prosumer) and DSO/TSO are also affected. Moreover, providers of PV and connected technology are concerned by this issue and in particular those who produce locally and with RES, as they can support claims that their offerings are profitable and viable based on sound data.

For policy makers in general the results are interesting to design feed-in tariffs and incentives for consumers to invest in necessary equipment. Incentives for prosumers may increase their inclination to invest in prosumage. However, the majority of households does not generate electricity. Thus, these households (non-use) are excluded from any benefits that are extended to prosumers. This might lower the acceptance of the transition of the energy system towards renewable electricity generation.

Who is interested in the results? / Who has the problem?

The problems such as grid instability and continued use of fossil fuels arise a) when RES are not attractive enough for wide use and b) when RES are widely used in feed-in settings without options for self-consumption. The first constellation means that policy goals for carbon dioxide reduction cannot be reached, and the potential risks of climate change are not addressed. The second constellation means that the grid becomes unstable.

Both problems affect policy makers, supply and service organisations on various levels, consumers and prosumers.

Who is responsible for its execution?

Policy makers have a central role in tackling that problem, by adapting regulations to take away barriers (e.g. Spain), and providing incentives for investment in RES tailored for the specific conditions in different regions of Europe. Greece and the entire Mediterranean region benefit from high irradiation of over 1700 kWh/m^2 of panel surface, harvesting a specific annual demand can therefore be achieved with smaller panels compared to Denmark or other Nordic countries with an average potential of 1200 kWh/m^2. Retail prices for electricity vary in Europe, private households in Denmark pay more than 0,30 Euros per kWh; in Greece, households experienced an increase from 0,17 to 0,19 Euros per kWh.

Supply and service organisations need to provide technical means to adapt the grid to prosumers demands.

Where does it take place?

Locations in the EU – different conditions based on irradiation,

The need to incorporate increasing shares of intermittent sources of electricity generation into the electricity mix exists everywhere electricity is generated by renewables. Prosumage may be a viable way to better align production of renewables and electricity consumption.

As sketched in the case description above, the requirements and possibilities differ depending on location specific availability of renewable resources and on markets. The financial attractiveness of a self-consumption based BM might even change over time, as indicated based on the case for Germany. As a basic requirement, self-consumption has to be legally permissible, and taxation needs to be adapted.

Where would it be applied?

Bespoke solutions/recommendations for different locations necessary, then the issue will be addressed according to needs,

What's your perspective for the next BRIDGE meeting (1 year)?

A list of detailed and specific recommendations will be described, in order to overcome the existing barriers of the self-consumption in Europe, based on two pillars. The first one regards the required hardware (infrastructure); and the other concerns to the associated legislation and regulation.

Since when do you have this problem?

In some cases, the regulation of national electricity markets has failed in the last years to keep up with the pace of renewable energy production. For example, in the Mediterranean countries of Greece and Spain that enjoy substantial solar irradiance, regulatory framework for self-consumption have only been recently established. Spain did so in 2015 while Greece had done so previously in 2014.

Even if this constitutes a positive step, it hardly balances the priority given to larger solar and wind parks via financial mechanisms. Conversely, the regulation and policies in place fail to promote self-consumption. In Spain, small-scale investors have to pay an obscure tax, dubbed “tax on the sun” to be allowed to carry these activities. On top of that, the most common type of self-consumer is not entitled to any remuneration should they wish to export their electricity surplus to the domestic grid. As a result, such self-consumers have no incentive to do so.

By when it would be needed to be solved?

The European Commission has been calling for a paradigm shift. This lies in placing EU citizens at the heart of energy security by means of self-consumption, and the creation of prosumers’ markets and local energy communities. Hence, it is imperative to create mechanisms that will ensure the optimal balance of the electricity load at all times.

In this context, EU countries have agreed on a new 2030 framework for climate and energy, including EU-wide targets and policy objectives for the period between 2020 and 2030. These targets aim at helping the EU to achieve a more competitive, secure and sustainable energy system and to meet its long-term 2050 greenhouse gas reductions target.

3.2.2 Recommendations

Preliminary simulations from WiseGrid project and similar findings from literature overview show that, as traditional governmental energy financial support schemes (e.g., feed-in tariffs) are reduced, the prosumer business model becomes profitable in cases where:

- The benefits from self-consumption are very important, such as:
  - in countries with high retail prices, for example in Germany,
  - for large buildings where demand usually exceeds production, such as offices,
  - smaller buildings with temporal overlap of production and load curves (such as residents with pensioners), or flexible loads (such as smart homes),
  - holiday areas/resorts with fluctuating/temporary demand which makes it difficult to design the local grid capacity;
- High solar irradiation (e.g., southern EU countries). In such countries, the prosumer BM can become profitable, even in the absence of subsidies, if:
  - third-party entities that can achieve significant cost savings due to economies of scale, such as ESCOs and RESCOs, correctly dimension and finance the system,
  - production is combined with storage systems (e.g., battery).

In other cases, for example Northern countries, the prosumer business model can be viable if ESCOs and RESCOs are involved in the dimensioning, financing and possibly managing of the excess energy.

Furthermore, the prosumage business model can be attractive, even in the case of low financial support regimes, when load profiles can change in a way that self-consumption can be increased.

Generally, candidate prosumers need to be aware of this potential and thus ESCOs/RESCOs and non-profit organizations should make available easy-to-digest information on the benefits, risks, managerial processes, etc.

Regulators should regularly update supporting policies (e.g., as in Germany) in order for those to be cost-efficient and provide the appropriate investment signals, without distorting the market. Furthermore, prosumers should participate in a fair manner to the network expansion and management costs, e.g., by introducing capacity-based network tariffs (instead of those that are purely based on energy volume).

In order to avoid the uncoordinated integration of prosumers to the power system and market, DSOs should provide transparent, localized and up-to-date information on eligibility criteria and capacity limits via a web portal. In that way, candidate (grid-connected) prosumers are better informed about network needs, such as holiday areas/resorts with fluctuating/temporary demand which makes it difficult to design the local grid capacity. Furthermore, having this information online is a first step for the approval process to become more automated.

For Case C, the pros and cons are fleshed out in Schill, Zerrahn, Kunz (2017)[2]. Arguments in favour of prosumage which support the business model lined out here are, for example, that some consumers are intrinsically motivated by the ideal of partial or full self-sufficiency although this is most often not cost effective. Furthermore, prosumage offers (some) consumers the possibility to participate in the transformation of the energy system. In case of sufficient quantity of storage, energy arbitrage should lead to lower overall electricity prices and reduced volatility.

However, for viability, a certain magnitude of volatility is required. In addition, there is the potential to reduce congestion in the distribution and the transmission grid.

However, there are also potential downsides with grid-connected local storage. First, local storage is an additional condition in the operation of the overall system. While from the private and business perspective there is scope for profit, the cost of the overall system increases.

Synergies to be foreseen with "Regulated Issues", "Storage" and "Demand Response" subworking groups.

3.3 Issue 2 – Business Model for collective self-consumption

3.3.1 Definition and characterisation

Similar to the case of individual self-consumption, the benefits of self-consumption are very important drivers for an entity to become a prosumer. One way to reduce the levels of injected energy (and thus the importance of low feed-in-tariffs etc.) is to aggregate the demand of multiple consumers. In this section we will focus on business models for collective self-consumption in presence of low government support.

According to the Art. L 315-1, Energy Code: "Self-consumption is collective when the electricity supply is taking place between one or more electricity producers and one or more end consumers, linked together by a legal entity all or a part of the electricity produced by his installation."

Apart from the individual self-consumption, the Commission also refers to 'collective schemes and community initiatives' that 'have been emerging with increasing frequency in a number of Member States. An increasing number of consumers engage in collective self-generation and cooperative schemes to better manage their energy consumption. This innovation by consumers leads to innovation for consumers and opens up new business models. Energy services companies, aggregators, brokers, data handling companies, other intermediary companies and frequently also consumer organisations are emerging to help consumers achieve better energy deals while relieving them from administrative procedures and cumbersome research. This also opens new opportunities for local communities and authorities whose regional and local energy initiatives can provide a valuable link between decision-makers, citizens and innovators at the local level. The Opinion of the European Economic and Social Committee on the 'Communication from the Commission to the

[2]"Prosumage of solar electricity: pros, cons, and the system perspective" Wolf-Peter Schill, Alexander Zerrahn and Friedrich Kunz. © DIW Berlin, 2017. http://www.diw.de/discussionpapers

European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — Delivering a New Deal for Energy Consumers' specifically exemplifies issues related to collective consumption based on a civic wind turbine which is operated by a collective; members of the collective are often unable to access the electricity direct but must place it on the market via distributors and buy it back from them.

Electricity directly, but have to place it on the market via a distributor and buy it back. This requires an additional administrative layer. The collective that operates the wind turbine is not allowed to distribute the electricity and needs to involve another entity.

In line with this, collective self-consumption, recently authorized by the law in some European countries such as France, allows various participants, energy producers (self-producers) and end users, members of the same legal entity, to decide what to do with any energy surplus. Only one condition: to be connected to the same public medium and low voltage electricity station. So, it is at the level of a neighbourhood, for example, groups made up of individuals, companies, businesses and local authorities with the resources to produce energy and local end users, so the latter can take advantage of the surplus not consumed by the other members of the collective.

In summary, in the collective self-consumption schemes:

- Producers and consumers HAVE TO be part of the same legal entity;
- The choice of the type of entity is free (company, cooperative, association…);
- The entity in charge of the whole operation:
    - It manages the relationship between consumers and producers,
    - It informs the grid operator about the breakdown of consumed electricity among consumers.

What are the characteristics of the issue?

In addition to the characteristics of the individual self-consumption case, collective self-consumption is characterized by **complex legal rights and management issues**. In particular, a number of consumers need to agree on the investment (e.g., its viability, technical details etc.) and how the produced energy will be shared. Furthermore, such investments cover a long period (e.g., 20 years) and thus the set of consumers cannot be considered fixed.

Consumers do not own the flat/store where prosumage takes place, as the permission of both the tenant and the landlord is required.

On the other hand, multi-family (or multi-business) buildings have less roof space (and therefore PV capacity) per consumer, which leads to **higher rates of self-consumption**.

What are the consequences of the issue?

Case A: All consumers own their place

Assuming that all owners agree to become prosumers and local regulation allows collective self-consumption, then the problem of sharing the produced energy amongst the owners on a fair manner arises. This is especially true when not all consumers have similar profiles. This problem is usually less prevalent in office buildings. Another case where owners may have the incentive to co-invest in RES despite their differences in load profiles, is the case of large buildings where communal demand (e.g., elevators, cooling, and lighting) is high.

Case B: Some consumers rent their place

The landlord/tenant dilemma arises in this case, where the landlord has no incentive to invest in RES if the benefit goes to the tenant. In this case, the owner, or a third-party, could pay the upfront cost and lease/rent the infrastructure to the tenants or occupiers

What are the risks of the issue?

In both cases, the risk is that the complex legal rights and management issues will discourage RES investments, even though the economic benefits are much clearer than in the case of individual self-consumption.

From a legal point of view, collective self-consumption is highly similar to individual self-consumption because producers and consumers have to be part of the same legal entity. The internal problems in general and the distribution of the benefits in particular, however, may complicate collective self-consumption to the point of rendering it unattractive. There do not seem to be any policy measures available that may help to reduce the complexity. Otherwise, the same incentive structure that was laid out for individual self-consumption (Case C) applies to the case of collective self-consumption.

Who?

Clearly, traditional retailers are affected by collective self-consumption. Furthermore, DSOs' revenues from capacity-related charges will be reduced. We should note that due to low levels of surplus production, DSOs face less operational risks, such as congested links.

Where?

In some Member States, the building wires are considered property of the DSO and thus no collective self-consumption can take place without its consent.

Furthermore, in some countries, consumers are not allowed to have contracts with more than one retailer/supplier. The last restriction is important in cases where a third-party installs the PV/wind turbine and sells the produced energy to the consumer, who buy the rest energy from a traditional retailer.

3.3.2 Recommendations

Wherever the building is owned by one entity and inhabited by tenants, then policy makers should provide clear regulatory frameworks and standards for shared investments. A carefully designed regulation would allow households to become prosumers who are unable to do so at present for the arguments laid out above.

3.4 Action Plan for 2018

The strategy to follow during the year 2018, in order to foster the evolution of the Local Energy Management subgroup issues:

- *Action 1. February 2018 – Lola Alacreu (Project NOBEL GRID):*
    - To provide the last version of the document to BRIDGE organizers (Technofi)
- *Action 2. March 2018 – All the Subgroup participants*
    - To complete the description of the issues described in this document, if needed, based in the rest of the BM working feedback.
    - To identify new issues related to Local energy management.
- *Action 3. June 2018 (next BRIDGE Meeting) - All the Subgroup participants*

- To complete the description of the issues described in this document, if needed.
- To provide and analyse the content (characterization and questions) to the new issues identified.

Synergies to be foreseen with “Regulated Activities” sub-working group.

4. Business Models for Energy Storage

4.1 Context

The BRIDGE projects represented in the Business Model WG, Energy Storage SWG identified a range of issues that are of interest in their projects.

The list of participants of the Sub-working group is the following (the leader being in bold font):

Table 6. Participants of the SWG for Energy Storage

First name	Last name	Company	Project
Andrej	**GUBINA**	**University of Ljubljana**	**STORY**
Massimo	BERTONCINI	Engineering	ELSA
Jose Miguel	ESTEBARANZ PELAEZ	Cobra Energia	GRIDSOL
Nicole	MERMILLIOD	CEA	NAIADE
Peter	VAESSEN	DNV GL	PROMOTION
Ricardo	MENDES ANDRE	EDP	SENSIBLE
Catrinus J.	JEPMA	RUG	STORE&GO
Xin	LI	University of East Anglia	TILOS

The list of issues identified within the SWG is provided below:

Table 7. List of issues identified by Energy Storage Subgroup

Issues
Issue 1 - Adoption of an appropriate business model (service-oriented business model, or hybrid business model) for various actors
Issue 2 - Definition of a hybrid storage business model
Issue 3 - Differentiation of a particular Business Model application
Issue 4 - Financial instruments to stimulate battery storage deployment
Issue 5 – Definition of business models for hybrid power plants
Issue 6 - Coordination of centralized and distributed energy storage
Issue 7 - Inclusion of externalities in storage investment
Issue 8 - Differentiation of storage-provided flexibility from other providers
Issue 9 - Required amounts of flexible sources in the future energy system, their type and services provided
Issue 10 - Influence of storage properties (location, scale, energy carrier…) on Business Models

4.2 Issue 1 - Adoption of an appropriate Business Model (service oriented Business model, or hybrid Business Model) for various actors

4.2.1 Definition and characterization

The issue describes the potential and the possibility for DNOs/DSOs and energy suppliers to adopt a service-oriented business model (e.g. software-as-a-service model). In particular, we would like to know what kind of service-oriented business models could be designed for such regulated activity actors. The issue is characterized in the table on the next page.

Table 8. Characterisation of Issue 1 - Adoption of an appropriate business model (service-oriented business model, or hybrid business model) for various actors

Project	Priority	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
NETfficient	High	medium voltage storage	Electricity	Utility	DSO	Island	Energy balancing and ancillary services	Installed, currently being commissioned
NETfficient	Medium	Low voltage, home storage (Li-Ion, hydrogen, supercaps,2LEV)	Electricity and H2	House	DSO or private wire	Island	RE self-consumption	Installed, currently being commissioned
NETfficient	Medium	Low voltage, larger applications	Electricity	Commercial properties	DSO or private wire	Island	RE self-consumption	Installed, currently being commissioned
STORY	High	Storage, RES, DR - heating and cooling	Electricity, heat, cool	Utility/house	DSO	Everywhere	Energy provision, Ancillary services	The business models are too "loosely" defined - just on conceptual level

4.2.2 NETfficient: Medium voltage storage for energy balancing and ancillary services in an island Borkum

Context & Risks:

Three types of storage applications are investigated:

- Medium voltage storage for energy balancing and ancillary grid services,
- Low voltage, home storage (Li-Ion, hydrogen, supercaps, 2LEV) for renewable energy self-consumption and
- Low voltage, larger applications for renewable energy self-consumption.

End users aren’t gaining the financial benefits they expect; what to do with the storage at the end of the experiment? What business model to use? Who should be the investors? MV-battery operation under project is not affected. Moreover, the issue arises towards end of project and needs to be resolved before.

The risk that storage is not being maintained after the end of project, or that MV-battery would be dismantled from pilot and used for research instead is high.

The project partners will either form an Energy Service Company (ESCO) or find a third-party business to take over the storage battery.

Recommendations:

Clarifying status of batteries in the energy market would mean there is a clearer business case for having them. With the rising interest in self-consumption and high retail energy prices in Germany, there is a reasonable incentive to buy storage without a sophisticated business model, however, the optimum benefit to the grid can only be reached with networked models in virtual power plant setting.

4.2.3 STORY: Storage, RES, DR - heating and cooling for energy provision and ancillary services

Context:

The risk of improper evaluation of the true storage potential leads to over or under-estimation of the storage effect.

The business models for the storage applications in connection with RES, DR - heating and cooling for energy provision and ancillary services are defined too "loosely" - just on the conceptual level.

Recommendations:

ICT and technology providers team up with the research partners to define the business models and test them in the demonstration locations.

4.3 Issue 2 - Definition of a hybrid storage Business Model

4.3.1 Definition and characterization

Some storage companies use a hybrid business model, developing a software platform on top of supplied energy storage hardware. Further investigation may be needed to understand the benefit of this hybrid business model. The issue is characterized in the table below.

Table 9. Characterisation of Issue 2 - Definition of a hybrid storage business model

Project	Priority	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
NETfficient	High	Energy Management Platform	Electricity	Neighbourhood	DSO	Island	Energy balancing and Ancillary services	Installed, currently being commissioned

4.3.2 NETfficient: Energy Management Platform for energy balancing and ancillary services in an island Borkum.

Context:

If no hybrid model can be found at the end of the project, the energy management platform linking the different types of storage will no longer operate / or not operate efficiently, losing the benefit of networked storage and access to balancing market.

Recommendations:

- Investigate the creation of an ESCO.
- Either Project partners constitute an ESCO or find a third party business to take over the storage battery.

4.4 Issue 3 - Differentiation of a particular Business Model application

4.4.1 Definition and characterization

The issue deals with the differentiation of a particular Business Model when applied to different storage usages (grid services or grid asset), type of devices, and the different locations (islands, isolated area...). The issue is characterized in the table below.

Table 10. Characterisation of Issue 3 - Differentiation of a particular Business Model application

Project	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
STORE&GO	Methanation	Green power and green syngas	Still in pilot phase with electrolyser capacity < 1 MW	DSO	Throughout the EU	Adding to conversion and storage capacity; enhancing renewable production business case; extending the scope for storage; and contributing to e-grid balancing	Project about halfway

4.4.2 STORE&GO: Methanation adding to conversion and storage capacity

Context & Risks:

Pilots featuring storage of green electricity via hydrogen production and methanation, providing service to the grid, including medium to long term storage.

Industry responsible for energy conversion and storage of syngases, storage operators and the providers of power and CO2, DSOs/TSOs are involved in the pilots in Germany, Switzerland and Italy. Analysis covers the whole of the EU, carried out in about 10 EU countries. Start in March 2016, end in March 2020. In about a year all pilots will be more or less operational. The majority of the crosscutting studies will be ready as well. In the pilots, the emphasis is on physical testing of the methanation process. The crosscutting analyses are using a variety of models for analysis and simulation.

The risks involve running out of time with regards to the schedule of the project, leading to delayed availability of the main results.

Recommendations:

Traditional business cases insufficiently imply stakeholder analysis, externalities, and the spatial optimality given the existing e-grid and g-grid. Therefore, a new generation of business models will need to be developed, capturing all this. In the project, a quantified business model for methanation will be set up that can be used for simulation, break-even analysis, and risk assessment, taking into account possible impact of policies and measures, varying future power prices, CO2 penalties, syngas prices, and technology costs. This modelling structure will be used for sensitivity analysis and for answering the question "what the optimal use load of electrolysis and methanation units may be?".

4.5 Issue 4 – Financial instruments to stimulate battery storage deployment

4.5.1 Definition and characterization

The issue concerns the financial instruments (including public subsidy) and regulatory framework to encourage the growth of battery energy storage. Why storage does not receive public subsidies if it generates externalities benefits? The issue is characterized in the table below.

Table 11. Characterisation of Issue 4 - Financial instruments to stimulate battery storage deployment

Project	Priority	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
NETfficient	High	Li-Ion, Hydrogen, ultracaps, 2LEV	Electricity, H2	Various scales: from house to utility scale	DSO	Island	Self-consumption	Installed, currently being commissioned
Naiades	High	Batteries; Na-Ion in Naiades case	Electricity in Naiades case, but the question arises also for other type of storage	From house up to Dist. grid level	DSO, TSO (for grid services,…)	local up to regional	Energy balancing (up and down), capacity market, ancillary services, eventually energy provision	Except in some islands, most EU countries lack encouraging regulatory frameworks and adapted markets to develop electricity storage

4.5.2 NETfficient: Li-Ion, Hydrogen, ultracaps, 2LEV for energy balancing (up and down), capacity market, ancillary services, eventually energy provision at Island of Borkum

Context & Risks:

How to stimulate the demand for battery storage?

The lack of demand for battery storage is hampering exploitation of project results, leading to a lack of demand for storage-related technologies (hardware and software).

Recommendations:

As for NETfficient solutions, the highest value component are the batteries, effective stimulation of battery market would lead on to investment of accompanying technologies (software and hardware).

4.5.3 Naïades: Development of a new Na-ion battery for stationary applications.

Context & Risks:

Except in some islands, most EU countries lack encouraging regulatory frameworks and adapted markets to develop electricity storage. One risk for battery storage is the competition with potentially less expensive flexibilities, and/or other energy careers storage. Another risk is a too limited market not allowing an efficient price reduction of the technology. Lack of investors and "regulated" investment in storage might prevent other type of storage and type of actors to become competitive.

Such situation might result in a lack of investment in new low cost and high efficiency European technologies, and further imports of battery technologies developed abroad.

Definition and characterisation:

Prototyping a Na-Ion that should later address all kind of stationary applications, from house up to grid level.

Recommendations:

In France it should be solved within the next 5 years to allow and facilitate the massive integration of RES, and nuclear energy reduction according to the law. The Winter Package application is expected to drive the process, together with the discussions within the ACER and national regulation commissions. It is important to continue to invest in new technologies at national & European levels, and to define public policies that will facilitate innovative battery technologies to get to the market.

4.6 Issue 5 – Definition of Business Models for hybrid power plants (HyPP)

What Business Models are appropriate for a hybrid Power Plant? How do they differ from that of a traditional power plant? What is a clear definition of a Hybrid Power Plant? The issue is characterized in the table below:

Table 12. Characterisation of Issue 5 – Definition of business models for hybrid power plants (HyPP)

Project	Priority	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
STORY	High	HyPP definition: 2 or more technologies for gen or storage connected to the same PCC. When connected at different locations, this is already a Virtual power plant VPP	Electricity, gas, heat, combinations	House, Utility	TSO and DSO	Everywhere	Energy provision, Ancillary services	To be ready for change in regulation and support schemes.

Project	Priority	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
GRIDSOL	High	Combination of renewables (CSP, PV, Wind, Biogas, Biomass) with energy storage. (BES, TES, etc.) at a single power plant.	Electricity	Utility	Generator / TSO	Island and Continental EU	Time shifting, provision of ancillary services, etc.	Depending on the location, regulatory framework and technologies the business model applicable to a service changes and then the profitability analysis differs.

4.6.1 STORY: HyPP definition for ancillary services and energy provision

Context and risk:

Hybrid power plant need to be defined properly and to be ready for a change in regulation and support schemes.

The risk could involve underestimating the potential financial impacts of HyPP and the assessment of the potential flexibility from such plants, leading to reduced interest in investment.

Recommendations:

Trying to define as many different options/business models as possible (different sources of revenue) and include HyPP in business model canvassing process.

4.6.2 GRIDSOL: HyPP definition for time shifting, provision of ancillary services, etc.

Context and risk:

Depending on the location, regulatory framework and technologies the business model applicable to a service changes and then the profitability analysis differs. Depending on the location (market rules and grid requirements) the characteristics are implemented in the control of energy storage solutions.

The risks involve the regulatory barriers (changes not favourable to energy storage, harmonisation rules, etc.). Not every technology and service are equally remunerated in the whole Europe and hence only countries encouraging energy storage development will find the way to develop these solutions.

Recommendations:

In Europe for the next 5 years the business model of energy storage should be demonstrated. When investors will see profitability, they will invest. Regulators should not oppose to hybrid solutions. The solutions involve implementation of harmonised rules to deploy energy storage and clear price signals remunerating flexibility provided by storage. A solution would be to make a clear and favourable regulatory framework encouraging the development of flexible hybrid power plants (RES + storage) at generation side.

4.7 Issue 6 - Coordination of centralized and distributed energy storage

This issue discusses the threat of discrepancy in storage investment at different levels (centralized vs distributed) considering the increase of RES at those levels and its volatility. The issue is characterized in the table below.

Table 13. Characterisation of Issue 6 - Coordination of centralized and distributed energy storage

Project	Priority	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
NETfficient	High	Energy Management Platform	Electricity	All scales (MW and LV)	DSO	Island	Balancing and ancillary services	Installed, currently being commissioned
GRIDSOL	High	Dynamic Output Manager of Energy (DOME). This control system dispatch the energy of different RES+storage units on a single output according to TSO requirements.	Electricity	Utility	Generator-Prosumer/TSO / DSO	Island and Continental EU	Control of Energy services, Power availability, Time shifting, provision of ancillary services, etc.	Depending on the size of the storage units it could be coordinated in a central or distributed manner.
Naïades	High	Battery storage	Electricity in Naiade case, but the question arises also for other type of storage	From house to utility	From aggregator to DSO	From village, island up to region	Energy balancing (up and down), capacity market, ancillary services, eventually energy provision	The question of investment is to be paired to the real value of flexibility and its value on a future "flexibility market", which is not so clear at present.

4.7.1 NETfficient: Energy Management Platform for balancing and ancillary services

Context and risk:

Energy Management Platform for electricity at all scales (Medium Voltage – MV- and Low Voltage - LV -) for the DSO in an island intended for balancing and ancillary services has been installed and is currently being commissioned.

The implementation of the Energy Management Platform is technically complex, as it needs to combine various managements systems (e.g. GIS, SCADA, forecasting and market operation platforms), and many partners need to collaborate and be coordinated.

This is the core challenge of the NETfficient Project on Borkum Island. Therefore, it is being dealt with throughout the project through progressing of the planned implementation, fine-tune the remaining technical issues.

Recommendations:

Increase the financial incentives for operators of distributed storage to take part in coordinated schemes (such as VPPs). Also, the remaining technical issues need to be fine-tuned.

4.7.2 GRIDSOL: Dynamic Output Manager of Energy (DOME) for control of energy services, time shifting, provision of ancillary services, etc.

Context and risk:

Dynamic Output Manager of Energy (DOME) is a control system that enables the dispatch of the energy of different RES + storage units on a single output according to TSO requirements. It can be used by Electricity Utility, Generator-Prosumer/TSO / DSO at Island and Continental EU. The envisioned application includes Control of Energy services, Power availability, Time shifting, provision of ancillary services, etc.

Depending on the size of the storage units their operation could be coordinated in a central or distributed manner.

Recommendations:

Generators, RES developers, investors, TSOs, DSOs, Consumers, etc. at the EU level require decision making tools to select the best control strategy.

4.7.3 Naïades: Development of a new Na-ion battery for stationary applications

Context and risk:

Prototyping a Na-Ion that should later address all kind of stationary applications, from house up to grid level.

The question of investment is to be paired to the real value of flexibility and its value on a future "flexibility market", which is not so clear at present. Battery storage can contribute to the demand response efficiency for the customer, i.e. in a very decentralized way, but the reward for DR must allow a Return On Investment (ROI) on less than 10 years. The question is similar for Centralized batteries, but they shouldn't be allowed to participate to any flexibility market if they belong to some regulated entities.

If only regulated entities own and operate the flexibilities (batteries included) then the flexibility market is dead, probably even for DR. The investment in batteries might be very limited

Recommendations:

Centralized batteries shouldn't be allowed to participate to any flexibility market if they belong to a regulated entity, because if regulated entities own and operate the flexibilities (batteries included) then there will be no room for any flexibility market. Customers, aggregators might have difficulties to get correct ROI and even adequate payment for their services. This issue should be solved or at least clarified after the end of the present discussions on the Winter package proposed legislation. The competition between delocalized and localized storage is a public policy question, and even a European one if the "customer at the centre of the energy system" vision is to be respected.

4.8 Issue 7 - Inclusion of externalities in storage investment

4.8.1 Definition and characterisation

Non-inclusion of externalities in storage investment analysis and in its market positioning may lead to sub-optimal storage investment from societal perspective. The issue is characterized in the table below.

Table 14. Characterisation of Issue 7 - Inclusion of externalities in storage investment

Project	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
NETfficient	All storage technologies: Li-Ion, supercaps, hydrogen, 2LEV	Electricity, H2	All scales (MW and LV)	TSO and DSO	Anywhere	Applies to all services	NETfficient undertakes an LCA, the LCA-experts accompany development of the project throughout
TILOS	Storage and renewable energy	Electricity	Island	DSO	Island	Electricity supply, renewable energy time shift, ancillary services	Having all equipment installed (both RE and battery) by the end of September 2017. Testing equipment and gather data for next steps, which include estimation of the wider socio-economic impacts

4.8.2 NETfficient: Storage technologies for provision of ancillary and other services

Context and risk:

All storage technologies (Li-Ion, supercaps, hydrogen, 2LEV) using electricity and H_2 at all scales (MW and LV) by TSO and DSO can provide any type of services. NETfficient undertakes a Life cycle analysis (LCA), so the LCA-experts accompany the development of the project throughout its course.

Two main risks have been identified:

1) LCA-expert cannot obtain data to conduct a truly relevant LCA;
2) Data arrive too late for the LCA to influence other decision making processes within the project.

As a consequence, the relevance of LCA may be limited. NETfficient project consortium tackles these risks within the NETfficient project, but also through knowledge transfer influencing other projects, in particular near the end of the project.

Recommendations:

LCA-expert to be given greater prominence within project development phases in order to explain basic decision-making criteria of LCA, based on Literature; to generally educate engineers on LCA.

4.8.3 TILOS: Storage and renewable energy for electricity supply, renewable energy time shift, ancillary services

Context and risk:

An island DSO uses storage and renewable energy to provide island electricity supply, renewable energy time shift, and ancillary services. Having all equipment installed (both RE and battery) by the end of September 2017, the subsequent steps include testing of the equipment and gathering data for next steps, which include estimation of the wider socio-economic impacts.

The risk could be underestimating the potential impacts on environment and society. When reaching a final investment decision, it may be up to the investor (who cares most about economic return) and not to other actors favouring wider social-economic-environmental impacts. This may lead to sub-optimal storage investment from societal perspective.

The concerned actors (investors, policy makers, consumers) and many others who might be influenced by the investment. Need to engage with key stakeholders and seek opinions on the factors covered in the estimation.

Recommendations:

Design a cost-benefit model which takes into account these externalities in storage system. Have a clear view about wider socio-economic factors to be considered. For example, does the benefit of improved energy security level matter? How about avoided emissions and avoided investment on power generation related infrastructure?

4.9 Issue 8 – Differentiation of storage-provided flexibility from other providers

How does flexibility provided by storage (including other energy carriers) differs from that provided by other flexibility sources? Under which condition can storage prevail? The issue is characterized in the table below.

Table 15. Characterisation of Issue 8 - Differentiation of storage-provided flexibility from other providers

Project	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
NETfficient	All storage technologies within NETfficient (networked)	Electricity	All scales (MW and LV)	TSO and DSO	Anywhere	Energy balancing, Energy provision, other Ancillary services	Almost ready to connect to wholesale market to sell balancing and ancillary services,

4.9.1 NETfficient: All storage technologies within NETfficient for Energy balancing, Energy provision, other Ancillary services

Context and risk:

All storage technologies within NETfficient (networked) focusing on electricity at all scales (MW and LV) by TSO and DSO applied to Energy balancing, Energy provision, and other Ancillary services are almost ready to connect to wholesale market to sell balancing and ancillary services.

Margins on balancing markets are too low for storage to be profitable, leading to not viable traditional business models.

Recommendations:

Storage must be differentiated against other providers. Its role must be defined clearly. It must be dealt with differently to energy supply technologies, and its options to provide services must be valued.

4.10 Issue 9 - Required amounts of flexible sources in the future energy system, their type and services provided

How much of the flexible sources do we need in the future energy system? What type of sources? What services are needed? The issue is characterized in the table below.

Table 16. Characterisation of Issue 9 - Required amounts of flexible sources in the future energy system, their type and services provided

Project	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
NETfficient	Storage	Electricity, H_2	All scales (MW and LV)	TSO and DSO	Anywhere	Applies to all services	Storage
GRIDSOL	Scenario investment models	Electricity, Heat, CO_2, etc.	EU level and County level	Generator/TSO/DSO/consumer	EU level, country level	Energy services	Scenario investment models

4.10.1 NETfficient: Storage for provision of any type of services

Context and risk:

Electricity and H_2 storage at all scales (MV and LV) used by TSO and DSO can be used to provide a wide array of services. In NETfficient the reliance on PV is a weakness - Wind should be incorporated to deal with periods of low solar irradiation.

There is a risk that inflexible conventional power generation is distorting the market, so flexible sources cannot be operated profitably.

EU/ national Regulators should therefore define a coal-exit strategy for Germany (and EU) at a level of regulations.

Recommendations

Currently levels of intermittent RE are too low, hence the market for flexible sources is too small and unprofitable. To remedy this, Germany needs to reduce its reliance on coal and push for more RE.

4.10.2 GRIDSOL: Scenario investment models for provision of energy services

Context and risk:

Scenario investment models in electricity, Heat, CO_2, etc. at the EU level and at country level as defined by the Generator/TSO/DSO/consumer should cover a portfolio of energy services. Scenario investment models will facilitate the adoption of fruitful pathways for energy storage solutions.

Regulatory barriers changes, new alternative technologies, high energy storage costs, etc. pose a risk leading to unclear scenarios for decision makers.

Recommendations

Include a multi-thread scenario-building tool to support decision making by the relevant actors.

4.11 Issue 10 - Influence of storage properties (location, scale, energy carrier…) on Business Models

How do the location, scale and the nature of the storage (energy carrier) influence the Storage business models and the associated business cases? The issue is characterized in the table below.

Table 17. Characterisation of Issue 10 - Influence of storage properties (location, scale, energy carrier…) on Business Models

Project	Technology	Energy Carrier	Scale	Grid level	Geography	Service Type	Current Status
NETfficient	All storage technologies: Li-Ion, supercaps, hydrogen, 2LEV	Electricity, H2	All scales (MW and LV)	DSO	Anywhere	Energy balancing, Energy provision, other Ancillary services	Different types of storage are being tested to gauge this influence
STORY	Storage	Electricity	Utility, house	DSO	Everywhere	Energy balancing, ancillary services	Regulatory problems with limiting storage use by not allowing the trading of flexibility, problems with market power.
STORE&GO	Storage of methane produced from hydrogen based on methanation	Renewable power, which is converted to a green syngas	STORE&GO is centred around three pilots with electrolyser capacities between .25 and 1 MW	Primarily DSO	Pilots in Germany, Switzerland and Italy. Analysis covers the whole of the EU.	The technology adds to balancing the grid, providing storage options, and generating energy by way of green syngas	Pilots are being set up. Cross-cutting analysis on economic, business, legal, and spatial aspects roughly halfway the project.

4.11.1 NETfficient and STORY: Storage technologies for Energy balancing, Energy provision, other Ancillary services

Context and risk

All storage technologies (Li-Ion, supercaps, hydrogen, 2LEV) used in electricity, H_2 at all scales (MV and LV) by DSO to provide Energy balancing, Energy provision, and other Ancillary services. Different types of storage are being tested to gauge the influence of regulatory problems with limiting storage use by not allowing the trading of flexibility, and the influence of problems with market power.

The lack of inter-seasonal storage options limit the effectiveness and efficiency of the services provided. This leads to the lack of investment as the full economic potential can't be utilized. No new investment means the potential storage service buyers (e.g. DSOs) resort to solving the grid problem in the traditional way by grid reinforcement.

Recommendations

Making a list of actions / proposals of regulatory changes that are needed to allow exploiting the full storage potential.

4.11.2 STORE&GO: HyPP definition for time shifting, provision of ancillary services, etc.

Context and risk:

The focus in this issue is the storage of methane produced from hydrogen based on methanation. In STORE&GO, the renewable power, which is converted to a green syngas is centred around three pilots with electrolyser capacities between 0.25 and 1 MW intended primarily for the DSO. With the pilots in Germany, Switzerland and Italy, the analysis covers the whole of the EU. The technology adds to balancing the grid, providing storage options, and generating energy by way of green syngas. Currently, the pilots are being set up. A cross-cutting analysis on economic, business, legal, and spatial aspects is expected roughly halfway through the project.

The industry responsible for energy conversion and storage of syngases, the storage operators and the providers of power and CO_2, the DSOs/TSOs are involved in the pilots in Germany, Switzerland and Italy. The analysis covers the whole of the EU (10 EU countries) between March 2016 and March 2020. In about a year all pilots will be more or less operational. The majority of the crosscutting studies will be ready as well. In the pilots, the emphasis is on physical testing of the methanation process. The crosscutting analyses are using a variety of models for analysis and simulation.

The risks involve the pilots not coming off the ground according to original time schedule. This would lead to a less detailed information available according to the planned time profile of the project.

Recommendations

More research is needed on conversion and storage options with respect to intermittent renewable power production, and in particular what adjustments in the grid and in appliances may be needed to make them suitable for syngases. Also, the activities would need to include completion of the list of deliverables according to schedule and to start informing the wider public about the potential of generating syngases from renewables in terms of its business case, economics (including externalities), optimal spatial conditions given the existing grid, and possible acceptance and safety issues.

4.12 Action Plan for 2018

The Action Plan 2018 for most of the Issues raised within the Business Model WG - Energy Storage SWG is the following:

- *Action 1. February 2018 – Andrej Gubina (Project STORY):*
    - To provide the last version of the document to BRIDGE organizers (Technofi)
- *Action 2. March 2018 – All the Subgroup participants*
    - To complete the description of the issues described in this document, if needed, based in the rest of the BM working feedback.
- *Action 3. June 2018 (next BRIDGE Meeting) - All the Subgroup participants*
    - To complete the description of the issues described in this document, if needed.
    - To extend the characterisation of each issue described in this document;
    - To provide more information regarding the possible solutions to the issues;
    - To recommend possible implementations of the solutions.

The subgroup will analyse the possibility to include the benefit distribution among stakeholders within the characterization of each issue addressed. In addition, the subworking group will define clearly what should be an active and efficient “flexibility market”, its behaviour, its contributors, its functioning rules, including the definition of what should be the respective ratio between public (regulated) and private storage and other flexibilities investments.

Synergies to be foreseen with “Regulated Issues” and “Demand-response” subworking groups.

5. Business Models for Demand Response

5.1 Context

The list of participants of the Subworking group is the following (the leader being in bold font):

Table 18. Participants of the SWG for demand response

First name	Last name	Company	Project
Rowena	**MCCAPPIN**	**Glen Dimplex**	**RealValue**
Petri	AHOKANGAS	Oulu Business School	P2P – SmartTest
Giannicola	LORIGA	Rina Consulting	Smile
David	NOROHNA	SSE Airtricity	RealValue
Peter	NEMCEK	cyberGrid	FutureFlow
Stefano	BARBERIS	Rina Consulting	SMILE

The table below lists the specific issues identified as central to business models for demand response:

Table 19. List of issues identified for demand response business models

Issues
Issue 1 - Allocation of 5G spectrum by telco operators for managing microgrids
Issue 2 - How to engage consumers
Issue 3 - Enabling a fair and open market framework for flexibility services
Issue 4 - Revenues, costs & ROI of demand response

5.2 Issue 1 - Allocation of 5G spectrum by telco operators for managing microgrids

5.2.1 Definition and characterisation

As regards potential business models for 5G operators in demand response, DR services could be offered as a part of larger service portfolio (to attract enough users) addressing multiple stakeholders in value chains, for example as part of a Smart Home service portfolio provided by a Telecom (or similar party). A Telecom company could then offer demand-response services to DSOs by utilizing their (large) customer base in specific areas and offer sufficient incentives for their users/customers. Telecom operators are in a strong position to offer DR services because of their large customer base. They can also help manage the micro grids, e.g. assisting the DSO with managing the balance of the micro grid (within and across different micro-grids).

Micro grid companies need spectrum resources for managing their grids. Currently, however, only mobile networks operators have spectrum licenses, and they are nationwide. For micro grids, there is a need for local licensing of spectrum resources, which is a regulatory issue. From a business models perspective, the question is who will take the role of local micro operator.

The main risks relate to availability, reliability and security of communications inside micro grids and between micro grids; communications networks for Virtual Power Plants; ownership of communications data as well as understanding the maturity and reliability of 5G technology, and how to use it. Lack of regulation regarding spectrum allocation may hamper adoption of smart grids.

This issue is relevant at all levels as essentially it impacts anyone who manages a microgrid e.g. energy cooperatives, energy companies, DSOs, mobile network operators, large local energy consumers (industrial, public services e.g. hospitals, commercial).

5.2.2 Recommendations

This issue should be resolved alongside the adoption of 5G technology. The regulatory issues should be evaluated immediately. The issue of allocation of spectrum for managing microgrids could be addressed by introducing local micro licensing and allocating spectrum resources for managing smart grids. For energy companies and mobile operators managing micro grids, solving this issue could open up new business potential. Therefore, the main recommendations are:

- Make micro licensing possible.
- Grant micro licenses for managing micro grids.

5.2.3 Action Plan for 2018

The following actions have been identified for P2P-Smartest to implement (Please note that the P2P-Smartest Project finished in December 2017):

- Deliver detailed description of the issue by 18 December 2017.
- Deliver detailed recommendations by 19 January 2018.

5.3 Issue 2 – How to engage consumers?

5.3.1 Definition and characterisation

It is assumed that in order for devices in consumers' homes to be used for DR, the owners of the equipment will need to be incentivised and engaged. Following this premise, the issue then is that there is not one solution / proposition which suits all customer types. Some customers may willingly participate in order to unlock other features from these appliances (such as the option for remote control), whilst other consumers may not be willing to facilitate DR without some other incentive (financial or other). The current uncertainty of revenue streams from DR means that it could be difficult for DR providers to offer financial incentives to consumers. For high energy consumption appliances, there may be other means of engaging consumers such as providing more granular levels of energy reporting or providing information and insights which will help them to use less energy and/or save money. However, it is difficult to quantity the value of such incentives without testing against suitable large test cases.

This is a very wide-reaching issue which affects a broad spectrum of technologies (e.g. smart loads and white goods, storage (battery or thermal storage via smart electric space / water heaters), PV and RES installed locally, EVs etc.) and all players in the energy supply chain (retailers, aggregators, DSOs, TSOs, consumers/prosumers, policy makers, technology providers, citizen advice groups etc.). The issue is relevant on a district level, but also at the level of individual properties.

Experience from RealValue and SMILE indicates that the greatest risk to engagement is lack of interest or understanding on the part of consumers and / or lack of willingness to understand (perhaps due to low perceived value or benefit). Incentives (perceived or actual) may not be sufficient to engage consumers, there may be competition with other products, and in some cases DR may be accompanied by some level of discomfort or inconvenience for the end-user (e.g. EVs, smart loads / white goods). Additionally, a single bad experience (e.g. spike in electricity bill) can put consumers off completely. As regards project insights, it is important to consider how closely aligned the demonstration demographic is with that of the actual market, and bear in mind that unless there is sufficient scale, it can be challenging to deliver cost-effective incentives that will engage consumers.

Specific insights from SMILE demonstrations:

- High CAPEX for the DSO or the house tenant

- Samsø: battery performance assessment and interaction with the grid
- MADEIRA: surplus of PV production not storable anymore due to low power capacity and impossibility to interexchange electricity with the grid
- ORKNEY: unconventional heating system, not applicable for all kind of distribution systems (i.e. radiators)

High-level insights from RealValue:

- Customers are much more motivated by cost savings than by environmental impact or improving the energy rating of their property.
- Control and comfort are important for customers, but are secondary to cost considerations.
- Clear and consistent communication delivered in a user-friendly and accessible way is crucial to ensuring consumer engagement.

Insufficient incentives and / or social acceptance lead to a lack of a proper infrastructure even at domestic level for smart appliances. As potential revenues for prosumers are low, it would be better for DSOs to directly promote installation of smart loads and flexibility appliances (RES, storage etc) at domestic level. This would be more cost-effective thanks to scale purchasing, and would allow end-users to play a role in contributing to environmental benefits even if there were no strong economic benefits.

Different countries and different technologies are at different stages of delivery for DR. By 2019, more technologies will be providing DR in more markets, therefore this issue needs to be solved as soon as possible. Some technologies can be more easily brought to maturity (i.e. made marketable for consumers), for example electric vehicles (bikes, scooters, cars…) as they are already more accessible and attractive to consumers.

Within the SMILE project, the demonstration has not started yet; all business model evaluation activities are related to theoretical analysis, sometimes supported by simulation activities (i.e. Samsø).

5.3.2 Recommendations

Based on the above, the recommendations are as follows:

- Study ESCO models to facilitate the penetration of some smart loads, storage and RES at individual house level, promoting policies and large demonstration cases
- Gain a thorough understanding of what is required to engage specific consumer categories i.e. gather feedback from large cohorts of consumers from diverse demographics to see what works for them.
- Increase customer engagement regarding the benefits through appropriate marketing / dissemination activities.
- Work with regulators to get TSOs/DSOs to release the value of flexibility services at a domestic level.
- Consider if a group of prosumers could act on local grids offering flexibility services.
- Work with regulators to enable the opportunity all around EU to interexchange electricity bi-directionally with the grid.

5.3.3 Action Plan for 2018

- Investigate organising a stakeholder event at EUSEW involving potential smart loads / small-scale domestic RES/EES appliance manufacturers to study business models/ESCOs (without too much expense for end-user) / regulation to facilitate the acceptability of the aforementioned solutions.
- Specifically, for SMILE:
  - Evaluate end-user availability/acceptance using surveys.
  - Understand what kinds of discomfort consumers will accept and which kind of benefits / incentives t they are interested in.
  - Understand if the demonstration's regulatory framework would enable the proposed business model to be promoted after demonstration for future replication.
- Specifically, for RealValue:
  - Carry out final surveys with project participants and analyse data collected over the project (telemetry data, surveys / interviews with end-users, installation and customer service teams, middle actors e.g. housing managers, local councils etc.) to gain an understanding of consumer behaviour.
  - Presented findings and conclusions in Consumer Impact Study due to be published in May 2018.

5.4 Issue 3 – Enabling a fair and open market framework for flexibility services

5.4.1 Definition and characterisation

This issue addresses the need for adequate measures to ensure market uptake of innovative technological solutions and services (EMS). It is an EU-wide, TSO and DSO level issue which impacts a range of technologies (RES, loads, batteries, DG), which use electricity, gas, heat or a combination, relevant to a number of service types (balancing, intra-day, day-ahead, voltage control, congestion management).

Demand Response access to markets: first and foremost, participation of flexibility resources in all electricity markets should be allowed. This very basic condition is still not fully met in the majority of EU Member States. General market opening is a fundamental pre-condition for flexibility services to evolve. At the same time, aggregated flexibilities (load, generation and storage) must be allowed and encouraged to participate.

Service providers' access to markets: enabling independent aggregation is important for the healthy growth of market competition around consumer-centric services. Evidence from markets around the world shows that for these services to be successful and lead to market growth, it must be possible for consumer flexibility to be unbundled from the sale of electricity to the same consumer. In many European countries, this is not possible.

Product Requirements: participation requirements in the electricity markets should enable access to a range of resources, including demand-side, distributed generation and storage resources. While genuine system constraints and security concerns must be respected, many different product/programme participation requirements were historically designed around what conventional generators could conveniently deliver. Today these narrow criteria are no longer justifiable because they block low-cost flexibility resources, and hence artificially inflate procurement costs.

Measurement and verification, payments and penalties: the volume of demand variation being sold into the market is assessed against a baseline. In the EU today, there is a lack of transparency concerning the methodology and its requirements, this acts as a strong barrier against the development of Demand Response programmes. Finally, payment criteria, volumes, and values, should be transparent and based on open and fair competition. For similar services delivered to the system, which meet the requirements of the market, compensation for flexibility services should be commensurate with those services delivered by generation.

There are a number of risks related to this issue: prices on electricity markets are too low for flexibility services to be feasible; HW and communication requirements are too strict and too expensive; regulatory and market requirements and definitions are undefined, too strict or unfair (protecting conventional generators and utilities); and cross border provision of flexibility services is not possible or hindered by unharmonized regulatory and market conditions.

Consequently, development and market up take of flexibility services (implicit and explicit) may be fully or partially hindered causing higher power system inefficiency, balancing costs, investment costs, environmental implications etc.

This issue is most relevant to electricity retailers, independent aggregators, ESCOs and flexibility resources involved in various electricity markets (e.g. balancing, intraday, day-ahead, ancillary services etc.), and needs to be resolved as soon as possible.

5.4.2 Recommendations

This issue can be addressed by implementing the Winter Package directives into MS regulation based on the following BRIDGE and SmartEn (http://www.smarten.eu) recommendations:

- **Demand Response access to markets**: participation of flexibility resources in all electricity markets should be allowed, both individually and aggregated.
- **Service providers' access to markets**: to enable independent aggregators to enter the market at scale, it is critical that the role and responsibilities of these new entrants are clarified. In particular, it is important that the relationships between retailers, balancing responsible parties (BRPs), and independent aggregators are clear, fair, and allow for fair competition between market parties. A regulatory framework should be put in place that is proportionate to the challenges faced by aggregators, and ensures that they can access the market without depending on the agreement of the consumer's retailer. Such a framework should define standardised processes for information flows on a need-to-know basis, as well as volume and financial settlements between the different market parties, with a view to avoiding any significant distortive impacts on the retailers/BRPs. Furthermore, it must be possible for consumer flexibility to be unbundled from the sale of electricity to the same consumer.
- **Product Requirements:** market products should be designed in a granular manner, in order to enable the full range of flexibility resources to participate.
- **Measurement and verification, payments and penalties:** Member States should adopt a small number of standardised baseline calculation formulas, ideally the same across Member State boundaries. It is essential that the baseline methodologies in place are made available to consumers and flexibility service providers. Finally, payment criteria, volumes, and values, should be transparent and based on open and fair competition. For similar services delivered to the system, which meet the requirements of the market, compensation for flexibility services should be commensurate with those services delivered by generation.

5.4.3 Action Plan for 2018

- Prepare EC/ACER implementation guidelines for different stakeholders (TSO, DSO, BRP, aggregators).
- Develop implementation road map.
- Design implementation progress KPIs.
- Monitor KPIs.

5.5 Issue 4 - Revenues, costs & ROI of demand response

5.5.1 Definition and characterisation

Reducing the cost-to-serve customers greatly impacts the ability to create value out of a DSM / DR service. Currently costs are prohibitively expensive due to a number of factors, but to highlight a few: cost for verification, possible inclusion of more sensor hardware (very costly for domestic application).

Within RealValue, this issue relates to smart electric thermal storage space and water heating devices, however it applies to a much wider range of DR technologies beyond these. If the cost to serve is too high, there will be no uptake of the product / technologies. This is an issue which impacts all levels of the electricity supply chain (supplier/retailers, policy makers, customers, aggregator, TSOs, DSOs) and applies at individual house, district, national and EU levels.

The costs to serve are at their peak during the early stage of deployments. In theory, the cost should decrease as more and more service providers come online.

5.5.2 Recommendations

To address this issue, there is a requirement for collaboration with TSOs/DSOs to ascertain higher values for flexibility and provide longer term contracts to encourage more investment and technology adoption. Therefore, the recommendations are as follows:

- Work closely with TSO/DSO to develop standards for verification encourage longer term contracts.
- Lobby the regulators to allow the TSO/DSO to spend more budget on flexibility and encourage more participation.
- Create a forum of EU DSM players to collectively develop standard guidelines and operational standards.
- Work with key national / EU stakeholders to begin the lobby process.
- Conduct industry surveys on approaches to revenue budgets and mechanisms for auction / win contracts.

5.5.3 Action Plan for 2018

- Design and develop an industry survey on approaches to revenue budgets and mechanisms for auction / win contracts.
- Conduct the Survey to encompass all EU member states by January 2019.
- Report on findings and disseminate results.

Synergies to be foreseen with “Regulated Issues”, “Storage” and “Local Energy Management” subworking groups as well as with the BRIDGE Data Management and BRIDGE Customer Engagement Working Groups.

6. Business models Tools

6.1 Context

This part focuses on 3 different tools being relevant to tackle the Business Models Issues. Those tools are the following:

- The Nobel Grid tool: the tool develops scenarios for the techno-economic evaluation of innovative smart grid technologies and associated business models;
- The Technofi tool: this tool aims at calculating key performance indicators (KPIs) to shape the socio-economic impacts of use cases/business models of smart grids and energy storage solutions;
- The inteGRIDy tool: this tool aims at helping the business modelling for future cities and technologies.

For the next update of the report, collaboration between those 3 tools will be further investigated.

6.2 Nobel Grid Tool

6.2.1 Description

The Nobel Grid Business Model Evaluation tool[3] is a "what-if" scenario tool for the techno-economic evaluation of innovative smart grid technologies and associated business models. Performing a techno-economic evaluation of innovative technologies is a complicated task due to the uncertainty that even experts face in estimating future costs and revenues, as well as the difficulty in choosing the appropriate set of modelling assumptions. This is particularly true in the smart grid context, which is attributed to the large number of roles and stakeholders and the nature of the electricity grid.

The Nobel Grid Business Model Evaluation tool allows the user to model value networks of multiple roles/actors, aiming at:

- Evaluating business models enabled by innovative smart grid technologies (e.g., those by H2020 EU-funded projects, off-the-shelf products/services);
- Evaluating the replication & upscaling of technologies and
- Evaluating the Cost-Benefit of technologies.

This techno-economic evaluation is done by:

- Comparing standard/existing against new innovative business models using several financial metrics based on data inputs supplied by the user. The current version supports up to 12 candidate value networks. We should note that traditionally business models are actor-specific. Nowadays, however, it is hardly the case that a business model is disconnected from the (business models of) the rest actors. For example, an Aggregator running ADR campaigns will depend not only on the participation of end customers, but also on the willingness of DSOs/Retailers etc. to adapt their business models so that they consider demand-side flexibility as an effective way for dealing with their everyday needs. Furthermore, we may be interested in understanding the (negative) effects of a role's business model to the business model of another competing role, with whom they don't interact directly. For example, the

[3] It is developed by the *Services, Technologies, and Economics lab (STEcon)* of the Athens University of Economics and Business, in the context of the Nobel Grid project, funded by EU under H2020-646184 contract. It can be downloaded from http://nobelgrid.eu/business-model-evaluation/.

business model of a Virtual Power Plant (VPP), coordinating the production of a set of prosumers, competes with the business model of a traditional generator. In addition, we may want to evaluate the impact of the VPP business model on the whole society, in other words perform Cost-Benefit analysis. For the reasons described above, we treat each value network VN1, ..., VN12, as a combination of business models, which can involve potentially all the roles. Regarding the techno-economic evaluation of individual business models, the Internal Rate of Return (IRR), Return on Investment (ROI) and Payback period are employed. Furthermore, most of the KPIs endorsed by EU for evaluating the costs and benefits on the society level[4] (CBA), such as Deferred Distribution Capacity Investments, are already supported;

- Considering multiple roles organized into value networks where multiple roles/business actors interact, including technology providers. The range includes single-actor business models to complex value networks, with up to 14 roles (DSOs, Retailers, Aggregators, TSOs, Suppliers, Balance Responsible Parties, SW providers, HW providers such as smart meter vendors). Furthermore, this is true for any context (telecommunications, logistics, etc.) and thus not restricted to smart grid markets;

- Supporting multiple locations simultaneously, such as pilot sites, regions or countries. The current version supports the comparison of results in up to 6 locations;

- Considering the incentives of the roles when deciding how money flows within the value network (e.g., how revenues should be split, how services should be charged, etc.);

- Performing sensitivity analysis for cost items and revenue streams whose magnitude is not known a-priori. In particular the current version already supports Monte Carlo simulation with user-defined random variables and number of iterations;

- Automating error-prone tasks. For example, the user is asked to define a BM canvas for each actor participating on a certain value network and this information is used for tracking the money flows amongst all actors and thus avoiding any double-counting problems;

- Providing a fully-customizable, transparent and extensible tool. For example, the user can define new cost items, revenue streams, cost drivers, revenue drivers and so on. Furthermore, by using the Microsoft Excel the user can see under the hood, add features and update formulas as seen appropriate;

The figure below summarizes the key features of the Nobel Grid Business Model Evaluation tool and the approach followed.

[4] EC Task Force for Smart Grids 2010

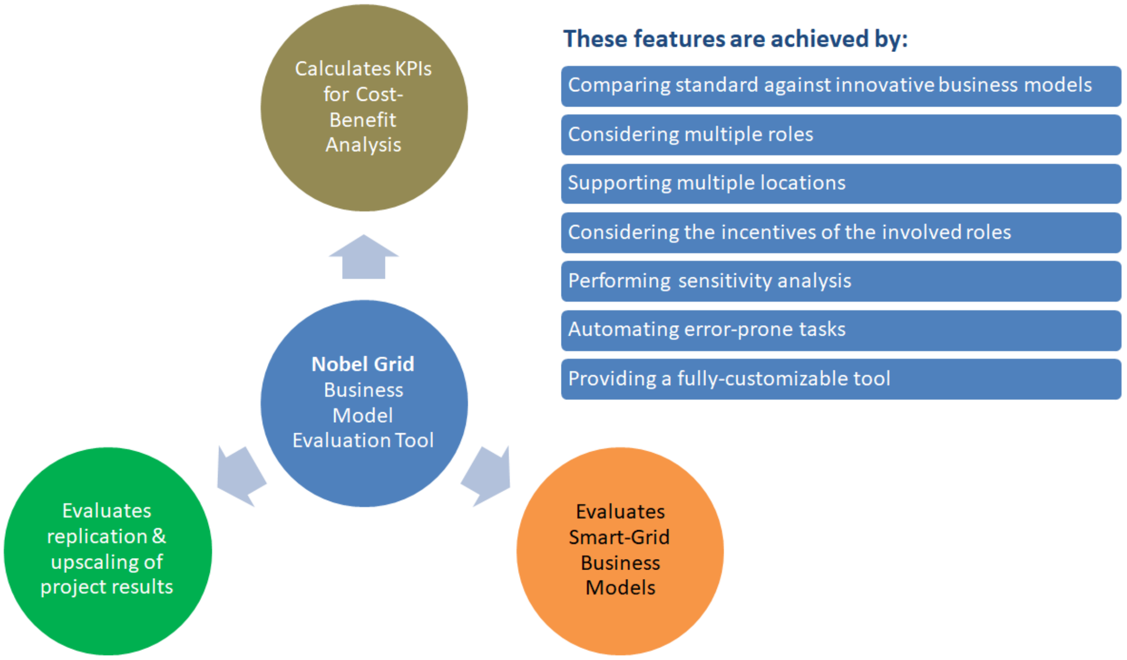

Figure 9. Key features of the Nobel Grid Business Model Evaluation tool and the approach followed

6.2.2 Use cases

As already described above, the Nobel Grid Business Model Evaluation tool supports any use-case that the user can think of, as soon as the existing limits (e.g., for the number of actors, locations etc) are not violated.

Suppose, for example, that we want to evaluate candidate value propositions of Aggregators and the profitability of associated business models for all involved actors; in our case DSOs, prosumers and retailers. In that case, we could define the following value networks:

- In the baseline VN (as shown in Figure 10), prosumers (who have already invested in a solar rooftop panel and thus these costs are excluded) inject excess electricity to the grid based on a feed-in tariff and, assuming that the retail price is higher, they try to minimize the injected energy. However, they do so without receiving any recommendations from market experts, such as Aggregators.

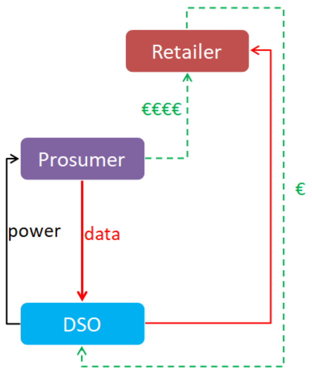

Figure 10. A graphical representation of the exemplary baseline value network

- In VN1, Aggregators offer energy efficiency services to prosumers for a fixed monthly fee.
- In VN2, Aggregators expand their service portfolio of VN1, by offering flexibility services to DSOs. More specifically, each instance of the Aggregator role runs manual demand-response campaigns asking its members (in our case prosumers) to shift their demand to another period and help the DSO dealing with grid issues.
- In VN3, Aggregators expand their service portfolio of VN2, by offering automated demand response campaigns to the prosumers who have invested in smart-home controllers.

Figure 11 provides a graphical representation of the exemplary value networks to be evaluated. Note that interactions appearing in baseline value network are omitted for simplicity.

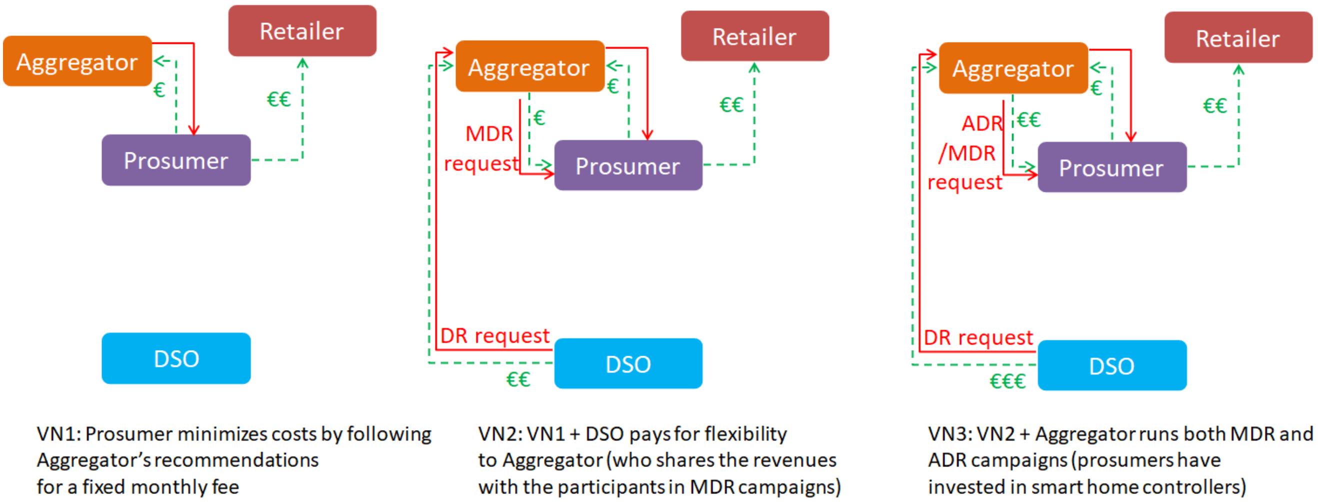

Figure 11. A graphical representation of the exemplary value networks to be evaluated

6.2.3 Action Plan for 2018

The main task for 2018 is to get feedback from other H2020 projects participating in the Bridge BM Working Group and make the necessary updates to the Nobel Grid Business Model Evaluation tool. For that purpose, a webinar will be scheduled on spring 2018 to present the tool in order to demonstrate its features using a simple use-case, attract candidate beta testers and identify potential synergies with the other BM tools (inteGRIDy and Technofi tools).

6.3 Technofi Tool

6.3.1 Description

Technofi is part of the support team of the BRIDGE initiative. Further to a coordinating and supporting role, within the Business Models Working Group, Technofi has proposed to elaborate a tool which aims at calculating key performance indicators (KPIs) to shape the socio-economic impacts of use cases/business models of smart grids and energy storage solutions[5]. This tool intends to be crucial for a first cost-benefit analysis that would help the Business Model WG to determine the viability of the targeted projects on different scenarios in several countries. The main target of this tool would be to allow to different energy-related stakeholders to exchange about the economic and technical

[5] The development of the Technofi tool is detailed in the professional thesis: *Calculating Key Performance Indicators for Smart Grids and Energy Storage projects*, Daniel Hernandez Maldonado, 2016.

issues. It may facilitate the discussions between the concerned actors. The calculator would serve as a guidance in order to enhance the debate between stakeholders allowing to perform quick analysis which will help to understand the missing elements, technologies, subventions and/or political conditions that could let a project to be economically profitable and facilitate its deployment.

The calculator would provide the following Key Performance Indicators (KPIs): the Profitability Index (PI), the Net Present Value (NPV), the Cash Flow (CF) with its respective graph, the Capital Recovery Factor (CRF), the Overall Discounted Cost (ODC) and the Benefit to Cost Ratio (BCR)[6].

The dimensionless Profitability Index (PI) which corresponds to the ratio between the Net Present Value (NPV) and the investment cost of the project is the most important indicator that we will consider to evaluate the project's profitability.

The resulting analysis will allow to position each business model of the projects submitted and compare their expected profitability over 20 years.

6.3.2 Use cases

There are two different business cases proposed in the calculator based on the example of a flexibility project which would consist on storage devices (i.e. batteries) installed at the household level:

- In the first example, the flexibility project could be used for intraday arbitrage on the day-ahead market. Two main actors have been identified for this example: the market player acting on the day-ahead market (retailer or aggregator) and the end-consumers (having the storage device at home).
- For the second example, the project is deployed to participate in the electricity balancing market of secondary reserves (manual Frequency Restoration Reserve [mFRR]). For this case, the participation of three stakeholders is taken into account: the market player, the households and the system operator

6.3.3 KPIs calculation

Users should complete an input panel with their respective project's parameters (figure below). This project-related data is organised as follows:

- Country and scenario data:
  - Type of solution: for the moment by default this is a storage device (batteries)
  - Country of deployment: France, Germany, Norway and Great-Britain (**scrolling option**)
  - Testing Scenario: 2015, Reference Scenario and Technological Breakthrough (**scrolling option**)
- Technical data:
  - The number of units to be installed in the project,
  - The unitary capacity of each unit (kW),
  - Storage device charging and discharging time per day (h)
- Economic data:
  - The market where the project is going to be valuated: day-ahead or electricity balancing markets (**scrolling option**)
  - The fixed, installation, maintenance and variable costs per unit installed (€),
  - The investment and revenues shares between the retailers and customers involved in the project (%),
  - The possible subsidies or incentives granted,

[6] The KPIs calculation has been based on the work of Bernard Chabot entitled "Are your energy efficiency projects enough profitable? Check it from the profitability index method!"

- Some hypotheses:
  - Project’s valuation period (20 years by default),
  - Discount rate,
  - Δ price reduction (%) <u>(for the Technology Breakthrough scenario only!)</u>.

Country and scenario data

Please enter here the data required for the economic analysis

(default values have been entered but please adjust them)

Type of flexibility solution	Batteries
Country of depeloyment	France
Scenario	2015 Scenario

Play

Technical data

Technical features	value	unit
Number of devices:	100 000	units
Unit capacity:	4	kW
Charge max duration:	4	hours
Discharge max duration:	4	hours

Economic data

Economic data		
Valuation on:	Day-ahead market	
Costs	**value**	**unit**
Unit fixed cost:	300	€
Installation cost:	100	€
Yearly maintenance cost per unit:	30	€/year
Unit variable cost:	0,50	€/kWh
Additional investments	1 000 000	€
Investment share paid by retailer/aggregator:	70%	
Investment share paid by the consumer:	30%	
Revenues	**value**	**unit**
Revenues share for retailer/aggregator:	70%	
Revenues share for consumer:	30%	
Incentives per unit installed:	20	€
Public subsidies per unit installed:	100	€

Some hypotheses

Hypothesis	value	unit
Calculation of profitability during (n):	20	years
discount rate (t)	8%	
Δ price reduction of the techn. breakthrough scenario (%)	20%	

Figure 12. Input panel of the KPIs calculation tool

The resulted KPIs for the project simulated will be presented as below:

Key Performance Indicators (KPI)

	value	unit
Total Cash Flow	865 484 360,39	€
Capital Recovery Factor (CRF)	10%	
Profitability Index (PI)	8,78	
Net Present Value (NPV)	395 066 234,57	€
Overall Discounted Cost (ODC)	3,71	€/MWh
Benefit to Cost Ratio (BCR)	9,78	

Key Performance Indicators (KPI) for the retailer

Retailer	value	unit
Profitability Index for the retailer (PI retailer)	8,78	
Net Present Value for the retailer (NPV retailer)	276 546 364,20	€
Cash flow	605 839 052,27	€

Key Performance Indicators (KPI) for each consumer

Consumer	value	unit
Profitability Index for the consumer (PI cosumer)	8,78	
Net Present Value for the consumer (NPV consumer)	1185,20	€
Cash flow	2596,45	€

Key Performance Indicators (KPI) for the system operator

	value	unit
Balancing net cost for the system operator:	200 324,15	€
Balancing net cost for the system operator by implementing this project:	84 737,65	€
Savings for the system operator by implementing this project:	115 586,50	€
Project's market share:	57,70%	

Figure 13. KPIs generated by the calculator for the project and its different stakeholders involved.

As described in the draft 2016 report of the Business Model Working Group (section 5.2), the Profitability Index is the main indicator of the profitability of the project:

- The project is profitable if and only if its Profitability Index is positive;
- The Profitability Index of successful investment projects should be at least equal to 0.3 (“Golden Threshold”).

The different scenarios developed so far in the tool correspond to:

- Day-ahead market: three scenarios have been developed for the calculation tool on the day-ahead market:
  - The first one (“2015 Scenario”) is considering the 2015 market prices and duplicates those over the next years. This is a simplistic scenario, since in real life market prices will be impacted by the development of renewables and other drivers. However, the advantage of such scenario is that it limits the number of hypotheses considered to forecast day-ahead market prices for the next decades.
  - The second scenario (“Reference Scenario”) consists in anticipating how day-ahead market prices would evolve for the next decades depending on the foreseen changes in the energy mix (more renewables and less fossil-fuel generation). Based on ENTSO-E’s forecasts for 2030 regarding the installed capacities of each type of generation means (wind, solar, nuclear, coal, gas…), and on the link between current installed capacities, current CO2 and fuel prices and day-ahead market prices, we have developed a method to assess day-ahead market prices at 2030. We have then considered a linear evolution of prices between the present and 2030. Within this scenario, the average day-ahead price spreads (the difference within each day of the highest price and the lowest price) are increasing along the years, since increasing renewable generation leads to a greater occurrence of very low (possibly negative) prices, and the higher fuel and CO2 prices leads to a greater occurrence of price spikes. The detailed methodology to assess prices at 2030 is presented in the Annex.
  - The third scenario (“Technological Breakthrough Scenario”) is based on the previous one, but also considers a technological breakthrough due for instance to a broad development of cheaper storage technologies or of demand response. If such technologies develop on large-scale and allows market players and consumers to arbitrate between high- and low-price hours, the average day-ahead price spreads will decrease, thus leading to a decreasing profitability of the concerned technologies.
- Electricity balancing market:
  - The scenario proposed for this market is similar to the “Scenario 2015” from the day-ahead market. Therefore, we have used the same UP and DOWN prices of the electricity balancing market of secondary reserves (manual Frequency Restoration Reserve [mFRR]) during the 20 years of project’s length.

The following table sum up the scenarios developed in the tool:

Table 20. Table of the different scenarios developed for the Technofi BM tool.

Country	Day-ahead market			Electricity Balancing market
	2015 Scenario	Reference Scenario	Technological Breakthrough Scenario	2015 Scenario
France	X	X	X	X
Germany	X			
Norway	X			
United Kingdom	X			

6.3.4 Feedback from projects

Two BRIDGE projects, REAL VALUE and NAIADES have tested the Technofi tool and provided the following outcomes.

NAIADES

NAIADES has found that the Technofi tool would fit the parameters, function and characteristics of the batteries deployed in the project. The tests were performed by Xavier Martinez Masana (Estabanell, Spain).

The tests were mainly performed to assess the different costs (i.e. installation) of the batteries used in the NAIADES project and compared with those already commercialised by different companies such as Tesla.

The next figures represent one case studied by NAIADES:

Technical features	value	unit
Number of devices:	1.000.000	units
Unit capacity:	300	kW
Charge max duration:	4	hours
Discharge max duration:	4	hours
Economic data		
Valuation on:	Day-ahead market	
Costs	**value**	**unit**
Unit fixed cost:	8000	€
Installation cost:	15000	€
Yearly maintenance cost per unit:	3000	€/year
Unit variable cost:	15,00	€/kWh
Additional investments	60.000	€
Investment share paid by retailer/aggregator:	70%	
Investment share paid by the consumer:	30%	
Revenues	**value**	**unit**
Revenues share for retailer/aggregator:	70%	
Revenues share for consumer:	30%	
Incentives per unit installed:	10000	€
Public subsidies per unit installed:	0	€
Hypothesis	**value**	**unit**
Calculation of profitability during (n):	20	years
discount rate (t)	10%	
Δ price reduction of the techn. breakthrough scenario (%)	20%	

Figure 14. Example of conditions used by NAIADES to simulate the business case of their batteries.

Key Performance Indicators (KPI)		
	value	unit
Profitability Index (PI)	3,48	
Net Present Value (NPV)	80.049.871.497	€
Total Cash Flow	231.799.065.728	€
Capital Recovery Factor (CRF)	12%	
Overall Discounted Cost (ODC)	13,02	€/MWh
Benefit to Cost Ratio (BCR)	4,48	

Key Performance Indicators (KPI) for the retailer/aggregator		
Retailer/aggregator	value	unit
Profitability Index for the retailer/aggregator (PI ret./agg.)	3,48	
Net Present Value for the retailer/aggregator (NPV ret./agg.)	56.034.910.048	€
Cash flow	162.259.346.010	€

Key Performance Indicators (KPI) for each consumer		
Consumer	value	unit
Profitability Index for the consumer (PI consumer)	3,48	
Net Present Value for the consumer (NPV consumer)	24014,96	€
Cash flow	69539,72	€

Estimate your PI by introducing an average delta between the max and min day-ahead market prices (€/MWh) for your project's length		
Average delta between the max-min day-ahead market prices	15,00	(€/MWh)
Profitability Index (PI)	0,32	

Figure 15. Example of the outcomes obtained by NAIADES from the simulation of the business case of their batteries.

To sum up, the different analyses performed by NAIADES project intend to find a logical figure in terms to get a realistic outcome for 1 MWh batteries. The criteria understood was that each unit capacity would be of 300 kW as an optimal cost for kW per unit. The country chosen for the calculations was France as Spain is still not available in the tool under the "Reference scenario" conditions because they wanted to assess the evolution of the business case during 20 years. The charging time for the battery selected was from 2 to 4 hours per day. The units cost in the example presented in the figures above was 8.000€ and 15.000€ for the installation. It is to highlight that that the battery installation cost did not include the cost of the connection to the grid. NAIADES considered an OPEX cost of 3000 € (which would correspond to the work of a specialist during two days and two workers with their commute, food, etc.). Following these assumptions, the cash flow started to be positive after the 1st year of operation which is a very optimistic output.

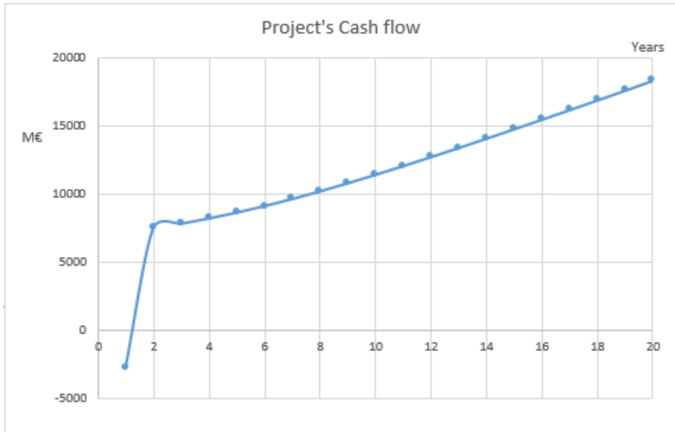

Figure 16. Example of the cash flow simulated in the example of the NAIADES project

Several recommendations have been proposed by NAIADES team to improve the technical design of the tool. For instance, regarding the batteries charging time the Technofi tool assumed that each battery should discharge the same amount of energy charged during the day (i.e. if the battery charged 4h during the day, it should discharge 4h as well). NAIADES has pointed out that the possibility of providing different charging and discharging hours for the batteries should be given. They suggested that for example, in the conventional electric system a battery charging 8 hours, it would have the possibility of only discharge 4 hours.

REAL VALUE

Wolf-Peter Schill (DIW) and Nolan Ritter (DIW) from the Real Value project have assessed the tool and performed the following report which contains very constructive remarks and it is on line with the developments foreseen for the tool by Technofi.

Critique of the Bridge Business Models Calculator

By Wolf-Peter Schill (DIW) and Nolan Ritter (DIW)

What it does?

This Excel based tool calculates the net present value and a profitability index for electricity storage devices. The storage devices are (like) batteries that can charge from and discharge electricity to the grid. The tool concerns itself with two business cases. First, it calculates the value of arbitrage on the wholesale market. This value is generated by charging when it electricity is cheap and discharging when it is more expensive. Second, the tool also calculates the value of being able to provide for secondary reserves. It does so for the French electricity market only. The current version includes 2015 as the base year for 4 countries. There are two additional wholesale price scenarios for France.

Strengths

The Excel based tool is easy to use. Users do not need to be familiar with any additional software. It is possible to specify investment and revenue shares for retailers, aggregators and consumers.

Limitations

The business model calculator uses a heuristic approach to determine the daily charging and discharging hours. We would suggest to use an optimization approach to better approximate the true potential of the storage devices.

The tool only seems to cover electricity storage technologies, that is devices that charge from and discharge to the grid. The tool cannot be used for calculating the value of electricity arbitrage using smart electric thermal storage heaters that can only charge from but not discharge to the grid.

It also seems that the tool can only handle the two business cases separately. However, using the storage device for different value propositions simultaneously would seem prudent from a theoretical and practical point of view. In fact, most flexibility options cover capacity and network-related services at the same time.

The heuristic approach of determining storage operations does not indicate the true potential. Each day is treated separately. Charging cheaply on one day and discharging the next is not possible. This limitation places a downward bias on the indicated value.

The excel tool defies the laws of physics. On days in which the price level is first high and then low, the initially empty battery is discharged to sell electricity at the high price. Later, the battery is charged to the empty level again.

The heuristic leads to another problem. The device is charged when it is cheapest and discharged when electricity is most expensive. In case that the lowest or highest electricity price occurs multiple times, the battery is charged or discharged in each of these hours. This violates the energy balance that demands that the amount charged has to equal the amount discharged.

Another shortcoming is that the charging and discharging has to be symmetrical. In particular, the user has to set the "discharge max duration'' to the same value of the "charge max duration'' setting. Otherwise, the energy balance will be violated.

The tool assumes that batteries are loss free. This amounts to an efficiency of 100% which is highly improbable. The user cannot change this assumption.

The value calculation is based on a project lifetime of 20 years. Thus, there is an implicit assumption that all projects last 20 years. The user cannot vary this time span.

It seems that the price simulation for France in 2030 is rather coarse. Moreover, it would seem that the prices for the years between 2015 and 2030 are interpolated. This does not reflect that prices are determined by supply and demand. It seems more appropriate to use a regular dispatch model.

The tool only focusses on hourly wholesale prices. However, it is also possible to do energy arbitrage using 15 minute contracts that are traded in the same way as the hourly contracts. This limit places a downward bias on the value of the storage.

The user is a little overwhelmed by the overall architecture of the tool. The same information seems to appear on multiple sheets. Results from calculations performed on the third sheet are displayed on the second sheet.

Conclusions

The authors of the tool might want to consider using an optimization approach.

6.3.5 Action Plan for 2018

The Technofi tool is to be updated during 2018. Thanks to the feedback provided by the projects who volunteered to perform some tests and to the different technical development axes foreseen by Technofi the tool would be upgraded. The different development would consist first in improving the technical changes such as the technical charging and discharging limitations of the tool identified by the projects, the batteries lifespan, yield, etc. Moreover, it would be interesting to enrich and continue with the robustness of the different scenarios of the tool for the future tests and diversify the use cases i.e. balancing market-collaboration which would allow to collaborate with different regulated players who are members of the BM WG. Also, as suggested by REAL VALUE, it would be interesting to try to integrate different type of storage (thermal?), etc.) in the tool beyond batteries.

An update of the status of the tool will be made for the next report of the Business Model WG. The tool is intended to keep its simplicity, something which will facilitate the future tests for new volunteers towards its improvement and acceptation for different stakeholders involved in the different projects.

6.4 inteGRIDy Tool

6.4.1 Description

The inteGRIDy project is developing a tool aiming at helping the business modelling for future cities and technologies. The tool is still under construction and will tackle the following aspects:

- Business modelling methodology with step-by-step guidance and advice from industry and academia experts;
- Online coaching on business modelling with real life case studies in the context of smart cities;

- The uniquely designed energy pattern database to allow energy industry professionals to create innovative business models tailored to their target customers and key stakeholders.

The action plan for this tool is mentioned in the description of the issue “Market design to meet efficiency and scalability demands” (page 16). This tool will be more detailed in the next report update so as its outputs and its methodological progress and possible collaborations with the other tools developed within the Business Models Working Group.

7. Conclusions

The Business Models Working Group (BM WG) has identified the following topics related to smart grids and storage in which the projects involved in the initiative have identified issues of different nature and provided recommendations:

- Business Model aspects in Regulated Activities;
- Business Models for Local Energy Management;
- Business Models for Energy Storage;
- Business Models for Demand Response.

The present report gathers the contributions of the working group members related to these topics. The work achieved enabled to define clearly and prioritize each issue and to define recommendations. The main output of this work, within each category, is summarised in the boxes below:

Regulated activities

The category assessed business model conditions for **grid regulated activities** such as those related to new grid devices, the involvement of flexibilities for grid planning, operation and control. The action plan to tackle the issues related to this topic includes:

- the development of tools for market design, CBA strategies, methodologies, analysis and characterisation of relevant data for regulated players;
- interviews to DSOs for better assessing their needs related to flexibility;
- interviews to existing projects, describing and demonstrating local flexibility markets to have a ‘full picture’ in order to provide more recommendations about this topic.

Local energy management

Regarding **local energy management**, the BM group analysed the scope for business models revolving around consuming self-generated electricity, also referred to as prosumage, in two perspectives, individual and collective self-consumption. Recommendations in these topics have been made related to:

- financial support schemes (e.g., feed-in tariffs), climate conditions (solar irradiance, etc…), involvement of ESCOs and how to have profitable BM in different parts of EU;
- the need of clear regulatory frameworks and standards for shared investments.

Energy storage

The BM subgroup working with **storage issues** focused on service-oriented and hybrid BM for various actors and how to apply this kind of BM. Also, the group dealt with BM for hybrid power plants, centralised and distributed storage, storage and flexibility, and how storage nature and properties (location, scale, energy carrier…) may influence the respective Business Models.

This group will continue the characterisation of the issues proposed and analysed. More recommendations are to be provided along 2018 while the projects involved will progress in their respective research.

Demand Response

The BM for **demand response** characterised and provided recommendations about the allocation of spectrum for microgrids 5G operators. This subject could be worked in synergy with the BRIDGE Data Management Working Group as it is a hot topic for the EU Community nowadays.

Moreover, this group has assessed issues related to customer engagement which is a subject deeply analysed within the BRIDGE Customer Engagement Working Group. Finally, the demand response group has described how to enable a fair and open market framework for flexibility services and the revenues, costs & ROI of demand response.

Business Models tools

T**hree Business Models tools** have been developed within the WG. Two of them by NOBEL GRID and inteGRIDy projects and the third one by Technofi. The NOBEL GRID and inteGRIDy tools have to be assessed and tested by some volunteers of the initiative during 2018. The tool developed by Technofi has already been tested by two projects and thanks to the feedback received it will be improved so as to provide more accurate analysis.

Moreover, the Business Models report sets the basis and guidelines of the work to be developed by the Business Models working group members during 2018 (Figure below). The action plans described all along the document for each issue/ topic have helped to set activities (such as academic research, methodologies development, analysis of demo sites outputs of the different projects) to provide recommendations and a methodology to better approach and tackle the different issues identified. The outcomes obtained thanks to these actions will be included in the next update of the Business Models report. Furthermore, once an issue is tackled more issues are to be identified by the members to provide as much recommendations as possible within the BRIDGE initiative to the European Community, European Commission, SET PLAN, and beyond.

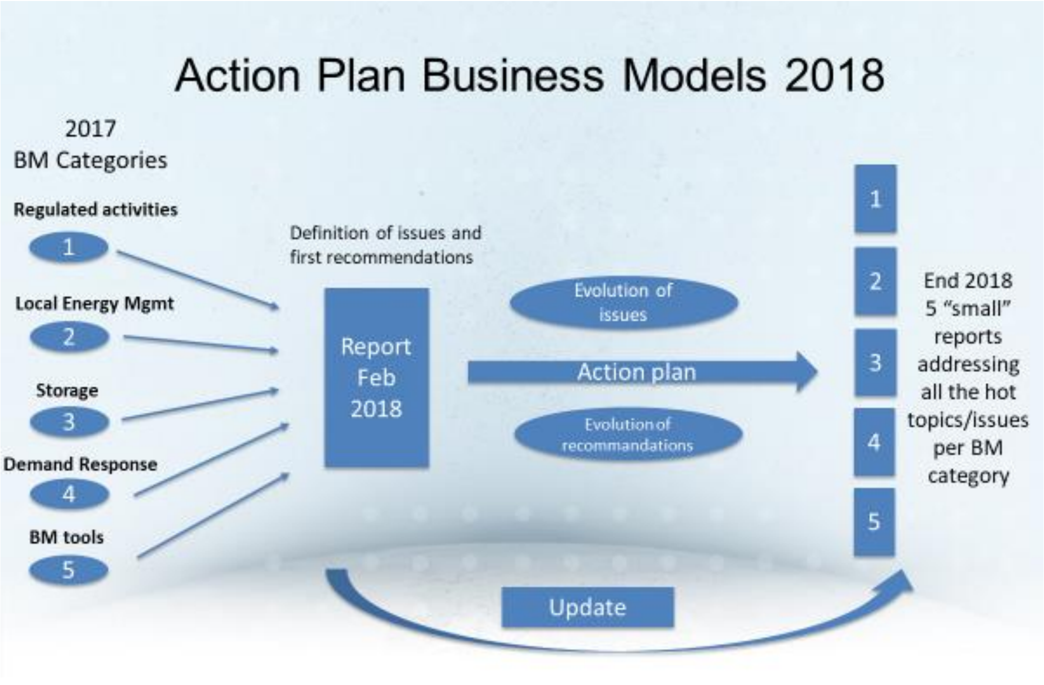

Figure 17. Representation of the BM work for 2018

The next report of the BM WG is expected by the end of the 2018. It will continue the work presented in this deliverable. More BM issues are to be identified and characterised in line with the topics and barriers addressed in each of the use cases developed in the BRIDGE projects of the BM WG members. Also, more detailed and enriched recommendations are to be provided for the issues addressed in this report in line with the different action plans described.

Finally, the activities to be held during 2018 and be included in the next report aim at fostering the synergies between the BM subgroups and their topics with the other main BRIDGE WG such as Regulations, Data Management and Customer Engagement in order to provide more recommendations with a holistic and structured perspective of all the “hot topics” assessed to the European Commission.

8. Annexe 1 - Business Models Working Group: participants and methodology to structure the 2018 Business Models report

The "Business Models" Working Group (BM WG) has been created in March 2015. Based on the first period experiences, the group members have decided to work in a new collaborative manner so as to restructure the way of working all together and identify more effectively the main recommendations and lessons learned from the WG.

Within the BRIDGE Initiative, the projects involved in the BM WG (25 projects in total) are provided in the table below:

Table 21. List of the BM WG projects within the BRIDGE initiative

Project	Description of the project	Length (years)
AnyPLACE	AnyPLACE is a European project that will develop a modular energy management system capable monitoring and controlling local devices according to the preferences of end-users.	2015-2017
EMPOWER	EMPOWER encourages micro-generation and the active participation of prosumers to exploit the flexibility created for the benefit of all connected to the local grid.	2015-2017
Flex4Grid	Flex4Grid aims at creating an open data and service framework that enables a novel concept of prosumer flexibility management.	2015-2017
Nobel Grid	NOBEL GRID will provide advanced tools and Information and Communication Technologies (ICT) services to all actors in the Smart Grid and retail electricity market in order to ensure benefits from cheaper prices, more secure and stable grids and clean electricity.	2015-2018
P2P-smarTest	P2P-SmartTest project investigates and demonstrates a smarter electricity distribution system integrated with advanced ICT, regional markets and innovative business models. It will employ Peer-to-Peer (P2P) approaches to ensure the integration of demand side flexibility and the optimum operation of DER and other resources within the network while maintaining second-to-second power balance and the quality and security of the supply.	2015-2017
SmarterEMC2	SmarterEMC2 implements ICT tools that support the integration of consumers through Demand Response services and the integration of Distributed Generation (DG)/RES through Virtual Power Plants.	2015-2017
UPGRID	UPGRID project focuses on addressing the constraints and needs arisen from poor observability of Low Voltage (LV) grid, local accumulation of distributed generation, risks and difficulties in managing the distribution network, aging infrastructure and social and environmental restrictions that inhibit the grid development. To be successful, UPGRID proposes an open, standardised and integral improvement of the LV grid.	2015-2017
Elsa	ELSA will adapt, build upon, and integrate close-to-mature storage technologies and related ICT-based energy management systems for the management and control of local loads, generation and single or aggregated real or virtual storage resources, including demand response, in buildings, districts and distribution grids.	2015-2018
NETfficient	The NETfficient project will deploy and demonstrate local energy storage technologies and develop information and communication tools, to exploit the synergies between energy storage, the smart grid and the citizens.	2015-2018

RealValue	RealValue will demonstrate, through the deployment of Smart Electric Thermal Storage (SETS) technology in 1,250 properties in Ireland, Germany and Latvia how it can provide value and benefits to the whole electricity supply chain.	2015-2018
SENSIBLE	Project SENSIBLE aims at developing, demonstrating and evaluating a storage-enabled sustainable energy supply for buildings and communities	2015-2018
STORY	STORY is a European project researching new energy storage technologies and their benefits in distribution systems and involves 18 Partner Institutions in 8 different European countries.	2015-2020
TILOS	TILOS' main goal is to demonstrate the potential of local / small-scale battery storage to serve a multipurpose role within a smart island microgrid that features high shares of renewable energy and trades electricity with the main electricity network.	2015-2019
NAIADES	The NAIADES project aims to develop and demonstrate the ambient Na-ion battery under realistic conditions as an effective alternative to the Li-ion battery for stationary Electric Energy Storage (EES) application.	2015-2018
PROMOTioN PROGRESS ON MESHED HVDC OFFSHORE TRANSMISSION NETWORKS	PROMOTioN seeks to develop meshed High Voltage Direct Current (HVDC) offshore grids on the basis of cost-effective and reliable technological innovation.	2016-2019
FutureFlow	FutureFlow aims at designing and piloting test comprehensive techno-economic models for open and non-discriminatory access of advanced consumers and distributed generators to a regional platform for ancillary/balancing and redispatching services.	2016-2019
STORE&GO	STORE&GO focuses on the integration of Power to Gas (PtG) into the daily operation of European energy grids to demonstrate the maturity of the technology. Additionally, STORE&GO identifies current and future PtG business cases to develop a European PtG roadmap.	2016-2020
GOFLEX	The GOFLEX project innovates, integrates, and demonstrates a group of electricity smart-grid technologies for managing flexibility in energy production and consumption.	2016-2019
integrid bridging the gap	InteGrid's vision is to bridge the gap between citizens and technology/solution providers such as utilities, aggregators, manufacturers and all other agents providing energy services.	2017-2020
inteGRIDy	inteGRIDy pursues facilitating the optimal and dynamic operation of the Distribution Grid, fostering the stability of the electricity grid and coordination of distributed energy resources, Virtual Power Plants and innovative collaborative storage schemes within a continuously increased share of renewable energy.	2017-2020
InterFLEX	InterFlex investigates during 36 months the INTERactions between FLEXibilities provided by energy market players and the distribution grid. This project focuses particularly on energy storage, smart charging of electric vehicles, demand response, islanding, grid automation and integration of different energy carriers (gas, heat, electricity).	2017-2019
INVADE	INVADE proposes to deliver a cloud-based flexibility management system integrated with Electric Vehivles (EV) and batteries empowering energy storage at mobile, distributed and centralised levels to increase renewables share in the smart distribution grid. The project integrates different components: flexibility management system, energy storage technologies, electric vehicles and novel business models.	2017-2019
wiseGRID	WiseGRID will provide a set of solutions and technologies to increase the smartness, stability and security of an open, consumer-centric European energy grid.	2016-2020
GRIDSOL	GRIDSOL aims to provide secure, clean and efficient electricity by combining primary renewable energy sources and technology under an advanced control system called Dynamic Output Manager of Energy (DOME) supplying secure electricity and contributing to grid stability through Smart Renewable Hubs.	2016-2019

8.1 A preliminary phase of collaborative work

The construction of this report of the Business Models Working Group (BM WG), has been based on the following approach:

- A first phase has started during the summer 2017 relying on the pitches given by the 16 projects[7] during the BM WG meeting in January 2017. From those pitches, a list of BM issues has been identified by categories and by projects and reviewed by the BM WG members. New inputs have been shared enabling the consolidation of the final list of issues.
- Following this solicitation, the issues raised have been collected and gathered within four main categories:
  - Business Models aspects in Regulated Activities;
  - Business Models for Local Energy Management;
  - Business Models for Energy Storage;
  - Business Models for Demand Response.

There is one leader for each category. The detailed list of participants is indicated in the dedicated sections of the report.

8.2 An innovative working session with specific targets

During the meeting of the BM WG the 20 November 2017, the projects worked together within their respective category. They followed a working session structure aiming to:

- Provide a clear definition of each issue identified;
- Prioritize the issues to be worked on during the session;
- Define recommendations and an action plan for 2018 to tackle each issue. This part was based on a problem-solving methodology (What? Who? Where? When? Why? How?).

This iterative work helped clarifying the different challenges to be tackled within each category as well as elaborating tangible action plans for 2018.

[7] List of the 16 projects: SmarterEMC2, WiseGrid, GRIDSOL, Nobel Grid, RealValue, STORY, EMPOWER, NAIADES, FutureFlow, SENSIBLE, UPGRID, AnyPLACE, Flex4Grid, P2P-smartest, TILOS, NETfficient

8.3 The involvement of projects' tools

In parallel of the work related to the Business Models Issues, business model tools have been provided by two projects and the BRIDGE support team:

- The Technofi Tool;
- The NobelGrid Tool;
- The inteGRIDy Tool.

The 2 first tools have been introduced to the Business Models projects during a webinar the 12th of September 2017. Following these presentations, volunteers agreed to test the tools. The aim was to collect feedback on the added value of each tool in the perspective of addressing Business Models Issues and provide recommendations.

Moreover, during the working session meeting of the BM WG (November 2017), the inteGRIDy tool has been presented bringing a complementarity perspective for the BM WG.

A specific section of the report is dedicated to those 3 tools. Collaborations between the 3 tools will be further investigated.

8.4 The results of the Business Models Working Group (BM WG) collaborative work

The structure of this document presents the results of the collaborative approach as follows:

- For each category, the list of issues identified, characterised and to be tackled;
- For each issue, the specific action plan for 2018.

Synergies between the categories have also been identified to be further investigated along the year 2018.

An additional part specific to the Business Model tools introduces their specificities, their strengths, the feedback from the projects having tested them as well as the challenges to be overcome for 2018.

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