D7.5 - Exemplary Business Cases and Value Propositions

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2020-01-22 (v0.10)	ENIIG	• Minor corrections and comments
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Executive Summary

This deliverable presents the results generated by Work Package 7 “Dissemination, exploitation and Standardization”, and more specifically by task T7.4 “Exploitation and Policy Support”. Starting from the findings stemming from D2.2 and D2.4 it describes S4G exemplary business cases.
The report aims at proposing a big picture of the 14 S4G business cases defined in D2.2 taking a cross-test-site point of view. For this purpose, the business cases have been firstly grouped in four clusters that include cases with similar objectives. Then, in order to define the “exemplary business cases”, the most relevant business cases within each cluster have been selected. The analysis of the clusters and the exemplary business cases allowed to point out that business cases within the same cluster have similar business models, in terms of stakeholders involved, value propositions, types of costs, and revenue streams. Thus, it has been possible to define six business models archetypes, modelled according to three dimensions (ESS location; ESS ownerships; and involvement of the customer in the market: possibility to sell ancillary services to the DSO) and to identify which business model archetypes are more valuable for each cluster.
It has to be noted that the three dimensions that determine the business model archetypes are not only relevant for the purposes of the project, but are also consistent with literature review: they are considered as key elements that characterise business models for distributed energy resources in many researches on this topic. As a consequence, the resulting framework, constructed within the project and aligned with existing studies, can be taken in consideration not only for the scopes of the S4G project but also by other similar initiatives that are exploring to develop new business cases in the energy sector.
In addition, this deliverable contains also the results of the workshop regarding “business models for exploitation” with the S4G External Stakeholder Group held in Brussels on 24th October 2019 during the SHAR-Q and S4G joint final event (see Appendix A).

1 Introduction

This document proposes an analysis of S4G business cases starting from the outputs of D2.2 and D2.4 and attempts to answer to the following research questions:

1. Which are the main scopes of S4G business cases?
2. Which business cases best represent the project, in terms of alignment with the project objectives and potential impact generated ("exemplary business cases")?
3. Which are the characteristics of the business models underlying S4G business cases?

In order to answer to these questions the 14 S4G business cases have been firstly clustered considering their scopes. In this way, it has been possible to offer a comprehensive big picture of S4G business cases using a cross-test-site perspective. Subsequently, a selection and analysis of exemplary business cases has been conducted by considering the most impactful business cases within each cluster. Finally, some business model archetypes modelled according to three variables (ESS location, ESS ownership and involvement of the customer in the market) have been defined and associated to the business cases within each cluster. The resulting framework is aligned with existing literature on business models in the energy sector and can be considered not only for the purposes of the S4G project but also by other similar initiatives that are evaluating to develop new business cases in the energy sector.

The deliverable is structured as follows: after these introductory remarks, chapter 2 proposes a review of existing literature on energy storage business models, making reference to relevant projects and research initiatives dealing with this topic; chapter 3 proposes an overview of S4G business cases and clusters; chapter 4 analyses the exemplary business cases selected within each cluster; chapter 5 defines the business models archetypes that characterise the business cases of each cluster and, finally, chapter 6 provides conclusive remarks. In addition, the main outcomes from the workshop with the S4G External Stakeholder Group (ESG) regarding business models for exploitation is reported in Appendix A, while Appendix B summarises the features of the main use cases considered by Low TRL Smart Grid & Storage projects and Appendix C proposes some methodological remarks on the tools used for the analysis of the business cases.

1.1 Scope

This deliverable presents the results generated by Work Package 7 "Dissemination, exploitation and Standardization", and more specifically by task T7.4 "Exploitation and Policy Support". It explains the methodology for the selection of S4G exemplary business cases and describes their value propositions. Furthermore, it reports the main insights stemming from the workshop with S4G ESG hold in Brussels on 24th October 2019 during the SHAR-Q and S4G joint final event.

1.2 Related documents

ID	Title	Version	Date
D2.2	Final storage scenarios and use cases	1.0	31/07/2018
D2.4	Final S4G business models	1.0	24/07/2019

2 Review of business models for distributed energy resources

In the last two decades the energy sector, like almost all business sectors, has been involved in a deep transformation process, determined by some global challenges: technological breakthroughs; climate change and resource scarcity; demographic and social change; a shift in global economic power and rapid urbanisation[i]. The impact of these challenges on the energy sector has been disruptive and involved several factors: customers' behaviours, competition, the production service model, distribution channels, government policy and regulation. In short, according to PWC, energy sector is going to evolve into a new market paradigm (Figure 1) characterised by a new and more active role of customers (customers become producers, active participants in the market, can go-off grid) and the management of decentralized and distributed resources.

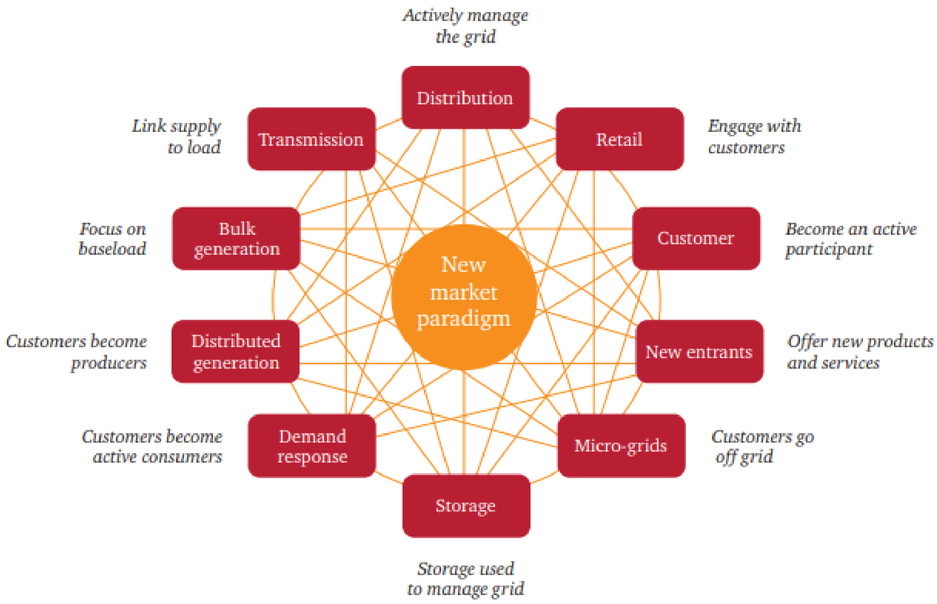

Figure 1 – The energy sector new market paradigm (source: PWC, 2015[i])

Moreover, knowledge about data ownership, policy constraints, relationships between different stakeholders involved, pricing mechanisms, partnering and regulatory issues are considered the key levers for future business models (Figure 2).

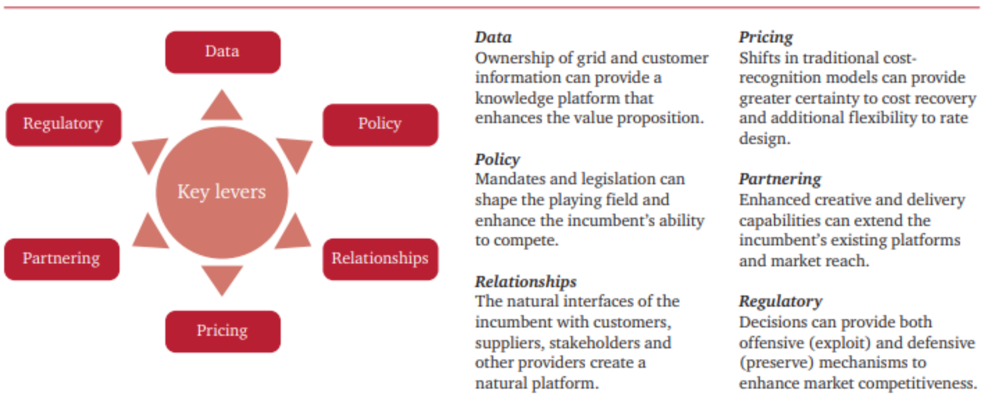

Figure 2 – Future business model levers (source: PWC, 2015[i])

As highlighted by the Energy Union Strategy[ii] energy storage could play a crucial role in this energy transition, by enhancing the reliability, flexibility and security of the European energy industry. In addition, the combination of ESS (Energy Storage Systems) with RES (Renewable Energy Sources) can help to significantly reduce the risks and impacts of climate change[iii]. As a consequence, new relevant business models that

combines ESS and RES are emerging. Several studies conducted within EU funded projects or by other research initiatives focused on this topic.
The report published by IRENA[iv] in 2019 "Innovation landscape for a renewable-powered future: solutions to integrate variable renewables" proposes an analysis of the renewable energy market landscape, in which batteries and renewables are considered between the most relevant enabling technologies. Moreover, it envisages the following business models for the power sector:

1. Aggregators
2. P2P trading
3. Energy as a service
4. Community ownership model
5. Pay as you go model

Figure 3 displays the resulting innovation landscape.

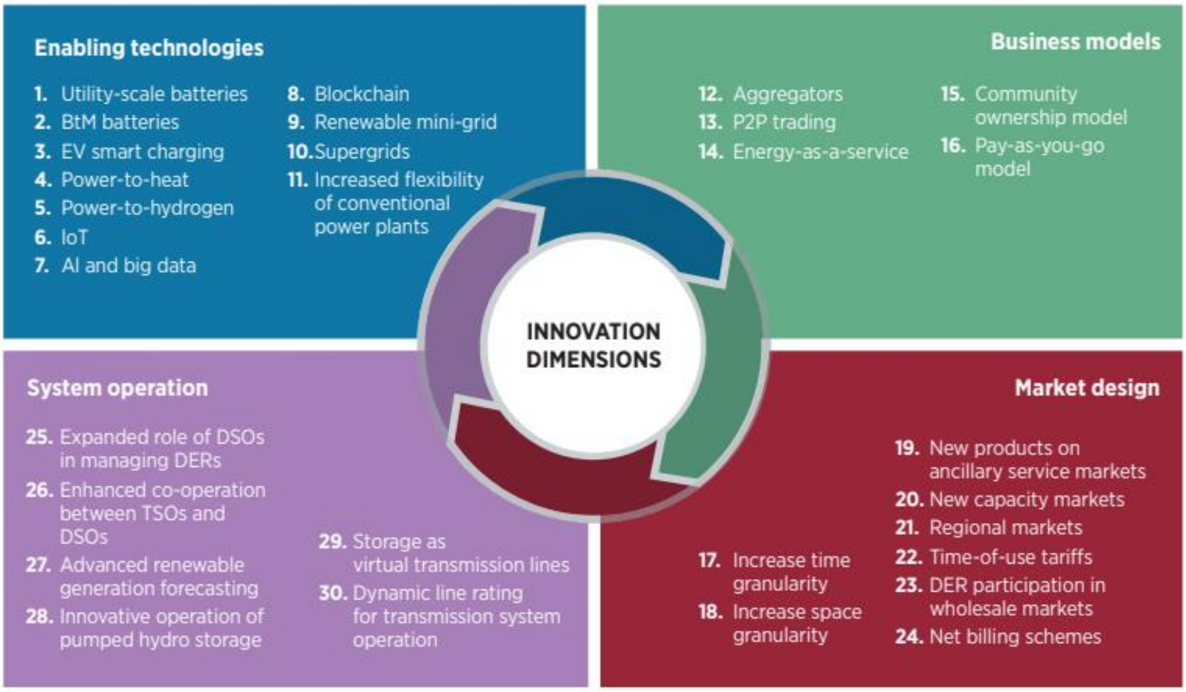

Figure 3 – The landscape of innovations for power sector transformation (source: IRENA, 2019[iv])

Another interesting point of view is provided by MIT Energy Initiative that in 2016 released a white paper[v] "Business Models for Distributed Energy Resources: A Review and Empirical Analysis", that analyses business models focusing on the end user. It considers not only the benefits related to the possibility to increase end user's self-consumption (solar-plus-storage end-user optimisation) but also the opportunities related to the possibility for the end-user to participate in power system markets (Solar-plus-storage end-user & system co-optimisation).
In addition, a review of relevant studies concerning energy storage sector business models is proposed by the H2020 funded project INVADE in the deliverable D9.1[vi]. The document recalls the vision of Jansen[vii] that identifies three primary approaches to sharing value between the energy system and the customer:

- A "**shared benefit**" approach that refers to business models providing customers with an additional profit. This is typically accomplished by aggregating behind-the meter energy storage capacities to provide flexibility services;
- A "**storage for free**" approach where business models rely on new financing schemes to overcome the barrier associated with costly initial investments. Such models can be targeting both commercial and residential customer segments and succeed in making their business offer perceived as different and attractive ;

- A **"community storage"** approach for which business models are based on utility side of the meter assets that integrate offers for a wide range of value chain stakeholders – e.g., DSOs, energy suppliers, commercial and residential customers, generators.

Moreover, another research proposed by Frost and Sullivan[viii] identifies 8 business models and stresses on the importance of business models that ease the capital expenditure burden in order to **encourage consumers' participation**. Business models are classified according to the different scale of energy storage systems that they utilise. In particular, the research distinguishes between:

- the application scale (grid scale, behind the meter and community scale);
- the level of ownership of the assets (TSO- or DSO-owned assets, third party-owned assets and shared assets).

Similar insights have been addressed by REEEM project (H2020) through its Innovation and Technology Roadmap[iii] that analyses the main business models stemming from different storage applications. It recognises the following storage applications and related business models (BM):

- **Grid-scale** encompasses stationary electrical storage implemented at a specific location on grid. Related BMs:
    - The system operator owns the storage asset and captures network value only,
    - The system operator owns the storage asset that captures both network and market values,
    - Third party owns the asset and captures both network and market value,
    - The system operator owns the storage asset to only captures network value and third party own assets to capture the market value.
- **Behind-the-meter** refers to stationary storage implemented at consumers' location and not in the grid. This application is for the consumers who are still connected to the grid. Related BMs:
    - Consumers owned assets not capturing market value,
    - Consumers owned assets capturing market value through aggregators,
    - Distributors own storage assets for network services,
    - Storage as a service - third party owned assets capturing market value.
- **Off-grid** includes energy storage installed at off-grid and remote areas for homes, telecom towers or mini-grids.
- **Mobility** focuses on energy storage system used for mobility and four wheel individual and fleet vehicles.
- **Thermal** incudes storage of thermal energy for heating, cooling or power generation purposes

Finally, the main results from SHAR-Q project[ix] – the project that has been funded with S4G under the same call for proposal (H2020-LCE-2016-SGS) – can be examined. Specifically, the project has developed the following relevant business cases documented in D2.5[x]:

- <u>Distributed flexibility management</u>: provision of a mechanisms that allows controlling overall capacities for optimising how the different capabilities of the participants are exploited.
- <u>Collaboration between Electric Energy Storage providers and Grid operator</u>: enable interoperability between entities connected through the electricity grid.
- <u>Collaboration between EVs and RES operators</u>: Electric vehicles offer significant inherent storage capabilities mainly because their mobility energy needs are lower than the capacity of the EV integrated battery and they remain parked and connected to the grid most of the day (>90%).
- <u>Peer to peer energy market</u>: manage and connect energy production units (PV-Plant operators) which are partly also combined with ESS systems with other neighbourhood prosumers and consumers to have a pro-active exchange of produced electricity and free storage capacities on peer to peer level.

The main results of SHAR-Q and S4G projects have been presented in Brussels during the final joint event on 24th October 2019 (see Appendix A for further details).

Moreover, SHAR-Q together with S4G are participating to the Cluster "Business Models for Exploitation" [1] promoted by the "Low TRL Smart Grid & Storage Projects Clustering Initiative". An analysis of the use cases developed by almost all the participating projects has been presented on 3rd October 2019 during a workshop

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[1] Participating projects: SHAR-Q; FLEXCoop; DOMINOES; Net2DG; CHESTER; FHP; S4G; E-LOBSTER; UNITEDGRID; PLANET; MAGNITUDE; TDX-ASSIST; DRIVE; RESOLVD

organised by INEA[xi] in Brussels with the objective of enhancing the networking and synergies between projects and identifying possible joint activities. Figure 4, Table 1 and Table 2 report the main outcomes presented in this occasion. A more detailed description of the use cases considered by each project is presented in Appendix B.

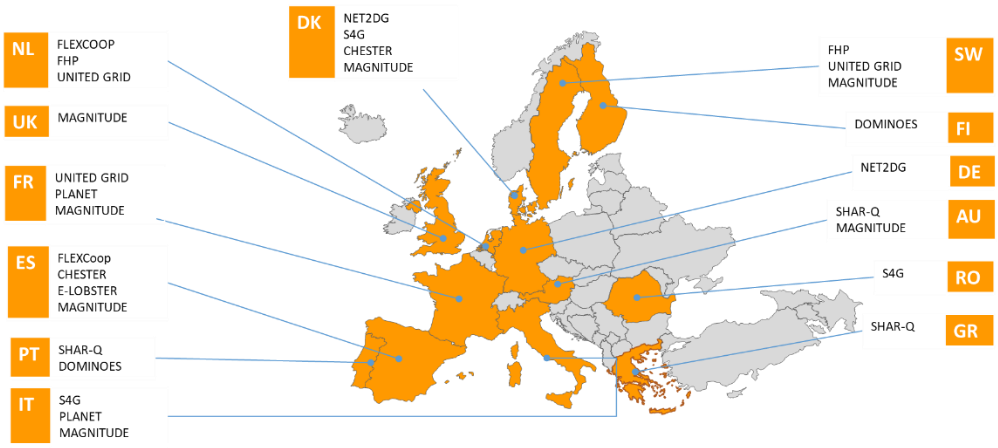

Figure 4 – Location of the main Use Cases promoted by Low TRL Smart Grid & Storage Projects

Table 1 - Low TRL Smart Grid & Storage Projects by typology

Cross Energy Vectors	CHESTER	FHP	MAGNITUDE		PLANET
ICT platforms	SHAR-Q	S4G	DOMINOES	NET2DG	
Energy Services	FLEXCoop	UNITED GRID	E-LOBSTER		

Table 2 – Low TRL Smart Grid & Storage Projects (other features, relevant for a comparison with S4G)

Focus on Electric Vehicles	SHAR-Q	S4G	E-LOBSTER	
Focus on ESS	SHAR-Q	S4G	E-LOBSTER	CHESTER

Finally, summing up the outcomes of the literature review it has been possible to identify the key elements that characterise business models for distributed resources (Table 3).

Table 3 – Key elements that characterise business models for distributed energy resources (from literature review)

ESS location:

- Behind the meter
  - Community scale (peer to peer)
- At grid scale
- Off-grid

ESS ownership:

- End-user;
- DSO (or TSO);
- Third party;

Customer involvement in the market:

- End user optimisation;
- End user co-optimisation, possibility to offer ancillary services to the DSO;
  - Role of aggregators.

These insights allowed S4G analyst to define six business models archetypes for distributed energy resources management, modelled according to the previously cited dimensions: ESS location, ESS ownership and involvement of the customer in the market (possibility to sell ancillary services to the DSO) (Figure 5).
The business models archetypes are typologies of business models characterised by similar features in terms of value network (that involves: stakeholders, power flux, cash flux and contracts / relationships between parties) and represent possible approaches for managing the grid in presence of storage systems and RES. They can be used to describe the business models of any initiative taking place in the distributed energy sector and, consequently, also S4G business cases. Chapter 5 will show how S4G business case fit with these archetypes.

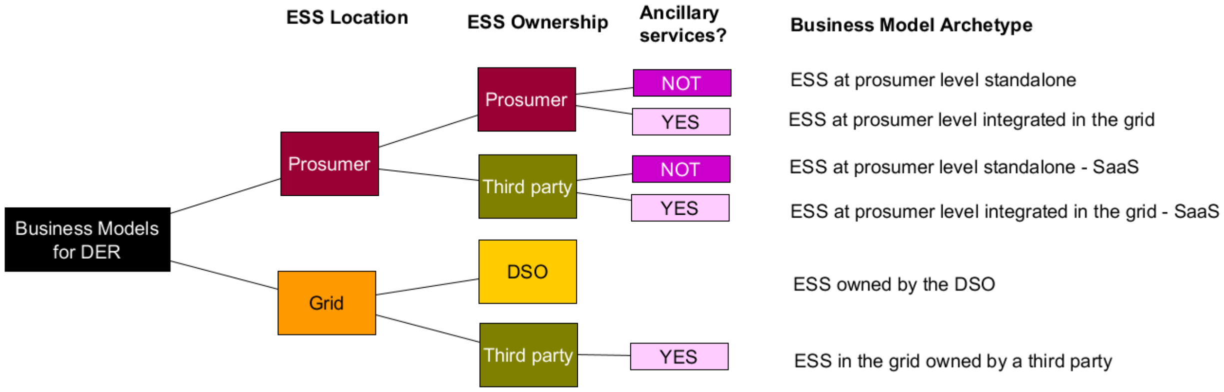

Figure 5 – Business models archetypes for distributed resources

3 S4G business cases overview

3.1 S4G business cases

D2.2 has presented and described S4G use cases, focusing on each test site (defined as High Level Use Case - HLUC). Specifically, for each test site, relevant use cases (defined as Primary Use Case – PUC) have been conceived and, finally, for each of them one or more associated business cases (BM) have been presented. These business cases have been deeply studied in D2.4. Table 4 briefly summarises the 14 business cases associated to the three S4G test sites.

Table 4 – S4G Uses Cases and related business cases

HLUC	PUC	BM	#
1 - Bucharest	**PUC1**: Grid strengthening[2] and ancillary services simulation	**S1a/b** Handle over-generation of renewable energy sources on DSO-level (avoid curtailment)	1
		S2 Serving peak demands on DSO-level	2
		S3 Provide ancillary services (black-start) on DSO-level	3
	PUC2: Advanced self-resilient prosumer	**PUC2_ BM1** Prosumer will act always as a consumer from the grid side	4
	PUC3: Resilient hybrid cooperative ecosystem	**PUC3_BM1** Enabling energy services to connected neighbourhood prosumers and consumers	5
2 – Bolzano	**PUC1**: residential prosumer with storage and EV	**PUC1_BM1** prosumer with ESS "stand alone"	6
		PUC1_BM2 Prosumer with grid integration	7
	PUC2: Cooperative charging in the parking lot of a commercial test site with PV and EV charging stations	**PUC2_BM1** Cooperative Charging at Commercial or Fleet level	8
	PUC3: Simulation of high penetration of EV chargers and of prosumers with storage and residential EV charging		9
3 – Fur / Skive	**PUC1:** Support for analysing storage dimensioning and positioning in the low-voltage grid	**PUC1_BM1** Baseline	10
	PUC2: Autonomous control of storage installed at user premises and distributed in the grid	**PUC2_BM1** Autonomous voltage control at household battery	11
	PUC3: Voltage and flux[3] control at grid side storage	**PUC3_BM1** Voltage control at grid side battery	12
	PUC4: Coordinated distributed storage in the grid	**PUC4_BM2** Voltage control at both household and grid side battery and Energy Flux[3] control at grid side battery	13
		PUC4_BM3 Flux[3] control and peak shaving at households with PV and battery	14

[2] Grid support
[3] Load flow

D2.4 analysed each business case focusing on its business model, pointing out the main stakeholders involved, the main revenue streams and costs associated. Starting from these observations, **the present deliverable aims at proposing a big picture of S4G business cases focused on their main scopes, from a cross- test-site point of view.** Specifically, the S4G business cases main scopes can be explained by the "exemplary business cases" that have been selected following the methodology, described in the next chapter.

3.2 Methodology for exemplary business cases selection

The methodology that has been used to select the "exemplary business cases" is proposed in Figure 6.
Three phases characterise the methodology:

1. Business cases clustering:
    a. Clusters definition: four clusters for S4G business cases have been identified. The business cases within each cluster share the same scope.
    b. Association of each business case to a specific cluster.
2. Business cases selection:
    a. max two business cases can be selected for each cluster.
    b. For the clusters with more than two business cases, they are selected for maximum representativeness with respect to ESS location and, where relevant, ESS ownership.
3. Exemplary business cases analysis
    a. Value propositions
    b. Value network analysis
    c. Business models

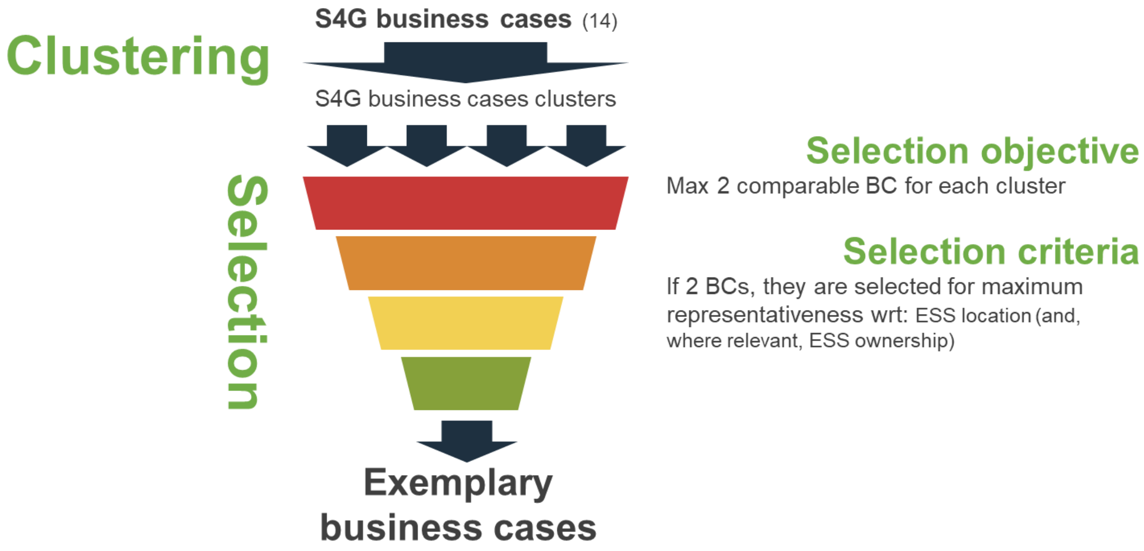

Figure 6 – S4G Exemplary Business Cases selection methodology

3.3 Business cases clusters

The business case clusters have been defined with the objective of synthetically representing S4G business cases considering their scopes.
These clusters have been identified by LINKS analysts and discussed with the Consortium during the project physical meeting on 24th October 2019.
The main goals of S4G business cases can be described as follows:
A. ESS positioning and dimensioning
B. Services for the prosumers
C. Voltage / load flow optimisation
D. Energy community

Figure 7 provides a brief overview on the four clusters.

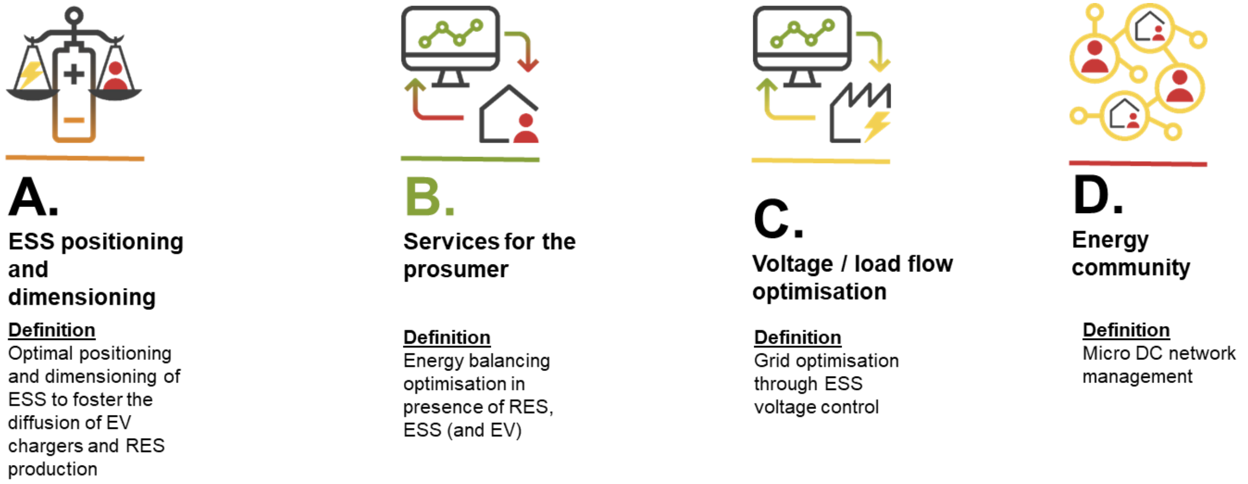

Figure 7 – S4G business cases clusters

Hereafter a more detailed description of the clusters and the cases to be included is proposed.

Cluster: ESS positioning and dimensioning - *Optimal positioning and dimensioning of ESS to foster the diffusion of EV chargers and RES production*

The first cluster includes the business cases that offer to the DSO the possibility to understand the optimal positioning and dimensioning of ESS to be placed in the grid to foster the diffusion of EV chargers and RES production.
Two situations are considered: (a) the presence of ESS at prosumer and / or at grid level; (b) the possibility for the DSO to place ESS in the grid and its ideal location.

Cases to be included:

- HLUC2_PUC3: Simulation of high penetration of EV chargers and of prosumers with storage and residential EV charging
- HLUC3_PUC1_BM1: Support for analysing storage dimensioning and positioning in the low-voltage grid - Baseline
- HLUC3_PUC3_BM1: Voltage control at grid side battery

Cluster: Services for the prosumer - *Energy balancing optimisation in presence of RES, ESS (and EV)*

The second cluster focuses on the prosumer and includes the BCs that allow the prosumers to optimise their energy consumption and production in presence of RES, ESS (and EV). These business cases demonstrate if it is profitable for prosumers to install ESS in connection to their local PV production and/or EV charging.
The DSO can indirectly benefit from the installation of ESS at prosumer level, because he can defer traditional grid strengthening.

Cases to be included:

- HLUC1_PUC2_BM1: Prosumer will act always as a consumer from the grid side
- HLUC2_PUC1_BM1: Residential prosumer with storage and EV - prosumer with ESS "stand alone"
- HLUC2_PUC2_BM1: Cooperative Charging at Commercial or Fleet level

Cluster: Voltage / load flow optimisation - *Grid optimisation through ESS voltage control*

The third cluster considers solutions of grid optimisation through ESS voltage control. In these business cases ESS at prosumer level are controlled by the DSO that can better manage ESS charging, voltage issues and load flow. Prosumers can make business by offering ancillary services to the DSO. In these cases, an external aggregator can manage ancillary services.

Cases to be included:

- HLUC1_PUC1_s1: Handle over-generation of renewable energy sources on DSO-level (avoid curtailment)
- HLUC1_PUC1_s2: Serving peak demands on DSO-level
- HLUC2_PUC1_BM2: Residential prosumer with storage and EV - prosumer with grid integration
- HLUC3_PUC2_BM1: Autonomous voltage control at household battery
- HLUC3_PUC4_BM2: Voltage control at both household and grid side battery and Energy Flux control at grid side battery
- HLUC3_PUC4_BM3: Flux control and peak shaving at households with PV and battery

Cluster: energy community - *Micro DC network management*

The last cluster is an example of micro DC network management. This case considers a local grid in which prosumers can consume their RES production and / or together with their neighbours, by using a cooperative energy control.

Cases to be included:

- HLUC1_PUC3_BM1: Enabling energy services to connected neighbourhood prosumers and consumers
- HLUC1_PUC1_s3: Provide ancillary services (black-start) on DSO-level

4 Selection of exemplary business cases

After having identified the business cases clusters and their related business cases, it has been possible to select the "exemplary business cases" considering the criteria displayed in Figure 6. Specifically business cases have been chosen in order to guarantee the maximum representativeness within the cluster in terms of ESS location[4] and relevance of the business case for the S4G Consortium (as agreed during the physical meeting in Brussels on 24th October 2019).

Table 5 shows the ESS location categories associated to each cluster in order to define the maximum number of exemplary business case to be considered.

Table 5 – Number of cases to be selected within each cluster

Cluster	Number of cases	ESS location categories	Number of cases to be selected
ESS positioning and dimensioning	3	1. Prosumers and / or grid 2. Grid level, owned by the DSO	2
Services for the prosumer	3	1. Prosumer	1
Voltage / load flow optimisation	6	1. Prosumer and grid 2. Prosumer	2
Energy community	2	1. Prosumer	1

Finally, Table 6 associates each business case within each cluster to a specific ESS location category, and highlights the selected exemplary business cases.

Table 6 – S4G Business cases and exemplary business cases (in green)

Cluster	ESS location categories + business cases	Exemplary business cases
ESS positioning and dimensioning	1. Prosumers and / or grid HLUC2_PUC3 HLUC3_PUC1_BM1 2. Grid level, owned by the DSO HLUC3_PUC3_BM1	HLUC3_PUC1_BM1 HLUC3_PUC3_BM1
Services for the prosumer	1. Prosumer HLUC1_PUC2_BM1 HLUC2_PUC1_BM1 HLUC2_PUC2_BM1	HLUC2_PUC1_BM1
Voltage / load flow optimisation	1. Prosumer and grid HLUC1_PUC1_s1 HLUC3_PUC4_BM2 2. Prosumer HLUC1_PUC1_s2 HLUC2_PUC1_BM2 HLUC3_PUC2_BM1 HLUC3_PUC4_BM3	HLUC3_PUC4_BM2 HLUC3_PUC2_BM1
Energy community	1. Prosumer HLUC1_PUC3_BM1 HLUC1_PUC1_s3	HLUC1_PUC3

[4] ESS location categories: at prosumer level, at grid level, both at prosumer and grid level

In the next sections a short recap of the main features of each exemplary business case is proposed. The template of analysis considers the following points:

- Test site location;
- Business case description;
- ESS location;
- Main stakeholders involved;
- Value proposition, through the use of the Value Proposition Canvas tool[xii] (see Appendix C, for further details).

More details on S4G business cases are available in D2.2 and D2.4.

4.1.1 Cluster: ESS positioning and dimensioning

4.1.1.1 HLUC3_PUC1_BM1: Support for analysing storage dimensioning and positioning in the low-voltage grid - Baseline

Test site location: Fur / Skive

Business case description: This business case aims to provide to a grid planning manager a tool that determines the best solution for grid stabilisation, simulating a variety of options with different variables focusing on the voltage level. In order to determine the current grid situation by analysing the voltage levels, the grid planning manager runs the power flow simulation without installing additional storage in the current grid topology. After the results in form of voltage level in each line are presented, the problems are visually highlighted in the grid. By placing new storage systems of different sizes and models, he starts to solve the issues locating additional storage in the grid topology and repeatedly simulating their impact on the grid behaviour. As soon as the simulation results do not depict errors anymore, he knows which storage configuration can solve the current problems. In order to be able to compare his results to classical grid reinforcement techniques, he has to perform a baseline calculation.

ESS Location: different configurations of ESS at prosumer and at grid level can be considered (simulation)

Main stakeholder involved:

- DSO

Value proposition

The value proposition for the key stakeholder involved in this business case (DSO) is briefly proposed in Table 7 and detailed in Figure 8, using the Value Proposition Canvas tool.

Table 7 – HLUC3_PUC1_BM1 Value proposition for the DSO point of view in a nutshell

Why	What	How
Better management of grid congestion Possibility to avoid / defer grid strengthening	Determine the optimal dimensioning and positioning of ESS in the grid	Using DSF-SE and Professional GUI

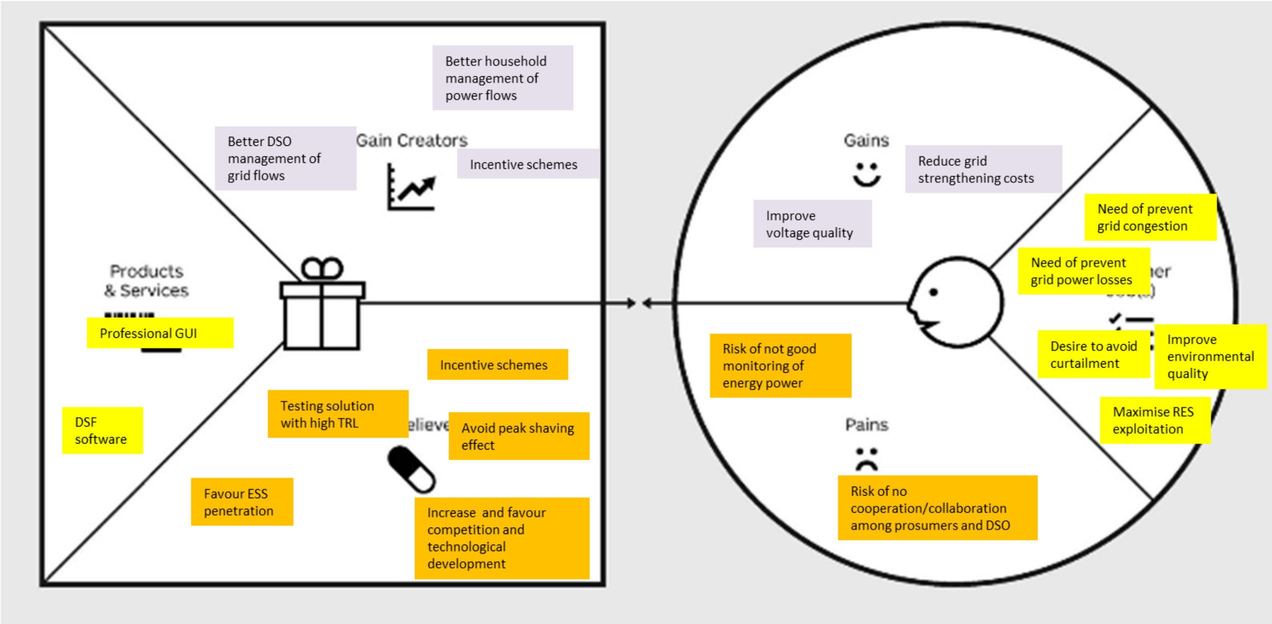

Figure 8 – HLUC3_PUC1_BM1 Value Proposition Canvas (DSO point of view)

4.1.1.2 HLUC3_PUC3_BM1: Voltage control at grid side battery

Test site location: Fur / Skive

Business case description: This business case investigates if the battery system can be placed in the LV grid and its ideal location. Due to either high local consumption or production it may be feasible to place storage at local feeder lines to overcome increasing or decreasing voltage levels and/or to control the flux, especially upwards flow in the grid. The optimal position of where to place the storage to gain the most positive effect will be addressed in this use case, taking consumption and production into account, as well as lifetime and operational cost. The owner and operator of the battery will be ENIIG (as a preliminary assumption) which allows for enhanced storage coordination all over the grid with respect to the current grid situation, generation, and consumption.

ESS Location: at grid level, owned by the DSO

Main stakeholder involved:

- DSO

Value proposition

The value proposition for the key stakeholder involved in this business case (DSO) is briefly proposed in Table 8 and detailed in Figure 9, using the Value Proposition Canvas tool.

Table 8 – HLUC3_PUC3_BM1 Value proposition for the DSO point of view in a nutshell

Why	What	How
Better management of grid congestion Possibility to avoid / defer grid strengthening Enhance storage coordination all over the grid.	Determine the optimal dimensioning of ESS at grid level	Using GESSCon and USM

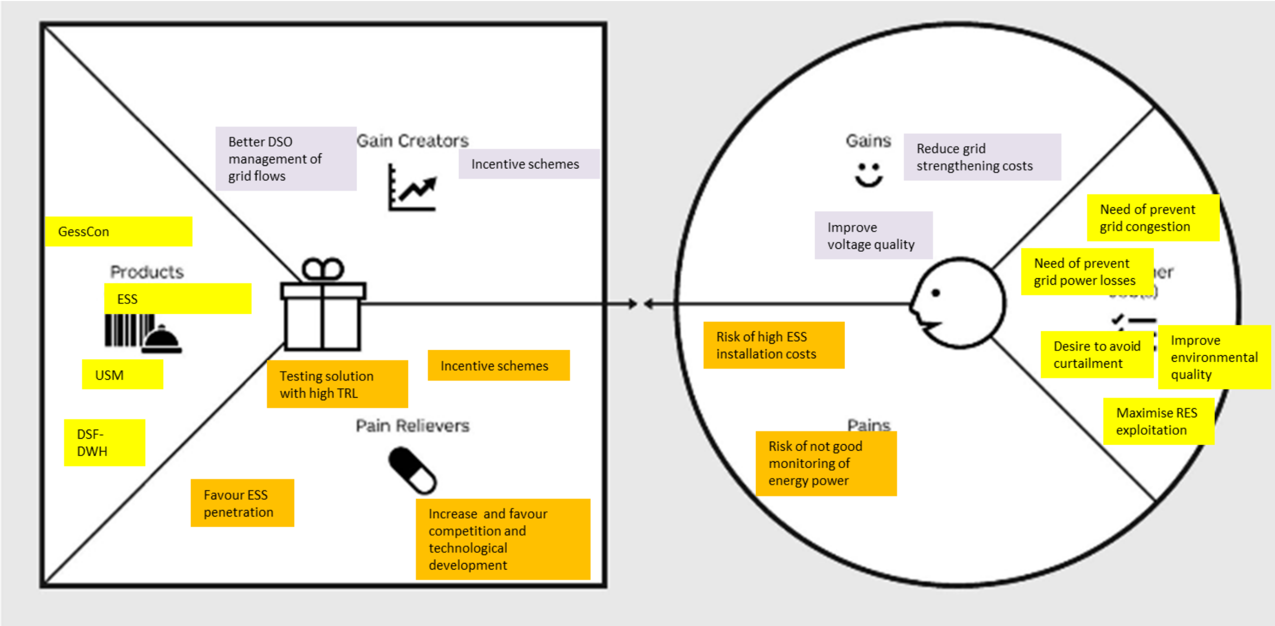

Figure 9 – HLUC3_PUC3_BM1 Value Proposition Canvas (DSO point of view)

4.1.2 Cluster: Services for the prosumer

4.1.2.1 HLUC2_PUC1_BM1: Residential prosumer with storage and EV – prosumers with ESS standalone

Test site location: Bolzano

Business case description: This business case focuses on the residential installation of individual charging systems for EVs where the prosumer has already installed also a PV system. The residential case is tested in a private house provided with a PV roof plant of 9.6 kW, and 1 plug for classical charging of the EV. During the first year of the project the house was provided by Alperia with an ESS of 12 kWh. The business case investigate if it is profitable for a residential prosumer with an EV charging station to invest money in a residential ESS.

ESS location: at prosumer level

Main stakeholder involved:

- Prosumer
- DSO (indirectly)

Value proposition

The value proposition for the key stakeholders involved in this business case is briefly proposed in Table 9 and detailed in Figure 10, using the Value Proposition Canvas tool.

Table 9 – HLUC3_PUC3_BM1 Value proposition for the prosumer and DSO point of view in a nutshell

Why	What	How
Maximisation of household energy self-consumption Achievement of savings in household electricity bill Sale of excess power to the DSO [The DSO can (indirectly): • Avoid / defer grid strengthening; • Better manage grid congestion	Optimisation of household energy production and consumption in presence of EV charging systems	Using Residential GUI and PROFFEV

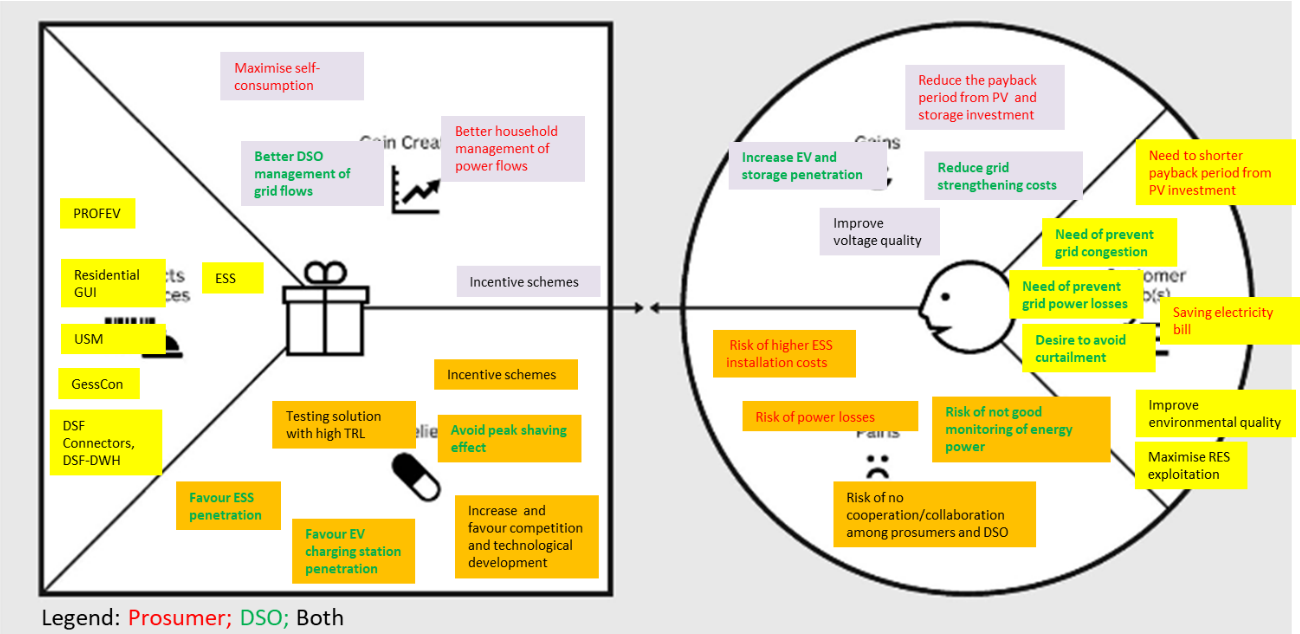

Figure 10 – HLUC2_PUC1_BM1 Value Proposition Canvas (prosumer and DSO point of view)

4.1.3 Cluster: Voltage / load flow optimisation

4.1.3.1 HLUC3_PUC4_BM2: Voltage control at both household and grid side battery

Test site location: Fur/Skive

Business case description: The case is that one feeder is filled with PV penetration, more than 60% of the houses have PV systems and that many customers experience instability electricity in their house. The installation of storage systems at different levels in the grid are considered by the DSO as a potentially interesting solution to help improving self-consumption, increase grid flexibility and deferring grid reinforcement. Such systems must be controlled externally to achieve adaptation to current grid conditions; achieving coordinated behaviour e.g. to exploit synergies arising between houses connected to the same radial and/or with storage at substation level; devising evaluation techniques to properly evaluate and dimension storage investments given specific user settings or load patterns. This business case gives information and control facilities to the house-owner about state of privately-owned battery.

The DSF-SE is used to model the situation of the grid when private storage and the storage on grid level is jointly operated and coordinated. In this situation, also ancillary services will be taken into consideration, depending on the regulatory environment.

ESS location: at prosumer level and at grid level (simulation)

Main stakeholders involved:

- Prosumer
- DSO, can control ESS voltage and load flow

Value proposition

The value proposition for the key stakeholders involved in this business case is briefly proposed in Table 10 and Table 11 and detailed in Figure 11, using the Value Proposition Canvas tool.

Table 10 – HLUC3_PUC4_BM2 Value proposition for the prosumer point of view in a nutshell

Why	What	How
Possibility to increase household energy self-consumption Possibility to obtain savings in household electricity bill Possibility to sell ancillary services to the DSO	Optimal management of household energy production and consumption (self sufficiency and resilience)	Using Residential GUI and PROFESS

Table 11 – HLUC3_PUC4_BM2 Value proposition for the DSO point of view in a nutshell

Why	What	How
Possibility to avoid / defer grid strengthening Better management of grid congestion, in case of high PV penetration (ESS at prosumer level are not enough) Benefits from ancillary services	Control voltage / load flows of ESS in the grid	Using PROFESS and USM

4.1.3.2 HLUC3_PUC2_BM1: Autonomous voltage control at household battery

Test site location: Fur/Skive

Business case description: This business case involves private households investing in residential storage to increase their self-sufficiency; local storage allows them to obtain more use of their own produced electricity from PV panels. In this case the DSO offers the prosumer to buy a battery and have automatic voltage control within defined limits controlled by the DSO. For this service, the DSO offers a limited payment to the prosumer for the ancillary services.

ESS location: at prosumer level

Main stakeholders involved:

- Prosumer
- DSO

Value proposition

The value proposition for the key stakeholders involved in this business case is briefly proposed in Table 12 and Table 13 and detailed in Figure 11, using the Value Proposition Canvas tool.

Table 12 – HLUC3_PUC2_BM1 Value proposition for the prosumer point of view in a nutshell

Why	What	How
Possibility to increase household energy self-consumption Possibility to obtain savings in household electricity bill Possibility to sell ancillary services to the DSO	Optimal management of household energy production and consumption (self sufficiency and resilience)	Using Residential GUI and PROFESS

Table 13 – HLUC3_PUC2_BM1 Value proposition for the DSO point of view in a nutshell

Why	What	How
Possibility to avoid / defer grid strengthening Better management of grid congestion Benefits from ancillary services	Control voltage / load flows of ESS in the grid	Using PROFESS and USM

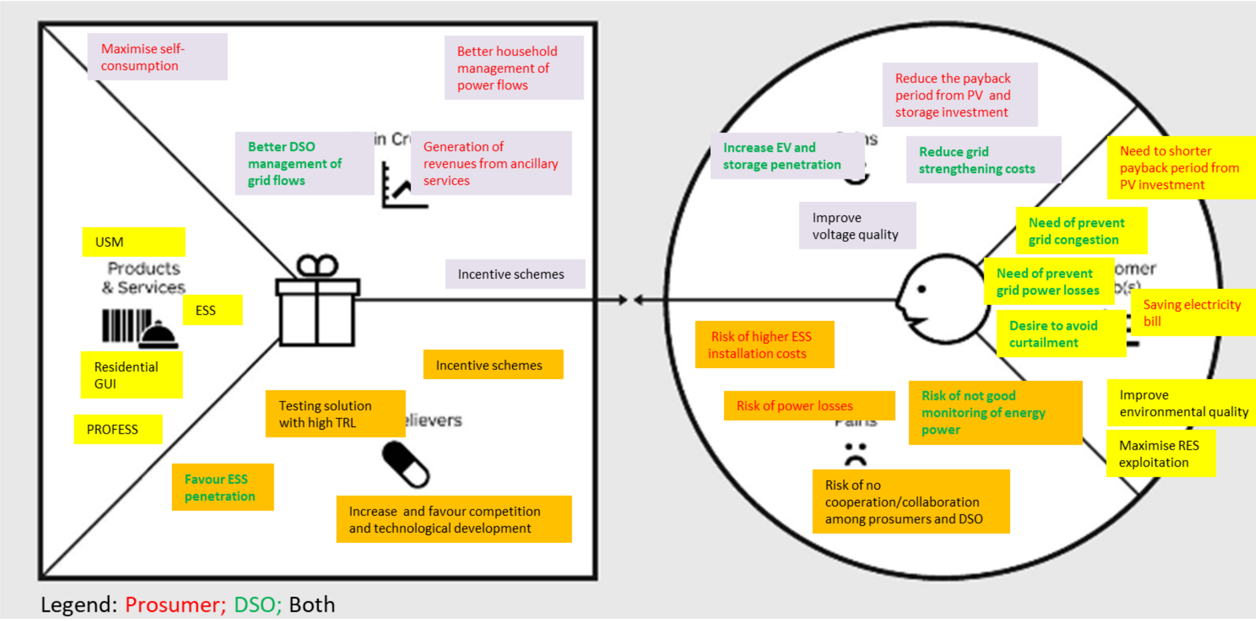

Figure 11 – HLUC3_PUC4_BM2 and HLUC3_PUC2_BM1 Value Proposition Canvas (prosumer and DSO point of view)

4.1.4 Cluster: Energy community

4.1.4.1 HLUC1_PUC3_BM1: Enabling energy services to connected neighbourhood prosumers and consumers

Test site location: Bucharest
Business case description: This business case is about testing more advanced resilient prosumers, with hybrid solution in the prosumer area, having a DC bus for all sensitive loads and with a DC exchange line with the neighbourhood. It is a cooperative resilience by design service.
Main stakeholder involved:

- Prosumer
- DSO (indirectly)

Value proposition
The value proposition for the key stakeholders involved in this business case is briefly proposed in Table 14 and detailed in Figure 12, using the Value Proposition Canvas tool.

Table 14 – HLUC1_PUC3 Value proposition for the prosumer point of view in a nutshell

Why	What	How
Possibility to increase household energy self-consumption Possibility to obtain savings in his electricity bill Possibility to sell ancillary services to the DSO Cooperation with other prosumers Possibility of being autonomous in case of outages [The DSO can (indirectly): • Avoid / defer grid strengthening • Better manage grid congestion • Benefit from ancillary services.]	Optimisation of household energy production and consumption Balancing household resources with neighbours using a local DC network	Using USM, LESSAg, ER

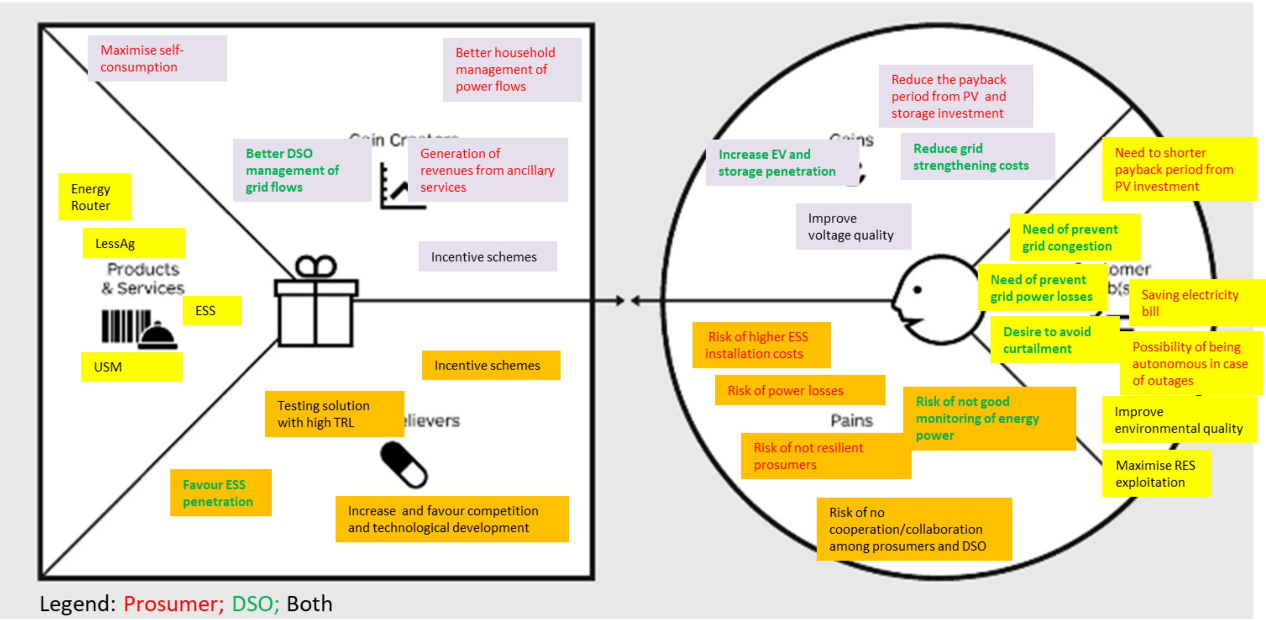

Figure 12 – HLUC1_PUC3 Value Proposition Canvas (prosumer and DSO point of view)

5 Business models underlying S4G business cases

The analysis of the business cases that has been conducted in D2.4 and refined in this deliverable through the definition of the business cases clusters allowed to discover that **business cases within the same cluster have similar business models**. Moreover, from the analysis of existing studies on business models for DER it has been possible to define six general business model archetypes for distributed energy sector (Figure 5). They can be taken in consideration by any subject interested in developing new initiatives in the sector, and, consequently, are also aligned with S4G business cases. Specifically, S4G business cases can be described by three of the six archetypes (Figure 13):
1 – ESS at prosumer level integrated in the grid,
2 – ESS at prosumer level standalone,
3 – ESS owned by the DSO.
However, even if some of the identified archetypes (namely the ones that consider ESS ownership by a third party – SaaS) are not reflected in any S4G business case, for sake of completeness, they are all described in the next part of the deliverable. As a matter of facts, although Storage as a Service has been left out from S4G business cases, we believe that it can be an alternative that prosumers and DSO could evaluate.

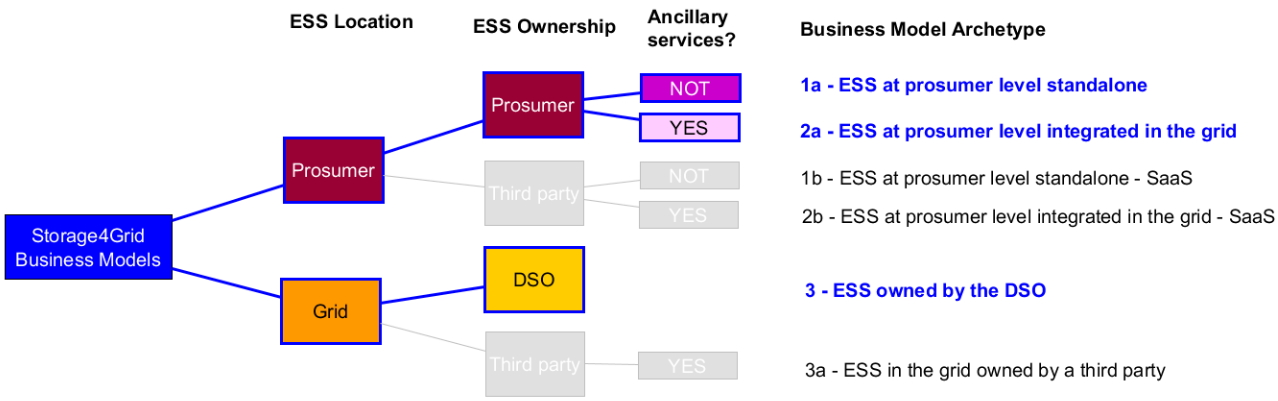

Figure 13 – Business models archetypes for S4G business cases

In the following chapters the archetypes are described. Moreover, the alignment between S4G business cases and the business model archetypes is exposed in the next sections and summarised in chapter 5.1.4.
The template of analysis of the business model archetypes considers the following points:

- Description of the archetype;
- Value network analysis (see Appendix C, for further details on this tool);
- Main revenues and costs table;
- Business model canvas[xiii] (see Appendix C for further details on this tool).

5.1.1 BM archetype 1a - ESS at prosumer level standalone

ESS location: prosumer
ESS ownership: prosumer
Possibility to sell ancillary services to the DSO: no

This business model archetype considers the presence of ESS at prosumer level, not integrated in the grid (standalone). All the cases within the cluster "Services for the prosumer" are included in this business model archetype.

Figure 14 reports the Value Network Analysis for this business model archetype, from which it is possible to highlight the different flows of cash and products / services between the main stakeholders involved (prosumers, ESS supplier and DSO).
This business model archetype assumes that the ESS is owned by the prosumer. As an alternative to this archetype the prosumer can decide to avoid to buy the ESS, using a SaaS offered by a third party (business model archetype 1b, see chapter 5.1.1.1).

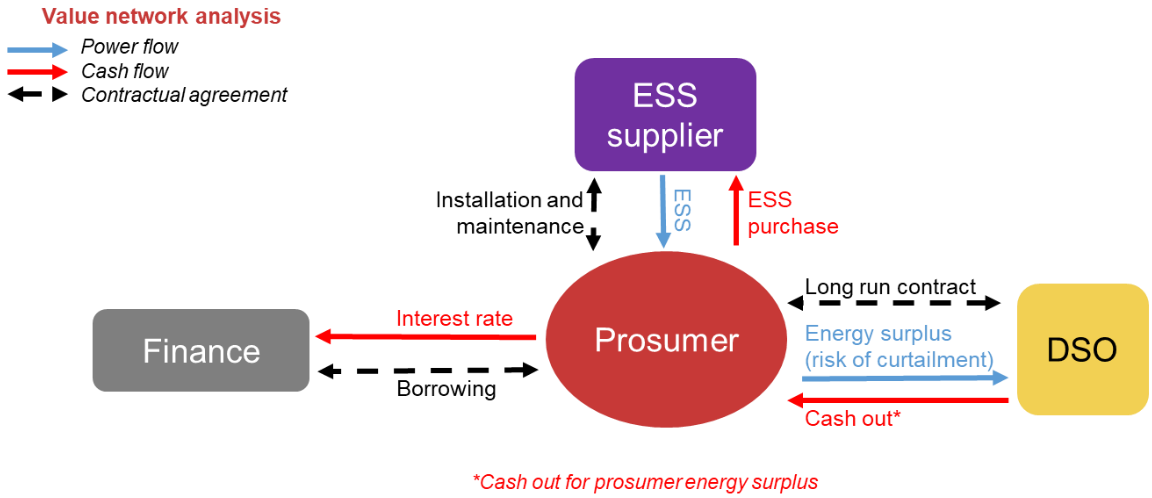

Figure 14 – Value Network Analysis for BM archetype 1a[5]

Table 15 summarises the main revenues and costs for the key stakeholders.

Table 15 – Main revenues and costs for key stakeholder involved in BM archetype 1a

Stakeholder	Revenues	Costs
ESS supplier	ESS sale (from prosumer) ESS installation + maintenance (from prosumer)	
Prosumer	Cash out for energy surplus (from DSO) Savings in the electricity bill from optimal energy consumption / production management	ESS purchase ESS maintenance
DSO	Savings from avoiding grid strengthening and reduced curtailment risk	Cash out for prosumer energy surplus (to prosumer)

An example of a business model in this vein is given by HLUC2_PUC1_BM1: Residential prosumer with storage and EV – prosumers with ESS standalone (4.1.2.1). Specifically, Table 16 reports the business model canvas (BMC) for the DSO and prosumers.

[5] Cash out for energy surplus can be managed by the TSO, like in the case of Denmark

Table 16 – The Business Model Canvas for DSO and prosumers (HLUC-2-PUC-1-BM-1)

<table>
<tr><td colspan="6"></td></tr>
<tr>
<td rowspan="2">Key Partners
• Energy Storage suppliers
• Installers
• ICT
• Storage owners
• EV charging station owner
• EV suppliers</td>
<td>Key Activities
<u>DSO</u>
• Curtailment activities
• Building and maintenance chargers
• Investigating claims from prosumers with voltage issues
• Setting set-points at local owned batteries to control charge/discharge on demand
<u>Prosumers</u>
• Household energy consumption and production management</td>
<td rowspan="2">Value Proposition
<u>Prosumers</u>
• Cost reduction and savings from grid power consumption
• Avoid the upgrade of the contractual maximum power at the POD thanks to the peak shaving effect of (Decision Support System (DSS)
• Maximise the self-consumption
<u>DSO:</u>
• Reducing grid congestion and costs
• Avoid curtailment and grid strengthening costs
• Possibility to guarantee stability in the grid</td>
<td>Customer Relationship
• Prosumers are encouraged to install ESS</td>
<td rowspan="2" colspan="2">Customer Segments
<u>For the DSO</u>
• Prosumers
• Small SME</td>
</tr>
<tr>
<td>Key Resources
• Grid-Planning people
• Grid-operation people</td>
<td>Channels
• Internal network</td>
</tr>
<tr>
<td colspan="3">Cost Structure
<u>DSO</u>
• Cash out for prosumer energy surplus (to prosumer)
<u>Prosumer</u>
• ESS operating costs
• Support</td>
<td colspan="3">Revenue Streams
<u>DSO</u>
• Postpones or avoid reinforcement
• Savings from grid strengthening
<u>Prosumer</u>
• Cash out for energy surplus (from DSO)
• Savings in the electricity bill for optimal energy self-consumption</td>
</tr>
</table>

5.1.1.1 BM archetype 1b - ESS at prosumer level standalone – SaaS

ESS location: prosumer
ESS ownership: third party
Possibility to sell ancillary services to the DSO: no

This business model archetype is an alternative to BM archetype 1.a (5.1.1), as it considers the presence of ESS at prosumer level, not integrated in the grid. However, in this case, the ownership of the ESS is transferred to a third party (ESS owner).

The prosumer can benefit from this business model as he can avoid to directly manage the battery.

Figure 15 reports the Value Network Analysis for this business model archetype, from which it is possible to highlight the different flows of cash and products / services between the main stakeholders involved (prosumers, third party (ESS owner), ESS supplier and DSO).

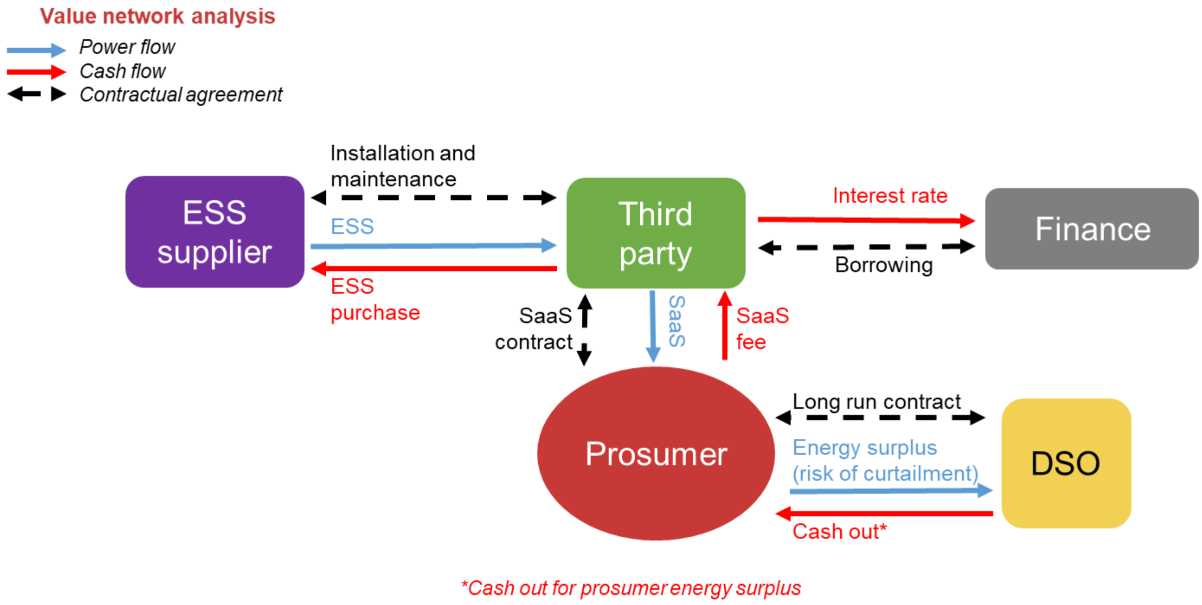

Figure 15 – Value Network Analysis for BM archetype 1b

Table 17 summarises the main revenues and costs for the key stakeholders.

Table 17 – Main revenues and costs for key stakeholder involved in BM archetype 1b

Stakeholder	Revenues	Costs
ESS supplier	ESS sale (from third party) ESS installation + maintenance (from third party)	
Prosumer	Cash out for energy surplus (from DSO)	Payment of SaaS fee (to third party)
DSO	Savings from avoiding grid strengthening and reduced curtailment risk	Cash out for prosumer energy surplus (to prosumer)
Third party	SaaS fee (from prosumer)	ESS purchase ESS maintenance

As an example, we can consider the possibility for the prosumer to use a SaaS offered by a third party (ESS owner) in the case of HLUC2_PUC1_BM1. The related business model canvas for the DSO and prosumers is proposed in Table 18. The differences with the corresponding original business model canvas (ESS owned by the prosumer) (Table 16) are highlighted in green.

Table 18 – The Business Model Canvas for DSO and prosumers, in the case of SaaS (HLUC-2-PUC-1-BM-1)

<table>
<tr><td colspan="6"></td></tr>
<tr>
<td rowspan="2">Key Partners
• Energy Storage suppliers
• Installers
• ICT
• Storage owners
• EV charging station owner
• EV suppliers
• Third party (ESS owner)</td>
<td>Key Activities
<u>DSO</u>
• Curtailment activities
• Building and maintenance chargers
• Investigating claims from prosumers with voltage issues
• Setting set-points at local owned batteries to control charge/discharge on demand
<u>Prosumers</u>
• Household energy consumption and production management</td>
<td rowspan="2" colspan="2">Value Proposition
<u>Prosumers</u>
• Cost reduction and savings from grid power consumption
• Avoid the upgrade of the contractual maximum power at the POD thanks to the peak shaving effect of (Decision Support System (DSS)
• Maximise the self-consumption
<u>DSO:</u>
• Reducing grid congestion and costs
• Avoid curtailment and grid strengthening costs
• Possibility to guarantee stability in the grid</td>
<td>Customer Relationship
• Prosumers are encouraged to install ESS</td>
<td rowspan="2">Customer Segments
<u>For the DSO</u>
• Prosumers
• Small SME</td>
</tr>
<tr>
<td>Key Resources
• Grid-Planning people
• Grid-operation people</td>
<td>Channels
• Internal network</td>
</tr>
<tr>
<td colspan="3">Cost Structure
<u>DSO</u>
• Cash out for prosumer energy surplus (to prosumer)
<u>Prosumer</u>
• Payment of SaaS fee (to third party)</td>
<td colspan="3">Revenue Streams
<u>DSO</u>
• Postpones or avoid reinforcement
• Savings from grid strengthening
<u>Prosumer</u>
• Cash out for energy surplus (from DSO)
• Savings for optimal energy self-consumption</td>
</tr>
</table>

5.1.2 BM archetype 2a - ESS at prosumer level integrated in the grid

ESS location: prosumer
ESS ownership: prosumer
Possibility to sell ancillary services to the DSO: yes

This business model archetype considers the presence of ESS at prosumer level and integrated in the grid. All the business cases encompassed within the clusters "Voltage / load flow optimisation" and "energy community" follow this archetype. All these business cases, in fact, take into account the possibility for the DSO to control the voltage or the flux levels of the batteries at prosumer level and to leverage on ancillary services offered by the prosumers.

Figure 16 reports the Value Network Analysis for this business model archetype, from which it is possible to highlight the different flows of cash and products / services between the main stakeholders involved (prosumers, ESS supplier and DSO).

This business model archetype assumes that:

- the ESS is owned by the prosumer;
- the offering of ancillary services to the DSO is directly managed by the prosumer.

As alternatives to this archetype the prosumer can decide to:

- Entrust the management of ancillary services to an external aggregator. This is a more realistic alternative: in this wat the DSO avoids to contract with single prosumers, thus obtaining economy of scale benefits (Figure 17).
- Avoid to buy the ESS, using a Storage as a Service offered by a third party (business model archetype 2b, see chapter 5.1.2.1)

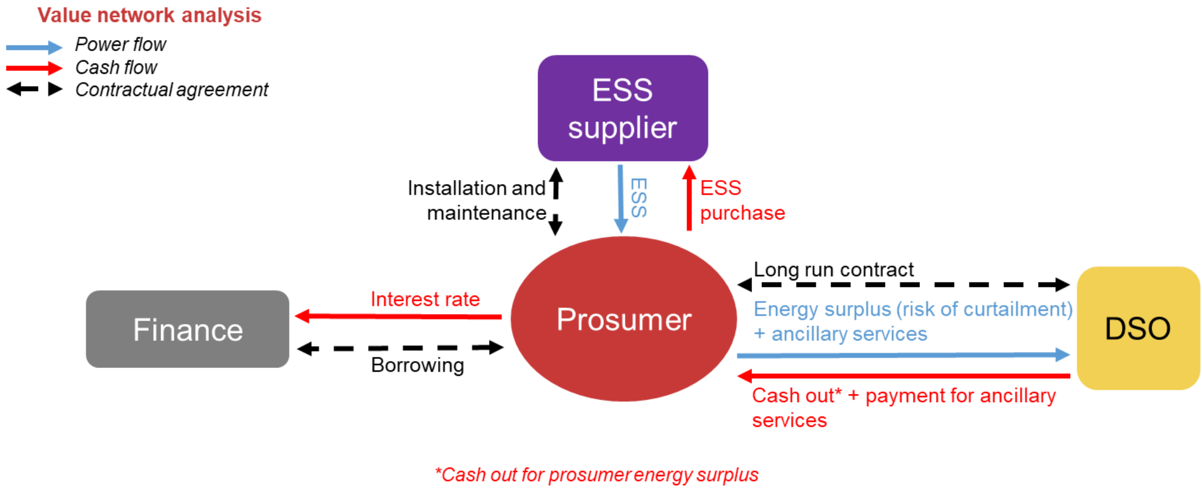

Figure 16 – Value Network Analysis for BM archetype 2a

Table 19 summarises the main revenues and costs for the key stakeholders.

Table 19 – Main revenues and costs for key stakeholder involved in BM archetype 2a

Stakeholder	Revenues	Costs
ESS supplier	ESS sale (from prosumer) ESS installation + maintenance (from prosumer)	
Prosumer	Revenues from ancillary services (from DSO) Cash out for energy surplus (from DSO)	ESS purchase ESS maintenance
DSO	Savings from avoiding grid strengthening and reduced curtailment risk	Payment for ancillary services (to prosumer) Cash out for prosumer energy surplus (to prosumer)

An example of a business model in this vein is given by HLUC3_PUC2_BM1: Autonomous voltage control at household battery (4.1.3.2). Specifically Table 20 reports the business model canvas (BMC) for the DSO and the prosumers.

Table 20 – The Business Model Canvas for DSO and prosumer - HLUC3_PUC2_BM1: Autonomous voltage control at household battery

<table>
<tr><td colspan="5"></td></tr>
<tr>
<td rowspan="2">Key Partners
• Energy Storage Suppliers
• Installers
• ICT</td>
<td>Key Activities
<u>DSO</u>
• Investigating claims from prosumers (or other customers with voltage issues)
• Setting set-points at local owned batteries
• Planning grid optimisation from a technical and economic point of view
<u>Prosumer</u>
• Household energy production / consumption management
• Sale of ancillary services and energy surplus to the DSO</td>
<td rowspan="2">Value Proposition
<u>DSO</u>
Stable grid at lowest cost using private storage to manage demands in voltage without reinforcing the grid
<u>Prosumer</u>
Possibility to increase household energy self-consumption
Possibility to make business by selling ancillary services to the DSO</td>
<td>Customer Relationship
• Customers are encouraged to become “partners”, cooperative prosumers
• Long term contractual agreement with ESS producers</td>
<td rowspan="2">Customer Segments
<u>For the DSO</u>
• Prosumers or small SME
<u>For the prosumer</u>
• DSO</td>
</tr>
<tr>
<td>Key Resources
• Grid-Planning people
• Grid-operation people</td>
<td>Channels
• Contractual power agreements</td>
</tr>
<tr>
<td colspan="3">Cost Structure
<u>DSO</u>
• Payment for ancillary services (to prosumer)
• Cash out for prosumer energy surplus (to prosumer)
<u>Prosumer</u>
• ESS operating costs
• Support</td>
<td colspan="2">Revenue Streams
<u>DSO</u>
• Postponed reinforcement costs (savings)
<u>Prosumer</u>
• Revenues from ancillary services (from DSO)
• Cash out for energy surplus (from DSO)</td>
</tr>
</table>

A (more realistic) alternative to this business model archetype consists in the possibility for the prosumer to ask to an external aggregator to manage the offering of ancillary services to the DSO. In this way the DSO can avoid to interact with all the single prosumers (thus, obtaining economy of scale benefits from the aggregated ancillary services management) and on their side, single prosumers benefit from a more agile management of the ancillary services guaranteed by the aggregator.

Aggregators make contracts with private house owners about ancillary services and bundle a community (eg. a feeder-line or transformer station), to make the business case sustainable. The aggregator can offer ancillary services to the local DSO with a bigger volume and the aggregator collect all the details and take care of local control. The regulation today highlights also the position of the aggregator that permits to favour the demand and supply market clearing. The aggregator makes contract with end-users to participate to the electric market on behalf of single operators and can manage the generation in order to satisfy the contractual commitments. Figure 17 reports the Value Network Analysis for this case, from which it is possible to highlight the different flows of cash and products / services between the main stakeholders involved (prosumers, ESS supplier, DSO, and the external aggregator).

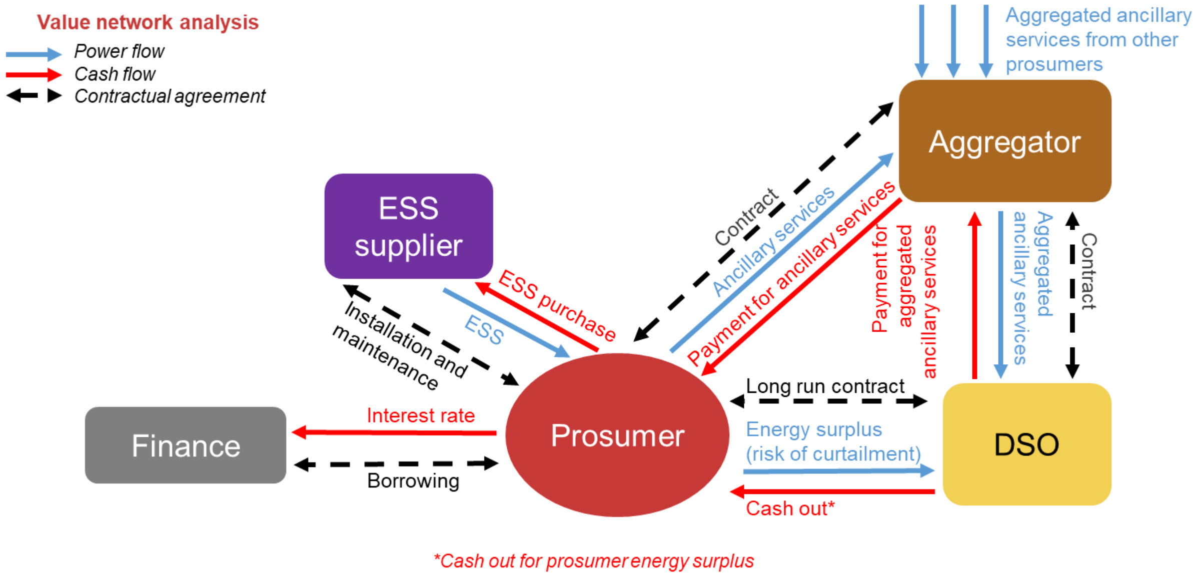

Figure 17 – Value Network Analysis for BM archetype 2a, in presence of aggregators

Table 21 summarises the main revenues and costs for the key stakeholders.

Table 21 – Main revenues and costs for key stakeholder involved in BM archetype 2a, in presence of aggregators

Stakeholder	Revenues	Costs
ESS supplier	ESS sale (from prosumer) ESS installation + maintenance (from prosumer)	
Prosumer	Payment for ancillary services (from aggregator). Cash out for energy surplus (from DSO).	ESS purchase ESS maintenance
DSO	Savings from avoiding grid strengthening and reduced curtailment risk. Economy of scale obtained from aggregated ancillary services management.	Payment for aggregated ancillary services (to aggregator) Cash out for prosumer energy surplus (to prosumer)
Aggregator	Revenues from aggregated ancillary services (from DSO)	Payment for ancillary services (to prosumers)

For instance, we can envisage the presence of aggregators for the management of ancillary services for HLUC3_PUC2_BM1. In this case the business model canvas for the DSO and prosumers is proposed in Table 22. The differences with the corresponding business model canvas without aggregators (Table 20) are highlighted in green.

Table 22 – The Business Model Canvas for DSO and prosumers (in case of aggregators) - HLUC3_PUC2_BM1: Autonomous voltage control at household battery

Key Partners	Key Activities	Value Proposition	Customer Relationship	Customer Segments
• Energy Storage Suppliers • Installers • ICT • **Aggregators**	DSO • Investigating claims from prosumers (or other customers with voltage issues) • Setting set-points at local owned batteries • Planning grid optimisation from a technical and economic point of view Prosumer • Household energy production / consumption management • Sale of ancillary services to the **aggregator** • **Sale of excess energy to the DSO.** **Key Resources** • Grid-Planning people • Grid-operation people	DSO Stable grid at lowest cost using private storage to manage demands in voltage without reinforcing the grid Prosumer Possibility to increase household energy self-consumption Possibility to make business by selling ancillary services to the DSO, **through the aggregator**	• Customers are encouraged to become "partners", cooperative prosumers • Long term contractual agreement with ESS producers **Channels** • Contractual power agreements	For the DSO • Prosumers or small SME For the prosumer • **Aggregator**

Cost Structure	Revenue Streams
DSO • Payment for **aggregated** ancillary services **(to aggregator)** • Cash out for prosumer energy surplus Prosumer • ESS operating costs • Support	DSO • Postponed reinforcement costs (savings) • **Economy of scale obtained from aggregated ancillary services management.** Prosumer • Revenues from ancillary services **(from aggregator)** • Cash out for energy surplus

5.1.2.1 BM archetype 2b - ESS at prosumer level integrated in the grid – SaaS

ESS location: prosumer
ESS ownership: third party
Possibility to sell ancillary services to the DSO: yes

This business model archetype is an alternative to BM archetype 2a (5.1.2), as it considers the presence of ESS at prosumer level and integrated in the grid. However, the ownership of the ESS is transferred to a third party (ESS owner). Third parties could be energy service providers, aggregators, or, (in the cases where it is possible) DSO[6].

The prosumer can benefit from this business model as he can avoid to directly manage the battery himself. In this case ancillary services can be offered by the third party[7] to the DSO through external aggregators.

Figure 18 reports the Value Network Analysis for this business model archetype, from which it is possible to highlight the different flows of cash and products / services between the main stakeholders involved (prosumers, third party (ESS owner), ESS supplier, aggregator and DSO).

[6] DSO can own / operate ESS under the conditions defined by the regulation framework (DIRECTIVE (EU) 2019/944 - REGULATION (EU) 2019/943).

[7] Examples of services to be provided by SaaS: https://en.wikipedia.org/wiki/Energy_storage_as_a_service

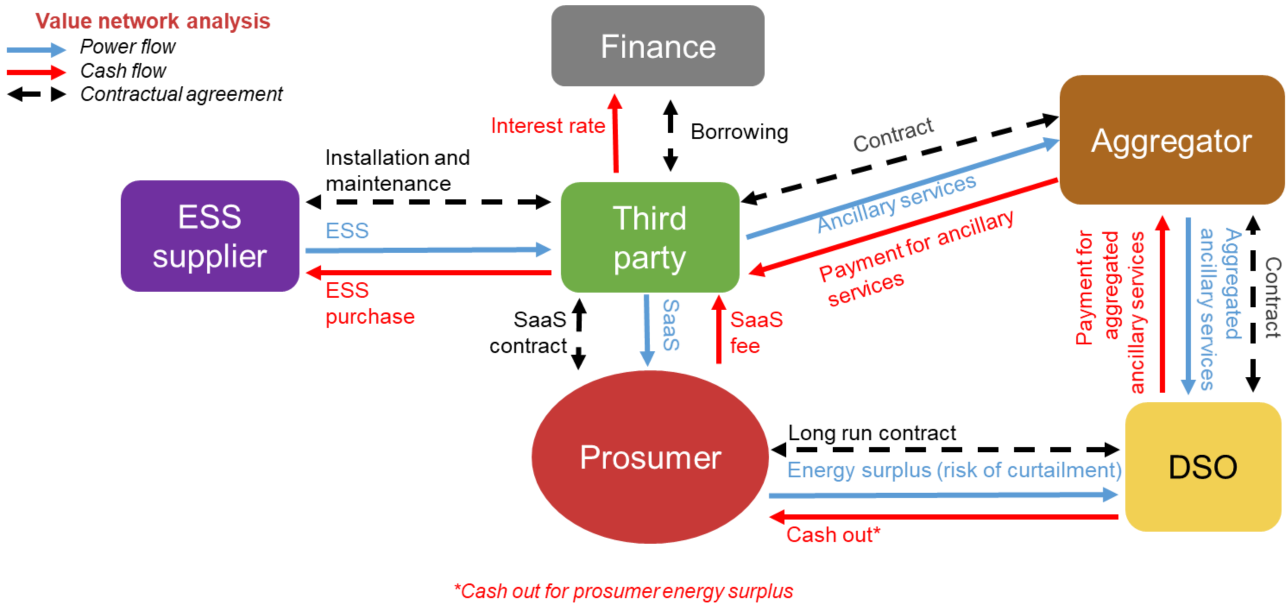

Figure 18 – Value Network Analysis for BM archetype 2b

Table 23 summarises the main revenues and costs for the key stakeholders.

Table 23 – Main revenues and costs for key stakeholder involved in BM archetype 2b

Stakeholder	Revenues	Costs
ESS supplier	ESS sale (from third party) ESS installation + maintenance (from third party)	
Prosumer	Cash out for energy surplus (from DSO)	Payment of SaaS fee (to third party)
DSO	Savings from avoiding grid strengthening and reduced curtailment risk Economy of scale obtained from aggregated ancillary services management.	Cash out for prosumer energy surplus (to prosumer) Payment for aggregated ancillary services (to aggregator)
Third party (ESS owner)	SaaS fee (from prosumer) Revenues from ancillary services (from aggregator)	ESS purchase ESS maintenance
Aggregator	Revenues from aggregated ancillary services (from DSO)	Payment for ancillary services (to third party)

As an example, we can consider the possibility for the prosumer to use a SaaS service offered by a third party (ESS owner) in the case of HLUC3_PUC2_BM1. The related business model canvas for the DSO and prosumers is proposed in Table 24. The differences with the corresponding original business model canvas (ESS owned by the prosumer) (Table 20) are highlighted in green.

Table 24 – The Business Model Canvas for DSO and prosumer (case of SaaS offered by a third party – ESS owner) - HLUC3_PUC2_BM1: Autonomous voltage control at household battery

<table>
<tr><td colspan="6"></td></tr>
<tr>
<td rowspan="2">Key Partners
• Energy Storage Suppliers
• Installers
• ICT
• Third party (ESS owner)</td>
<td>Key Activities
<u>DSO</u>
• Investigating claims from prosumers (or other customers with voltage issues)
• Setting set-points at local owned batteries
• Planning grid optimisation from a technical and economic point of view
<u>Prosumer</u>
• Household energy production / consumption management
• Sale of ancillary services to the DSO</td>
<td rowspan="2" colspan="2">Value Proposition
<u>DSO</u>
Stable grid at lowest cost using private storage to manage demands in voltage without reinforcing the grid

<u>Prosumer</u>
Possibility to increase household energy self-consumption
Possibility to make business by selling ancillary services to the DSO</td>
<td>Customer Relationship
• Customers are encouraged to become "partners", cooperative prosumers
• Long term contractual agreement with ESS producers</td>
<td rowspan="2">Customer Segments
<u>For the DSO</u>
• Prosumers or small SME
<u>For the prosumer</u>
• DSO</td>
</tr>
<tr>
<td>Key Resources
• Grid-Planning people
• Grid-operation people</td>
<td>Channels
• Contractual power agreements</td>
</tr>
<tr>
<td colspan="3">Cost Structure
<u>DSO</u>
• Payment for aggregated ancillary services (to aggregator)
• Cash out for prosumer energy surplus (to prosumer)
<u>Prosumer</u>
• Payment of SaaS fee (to third party)</td>
<td colspan="3">Revenue Streams
<u>DSO</u>
• Postponed reinforcement costs (savings)
• Economy of scale obtained from aggregated ancillary services management.
<u>Prosumer</u>
• Cash out for energy surplus (from DSO)</td>
</tr>
</table>

5.1.3 BM archetype 3a - ESS owned by the DSO

ESS location: grid level
ESS ownership: DSO

This business model archetype considers the possibility for the DSO to own and manage ESS placed at different levels in the grid in order to balance the local grid.

The relevance of this business model archetype is justified by the recent debate at national and international level about the possibility for the DSO to own and manage storage systems. This issue has been discussed during the SHAR-Q and S4G joint final event on 24th October 2019 with a member of the European Commission that explained the most recent updates of the EU normative in this regard (see Appendix A for further details). In brief, **DSO can own / operate ESS under the conditions defined by the regulation framework (DIRECTIVE (EU) 2019/944 and REGULATION (EU) 2019/943).**

Figure 19 reports the Value Network Analysis for this business model archetype, from which it is possible to highlight the different flows of cash and products / services between the main stakeholders involved (prosumers, ESS supplier and DSO). The purchase and maintenance costs of the ESS are guaranteed by the DSO. As an alternative to this archetype the DSO can decide to avoid to buy the ESS, using a SaaS offered by a third party (business model archetype 3b, see chapter 5.1.3.1).

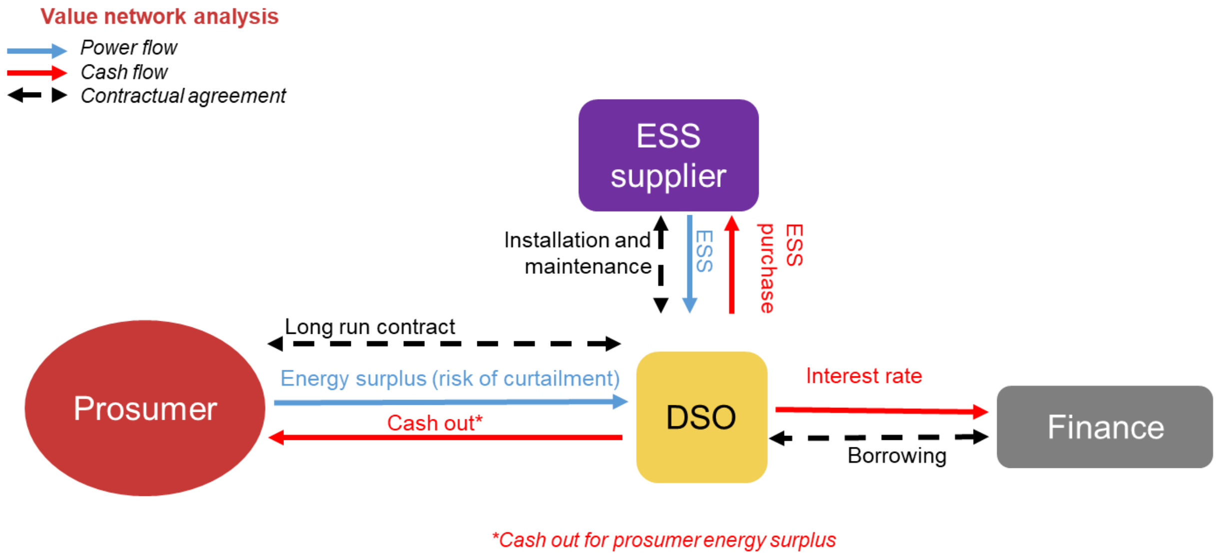

Figure 19 – Value Network Analysis for BM archetype 3a

Table 25 summarises the main revenues and costs for the key stakeholders.

Table 25 – Main revenues and costs for key stakeholder involved in BM archetype 3a

Stakeholder	Revenues	Costs
ESS supplier	ESS sale (from DSO) ESS installation + maintenance (from DSO)	
Prosumer	Cash out for energy surplus (from DSO)	
DSO	Savings from avoiding grid strengthening and reduced curtailment risk	Cash out for prosumer energy surplus (to prosumer) ESS purchase ESS maintenance

The unique case envisaged by S4G that considers the possibility for the DSO to own a storage system (located at grid level) is HLUC3_PUC3_BM1: Voltage control at grid side battery. The related business model canvas for the DSO is proposed in Table 26.

Table 26 – The Business Model Canvas for DSO (HLUC-3-PUC-3-BM-1)

<table>
<tr><td colspan="5"></td></tr>
<tr>
<td rowspan="2">Key Partners
• Energy Storage suppliers
• Installers
• ICT providers</td>
<td>Key Activities
• Curtailment activities
• Determine ESS dimensioning
• Investigating claims from prosumers</td>
<td rowspan="2">Value Proposition
• Determine the optimal dimensioning of ESS at grid level
• Enhance storage coordination all over the grid.
• Reducing grid congestion and costs and avoid curtailment and grid strengthening costs
• Possibility to guarantee stability in the grid</td>
<td>Customer Relationship
• Prosumers are encouraged to use ESS at grid level</td>
<td rowspan="2">Customer Segments
• Prosumers
• Small SME</td>
</tr>
<tr>
<td>Key Resources
• Grid-Planning people
• Grid-operation people</td>
<td>Channels
• Internal network</td>
</tr>
<tr>
<td colspan="2">Cost Structure
• ESS purchase
• ESS maintenance</td>
<td colspan="3">Revenue Streams
• Postpones or avoid reinforcement
• Savings from grid strengthening
• SaaS fee from prosumers</td>
</tr>
</table>

5.1.3.1 BM archetype 3b - ESS in the grid owned by a third party

ESS location: grid level **ESS ownership:** third party **Possibility to sell ancillary services to the DSO:** yes

The last business model archetype is an alternative to BM archetype 3a and considers the presence of ESS at grid level, owned by a third party (ESS owner). In that way the DSO can avoid to directly manage the battery. Moreover the third party can make business by offering ancillary services to the DSO.

Figure 20 reports the Value Network Analysis for this business model archetype, from which it is possible to highlight the different flows of cash and products / services between the main stakeholders involved (prosumers, third party (ESS owner), ESS supplier and DSO).

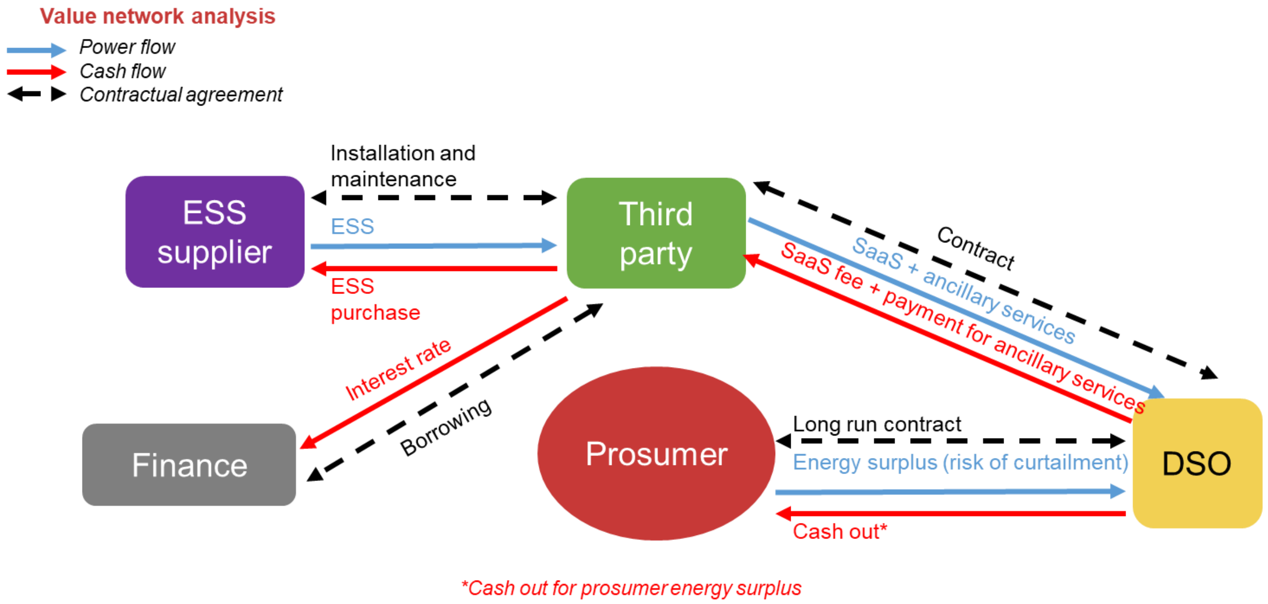

Figure 20 – Value Network Analysis for BM archetype 3b

Table 27 summarises the main revenues and costs for the key stakeholders.

Table 27 – Main revenues and costs for key stakeholder involved in BM archetype 3b

Stakeholder	Revenues	Costs
ESS supplier	ESS sale (from third party) ESS installation + maintenance (from third party)	
Prosumer	Cash out for energy surplus (from DSO)	
DSO	Savings from avoiding grid strengthening and reduced curtailment risk	Cash out for prosumer energy surplus (to prosumer) Payment of SaaS fee (to third party) Payment for ancillary services (to the third party)
Third party (ESS owner)	SaaS fee (from DSO) Revenues from ancillary services (form DSO)	ESS purchase ESS maintenance

5.1.4 Business models underlying S4G exemplary business cases - summary

As anticipated, the definition of the business cases clusters allowed to discover that **business cases within the same cluster have similar business models**, in terms of stakeholders involved, value propositions and types of costs and revenue streams.
Coming to the exemplary business cases selected, the analysis showed that:

- For the business cases that consider the presence of ESS at prosumer level, BM archetypes 1 and 2 can be appropriate, with a distinction:
    - The BCs within the cluster "services for the prosumer" focus exclusively on the end-user self-sustainability, and do not consider an integration in the grid (no ancillary services). As a consequence the most appropriate BM archetype for these business cases is 1a;
    - The BCs within the clusters "energy community" and "voltage load flow optimisation" envisage the possibility to offer ancillary services to the DSO. In this cases, the most adequate BM archetype is 2a.
- BM archetype 3a, is suitable for the unique case that considers the ESS ownership by the DSO (HLUC3_PUC3_BM1).
- HLUC3_PUC1_BM1 and HLUC3_PUC4_BM2 are simulation tools that offer to the grid planning manager the possibility to evaluate different grid configurations. In these two situations, the grid planning manager is able to determine an optimal grid configuration and, afterwards, can consider the most appropriate business model archetype accordingly with the grid configuration designed.

The alignment between the business cases within each BC cluster and the business model archetypes is reported in Table 28.

Table 28 – Business model archetypes underlying S4G Business cases clusters

Cluster	ESS location category	Ancillary services	Exemplary business case	BM archetype	Notes
ESS positioning and dimensioning	Prosumer and / or grid	Not relevant	HLUC3_PUC1_BM1	Any[8]	Simulation[9]
	Grid level	/	HLUC3_PUC3_BM1	3a	ESS owned by DSO
Services for the prosumer	Prosumer	No	HLUC2_PUC1_BM1	1a	Or 1b if ESS is owned by third party
Voltage / load flow optimisation	Prosumer and grid	Yes	HLUC3_PUC4_BM2	2a, 3a	Simulation[9]
	Prosumer	Yes	HLUC3_PUC2_BM1	2a	Or 2b if ESS is owned by third party
Energy community	Prosumer	Yes	HLUC1_PUC3	2a	Or 2b if ESS is owned by third party

[8] This BC allows the DSO to understand where to place ESS in the grid. Depending on the optimal solution any business model archetype can be taken in consideration

[9] Simulation that consider different grid configurations. Different options of ESS ownership and ESS location can be evaluated afterwards

6 Conclusions

This deliverable integrates the results presented in D2.4 and proposes an overview and analysis of selected business cases, namely "exemplary business cases".

Firstly, literature review on business models for the energy sector, with a particular focus on the integration of RES and ESS has been carried out. As a result of this initial phase the key elements that characterise business models for distributed energy resources and a set of business models archetypes have been identified (Table 3 and Figure 5). The business models archetypes have been modelled according to three variables: ESS location (at prosumer; at grid level; both at prosumer and grid level), ESS ownership (prosumer; third party; DSO) and involvement of the prosumer in the market (possibility to sell ancillary services to the DSO?).

Then, the analysis has focused on S4G business cases: first of all, S4G business cases have been grouped in four clusters in order to provide a synthetic overview of the business cases adopting a cross-test-site point of view and considering their scopes. The four resulting clusters have been defined as follows:

a. ESS positioning and dimensioning;
b. Services for the prosumer;
c. Voltage / load flow optimisation;
d. Energy community.

They represent the four main objectives of S4G business cases and exemplify the economic vision of the project. Successively, for each cluster the most relevant business cases have been selected and analysed. This analysis allowed to discover that business cases within each cluster have similar business models. Moreover the analysis showed that S4G business cases can be described by three of the six archetypes defined from literature review: 1) ESS at prosumer level standalone, 2) ESS at prosumer level integrated in the grid, 3) ESS owned by the DSO (Figure 13).

Thus, it has been possible to describe each business model archetype (value network analysis + business model canvas) making reference to the exemplary business cases identified. Furthermore, the alignment between S4G business cases and BM archetypes has been verified (Table 28).

Finally, it has to be noted that the framework of analysis that has been used for the definition of the business models archetypes and their alignment with S4G business cases is coherent with literature review outcomes and can be taken in consideration not only for the scopes of the S4G project but also by other similar initiatives that are evaluating to develop new business cases in the energy sector.

The analysis of the S4G exemplary business cases is integrated with the insights coming from the workshop with the S4G External Stakeholder Group (Appendix A), that focused on two main aspects:

a. business models for exploitation (emerging business models, role of the technologies and gaps/barriers for the development of successful business models in the smart grid domain);
b. update on the normative framework at EU level.

Appendix A

Insights from the workshop with External Stakeholder Group on 24th October 2019

A1. Background and goals of the meeting

On 24th October 2019 the SHAR-Q and S4G joint final event took place in Brussels. This event was the occasion for the two Consortiums to share the main results and achievements of the projects and discuss about relevant issues regarding the smart grid domain, especially the role of associations to boost cooperation in the energy grids (during the first panel session) and business models for exploitation (during the second panel session). The agenda of the event is displayed in Figure 21.

During the event the second panel session ("business models for exploitation") was led by S4G and involved three experts, coming from "Low TRL Smart Grid & Storage Projects Clustering Initiative" and a representative of the industry part of the ESG of the project. More details on the insights gained during the discussion are provided below (see A.1.1.).

Moreover, the initial keynote speech with Kostantinos Stamatis (DG – ENER, European Commission) gave the possibility to all the participants to the event to be updated on the European normative under the CEP (Clean Energy Package). More details in this regard are provided in the last chapter of this Appendix (see A.1.2.).

13:00 - 13:30	**Registration and welcome lunch**	
13:30 - 13:40	**Welcome and introduction**	**SHAR-Q & Storage4Grid Dissemination Managers**
13:40 - 14:00	**Keynote speech**	**Mr. Konstantinos Stamatis, DG ENER; European Commission**
SHAR-Q project: results & impact		
14:00	General overview and technical achievements	Evangelos Karfopoulos, ICCS; SHAR-Q Technical Coordinator
14:05	SHAR-Q platform	Viktor Oravec, BAVENIR; SHAR-Q Platform Architect
14:10	Güssing pilot (Austria)	Joachim Hacker, EEE; Austrian Pilot Coordinator
14:20	Meltemi pilot (Greece)	Evangelos Karfopoulos, ICCS; Greek Pilot Coordinator
14:30	Alcoutim pilot (Portugal)	Natalie Samovich, ENERCOUTIM; Portuguese Pilot Coordinator
Storage4Grid: innovation, tangible outcomes and business models		
14:40	General overview	Maurizio Spirito, LINKS Foundation; Storage4Grid Project Manager
14:50	S4G Test sites - Expected results - Technical achievements - Business models	- Vasco Delgado Gomes, UNINOVA; Storage4Grid Innovation Manager - Mihai Sanduleac, UPB; Storage4Grid Technical Manager - Elisa Pautasso, LINKS Foundation; Storage4Grid Exploitation and Policy Support Task Leader
15:20 - 15:40	**Coffee-break**	
Panel discussion with associations (Moderator: Andrea Rossi, ATOS; SHAR-Q Coordinator)		
15:40 - 16:30	The role of associations to boost technical, technological and social cooperation towards the energy grids of the future	-Mr. Roland Tual, Project Manager, REScoop.EU -Mr. Juergen Strum, Chairman of the Management Board, AIOTI.eu -Mr. Patrick Clerens, Secretary General, EASE -Mr. Arne Berre, Chief Scientist, SINTEF Digital (on behalf of BDVA)
Panel discussion with Low TRL cluster projects and representatives from the industry (Moderator: Elisa Pautasso, LINKS Foundation; Storage4Grid)		
16:30 - 17:20	Business models for Exploitation	-Ms. Vasiliki Katsiki, HYPERTECH (on behalf of PLANET project) -Mr. Jan Segerstam, EMPOWER (on behalf of DOMINOES project) -Mr. Michele Santovito, External Stakeholder Group Storage4Grid member
17:20 - 17:30	**Final remarks**	**SHAR-Q & Storage4Grid Project Coordinators**
17:30	**End of session**	

Figure 21 - SHAR-Q and S4G joint final event (24/10/2019) agenda

A1.1. Minutes of the panel session "Business Models for exploitation"

Figure 22 – "Business Models for Exploitation" panel session

Panellists

1) Michele Santovito

<u>EXPERIENCE</u>

Assoege (www.assoege.it), Italian Association of Certified Energy Manager - President
i-TES srl (www.i-tes.eu), Start Up for Latent Thermal Storage (PCM) – Founder & CEO
Certified Energy Manager Expert (EGE), CMVP
Master Degree in Chemistry, after 10 years of experience in semiconductor's industry as Facility Engineer Manager in 2009 became an independent consultant in the industrial chemistry and energy efficiency service areas. Certified as Energy Manager Expert and CMVP (International Protocol Measure & Verification), he works both directly to final customer, private and public, or supporting ESCOs.
In 2016 he founded i-TES, innovative start-up that operates in the thermal energy storage field with a specific attention to the Phase Change Materials (PCM) and their use in heat battery and thermal management devices. He is President of ASSOEGE, Italian association of Certified Energy Manager Experts, Member of the Board Council for Physics and Chemistry in Piedmont, Professor (external) at Industrial Chemistry Department of Turin's University.

2) Vasiliki Katsiki

<u>EXPERIENCE</u>

Hypertech Energy Labs (http://www.ht-energylabs.com/)
Electrical & Computer Engineer
Project Manager in research projects:
PLANET H2020: Planning and operational tools for optimising energy flows and synergies between energy networks (technical coordination)
MERLON H2020: Integrated Modular Energy Systems and Local Flexibility Trading for Neural Energy Islands (project coordination)
Professional background in energy storage technologies, uninterruptible power supply and renewable energy projects.

3) **Jan Segerstam**

<u>EXPERIENCE</u>
Jan Segerstam, Development Director
Empower IM Oy, www.empower.eu
Coordinator of the European DOMINOES project for market driven grids
Energy market process related service provider for over 100 utilities and industrial customers in the Nordic region, collaborative development within several European projects, such as INTERRFACE, SENSIBLE, SEAS, M2MGrids and more.
Jan Segerstam is the Development Director of the Finnish Energy Information Management Company Empower IM, which specialises in Services and Digital Platforms for energy-driven businesses in the Nordic countries and beyond.
Through multiple European projects and collaboration across the board with partners across the energy value chain in Europe, Jan Segerstam continues to look beyond the status quo while embracing emerging technologies in implementing solutions for today's markets in Europe.
Current projects include DOMINOES, INTERRFACE, National Smart grid demonstrator Smart Otaniemi among others in addition to advisory work
Past work includes development work for multiple regional utilities, ICT development and market design work as a Finnish representative in Eurelectric retail markets work, collaborative development within the Nordic energy markets and advisory work for industrial projects and regulatory work in market design

Discussion

Question 1*: According to your experience in which areas within the smart grid domain new business opportunities can be exploited?*
In the first part of the panel session panellists were asked to indicate in which areas within the smart grid domain new business opportunities can be exploited.
In this regard, the discussion focused on the following main points:

1. **Opportunities leveraged by smart grid domain:**

- Smart Grids are one of the best opportunity to put together several technologies, energy production and uses, new types of energy service providers;
- Despite the big opportunities leveraged by Smart Grids there are mainly small scale applications;
- Smart Grid is going to become more and more important in the next future and the EU commitment in this field demonstrate this;
- The challenge, not easy, is to lead the introduction of Smart Grid in every aspect of our life;
- There is a need to combine all the available resources in order to take advantage of the opportunities that they offer.

2. **Systemic view of the energy sector:**

- It is important to consider the energy sector in a systemic way;
    - Need to consider the energy sector as a whole, not segmented;
    - Systemic effects, not limited to the generation-consumption pair;
    - All market players must be considered and need to interact.

3. **Role of technology / sustainability:**

- Role of the technologies: business opportunities emerge through enabling technologies that give the chance to take the form of multi stream income models;
- It is important to take into account the sustainability of the energy resources that are offered to the sector actors.

4. **Emerging business models and markets:**

- Aggregation is a possible business model, but not the unique;
- Another relevant business model is service provisioning;
- Local markets play an important role.

Question 2: *Looking at the future, in your opinion which are the most promising technologies that could enable sustainable and successful business models in the smart grid domain?*
In the second part of the panel session the experts explained their point of view regarding the role of the technologies in enabling new business models in the Smart Grid domain. The main insights stemming from the discussion can be recapped as follows:

1. Technology is not the issue: **technologies** are present but **need to be used in the right way:**
- We can have the technologies but we have to be able to use them in the right way;
- If technologies are not used in the right way the benefits that they produce are reduced;
- It is important to understand which technologies are valuable and for what;
2. **Need of coordination and integration** between technologies, resources and information;
3. Technologies that connect the producer to the user (or prosumer) are:
- **functioning logic** (algorithm, data analysis, input & output management);
- **infrastructure** (cable, device, IoT, server room);
- **equipment connected to the grid,** including energy technologies (among which: batteries);
4. New opportunities come from next expected growth of **electric vehicles** with their charging station;
5. **High capital investments** are needed for some technologies (example: power to x technologies);

Question 3: *From your experience, which are the main lessons learnt studying / analysing business models in the smart grids domain? Which are the main gaps to be filled in terms of technologies and policies / regulations at national and European level?*
In the last part of the discussion experts were asked to specify which are the main lessons learnt from their experiences and to highlight the main gaps to be filled in the smart grid domain. The main topics that were dealt during the talk were the following:

1. **Need to know how to use the technologies:**
- It is important to know how to use the technologies, otherwise the investment is vain;
- Users need to be guided and helped in using the technologies (they are not ready; low level of competences);
- There is a gap in the technological competences between users and suppliers that need to be covered.
2. **High capital investments are needed;**
3. **Need to know how to manage complexity:**
- There is a high need to understand how to manage the complexity. There are many standards that need to be harmonised through an extensive work that needs to be done;
- Different legislation, different constraints on technologies between the countries;
4. **Market design gaps:**
- Need to provide incentives;
- Need to have "market makers";
- Need to establish a market design that enable interactions between different actors.

To sum up the main outcomes and related takeaways for the S4G project stemming from the workshop can be resumed in the following elements (Table 29).

Table 29 – Main outcomes and related takeaways for the S4G project from the ESG workshop

Workshop outcome	Takeaway for S4G
There are many opportunities leveraged by smart grid domain. • High EU commitment on this topic; • Need to understand how to take advantage from such opportunities; • Potential opportunities will arise if:	• **Focus on end-users' point of view**, in order to increase their awareness on the possible benefits from adopting the S4G solutions.

- the application scale increases (so far there are mainly small scale applications); - end users awareness is enhanced: how smart grids applications could affect citizens' everyday life?	
Technologies play a crucial role in enabling new business opportunities. - Technologies are in place, but they need to be used in the right way; - Gap in the technological competences, especially between users and suppliers that need to be covered; - There is a need of integration and coordination between technologies; - Many technologies require high capital investments: this could be a barrier for their adoption.	The **economic model**, based on the Total Cost of Ownership (TCO) formula, could support all interested actors (end-users, decision makers, market players, …) to effectively analyse and **evaluate the investment** required to operate ESS at prosumer / grid level.
Smart grids are complex systems. - Need to consider the energy sector as a whole (systemic vision); - Complexity needs to be managed with a particular focus on: (a) Standards: there are many standards that need to be harmonised; (b) Legislation: there are different legislations, different constraints on technologies between the countries.	- While evaluating the economic sustainability of the project it is important to **consider all stakeholders and their interactions** (focus on end-users, DSO and services providers). - The compliance of the business models archetypes defined in this deliverable to a potential business case should be evaluated considering **context specific constraints**, with particular attention to standards and legislation. In this regard, the most recent **updates on the EU normative** must be considered (Appendix A1.2).
Smart grids emerging business models / markets. - Business models should consider: - Aggregation; - Ancillary services provisioning; - Role of incentives; - Interaction between different actors: all market players must be considered and need to interact; - Important role of local markets; - Opportunities offered by the growth of electric vehicles market.	- The emerging business models discussed during the workshop are aligned with the business models archetypes described in this deliverable especially when considering the role of **aggregators, ancillary services and incentives**. - The business cases conceived for the test site in Bolzano are good examples of the opportunities leveraged by storage applications used in presence of **electric vehicles / charging stations.**

A1.2 Update on the EU normative framework

Figure 23 – "Flexibility and storage under the CEP" key note speech

During the keynote speech Kostas Stamatis – DG Energy (European Commission) presented the latest updates about flexibility and storage under the CEP, making reference to the following recent normative:

- **DIRECTIVE (EU) 2019/944**[xiv] of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast)
- **REGULATION (EU) 2019/943**[xv] of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity

This new normative introduces a new framework for a flexible system that considers: new actors; a level playing field for DER; a new role for TSO/DSO that can use and facilitate flexibility.

<u>**NEW ACTORS**</u>

Active consumers are key to delivering a more flexible energy system. They are final customers, or jointly active customers within confined boundaries and can consume, store or sell-self generated electricity or participate in flexibility or energy efficiency schemes, according to the following schema (Figure 24).

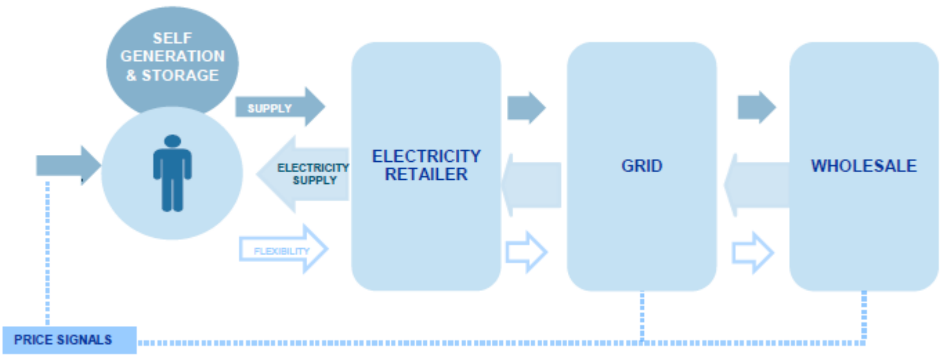

Figure 24 – The role of Active Customers in the new European normative framework under the CEP (source: Stomatis presentation, 2019)

The **energy communities** can be associations, cooperatives, partnerships, NGOs, other legal entities controlled by members or shareholders. They are recognised market players for generation, distribution, supply, aggregation, storage. They are subject to a non-discriminatory, fair, proportionate and transparent treatment and are subject to same rules as other market players. Energy communities can access to all electricity markets and balance responsible; the participation to energy communities is voluntary and members retain rights as (active) customers; DSOs can facilitate electricity transfers within communities; community's members have the right to share electricity to members from own generation

ENERGY STORAGE IN THE ELECTRICITY SYSTEM

- Definition of «energy storage» which accommodates all storage technologies
- Enable participation of energy storage in the electricity market as market based activity under competitive terms
- Non-discriminatory and effective provision of storage services:
    - Balancing services - TSO (Regulation)
    - Non-frequency ancillary services and flexibility services for DSO/TSO (Directive)
- Market rules for facilitating the participation of energy storage in the market alongside generation and demand response (Regulation):
    - Network tariffs should not discriminate against energy storage
    - Not subject to double charges, discriminatory licensing or fees (Directive - active customers)
    - Re-dispatching rules should account for storage
    - Participation in capacity mechanisms
    - Network code on DR and storage

ARTICLE 54 DIRECTIVE (EU) 2019/944 Ownership of energy storage facilities by transmission system operator

- DSOs and TSOs should not own or operate storage facilities or be involved in development/management of such facilities
- A derogation of this principle is permitted: **member States could allow operators to own/operate storage for ensuring reliable and secure operation of the system:**
    - **When storage facility is qualified as FINC (Fully Integrated Network Component)[10]**
    - **If other parties could not invest and deliver storage services, and in this case:**
        - **Open tendering procedure**
        - **Regulatory authority approval**
        - **Reassess the market every 5 years**
        - **DSO/TSO to phase-out activities in 18 months if market interest exists**
- FINC and battery storage facilities with a FID before the entry into force of the Directive for DSOs, and 2024 for TSOs are exempted from phase-out
- DSOs/TSOs to procure through market based procedures flexibility services and non-frequency ancillary services from distributed energy resources for local congestion and network operation
- Definition of required products / services in cooperation with other system operators (TSO/DSO) and relevant stakeholders - oversee by the NRA
- Member States to define the regulatory framework including incentives for system operators and provide adequate remuneration to SOs.

[10] Fully integrated network components means network components that are integrated in the transmission or distribution system, including storage facilities, and that are used for the sole purpose of ensuring a secure and reliable operation of the transmission or distribution system, and not for balancing or congestion management. FINCs can include energy storage facilities such as capacitors or flywheels which provide important services for network security and reliability, and contribute to the synchronisation of different parts of the system

Appendix B

Main use cases of Low TRL Smart Grid & Storage Projects Clustering Initiative – Cluster: Business Models for Exploitation

Table 30 – Main use cases of Low TRL Smart Grid & Storage Projects Clustering Initiative – Cluster: Business Models for Exploitation

Project	Use Case	Alignment[11] with S4G
SHAR-Q	**EV smart charging coupling RES and EV demand** Small modular systems are considered as part of the pilot demonstration. The project aims to add Solar powered EV charging station and leverage the existing batteries and solar and wind generation.	****
	RES-EES collaboration The latest developments in the market design, storage systems and DER RES systems are taken into consideration.	
	Prosumer integration A limited set of prosumers will be defined during the next months; offering would be designed and sourced. Additional PV-installations will be implemented as well as battery storage units in combination with smart meters addressing the prosumer market.	
FLEXCoop	**Optimisation of coop resources** Using demand-side flexibility (residential) in order to 1/ optimise consumption of solar PV (consumer side and retailer-side) and 2/ consume cheaper SPOT market electricity	*
	Providing flexibility to TSO using demand-side flexibility (residential) in order to provide balancing energy services to the TSO (aFRR)	
DOMINOES	**Local market flexibility and energy distributed resources for optimal grid management** Usage of local community distributed flexibility for grid management, including available storage systems and energy/power services to enable a more efficient renewable integration at Low Voltage level, with reserved capacity to serve grid needs and mitigate technical constraints.	***
	Local energy market data hub manager and technical validator of market transactions The Local Energy Market Data Hub Manager and Technical Validation of market transactions focus on the behaviour of the Data Manager role that will provide information to local trading market platform (LEMH) as well as the role of Technical Validator (TV) that should assess technically all transactions intentions provided to the LEMH in a defined timeframe.	
	Local community market with flexibility and energy asset management for energy community value Use of flexibility and management of resources for the benefit of the local market	

[11] Alignment has been defined considering the following elements: ICT platform; focus on ESS; focus on EV

	Local community flexibility and energy asset management for retailer value Use of flexibility and energy asset to provide value to the retailer **Local community flexibility and energy asset management for wholesale and energy system market value** The usage of flexibility and management of energy assets of the local community for the wholesale and energy system market value.	
Net2DG	**DSO Grid Analysis Services** The implementation of Grid observability functions using electricity data for optimal grid configuration and operation flexibility and grid quality **DSO Grid Analysis Services** Cost Benefit Analysis to understand value chain, business model of all contributors including DSOs	**
CHESTER	**CHEST integration in a DH network.** Integration of the CHEST system (A compressed heat energy storage for electric and heat supply) into a large District Heating (DH) network **CHEST integration in a micro-grid** Integration of the CHEST system (A compressed heat energy storage for electric and heat supply) into a micro-grid with share of local RES	**
FHP	**Local RES curtailment mitigation.** Using local P2H flexibility to mitigate local RES curtailment. **System RES curtailment mitigation** Using distribution grid connected P2H flexibility to mitigate system RES curtailment.	*
E-LOBSTER	**Rail + Grid Management System to be installed in Metro of Madrid** The overall scope of E-LOBSTER is to develop of an innovative, economically viable and easily replicable electric Railway + Grid Management System that will be able to establish synergies between power distribution networks, electrified transport networks (metro, trams, light railways etc.) and charging stations for EVs. The proposed solution encompasses the integration of Electric Storage with power electronics providing flexible control. The system, to be implemented in the Metro of Madrid the case study of the project, starting from the analysis of energy losses will be able to optimise the interexchange of electricity between the networks maximising local RES self-consumption.	***
UNITED-GRID	**Distribution system advanced forecasting** The advanced forecasting aims to maximise the hosting capacity of distribution systems for DERs by optimising grid utilisation with advanced forecasting techniques using energy (data) analytics **Market-based congestion management** Market-based congestion management aims to reduce the impact of the high penetration pf the DER together with novel grid tariff designs as well as by an overall framework for market-based solutions for network congestion management	*

	Safe and secure real-time monitoring control and protection Safe and secure real-time monitoring, control and protection aims to take advantage of emerging technologies and available information data from both grid operators and end-users to enhance protection an control functionalities to ensure grid safety and reliability	
PLANET	**P2G deployment for system control** P2G deployment for system operations relies on offering flexibility services to the grid, like absorbing excess electricity for grid congestion management and active/reactive power control for optimal voltage regulation and power quality.	**
	Biogas for Circular Economy P2G systems are deployed to enhance the production rates of biogas production plants. P2G methanation units combine biodigestion CO_2 with P2G outputs of H_2 and O_2 to generate methane (CH_4) for combustion engines and storage.	
	Smart thermal grid Building level P2H solutions are aggregated to provide ancillary services for the electrical distribution grid and the district heating grid. Building P2H devices and thermal storages are utilised to draw excess RES production electricity from the distribution grid and store it as heat in the thermal storage of the buildings.	

Appendix C

Tools used for business cases analysis - methodological remarks

C.1 Value proposition canvas

The ultimate aim of the value proposition design is to ascertain that the commercial offering solves problems and satisfies needs expressed by target customers. As part of the problem-solution fit analysis, the Value Proposition Canvas[xii] allows observing and codifying a set of customers' characteristics for designing a value proposition that meets needs and wants of target segments.

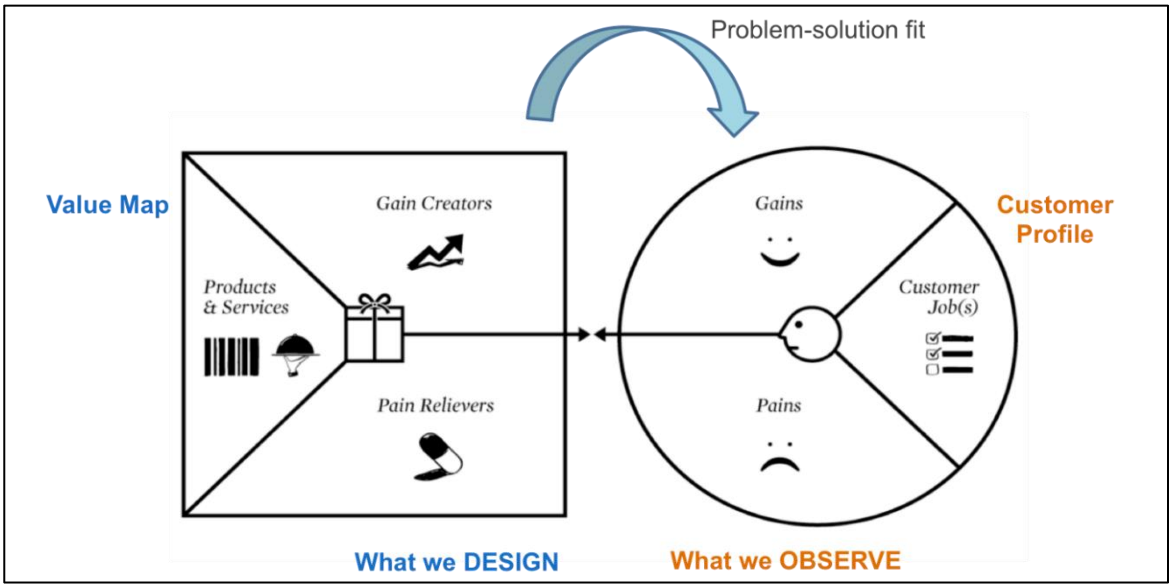

Figure 25 – Value Proposition Canvas

This process can require to identify and rank pains (i.e., risks and bad outcomes), gains (i.e., benefits and good outcomes) and jobs (i.e., needs and problems to be solved) of the potential end-users and to put a set of preferences and priorities for end-users.

C.2 Value network analysis

Value network analysis (VNA) is a business modelling methodology that visualises business activities and sets of relationships from a dynamic whole systems perspective[xvi]. The network analysis derives from the identification of the main actors involved in the scenarios for ES deployment. Actors participate in the network playing specific roles in which they "convert tangible assets into negotiable offerings and fulfil different functions"[12]. To develop the most valuable strategy for stakeholders, it is important to define and map the exchange of values across the network according to three main variables: roles (definition of stakeholders and their role to engage interaction and provide added value), deliverables (the 'things' to be moved from one role to another that can be physical, tangible or intangible) and transactions (activities that originate from one side and end in another side)[xvi], as show in Figure 26.

[12] Value network can be 'internal', when relationships are between individuals or within the same work group of the same organisation, or 'external' when relationships are between the organisation and the suppliers, investors and consumers. Tangible assets exchange means transaction involving goods, services or revenue as physical goods/services, contracts, invoices, return receipts of orders, knowledge products/services directly generating revenues.

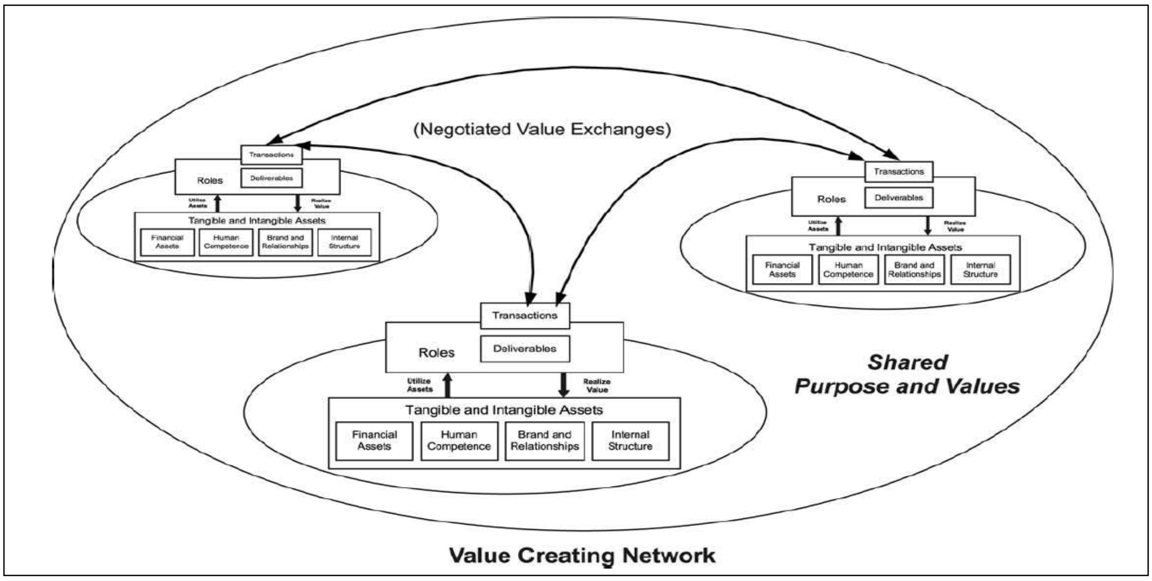

Figure 26 – VNA Diagram

The template of the value network analysis for each HLUC-# and PUC-# that has been adopted in this deliverable and in D2.4 follows the graphical scheme shown in Figure 27 (in this case, with the hypotheses that the prosumer asks a load for the purchase of the battery).

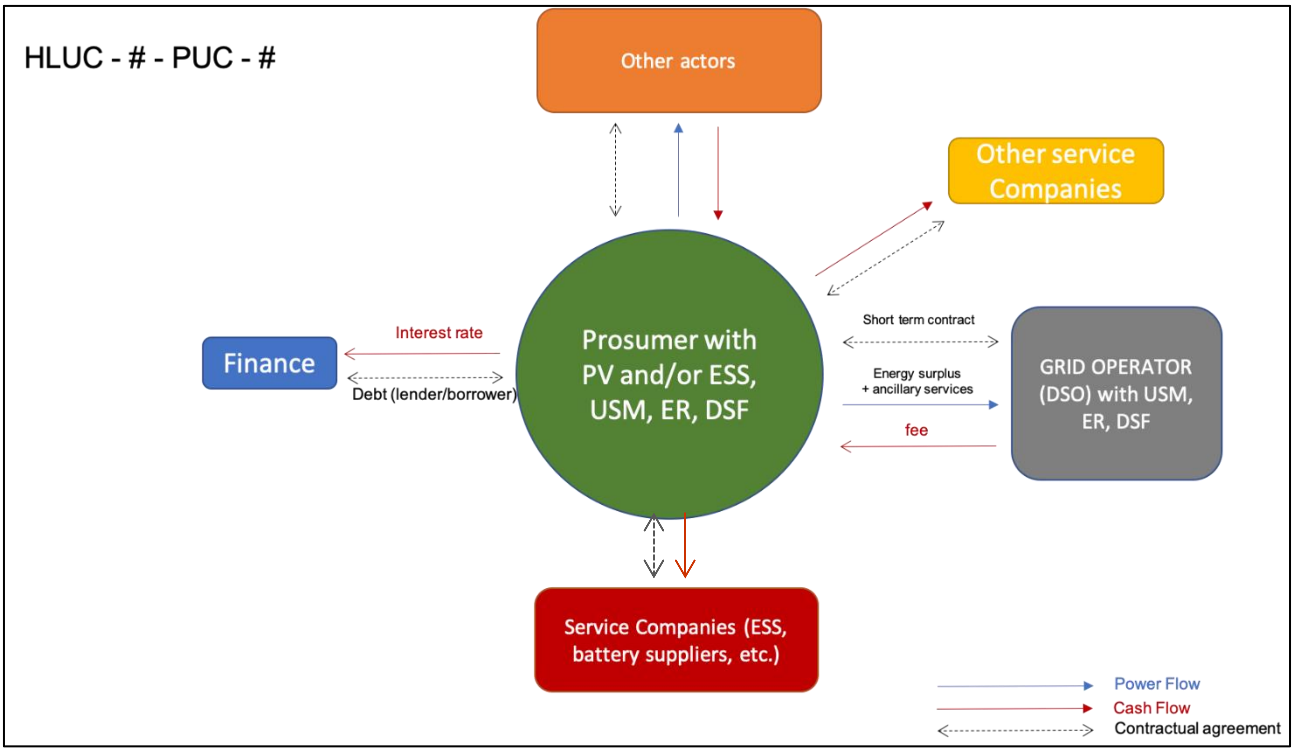

Figure 27 – Example of VNA and contractual relationship from different stakeholders

C.3 Business model canvas

The Business Model Canvas, developed in the context of the Business Model Generation Framework[xiii] offers a tool to visualise the framework of the business model, mapping the different building blocks and making the model easier to communicate and understand.
In order to have a visual framework of the business model the different building blocks have been made into a map, which helps the company communicate the business model and which makes it easy for partners and employees to understand it within that specific area. This tool is called the Business Model Canvas (Figure 28). It is a central part of the framework as it should help the company visualise the final business model, making it easy to communicate to other employees or to external partners.
Therefore, the Business Model Canvas can be perceived as a communication instrument and a dynamic paper which can be updated and adapted to the business model so that it matches the current challenges and meets always the customer demands. This will help the company prepare for the future and reduce also risk and uncertainty by being one step ahead of the development, making fast updates and changes to existing business models, as the business model environment changes.
It is important to note that the Business Model Canvas is the result of the Business Model Generation process and is used for documenting and communicating this result.

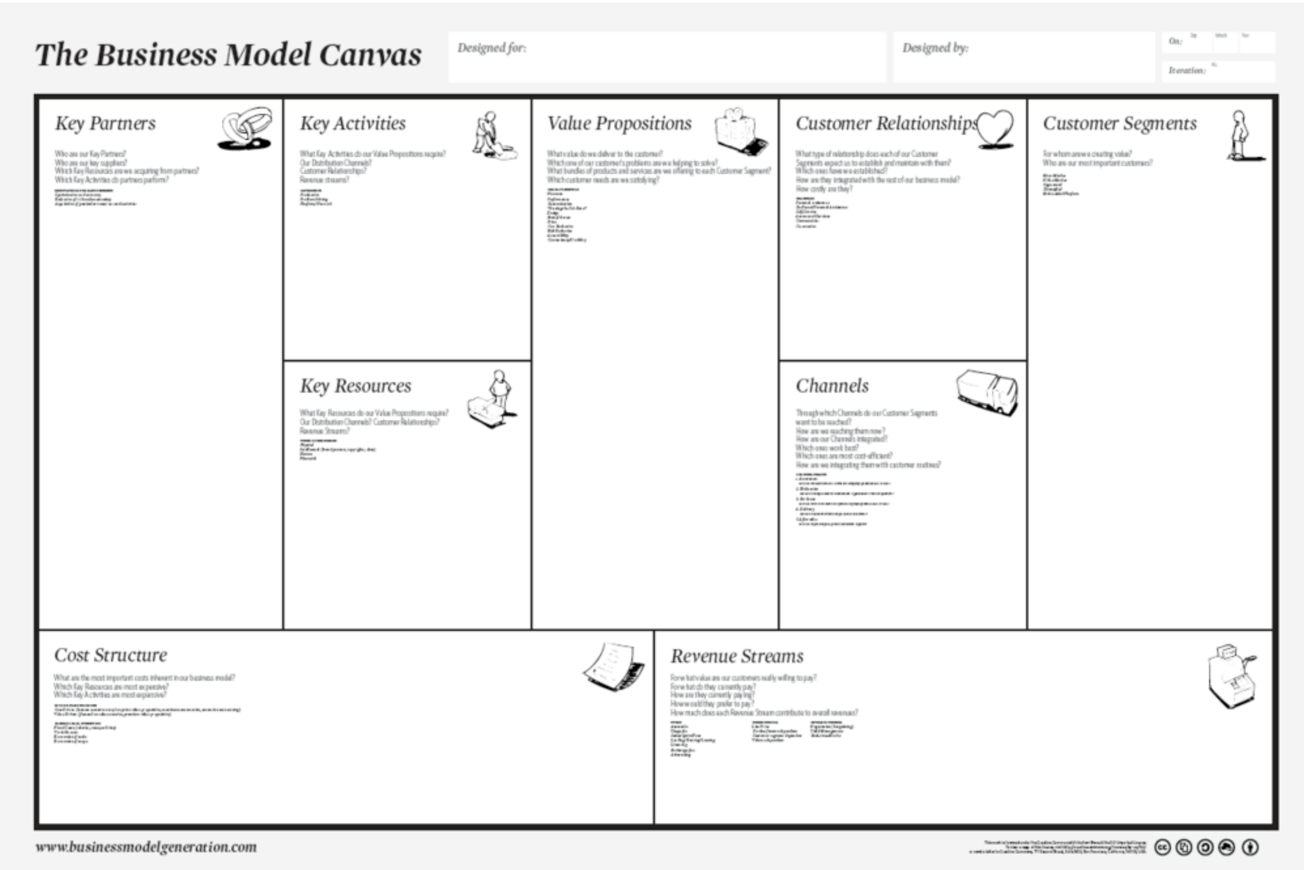

Figure 28 – The Business Model Canvas

Acronyms

Acronym	Explanation
BC	Business Case
BM	Business model
BMC	Business model canvas
CEP	Clean Energy Programme
DER	Distributed Energy Resources
DSO	Distribution System Operator
Dx.y	Deliverable x.y
ESG	External Stakeholder Group
ESS	Energy Storage System
HLUC	High Level Use Case
PUC	Primary Use Case
RES	Renewable Energy System
S4G	Storage 4 Grid
SaaS	Storage as a Service
TCO	Total Cost of ownership
TSO	Transmission System Operator
Tx.y	Task x.y
VNA	Value Network Analysis
VPP	Virtual Power Plant

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