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Abstract:

This report reviews the existing business models from the energy sector and propose new ones that will be demonstrated in real conditions in NOBEL GRID pilot sites. This task is considered important in order to understand the market potential of the NOBEL GRID technologies and the resulting interactions between the market players.

In addition, this study can be considered as the first step towards identifying the major socio-economic factors that will determine the adoption of NOBEL GRID products by providers, as well as, consumers' engagement due to the increasing importance of Demand-Response schemes. To this end, the need for incentive mechanisms is explored so that all involved entities are willing to participate.

Keywords:

Business models, Value Networks, Business Plans, DSO, Aggregator, Retailer, Prosumer, Incentive Mechanisms.

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EXECUTIVE SUMMARY

This document presents the results of Task 2.3 of NOBEL GRID. The main purpose of the document is to review existing business models from the energy sector and propose new ones that will be materialized in real conditions in NOBEL GRID pilot sites. This is important in order to understand the market potential of the NOBEL GRID technologies and the resulting interactions among the market players, namely DSOs, Aggregators, Retailers and Prosumers.

In addition, this study can be considered as the first step towards identifying the major socio-economic factors that will determine the adoption of NOBEL GRID products by providers, as well as, consumers' engagement due to the increasing importance of Demand-Response schemes and collective participation through virtual cooperatives. To this end, we need to explore for incentive mechanisms such that all involved entities are willing to participate (i.e., payments to consumers for adjusting their demand to providers' signals and subsidies from highly-profitable providers to the rest ones).

In order to do so, we followed a methodology that is based on state-of-the-art tools and techniques. The steps are:

- Step 1: Create a generic value network for Smart Grids.
- Step 2: Create a value network for each High-Level Use-Case, based on the generic value network for Smart Grids and for each High-Level Use-Case (HLUC) identify:
    - the key actors and NOBEL GRID products involved and
    - the value each entity perceives for being actively involved.
- Step 3: Describe the business model of the High-Level Use-Case for each key NOBEL GRID actors involved, using the Business Modelling Canvas methodology (1) extended appropriately in order to include social costs and benefits.
- Step 4: Identify the High-Level Use-Cases for each key NOBEL GRID actor and pilot site that are expected to be economically viable by performing a business plan analysis and comparing the IRR[1] against a reasonable threshold value.

The starting point of our work is the generic value network for smart grids, which describes the main contributions by all involved business actors for a certain product/service to be delivered to its current and prospective customers. Value network analysis is considered to be well-suited for understanding the exchange of goods, money and information flows in Internet-based ecosystems, and thus it was adopted in this study.

The figure below describes a generic value network for smart grids taking into account the distinction between roles and actors. More specifically, we identified seven (7) key roles, as follows: 1) Power Producer, 2) Power Transmitter, 3) Power Distributor, 4) Power Retailer, 5) Power Consumer, 6) Wholesale Market Operator and 7) Aggregator. Depending on the regulatory setting, one role can be performed by multiple actors, even if they have significant differences in terms of size, core market, etc. For example, power can be produced by companies or prosumers using renewable energy sources. Furthermore, one actor can be involved in one or multiple roles; for example a retailer can also act as an aggregator.

[1] Internal Rate of Return is a widely used benchmark for assessing the profitability of an investment where higher values are desirable.

Then, we defined a "standard" business model for each key NOBEL GRID actor and considered a set of 11 candidate extensions, called NOBEL GRID High-Level Use-Cases (HLUC). For example, we assumed that each Prosumer has installed Photovoltaic panels on their rooftop, instead of e.g. wind turbines, and selects how much of the produced power will be locally consumed or contributed to the pool. The importance of the Aggregator's role in smart grids can be evidenced in the generic value network by looking at the exchanged information and money flows.

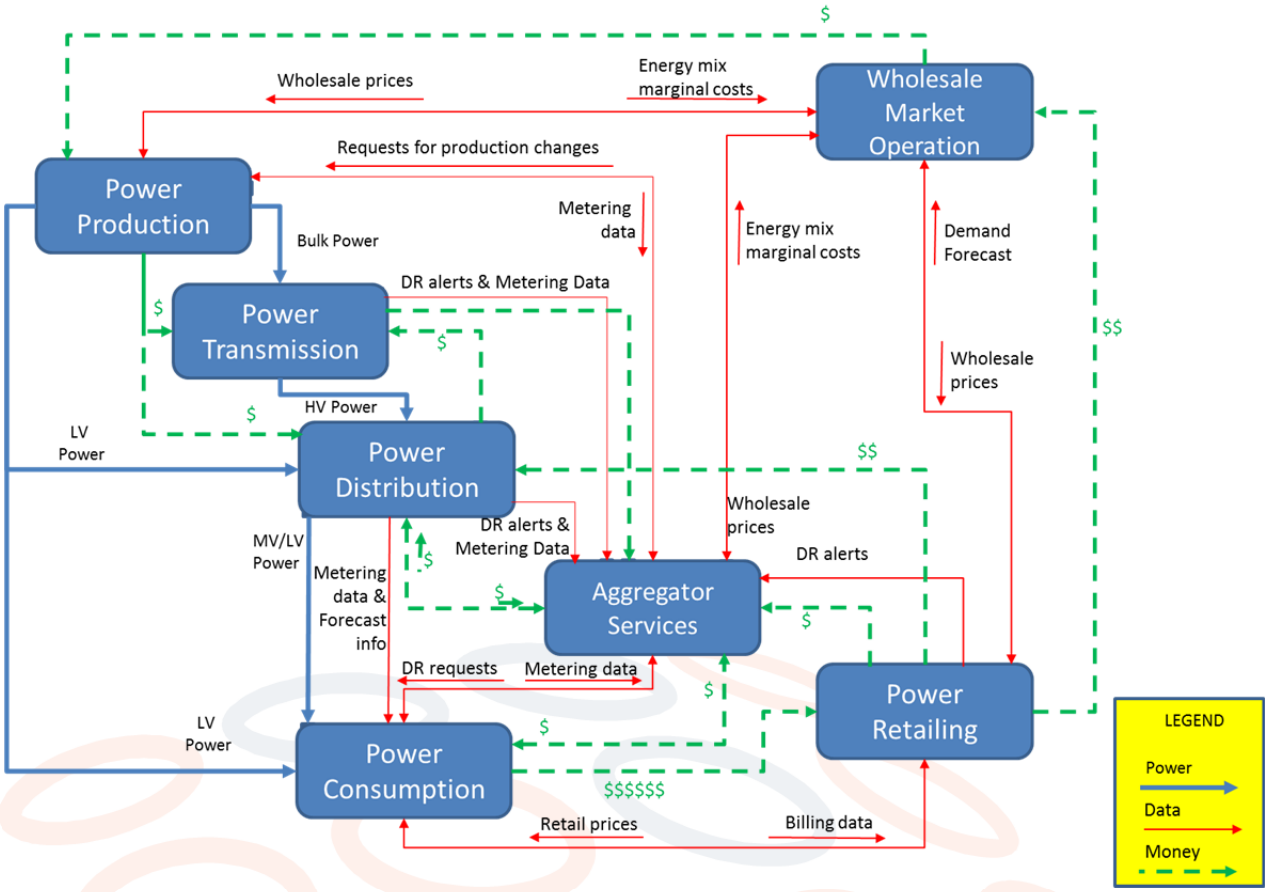

Figure 1: The generic value network for smart grids

The next step is to highlight the main techno-socioeconomic aspects of all 11 High-Level Use-Cases that were selected in D1.3 (2) for demonstrating the NOBEL GRID concepts and tools. For each one of those we summarize the underlying business case of the key actors, as well as, the added value of the key NOBEL GRID products.

While these value networks are ideal for giving us a bird's eye view of the industry, they provide no insight on the attractiveness of each scenario to each actor involved. For this purpose, we utilized the Business Modelling Canvas methodology, which was extended to consider social (innovation, sustainability, social costs, benefits etc.) aspects, as well. In that way, among others, the main value proposition, infrastructure used, customers, and finances for each HLUC/service and for each one of the four (4) key NOBEL GRID actors can be easily documented, which allows decision makers to quickly understand the business case. In particular, the above business model analysis eventually allowed us to develop a business plan for each actor and HLUC by taking also into account the key differences between the pilot sites, such as population and regulation. Quantifying the financial aspects for all these combinations was made possible by following an efficient approach that relies on defining the costs and revenues for each actor's business model

in a single location and using "scaling factors" for calculating the costs and revenues for the rest pilot sites.

By analyzing those 20[2] business template instances we are able to accomplish the following:

- Assess the profitability of each role in a certain location. Especially for the roles where no regulatory constraints exist, we focused at the equilibrium. In other words, we estimated the number of entities that would find lucrative to play that role and the expected return on investment for the last entrant (in order to take into account the customers' inertia in mature markets).
- Propose services (i.e. HLUCs) to be adopted by a certain role in a certain location.
- Identify bottlenecks in offering a certain service in a certain location. This means that all involved roles should have a positive net benefit (at least) for the service to be offered. If this does not apply, then for the HLUC to be offered we should investigate whether profitability of all actors can be attained by relaxing some of our assumptions or by putting some incentive mechanism in place.

We deduced that in none of the 5 pilot sites studied it is currently (i.e. prior to the NOBEL GRID approach, tools, and High-Level Use-Cases) economically viable for an entity to adopt the "standard" business model of the Prosumer role. However, members of cooperative schemes and other environmentally conscious citizens could set a lower IRR threshold and thus agree to become Prosumers. The rest of the roles are attractive in most cases but with differences in the highest acceptable competition level (maximum number of players being active). Notable exceptions to this conclusion apply to the following roles, who cannot be profitable even under a monopoly situation:

- the DSO in Flanders, attributed to the high corporate tax rate compared to other sites, and
- the DSO and Aggregator in Meltemi, mainly due to the small customer base.

As far as the effects of NOBEL GRID High-level Use-cases on the key actors are concerned, we noticed a positive impact in most cases. In particular we observed the following:

- New entities adopting the Prosumer role could adopt all relevant HLUCs and obtain a high return on investment (more than 30%). Interestingly, this is true for all pilot sites.
- For the DSO role, most NOBEL GRID High-Level Use-Cases (HLUC 2, HLUC3, HLUC4, HLUC5, HLUC6, HLUC7, HLUC8, HLUC9 and HLUC11) are beneficial in all pilot sites. While HLUC10 is very attractive in Terni only, it is profitable in the rest pilot sites as well. Nevertheless, the HLUCs are not profitable enough for making the "standard" business model of the DSO in Flanders and Meltemi a lucrative one.
- For the Aggregator role we noticed that at least one NOBEL GRID High-Level Use-Case is attractive in all pilot sites except for Meltemi. In particular, HLUC3 and HLUC9 are beneficial in Valencia, Flanders, Manchester and Terni, while HLUC10 is attractive in Flanders, Manchester and Terni. Similarly, HLUC7 is considered lucrative in Valencia, Manchester and Terni, while HLUC1, HLUC2 are very attractive only in Manchester. In general, an Aggregator in Flanders, Manchester and Terni would have the financial incentive to deploy all NOBEL GRID HLUCs. In Terni, an Aggregator would be better off

[2] The four (4) main NOBEL GRID actors multiplied by the 5 (five) pilot sites.

providing HLUCs selectively, due to the high rewards that should be given to Prosumers under HLUC8[3].

- Finally, for the Retailer role, the single relevant High-Level Use-Case (i.e., HLUC8) is beneficial for all pilot sites apart from Meltemi. Furthermore, adding HLUC8 to the service portfolio slightly improves the return on investment in all of these pilot sites.

As expected from the above results, there are HLUCs where at least one actor in a certain pilot site would not be willing to participate (i.e., such HLUCs are not incentive compatible). In other words, the end-to-end attractiveness of some HLUCs is not guaranteed and for this reason additional incentive mechanisms may be needed. More specifically, all actors would be voluntarily engaged in HLUCs 4, 5 and 6 (where a single actor is involved), as well as, in HLUC11 (where DSOs and Prosumers participate) across all pilot sites. Apart from these, each pilot site has additional HLUCs that are locally incentive-compatible (e.g., in Valencia the HLUC3, HLUC7 and HLUC9).

Given that each of the HLUCs will be demonstrated and evaluated in a specific subset of the pilot sites, we investigated whether additional incentive mechanisms would be necessary in these cases. The incentive mechanisms targeted not only consumers enrolled to Demand Response programs, but the rest actors of the value network as well.

In the former case we performed an initial selection of the best fitted incentives mechanisms for each pilot site according to a set of socio-economic aspects. In particular, given that the cooperatives of CCOOP and ECOPOWER have a very clear environmental orientation, with very environmentally conscious members, these pilot sites could focus more on social-based incentive mechanisms e.g., using gamification techniques or collaborative campaigns for increasing demand flexibility, rather than on monetary mechanisms. For the rest pilot sites the importance of financial incentives is expected to be higher. For example, although Alginet is a cooperative DSO it could be argued that its members are less willing to be actively involved in a DR process compared to CCOOP members, and thus, additional monetary incentives might be necessary.

In the latter case, incentive mechanisms for providers were deemed to be necessary for HLUC7 and HLUC 8, only. Due to the small market size in Meltemi no transfer of payments from DSOs and Prosumers to Aggregators was found that could make the HLUC7 attractive on an “end-to-end” basis. Nevertheless, the business model for HLUC 7 in Valencia, Manchester and Terni is expected to be profitable for all involved actors and thus this scenario should indeed be demonstrated (in Meltemi). On the other hand, if an Aggregator’s annual average revenue per user (ARPU) from the DSO in Flanders were higher than the rest of the pilot sites (e.g., €28 instead of €20) then this would lead to an “all-win” situation.

When it comes to the expansion opportunities of entities acting as Aggregators and Retailers in each of the pilot sites, we observe the following:

- In Valencia, an Aggregator would have the economic incentive to expand its business by becoming a Prosumer. As expected, the remaining two combinations (“Aggregator and Retailer” as well as “Aggregator and Retailer and Prosumer” are less attractive (due to the worst-case scenario examined) but, still, very close to the IRR threshold of 30%. On the other hand, a Retailer would find adopting the Aggregator and Prosumer roles a lucrative investment.

[3] As explained in section 7.4, an Aggregator should pay prosumers a higher price than the regulated wholesale price, which is significantly higher in Italy and Greece compared to Spain, Belgium and the UK.

- An Aggregator in Flanders and Terni would have an economic incentive to expand its business by becoming a Retailer and a Prosumer at the same time. On the other hand, a Retailer in Flanders would have an economic incentive to expand its business by becoming a Prosumer, only. The option of becoming an Aggregator is less attractive, but still profitable.
- In Manchester, both an Aggregator and a Retailer would have an economic incentive to expand their business and become rivals in each other's market, as well as, becoming a Prosumer, despite the additional competition arising this way.
- In Meltemi, an Aggregator should not expand its business. If, however, we consider the overall IRR, then a Retailer would achieve an adequate rate of return by adopting the roles of Aggregator and Prosumer. Note, however, that this is attributed to the high IRR of the standard business model and not to the individual profitability of the rest of the roles.

In the next version of this deliverable, D2.6 to be issued at the end of the project, we will take advantage of the business plan tool flexibility in order to incorporate actual economic data from the pilot sites trials and, eventually, validate the positive outcomes of this study. Furthermore, we would like to perform a sensitivity analysis of the financial results obtained. For example, we can examine the impact of some key assumptions on the results obtained. Furthermore, we can study the need for additional incentive mechanisms for the HLUCs not for a single pilot site, but for the rest as well. This will provide valuable input towards the definition of partner's final exploitation plans and producing final business plans fully exploiting the added value of NOBEL GRID products.

Furthermore, we should highlight again that the attractiveness of NOBEL GRID HLUCs to providers is subject to the number of consumers and prosumers willing to enroll to such programmes and adjust their consumption and/or production to real-time signals. Thus, the incentive schemes towards consumers and prosumers will have to carefully defined and evaluated in D2.6.

1 INTRODUCTION

1.1 INTRODUCTION

This document presents the results of Task 2.3 of NOBEL GRID. The main purpose of the document is to review existing business models from the energy sector and propose new ones that will be materialized in real conditions in NOBEL GRID pilot sites. This is important in order to understand the market potential of the NOBEL GRID technologies and the resulting interactions among the market players, namely DSOs, Aggregators, Retailers and Prosumers.

In addition, this study can be considered as the first step towards identifying the major socio-economic factors that will determine the adoption of NOBEL GRID products by providers, as well as, consumers' engagement due to the increasing importance of Demand-Response schemes and collective participation through virtual cooperatives. To this end, we need to explore for incentive mechanisms such that all involved entities are willing to participate (i.e., payments to consumers for adjusting their demand to providers' signals and subsidies from highly-profitable providers to the rest ones).

1.2 SCOPE OF THE DOCUMENT

In this deliverable we perform an initial assessment of the economic viability of candidate business models for the main NOBEL GRID actors, namely DSOs, Aggregators, Retailers and Prosumers. Our starting point is a "standard" business model for each actor and for each of the 5 pilot sites: Valencia (ES), Flanders (BE), Manchester (UK), Terni (IT) and Meltemi (GR). Then, we increase the set of services offered by each actor by taking into account the 11 NOBEL GRID High-Level Use-Cases (HLUCs) that were defined in D1.3 (2). Note that not all market players are actively involved in the realization of a certain HLUC. Furthermore, even though we have identified a wide set of possible revenue streams for each HLUC, when studying the attractiveness of the candidate business models us considered only a subset of these income sources.

1.3 STRUCTURE OF THE DOCUMENT

We start, in Section 2, with an overview of the state of the art on business models for the Smart Grid and challenges and opportunities that were identified in the literature for the market players. In Section 3, we propose a generic value network for smart grids and describe our overall methodology for analyzing candidate NOBEL GRID business models. Then, in Section 4, we examine whether there is a valid business case behind each High-Level Use-Case (HLUC), while in Section 5 we create a value network for each High-Level Use-Case, based on the generic value network. In Section 6 we describe the business model of the High-Level Use-Cases for each key NOBEL GRID actor involved, using the Business Modelling Canvas methodology adapted in order to include social costs and benefits. Then, in Section 7, we identify the economically viable High-Level Use-Cases for each key NOBEL GRID actor and pilot site by performing a business plan analysis, while in Section 8 we discuss a set of emerging business models in smart grids. In Section 9 we give an overview of incentive schemes that were proposed by other researchers and provide our findings for the trial sites. Finally, we conclude in Section 10.

2 BUSINESS MODELS FOR THE SMART GRID

2.1 STATE OF THE ART

The transition from traditional to smart power grids has come to be materialised and catalysed by the high renewable energy penetration and the imperative need for power supply reliability and economic viability. The IBM Institute for Business Value points out that long-standing electric utility business models are rapidly becoming outdated in light of new technologies, policy changes and more demanding consumers. Roles along the value chain are shifting, with traditional buyers gaining a foothold as value providers. To succeed in this new environment, there is a critical need to develop fresh business models, addressing not only traditional energy generation and delivery (updated to benefit from new technologies), but also emerging products and services enabled by new technologies (3). Table 1 describes significant changes that are expected with the widespread use of the smart grid.

Table 1: Comparison between features with and without the smart grid (4)

Environment	Without Smart Grid	With Smart Grid
Data	Offline, scarce data One-way stream	Online, abundant data (big data) Two-way interchange
Energy	Focus on fossil-based Centralized energy production	Prosumers Dynamic business model, Decentralised and dispersed energy production
Information and communication technologies	Some reactive systems in place/Weak preventive mechanisms Little use of Information and Communication technologies Infrastructure with scarce intelligence	Strong preventive mechanisms, complex and dynamic diagnostics and proactive management systems. Widespread use of information and communication technologies Information inference and Decision making features
Agents	Reduced amount of participating agents	Potentially huge amount of participating agents, introduction of 'virtual' agents enabled by information and communication technologies.

In this emerging energy landscape there are several new services that can be provided and that will constitute the basis for expanding business models.

To better exploit the SOTA of business models applied to the smart grid and discuss on emerging ones it is advisable to briefly describe which entities compose traditional value chain and how does it differ from the smart grid value chain. As shown in Figure 1 the value chain will extend further and become more complex involving a variety of new participants. The consumer will became an active, empowered value chain participant requiring integration in the smart grid. The information and the power will flow in multiple directions, while the exponential increase in information flow will add tremendous value to the system. The distributed resources (e.g., distributed generation, storage, electric vehicles) will also play an increasingly vital role in operations of both transmission and distribution network and in value creation.

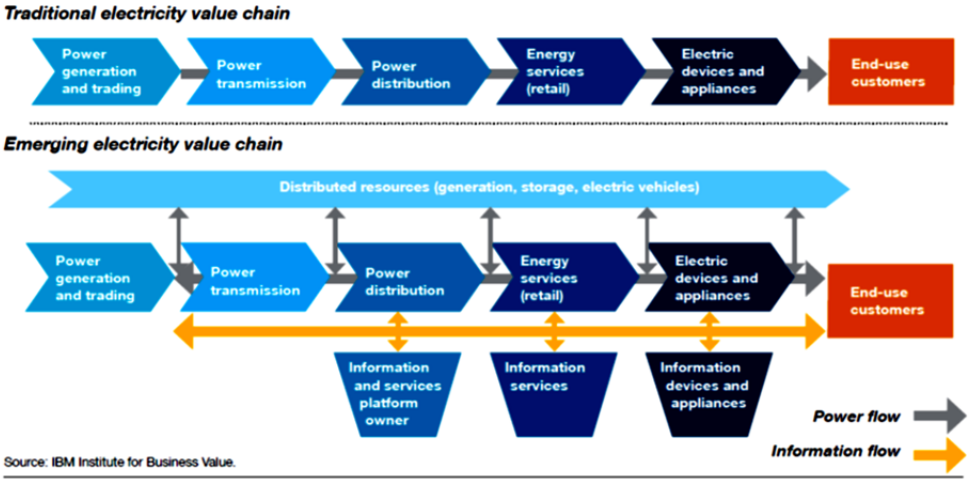

Figure 2: Traditional and emerging electricity value chain (3)

DSO

The authors in (5) argue that DSOs have to change their business focus in order to keep their business lucrative. By developing new business activities, thereby diversifying the business model, and by transforming operational philosophies from passive into active network management, DSOs can overcome the threats that arise from the increasing penetration of DG, incentive regulation, regulated connection charges, and unbundling. Towards this direction an adapted business model for the DSO is proposed based on the development of new business activities (see Figure 2). The latter will enable the transition from active to passive network management by developing new services for the electricity market, creating new revenue drivers for the DSO. The new services include the incorporation of advanced information exchange between generation and consumption, the provision of ancillary services at the distributed level, management of the network to provide network reliability and controllability, and improve customer benefits and cost-effectiveness.

The authors in (6) extend the business model proposed above in the one depicted in Figure 3 which illustrates the existing and new services, flow of revenue, costs, and interaction of key players (i.e. interaction with different consumer categories, transmission system operator (TSO), distributed energy operators and retail suppliers) in an extended business model of DSO. More precisely DSO will contribute to national load balancing and will be compensated for that by the TSO. Moreover, many commercial and industrial users need premium reliability as their production process is sensitive to the electricity input. DSOs will be reimbursed by those industries for providing highly reliable connections. Furthermore, with the use of information and communication technologies, valuable system data will be available that can be shared with DG operators and retail suppliers for efficient planning and operation in return for a payoff. Finally, an important part of the extended business model is the possibility to integrate distributed resources, also including demand response, as alternatives to grid capacity enhancement.

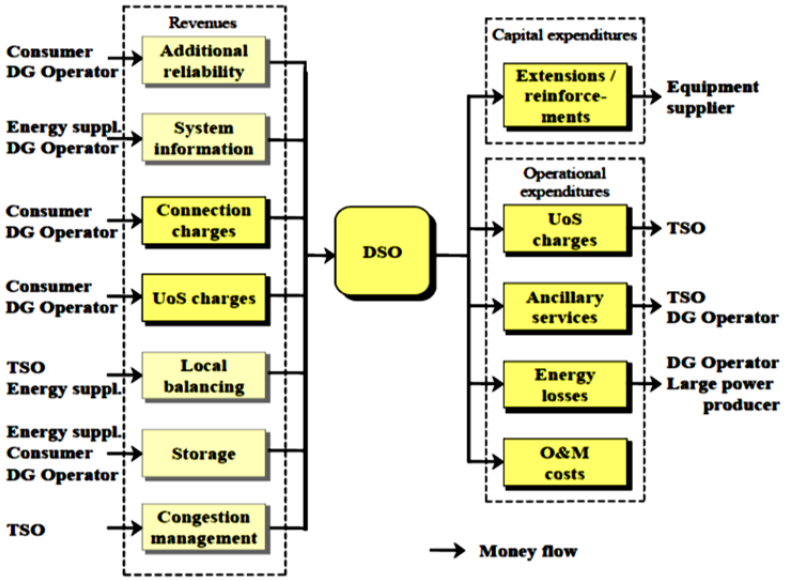

Figure 3: Example of an adapted business model of a DSO.

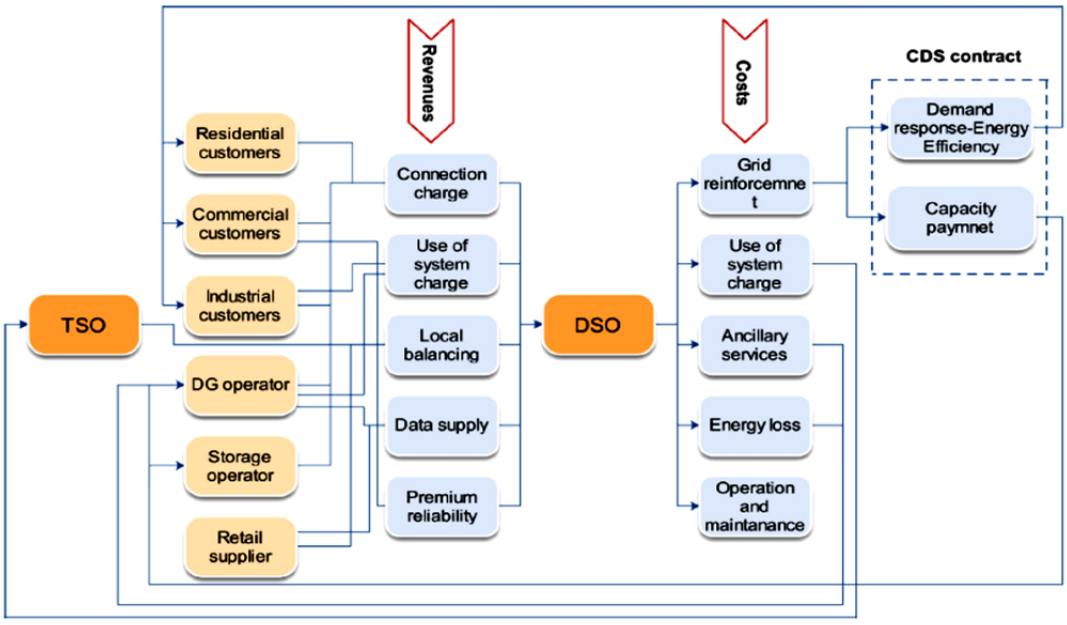

Figure 4: The extended business model for DSO (6).

Aggregator

The authors in (7) describe in general the operations that an aggregator performs. More precisely what kind of tasks the aggregator should take care of and what added value he brings to the power system. Initially, the aggregator collects customer demand flexibility and provides access to the market. The aggregator's job is to enable the demand response and bring it to the wholesale market. To achieve that the aggregator studies which customers can provide profitable demand response, promotes the demand response service to customers, installs control and communication devices at customer's premises and provides financial incentives to the customers to provide demand response. In addition, the aggregator actively offers the distributed energy resources to the disposal of other power system participants either through on one-to-one basis (bilateral contracts) or through organized markets by submitting offers to these markets. The DR

Service is purchased form regulated participants such as TSO and DSO, and deregulated participants such as retailers, generators, traders and BRP. Among other the aggregator facilitates market participation since the benefit for an individual (small-scale) customer from trading on organized markets would probably be too low compared to the costs. Currently the market operators have also set rules about the minimum bids and offers, probably to limit their transaction costs. The Aggregator should also try to anticipate the requests and make forecasts about them. This is difficult for a single customer. The aggregator also makes sure that the load control decisions do not cause problems for the electrical network. He can do this validation by consulting system operators (DSO's and TSO). He sends his planned schedules for load control to concerned DSO's. Within NOBEL GRID the aggregator also can offer non-flexibility based services to DSOs, like voltage control and harmonics filtering.

Then, the authors of the report (7) discuss the business opportunities of the DER aggregator in the Finnish electricity market. DER aggregator's relationship with other power system participants as well as end customers was discussed. The authors argue that the relationship with customers is crucial to the aggregator, and more important than the relationship with buyers of the aggregator's service. Taking into account that electricity is a commodity, and asserts that the aggregator does not have to make efforts to sell it to the buyers (e.g. TSO and DSO) as long as his service meets quality requirements (such as short enough activation time) and is cheap enough. On the other hand, joining a demand response program brings the consumer relatively small benefits compared to his total electricity bill while load control requires interfering with the customers' production processes or living comfort. Thus, the aggregator needs to build a personalized relationship with consumers and motivate them appropriately. In addition, the requirements placed on the existing business of the aggregator, i.e. what kind of companies can assume the aggregator role is presented in Figure 4.

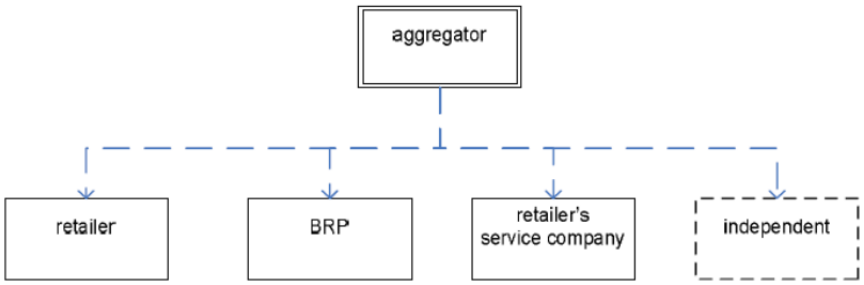

Figure 5: Aggregator business models classified according to the aggregator's identity (8).

The simplest case is if the aggregator himself is a retailer that aggregates the DER which his retail customers can offer. This is the business model which has been studied in e.g. EU-DEEP project task force 1.

Another possibility is that the aggregator acts as a service company to the retailer and has no independent position on the electricity market. In this case he performs activities such as forecasting, scheduling optimization and load control as normal but the effect of load control is summed into the consumption balances of the respective retailers. The retailers can then sell this power forward, based on the Aggregator's advice. In that case the Aggregator secured his income by making a service contract with the retailer. The benefit of this model compared to the retailer model is that the aggregator is not limited to a certain group of customers, with whom he has a retail contract. However, the disadvantage is that he has to first come into agreement with several retailers to take advantage of this fact. Third possibility is that the balance responsible party acts

as aggregator for customers whose retailers belong to his balance portfolio. The load changes are then automatically included in his consumption balance. Finally, the Aggregator can act as an independent company, which has made no agreement about income sharing or service provision with retailers. Instead his balance account would be directly credited by load reduction or charged by load increase, caused by the control actions which he has exerted on the customers.

Also, a number of international projects have paid attention to the role and business opportunities of the aggregator company. For example, the overall goal of EU-DEEP (Distributed energy partnership, FP6/2004–2009) was to produce innovative business solutions for enhanced DER (demand response, energy storages and distributed generation) deployment in Europe. Figure 5 below shows some of the money flows between the aggregator, his customers and buyers of aggregated services. The idea in this model was to balance intermittent generation with the use of DER. Besides balancing, the resources can also be used on the spot market and offered as reserves to the TSO.

In addition, ADDRESS's (Active distribution networks with full integration of demand and distributed energy resources, FP7/2007-2013) main objective was to enable the "active demand" in the context of the smart grids of the future, or in other words, active participation of domestic and small commercial consumers in the power system markets and service provision to the power system participants. Figure 6 presents the simplified representation of ADDRESS's architecture form which various business opportunities can be extracted. In this architecture, the aggregators are a central concept. The aggregators are the key mediators between the consumers on one side and the markets and the other power system participants on the other side. More precisely the aggregators collect the requests and signals for AD-based services coming from the markets and the different power system participants. They gather the "flexibilities" and the contributions provided by consumers to form AD-based services and they offer them to the different power system participants through various markets.

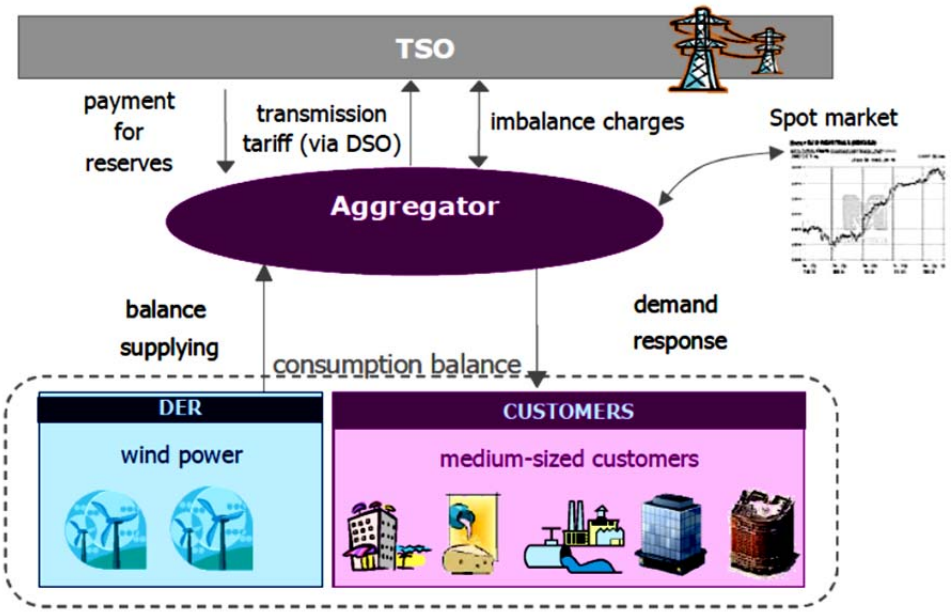

Figure 6: Money flows in the EU-DEEP first BM (9).

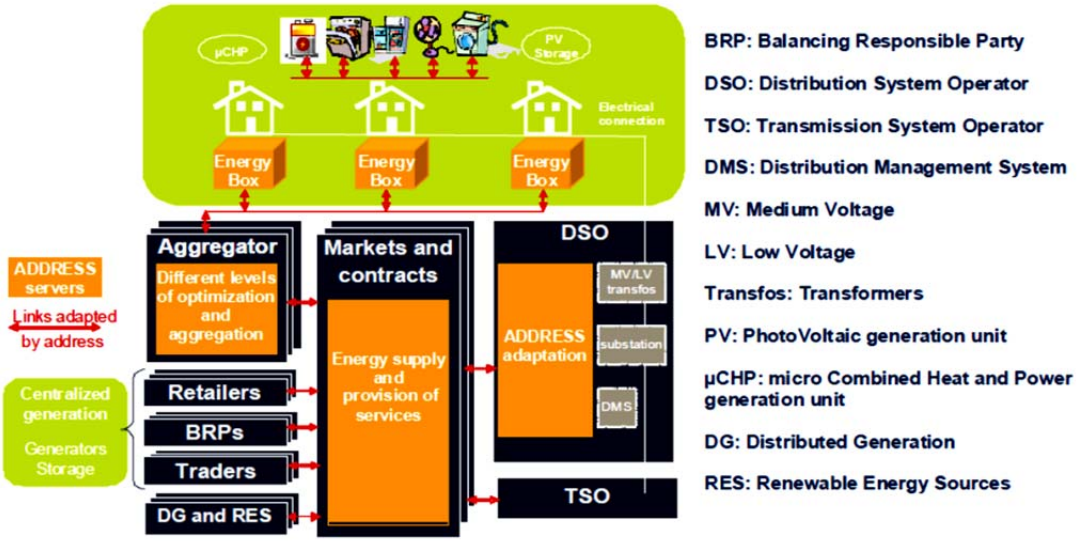

Figure 7: According to the ADDRESS project, the aggregator communicates with customers via "energy boxes", which perform load control and measurement, and with regulated and deregulated market participants through markets (10).

In contrast to the aforementioned projects the FENIX project (Flexible electricity networks to integrate the expected energy evolution, FP6) deals with distributed generation. FENIX project use the concept of virtual power plant (VPP), which includes a flexible portfolio of DER (flexible distributed generation, power storage facilities, flexible loads) remotely monitored and operated as a single entity. An aggregator acting as a commercial VPP (CVPP) applies FENIX concepts on behalf of DER to enable optimal participation of DER in electricity-related markets. More precisely this project considered CVPP applications under conditions prevailing in UK and Spain. More precisely, the following cases, constituting business opportunities for DER where evaluated: (i) optimized wholesale market participation, where the operating schedule of DER was optimized by a CVPP, (ii) commercial aggregation where the CVPP bundles the wholesale market transactions of DG operators to capitalize on the portfolio effect and to reduce administrative costs (iii) balancing services to the TSO, (iii) intra-day adjustment upward or downward services to the Supplier (Retailer), (iv) tertiary reserve services to the TSO, (v) active internal balancing where the CVPP arranges operational adjustments to minimize aggregate imbalance positions of DG under his control.

In the same context in 2008, RWE Energy and Siemens Power Transmission and Distribution started a pilot project to develop and pilot business models and technical concepts for the creation of a VPP consisting of 9 small hydro units (8.6 MW). In a VPP, the operation of distributed installations is scheduled and optimised by an "aggregator", either for the purpose of energy trading in the wholesale market or to provide ancillary services to the grid operator. Siemens proposes the two following business models shown in Figures 7 and 8.

Figure 8 depicts the business model enabled by direct marketing of power with market and management premium. The revenues derive from direct marketing e.g. at EEX (energy exchange). Also, the VVP Aggregator receives a market premium for compensation of difference between the EEG (Renewable Energy Act) feed-in tariff and monthly average spot market energy price. The management premium covers the costs for admission to energy exchange, connection to trading system, market clearing, etc. In addition, revenues occur from aggregation and marketing of distributed renewable generators (previously uncontrolled in-feed). More accurately it includes

market operation (energy marketing, administration of contracts with plant operators etc.), operation of distributed generators, and contracts with generation operators and VPP System incl. SW, HW & Integration.

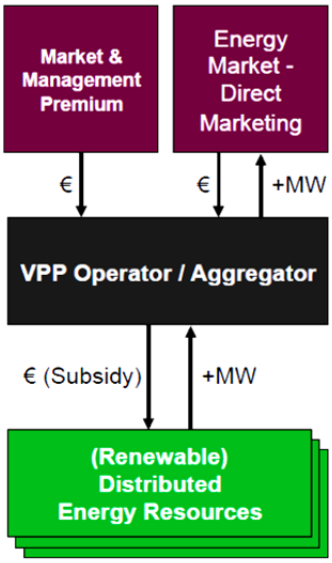

Figure 8: Business model enabled by direct marketing of power with market and management premium (11).

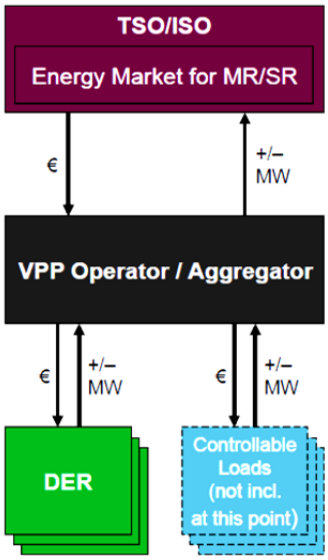

Figure 9: Business model to sell Tertiary/Minute Reserve in the TSO Reserve Market (11).

Figure 9 depicts Business model to sell Tertiary/Minute Reserve in the TSO Reserve Market. In that case the revenues come from providing capacity to Minute Reserve or Secondary Reserve and for making capacity available and particularly the aggregator receive a reward (price) for providing energy after call and for providing positive and negative reserve power.

Prosumer-oriented business model

The ever-increasing development of smart grid technologies allows prosumers to be economically active/motivated entities that:

- Consume, produce and store electricity;
- Take part in economic and technological optimization in electricity consumption;
- Get actively involved in the creation of value for electricity services.

The author in (12) has conducted a review of literature regarding business models for renewable energy production. The review showed that two basic choices exist: (i) utility-side renewable energy business models and (ii) customer-side renewable energy business models. With the term utilities the authors in (12) refers to the classical centralized energy utilities. In utility-side business model the renewable energy systems are on and off shore wind farms, large scale photovoltaic projects, etc. and range from one to some hundred megawatts. The value proposition in this business model is bulk generation of electricity fed into the grid. On the other hand in customer-side business models the renewable energy systems are located at customers' premises. Possible technologies are small photovoltaic, solar thermal water, micro turbines etc. Customer-side business models, or else, prosumer business models are directly in line with NOBEL GRID context and thus, we will focus on them in the sequel.

The growing penetration of renewable energy resources at distribution level which are installed at residential premises and commercial buildings leads to the change that energy is not only consumed behind the meter but also produced. In this setting consumers are evolving into a more

active part by being energy producers themselves, i.e. they are becoming prosumers. In (12) the authors review the current challenges of utilities to build new prosumer-oriented business models. As already mentioned the classical centralized utility's value proposition was comprised and in several cases still comprises production and delivery of service at a fixed price. However, among other the authors in (13), (14) and (15) dealing with business models for energy utilities expect have pointed out that the increasing share of renewable energy resources, energy efficiency techniques and smart energy applications the classical value proposition was no longer a foundation for further growth of electric utilities. From this side the authors conclude that there was an intense need for utility companies to develop new value proposition to remain competitive in the rapidly changing energy landscape. Thus, in this context it is often argued that electric utilities need to develop from simple commodities to comprehensive energy solution providers offering services such as consulting installation, financing, operation maintenance etc. (13), (16) and (17). The review concludes that these value propositions require significantly higher effort with the individual customer and leads to higher transaction costs per customer. Thus, the necessity to create packages of services since individual services are not profitable enough is pointed out.

As far as revenue streams are concerned in the context of utility's electricity sales increasing its business opportunities. Firstly, decoupling sales volume and revenues is proposed. More precisely this means separating the utilities fixed cost recovery from the amount of electricity sold. By breaking the link between sales volume and revenues, the utility shall be motivated to focus on its customers' energy service requirements and not just on increasing sales volume. Then, dynamic pricing is proposed meaning a flexible price which is orientated at the wholesale price of electricity. The extreme form is real-time pricing and a moderate one is Time of Use pricing with peak and off-peak rates. The price signals would motivate consumers to reduce consumption or shift consumption to lower-cost time-slots. The benefit for the utilities is a reduce in peak load which leads to lower back up capacity requirements and lower grid capacity requirements at peak times.

The authors in (18) propose seven new value proposals for prosumers. Then based on them they propose four prosumer-oriented business models.

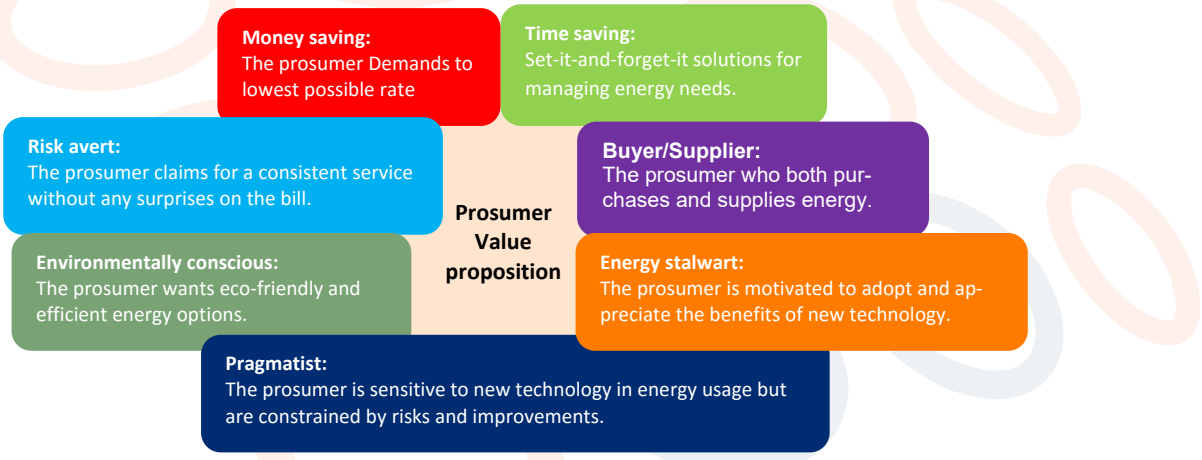

Figure 10: New prosumer value propositions (18).

They propose that ESCOs are capable of offering services for prosumers for management of electricity actively which correspond to the following value propositions: "money saving", "pragmatist users", "environmentally conscious", and "energy stalwarts" and propose the following ESCO prosumer-oriented business model (Table 2).

Table 2: ESCO prosumer-oriented business model characteristics (18)

Value Proposition	Prosumer Interface
Improved energy efficiency Reduced energy costs Energy performance contraction	Prosumer interactions management Prosumer segmentation Real-time media- or web-based communications
Infrastructure	**Revenue model**
Smart grid data management Grid monitoring	Energy savings Energy efficiency enhancements Charge for performance/service level offered

The authors in (19) consider how prosumers interact with DSOs in order to optimize the resources generated in a distributed manner. It is claimed by them that by using a distributed market-based control that sends adaptive signals to prosumers, the latter will become aligned with the concerns of the regulator/DSO, and both stakeholders will be satisfied. These basic elements introduced are applied to a DSO prosumer-oriented business model, i.e. suitable for users that produce, store and consume electricity by the authors in (18) have been further developed in Table 3.

Table 3: DSO prosumer-oriented business model characteristics (18)

Value Proposition	Costumer Interface
Security of supply and quality of service Choice of energy source System flexibility services Market facilitation	Active demand program Real-time media- or web-based communications In-home displays
Infrastructure	**Revenue Model**
Grid connection Smart metering systems Local network services	Energy selling Static pricing Provision of connection services Transmission/distribution fees

Challenges

There is a high need to review the main challenges regarding new prosumer-oriented business models taking into account the latest developments in the smart grid are and the role of the prosumer in the energy market value chain. Since there is a certain degree of disparity among the studied business proposals and their introduced business models, they have been summarized in Table 3 with all of their most prominent features, specifically considering the role of the prosumers in the reviewed related works.

According to the research that has been done (18), there are several common challenges that must be overcome for the presented models:

- Infancy of smart grid businesses: Although the technology is already present and in fact has been regarded as consolidated in several cases, the manufacturers and vendors still struggle to make it visible. What is more, the smart grid has still a low impact and is often mistaken for the advanced metering infrastructure, rather than all of the systems behind it.
- Lack of interconnectivity: The different manufacturers that develop goods and services for the smart grid are unlikely to cover all of its various aspects, so the final system will be prone to incorporate devices from different vendors. It is not clear how they are going to interact with each other with ease; nowadays, there are several different standards

covering information and communication technologies and power separately, but these remain poorly merged as a common effort.

- Unknown response for established business partners: The entrance of new SMEs, competitors and users in the electricity trade may be received with hostility from the already well-established DSOs and TSOs. Legislation must be created to prevent that from happening.

2.2 CHALLENGES AND OPPORTUNITIES

The Smart grid network introduces enhancements and improved capabilities to the conventional power network making it more complex and vulnerable to different types of issues. Because of its complexity new challenges arise, as well as plenty of room for new opportunities for the different actors involved.

One of the main challenges for new business models is that it involves almost always part of the role of existing actors, like the retailer or the balance responsible party. So, becoming an aggregator or offer aggregator services either means cooperation with an existing retailer and/or BRP or becoming one. However, in some cases, the national regulatory regime may prohibit a certain type of new market players to enter the market Also, even when no regulatory obstacles exist providing services may not always be economically viable.

Today, **customers** are demanding more from their providers than merely reliable power at reasonable rates. Consumers are willing to have more control over their expenditures and environmental impact, and more information about their energy usage—both in content and in frequency. To effectively analyse consumption data for the purposes of shifting behaviour, it is necessary to disaggregate "crude" building-level energy consumption into granular for households at room/floor level and appliance-level data, and for businesses at business unit and equipment level containing a detailed and itemised list of usage, energy consumption, time, and duration of consumption combined with intelligent analytics through application that can drive smart decision making.

Environment	Traditional Grid	Smart Grid
Agents	Reduced amount of participating agents	Potentially huge amount of participating agents
Data	Offline, scarce data One-way stream	Online, abundant data (big-data) Two-way interchange
Business Models	Static BM Producer and consumers	Dynamic BM Prosumers
Energy	Centralized energy production	Decentralised and dispersed energy production

	Fossil-fuel based	Focused on RES
ICT	Some reactive systems in place/ Weak preventive mechanism. Little use of ICT Scarce Intelligent in the Infrastructure.	Strong preventive mechanism Widespread of ICT Information inference and decision making features.

Figure 11 Comparison between features with and without the smart grid (18).

While customers are becoming more active in the smart grid environment, turning form passive consumers to entities that can also produce energy and/or participate in DR programs (prosumers) and thus, more demanding, they also have much more to offer in return to power providers and other participants, than just payments for the energy they consume. Some of these new elements of reciprocal value are primarily operational in nature; demand response, load profile flexibility, and distributed power and storage allow for optimization of system performance, asset utilization and contribute to energy production. Others, such as information on energy consumption patterns, other consumer demographic and behavioural information, and access to personal connections/networks for organisation and marketing purposes, provide the source for new business models and new revenue streams for companies able to effectively leverage the information. This contributes to the pool of data known as "big data" as part of an overall smart city strategy to provide more insight into the behaviour of citizens.

Smart meters are expected to provide many opportunities to the different actors in the grid. Digital electric smart meters stream electricity-usage data to a central utility system, which enables dynamic electricity pricing through real-time or near-real-time monitoring information. Other opportunities such as the decentralized wireless networks, where each node is fully connected to all the other nodes, allows for "self-healing" connections around broken nodes or blocked connections (i.e. closed-loop control & self-healing automation) (NOBEL GRID High Level Use Case (HLUC)[4]4.5 - Controlling the grids for power quality & security)

Given the rapid expected growth in smart-meter installations, **the current challenge faced by utilities** is how to integrate and optimize all the information collected across a much larger customer base. Right now, there are not many uses for second-by-second consumption data, but we anticipate certain entrepreneurial innovations in such areas as customer engagement and building efficiency that will be possible given the new data.

With the usage of the right appliances (smart meters, toolbox and different monitoring Apps), consumers and prosumers will have an active role in the grid, being able to reduce energy usage at times when the grid is at its most carbon intensive and/or shifting usage to periods when renewable generation is at its greatest (NOBEL GRID HLUC 4.1 - Green Energy Max). In addition, other opportunities arise from the co-operative side, which could provide valuable information to the prosumers in order to maximize the usage of the power they generate, reducing both costs and carbon emissions. Also, by providing a mix of information and automation (e.g. activating their appliances when their PVs are producing) the prosumers can get the best value from their

[4] For more information on NOBEL GRID High Level Use Cases see (2).

investment in RES technologies (NOBEL GRID HLUC 4.2– Prosumer Max). In the same way, individual consumers can also orient their usage based on times where the electricity usage is cheaper, for example using energy intensive appliances at times of cheaper prices – also helping the grid as these are times when the grid is "off-peak" when energy supply is abundant.

Since the flow of consumption data from the smart meters is continuous, opportunities for demand response are also continuous. Alerts can be sent automatically the end-users when overconsumption is detected in order to trigger the consumer for behavioural corrections. This perpetuates a virtuous cycle of providing direct and timely feedback to the consumer.

Moreover, with the new smart grid there is a huge amount of potentially new participating agents, such as groups of prosumers who might want to become a "cooperative virtual-power-plant" gaining access in the energy market, and receiving a revenue stream (either as direct revenue or in form of net-metering) for the energy and services provided. Opportunities might also arise for solutions providers that can offer reliable, automatic and remote control services (NOBEL GRID HLUC 4.8 – The Co-operative Power Plant). The potential for co-operative and collaborative virtual-power-plants, in providing previously disorganized individual players wholesale electricity access to the grid, is huge, promising to be a hugely disruptive business model to the traditional energy markets.

Some of the challenges regarding consumers, is the lack of information and misconceptions about electricity (e.g. pricing, consumption, fees paid to utilities, etc.). These misconceptions, which could be corrected with the provision additional information and greater transparency, for example real-time dynamic electricity pricing and appliance-level data, influence the measures that consumers in order to conserve electricity and will empower them to change their behaviour based on smart decisions. The procedure for traditional **energy audits**, meant to inform consumers of their specific usage and find conservation measures, is very manual. A professional technician will visit the home or business periodically, examine the insulation, inspect the furnace and ductwork, and perform a blower door test using an infrared camera. These audits are time and labour-intensive and are used by only a subset of households. Through smart-metering and disaggregated data new methods of auditing will be possible making energy audits cheaper and more automated. Automated analytics based on algorithm through software/hardware interactions could be conducted in real-time. Most importantly, these measures would be tailored for each specific household or business, based on their preferences and profiles rather than general recommendations. It will further be possible to automate and put in place actions immediately to change behaviour based on results of the audit or analysis. Another useful application for disaggregated data would be the ability to diagnose over-consumption or anomalies, detecting for example faulty electronics that lead to overconsumption. Presently, detecting faults is labour-intensive and time-consuming, often not detectable or requiring an on-site visit by a qualified electrician. Disaggregated data would allow for quick, automatic, inexpensive diagnostics to be performed.

Household activity data inferred from disaggregated electricity data could also have **security applications**. Because smart-grid data are often transmitted wirelessly, police agencies could tap into the encrypted feeds. This would provide them with an easy way to monitor activities within a suspect's home. On the other hand, this poses concerns regarding the data security of the citizens and raises the question on methods of encryption and protection of data, similar to the current debate regarding data crossing the internet.

Utilities would benefit from improvements in the quality of their demand-forecasting models. Accurate demand forecasting is important for a utility company when making decisions regarding generation capacity, infrastructure development, load-switching, and energy-purchasing contracts. More-granular, appliance-level data would facilitate a better understanding of residential and commercial electricity-usage behavior, which would improve the representation of consumption patterns in forecasting models.

Aggregators/ESCO could also benefit from certain software by performing user-oriented DR campaigns focused on fostering the renewable energy use (NOBEL GRID HLUC 4.1 - Green Energy Max and HLUC 4.2 – Prosumer Max). The software module capabilities perform savings in wasted time for collecting information about customers who have joined the program, in making energy-saving calculations and in obtaining external information. Utilities also often run conservation and retrofit programs but they have difficulty evaluating and prioritizing these programs. Better data allow for more-conclusive program-evaluation efforts, with the possibility of establishing causality. A final benefit for utilities is the better interaction and communication with their customers. Learning more about how their customers use electricity helps utilities to identify customers and customer groups for marketing purposes. Having real-time data also helps utilities to find quickly the location of network problems and dispatch support services. Pricing innovations would also be possible. Prices would not just vary by the time of day or the total system demand but also by the type of usage.

Grid stability, monitoring and maintenance offers great benefits to the new smart grid compared to the traditional centralised, one-way data stream grid (NOBEL GRID HLUC 4.3– Social Housing/electric heat automation). Large scale electric heating installations can play a role in grid balancing and provide opportunities for energy aggregators and ESCOs to enter the market by reducing consumer cost and increasing grid stability through, for example, demand response.

Moreover, there is a need to **monitor** the entire network (i.e. MV/LV) in order to react quicker and more efficiently to problems that arise in the network, as well as ensure power quality and security of the network. (NOBEL GRID HLUC 4.5 - Controlling the grids for power quality & security and HLUC 4.7- Increase in Power Quality). DSOs with the help of monitoring and prognosis tools will be able to forecast potential problems in the network, performing the necessary preventive actions (NOBEL GRID HLUC 4.4. - Maintaining grid assets). It will be possible to conduct software based predictive and pro-active monitoring of the network, and automatically reroute energy to maximise the resilience of the grid. As such there will be a big advancement in levels of SLA offered and savings in maintenance costs in comparison with the current distribution network.

Software engines could be able to take actions rapidly and plan in advance as well as monitor possible incidents and outages of the network (NOBEL GRID HLUC 4.6- Blackout and incident management) and react quickly and rapidly isolate incidents.

If an unexpected fault might occur, with the usage of the right software and devices, DSOs could use the demand flexibility to support system restoration after fault. Allowing the DSO to solve potential congestion problems caused by a reconfiguration in the network made after an unexpected fault event in the power grid. (NOBEL GRID HLUC 4.10 – DSO: Efficient Recovery from Power Outage). Collectively these incident management and problem resolution tools will make possible higher levels of OLA (Operational Level Agreement) to be offered between actors involved.

Customers may also want to have more control/information thought App devices, about the cause of outages or power cuts on their power supply (NOBEL GRID HLUC 4.11 - Secure Electricity Supply). Thus, appropriately designed applications can provide more transparency and active participation of citizens.

The challenge of the wider access to data and greater transparency will be in terms of legal and regulatory issues related to data protection and intellectual property ownership. Who will be the custodian of this large volume of data and how will the information be exchanged across multiple actors in a secure and ethical manner, ensuring the overall security of the grid and protecting the citizens' rights are examples of such issues. As such it a fine line to strike a balance between access to data and optimization of the 'data-potential' versus privacy and security of citizen – albeit this is not a new debate as the questions or challenges are being addressed by the same debate that affects the entire internet and the use of information technology in general. Therefore the debate on data security and citizen's rights is not specific to smart grids but forming part of a wider debate of our current 'information age'.

In summary, smart grids and smart meters are integral components of a disruptive technology, similar to the emergence of the internet, where there will be a huge opportunity for improvement, collaboration, transparency, cost reduction and sustainability. The smart grid and all its components are a vital part of the puzzle delivering the strategy for smart cities. It is paramount that all challenges regarding their management and security are dealt correctly and with diligently to ensure security, stability and confidence in the electricity grid of our future.

3 METHODOLOGY FOR NOBEL GRID BUSINESS MODELS

The following figure describes the overall methodology for analyzing candidate NOBEL GRID business models.

- Step 1: Create a generic value network for Smart Grids
- Step 2: Create a value network for each High-Level Use-Case, based on the generic value network for Smart Grids and examine whether there is a valid business case behind each High-Level Use-Case (HLUC) by
    - Identifying key actors and NOBEL GRID products involved.
    - Identifying the value each entity perceives for being actively involved.
- Step 3: Describe the business model of the High-Level Use-Case for each key NOBEL GRID actor involved, using the Business Modelling Canvas methodology (1) adapted in order to include social costs and benefits.
- Step 4: Identify the High-Level Use-Cases for each key NOBEL GRID actor and pilot site that are expected to be economically viable by performing a business plan analysis.

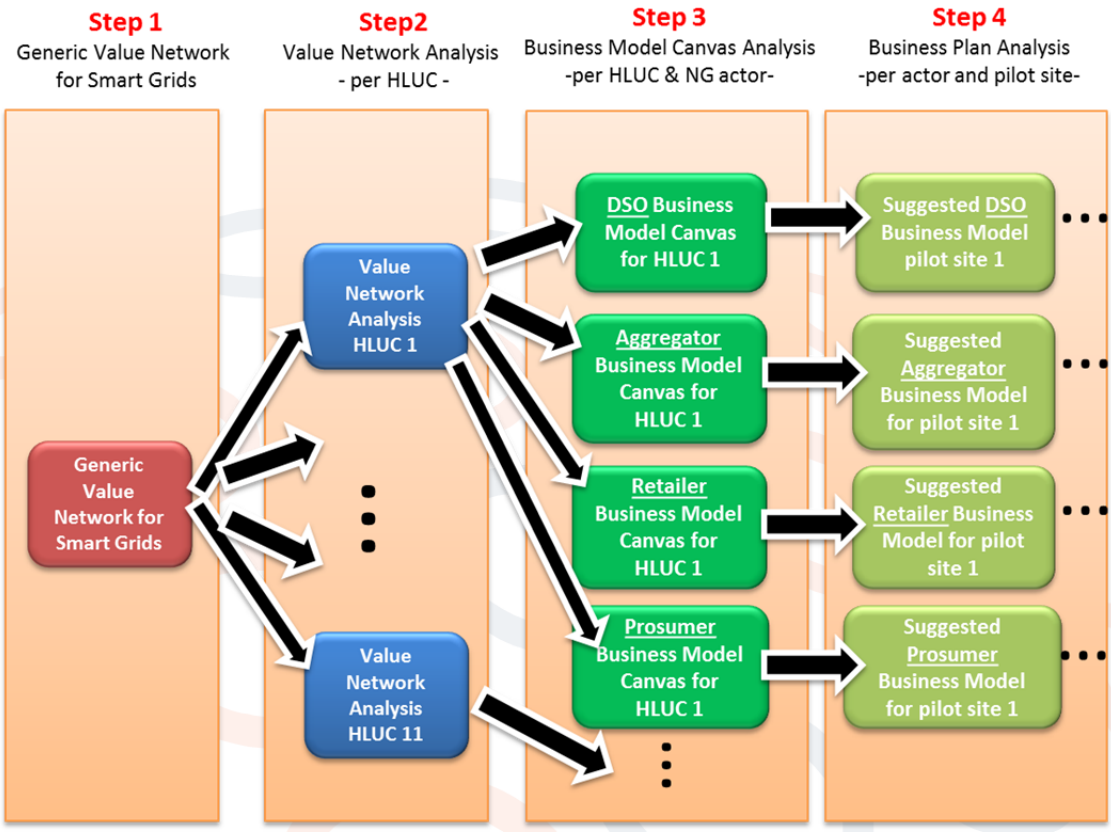

Figure 12: The overall methodology for analysing NOBEL GRID business models

The starting point of our work is to describe the main steps to be taken (by one or multiple business actors) for a certain product/service to be delivered to its current and prospective customers. It originates from the Porter's well-known value chain concept (20), widely used in the business literature to describe the value creation system among organizations. More specifically, a

service offered should be depicted as a system, made up of subsystems each with inputs, transformation processes and outputs, involving the acquisition and consumption of resources (money, labour, materials, equipment, buildings, land, administration and management).

The value chain model is a linear view of a business, more in the sense of an industrial production line, where money is exchanged for a particular input service/product. However, this is not sufficient to reflect the complexity and the inherent network character of the entities in the Smart Grid. For example, a DSO could offer an information service to end customers (e.g., when green energy is highly available) but the latter pay a membership fee to the aggregator with whom they have a direct business relationship. Finally, the aggregator will either share the fee with the DSO immediately or wait until all bilateral transactions are cleared. This is analogous to "freemium" services in the Internet; an end-user may not pay for a smartphone application but this is done by advertisers who want access to end-users' personal data.

Another reason for adopting the value network analysis methodology (21) is its focus on information flows, not only on physical outputs and money. Obviously information flows are key elements of Smart Grids and cannot be ignored. Note that NOBEL GRID report D3.1 (22), which focuses on mapping business goals of several actors to particular system architecture details, follows a complementary approach based on SGAM (Smart Grid Architecture Model) framework.

We have identified the following 7 main steps:

1. Power Production that is responsible for secure power generation (e.g., using fossil fuels, renewable sources, etc.). Note that this step can be performed by traditional, large power generators or even individuals (e.g., homeowners, entrepreneurs). This means that we focus on the core aspects of power production, which are not affected by size or technology.
2. Power Transmission by TSOs, which includes the High-Voltage transmission grid and the necessary actions to operate, ensure the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.
3. Power Distribution by DSOs, who provide customers with Low (or Medium) Voltage power and is responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.
4. Power Retailing that includes forecasting as accurate as possible the demand of end-users and customer relationships management (e.g., billing). In principle, this step can be performed by any service provider and thus can be highly competitive.
5. Power Consumption that includes all appliances that rely on electricity to operate or store energy for future use. These appliances can belong to both residential and commercial end-users. An interesting case is a company that operates a set of batteries for storing low-priced energy and selling it back to a DSO later. Such a company would perform both the roles of consumption and production, even though it does not generate new energy.

6. Wholesale Market Operation that is responsible for collecting cost information and expected demand in order to compute wholesale prices and production levels, as well as, for performing market clearing.
7. Energy-related aggregator services provided by Aggregators and ESCOs to the rest key participants of the smart grid (i.e. consumers/prosumers, DG, DSOs, retailers).

We should highlight again the distinction between roles and actors. One role (e.g., power production) can be performed by several actors (companies or prosumers), even if they have significant differences in terms of size, core market, etc. Furthermore, one actor can be involved in one or more roles; for example a retailer could also act as an aggregator.

Then, we defined a "standard" business model for each key NOBEL GRID actor and considered a set of 11 candidate extensions, called NOBEL GRID High-Level Use-Cases (HLUC). The importance of the Aggregator's role in smart grids can be evidenced in the generic value network by looking at the exchanged information and money flows.

Figure 1 (on page 13) describes a generic value network for smart grids. In wholesale electricity market competing generators offer their electricity output to retailers. Wholesale transactions (bids and offers) in electricity are typically cleared and settled by the market operator. Then, Electricity retailers provide fixed prices for electricity to their customers and manage the risk involved in purchasing electricity wholesale electricity prices. Retail bills paid by end-users usually cover the costs of wholesale energy, transport through transmission and distribution networks, and retail services.

Power generation from large scale power plants is transmitted through transmission network and distribution network to the end-users. Distributed generation (DG), connected at distribution network level is increasing its share in the energy generation mix. Also proactive consumers "prosumers", adopting distributing generation systems play a significant role in the smart grid market and alter the traditional business models.

Aggregators and ESCOs provide energy-related support services to key participants of the smart grid, i.e. consumers, prosumers, DG, DSO and retailers. The most important aspect of the aggregator's role is acting as Demand Response service provider and manage the negotiation between demand and energy sourcing stakeholders dispatching appropriate signals to aggregated consumers to provide demand flexibility to support grid operation after receiving an emergency signal from DSO or following retailers request, e.g. in particular timeslots when high wholesale prices are expected due to peak demand. An ESCO is a company that develops, installs and arranges financing for projects designed to improve the energy efficiency and maintenance costs for facilities over a time period. In the sequel Aggregators and ESCOs are merged in one actor called Aggregator.

In most European Member States, DSOs are responsible for metering as an integrated part of the grid whereas customers are always the owners of their data.

We believe that the selected steps/roles are key to analysing contemporary and future developments in Smart Grids. We could add additional supporting steps/roles but this would have a detrimental effect on the readability of the value network. Such omitted steps include, but are not limited to, the following:

- Information providers, such as those regarding weather forecast.
- Ancillary maintenance services, such as subcontractors for grid maintenance.
- Communications providers, such as Internet Service Providers.
- Financial institutions, such as banks and credit card issuers.

The next step is to perform a value network analysis for the set of 11 High-Level Use-Cases that were selected for demonstrating the NOBEL GRID concepts and tools, and whose business aspects were laid out in D1.3. For each one of those we will summarize the underlying business case of the key actors, as well as, the added value of the key NOBEL GRID products.

The third step is to describe the main value proposition, infrastructure used, customers, and finances among others for each HLUC/service and for each one of the 4 key NOBEL GRID actors. The large number of combinations requires a methodology supporting quick message delivery and efficient comparison. For this purpose, the business modelling canvas methodology has been selected which was extended to consider social (innovation, sustainability, social costs, benefits etc.) aspects, as well.

The following table gives an overview of a business model canvas.

Table 4: The business model canvas table and key information expected

<table>
<tr>
<td rowspan="2">Key Partners

The set of entities providing inputs (raw material or data) necessary for the service to be delivered. These partners can be upstream suppliers only, as well as, peers that occasionally become downstream providers.</td>
<td>Key Activities

The most critical tasks, i.e. those business processes whose details must be kept secret from rivals.</td>
<td rowspan="2">Value Propositions

The set of products / services and their properties (e.g., low-cost, high quality) an entity offers to meet the needs of its customers.</td>
<td>Customer Relationships

Automated & personalised relationships via the EMA app (e.g., forecast) and gamification techniques.</td>
<td rowspan="2">Customer Segments

The exact market that the business entity is focusing at. It can be a niche market (e.g., eco-friendly home owners) or a very broad one (such as Low-Voltage households and businesses).</td>
</tr>
<tr>
<td>Key Resources

The most important inputs for a product/ service to be realized.</td>
<td>Channels

The ways used for the value propositions to be delivered to customers. These can be privately owned or from third parties.</td>
</tr>
</table>

Cost Structure	Revenue Streams
The cost items that can be lump sum (such as the distribution network), repetitive but mostly fixed (for example personnel salaries), or repetitive and highly variable (like wholesale power bought).	The sources of revenue for the entity that can be either lump sum (e.g., connection fee), repetitive but fixed (such as monthly "all you can eat" prices) and repetitive but variable (like commission from sales of power).
Societal Costs	**Societal Benefits**
The negative effects of the product/service to the society (e.g., carbon emissions).	The positive effects of the product/service to the society (e.g., increased collaboration between society members).

The last step is to perform a business plan analysis for assessing whether a certain product/service (High-Level Use-Case) provides the desired return on investment. In other words, whether the expected revenues in a certain time period will not only cover the projected costs during the same period, but also allow a profit to be made that will secure the long-term viability of that entity. In order to do so we prepared a business plan template, which included the superset of cost items and revenue streams for all key NOBEL GRID roles. For example, the template included assets that are usually deployed by a single role (for example transformers by DSOs and Photovoltaic panels installed by power generators), as well as, those assets and services that could be of interest to more than one roles (such as servers and workstations).

Furthermore, the template supports two types of services; standard ones and the HLUCs. In the former case, it includes the baseline (standard) business model of a DSO performing the "Power distribution" role of the generic value network depicted in Figure 1, an Aggregator providing "Aggregator Services" only, a Retailer performing the "Power Retailing" role only, and a Prosumer who performs the "Power Production" by installing Photovoltaic panels on its rooftop, as well as, the "Power Consumption" role. In addition, the template captures the additional costs and revenues for each of the 11 HLUCs. The reason is to judge, from an economic point of view, whether a certain role should adopt a HLUC.

However, the business plan template should be able to handle differences among the 5 pilot sites. There are several factors for entities of the same role to judge the same service as profitable in one location, but not in another one. For example:

- costs may significantly vary across countries. This could be due to differences in the degree of competition to an upstream sector, or regulation (such as license costs)
- differences in regulation. For example, smart meters are installed by DSOs in all pilot sites but UK (Manchester), where it is the responsibility of the retailers.
- differences in population size and preferences that affect demand and thus revenues
- different corporate tax rates.

Thus, the business plan template is replicated along two dimensions. The first one is the key 4 NOBEL GRID roles, while the second is the location of the 5 NOBEL GRID pilot sites. In order to efficiently produce the business plans per location and role we worked as follows:

1. A reference business plan for each role was created. The costs and revenues for this reference business plan were specific to a certain location and covered both the standard/baseline business model as well as the 11 HLUCs. In Figure 13 we see that there is a reference business plan for DSO in Terni (Italy), which can be later be used for preparing a business plan for the rest pilot sites.
2. The costs and revenues between different locations and roles where associated using a set of scaling factors. For example, by multiplying the cost item for DSO licenses in Italy with the scaling factor for DSO licenses between Italy and Greece we could calculate the cost of DSO licenses in Greece. The main benefit of this approach was that scaling factors were defined and validated for each standard business model and were later utilized for associating the costs and revenues for the 11 HLUCs. Additionally, these were used for aggregating cost (or revenue) items into categories and using a single scaling factor for this category in a certain location. Furthermore, most cost and revenue items are proportional to the market size and thus were easily estimated.

By analyzing those 20 business template instances we are able to do the following:

- Propose services to be adopted by a certain role in a certain location. Note that not all roles are involved in the delivery of all services. The following table describes the presence of each role to the HLUCs, where a grey-shaded cell indicates inactivity.

Table 5: Roles active in each HLUC

Role	High Level Use-Case (HLUC)										
	1	2	3	4	5	6	7	8	9	10	11
DSO	X										
Aggregator				X	X	X					X
Retailer	X	X	X	X	X	X	X		X	X	X
Prosumer				X	X	X					

In order to evaluate the attractiveness we utilise the Internal Rate of Return (IRR), which is the interest rate at which the net present value of all the cash flows (both positive and negative) equal zero. A widely used rule of thumb is that IRR greater (or equal) than 30% are considered to be attractive. The time window used for evaluation has been set to 5 years. While, this is a rather conservative choice for capital intensive roles it is, however, in line with recent best practices for products/services following the agile product lifecycle paradigm. For compatibility reasons the costs and revenues are limited to those in the area under investigation, even

though some roles (notably retailers and aggregators) could have a national scope. However, we believe that this assumption has a limited effect on our results, since these roles require low CAPEX investments.

The overall approach together with an exemplary graphical representation of the results appears in the following figure.

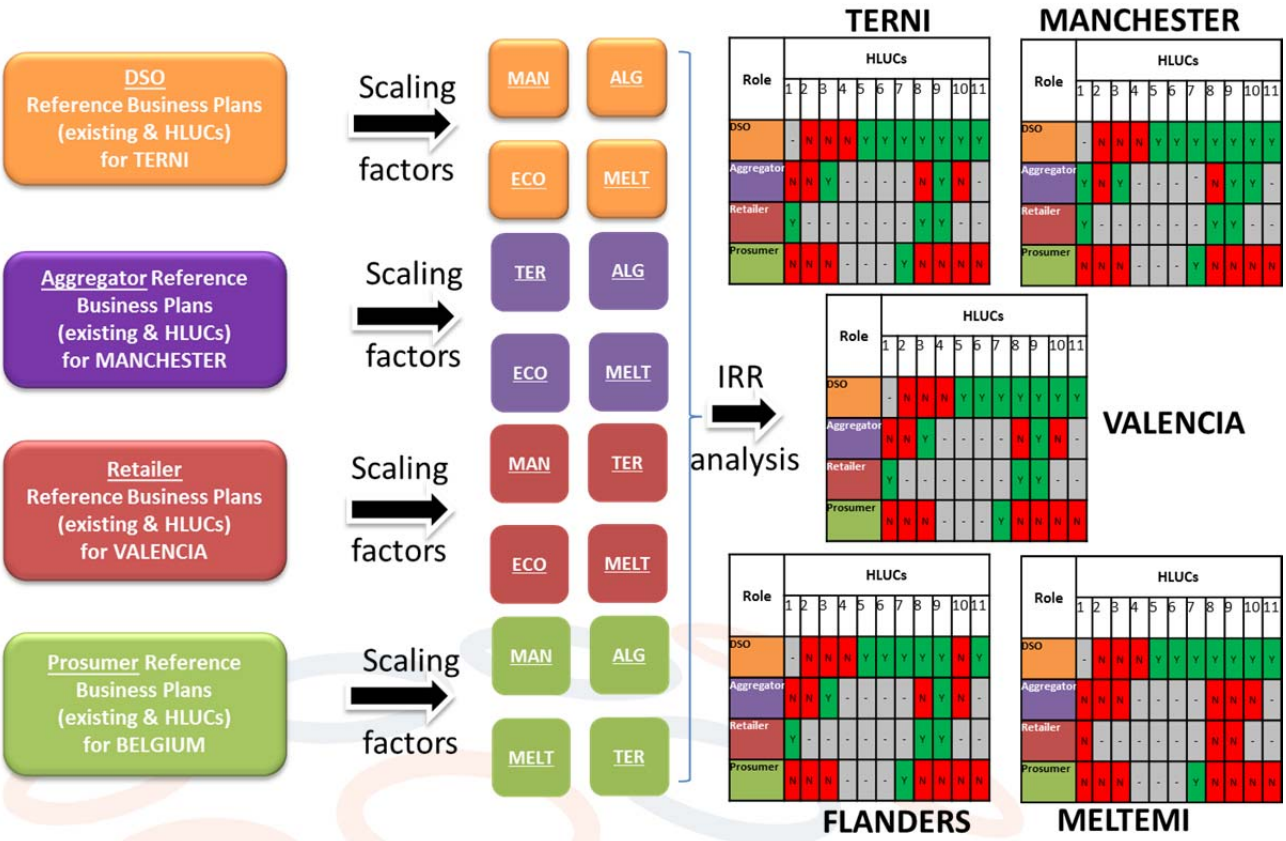

Figure 13: Our methodology for proposing services to be adopted by a certain role in a certain location.

- Assess the profitability of a certain role in a certain location at the equilibrium. In other words, how desirable was for the last entrant in the market for a certain role in absence of regulatory constraints (e.g., monopoly). We focus on the last entrant in order to take into account the effects of competition. For example, the profitability of roles characterized by high up front investments (Capital Expenditures) is expected to be more sensitive to the number of competitors. This means that we perform a worst-case scenario analysis for any newcomers. Again, finding that the IRR of this particular service exceeds the threshold of 30%, indicates that it should be adopted. In order to find the number of competitors at the equilibrium we started from the monopoly setting and, for the roles that no regulatory constraints exist, we increased the number of providers up to the point where an additional one would find the IRR threshold of 30% to be violated and thus reject the project.
  The overall approach together with a graphical representation of the results appears in the following figure. We observe that some roles are performed by more than one actors in some locations, for example in Valencia and Manchester Aggregators offer Aggregator

Services as well as the role of Power Retailer and vice versa, Retailers find profitable to extend their product portfolio to Aggregator Services. Note that this analysis is performed after assessing the attractiveness of each HLUC for all roles involved (the origin as well as the destination ones). Thus, the roles that could be merged are NOBEL GRID-enabled. Furthermore, the role of the DSO is assumed to be isolated due to regulatory constraints. Thus, we excluded the possibility of other roles becoming a DSO and, vice versa, a DSO expanding to other roles. Finally, we excluded the possibility of a prosumer becoming an Aggregator or Retailer as a very extreme case.

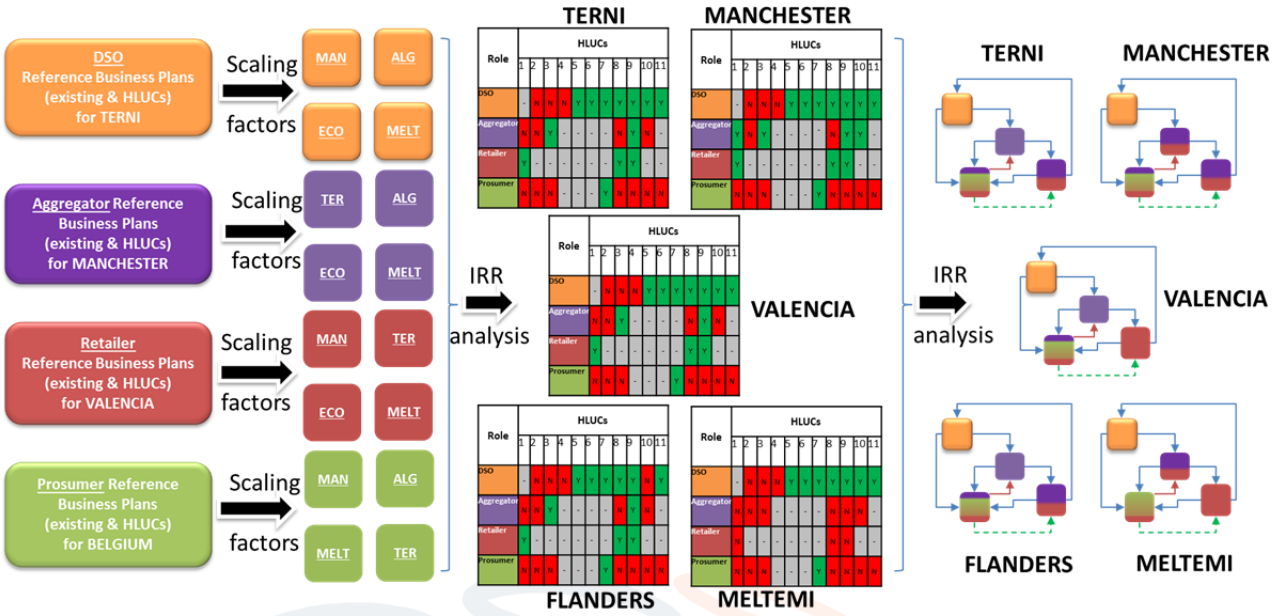

Figure 14: Our methodology for assessing the profitability of a certain role in a certain location.

- Identify bottlenecks in offering a certain service in a certain location. This means that all involved roles should have a positive net benefit (at least) in order for the service to be offered. Suppose, for example, that all roles but one (consumers) have a big interest in realizing Demand Response services. Then an incentive mechanism may exist that will make every participant happy (for example by slightly reducing the profitability of aggregators).

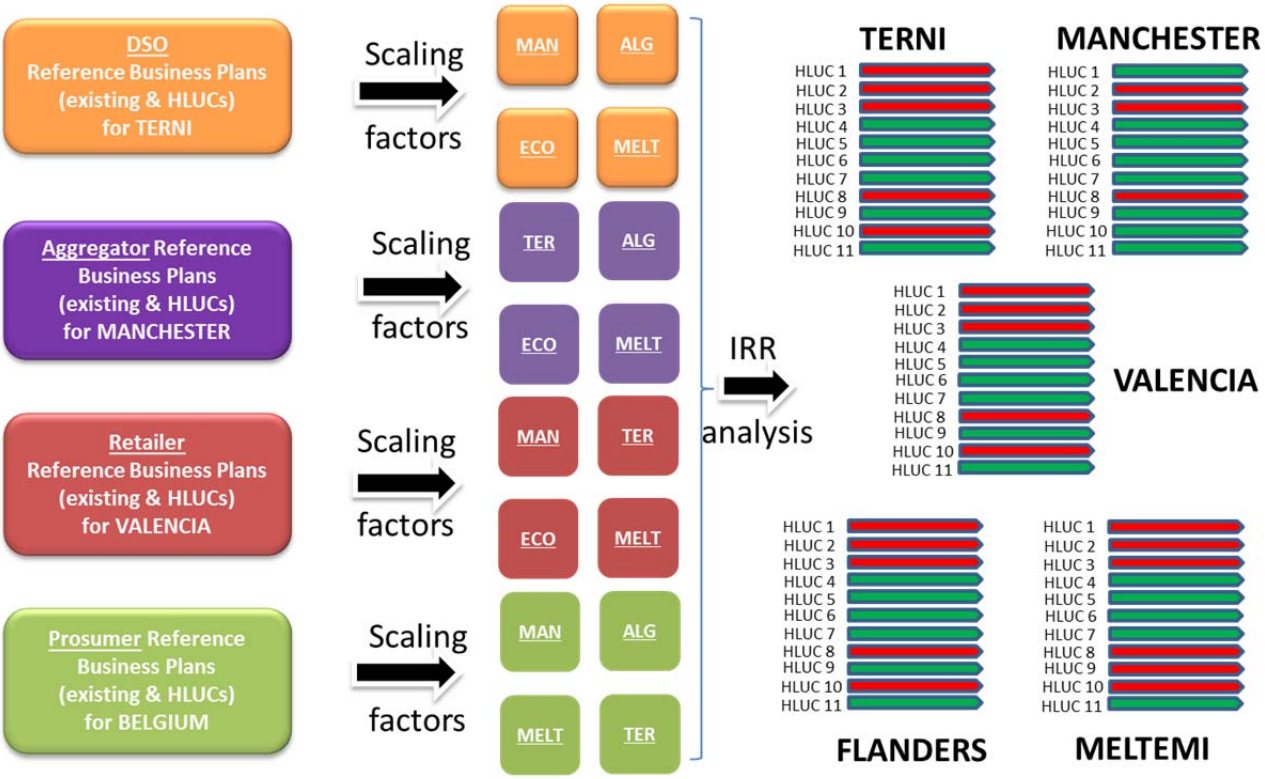

Figure 15: Our methodology for identifying bottlenecks in offering a certain service in a certain location.

4 USE CASE BUSINESS ANALYSIS

In this section, each High-Level Use Case is analyzed in order to document the expected value proposition of the involved NOBEL GRID products to the DSOs, Aggregators, Retailers and Prosumers.

4.1 HLUC – GREEN ENERGY MAX

Summary

The co-operative provides information around grid carbon intensity to the consumer. The main objective of this HLUC is to allow the consumer to reduce energy usage at times when the grid is at its most carbon intensive, by shifting usage to periods when renewable generation is at its greatest. Shifting is enabled by the provision of appropriate information that directs end users' actions and is further facilitated via device automation towards achieving consumer's goal of reducing personal carbon emissions.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), DRFM Cockpit, EMA App (such as the Carbon Coop toolbox)

Key Actors: Consumer/prosumer, and Aggregator (e.g., Carbon co-op)

Roles Involved

- *Power consumption:* Prosumers/Consumers will be customers and users of this product/service. By using social networks for publishing their achievements and other project results they could also act as intermediaries, fostering membership to the program.
- *Energy-related aggregator services:* The role for the Aggregator is to provide information and services to the consumers in order for the latter to maximize use of real time green energy; a service that has been identified as something prosumers want. Aggregators will be relying on the DRFM Cockpit for delivering tailored DR campaigns, reports, notices and alarms.

Value proposition for prosumers/consumers:

The new service, described in this HLUC, will enable users to maximize their green electricity use. This is a need that has been documented by members of non-profit cooperatives such as Carbon Co-op. More specifically, this service will provide **information** to the prosumers regarding the **renewable energy mix**, the **real-time energy consumption** and the **most suitable time for allocating energy consumption in terms of high renewable energy production**. In some cases joining the service could be an ethical choice instead of driven by financial incentives. This service would normally require a subscription fee to cover aggregator's costs. However, the energy cost won't be more expensive, nor there would be necessary for the end-user to make a high initial investment. Finally, the energy-related data will be privately provided. The prosumers will use a non-intrusive and easy-to-use technology (the EMA app) that ensures the continuous monitoring of their energy consumption through user-friendly dashboards, provides notifications of upcoming periods with high availability of renewable energy, manages DR campaigns, and controls remotely the wide-diversity of in-home loads/appliances. Prosumers will be able to put in practice recommendations about energy-efficient-use of their appliances. They will also enjoy the key

benefits of the service even if their loads can't be remotely managed. Finally, the service provided will use the most suitable communication and information channels for each prosumer, ranging from emails or SMS to mobile or tablet apps.

Value proposition for Aggregators:

The DRFM engine allows the Aggregator to perform user-oriented DR campaigns focused on fostering renewable energy use. The software module capabilities achieve savings in reducing wasted time collecting information about customers joined the program, in making energy-saving calculations and in obtaining external information. For DR campaigns, through the DRFM cockpit, aggregators will be able to do forecasting and simulations based on the business strategies of retailers etc. They will easily perform statistics, forecasts and calculations. Also, with minimal resources, they will broadcast notices and advertising information to customers in a consumer-oriented way. They will manage multi-channel communications satisfying end-customer needs and will offer a guaranteed service. The DRFM functionality runs in an interoperable way with IT already existing such as CRMs, ERPs, Business Intelligence, etc.

Revenue streams

- **Prosumers/Consumers**
  - Receive rewards/incentives from the Aggregator for participating in the program.
  - If the service is used by a company it can increase its revenues by selling "green products", e.g. green cooked dish by a restaurant (out of D2.3 scope).
  - If the service is used by a company, it can increase revenues by selling its non-used-emission's credits (out of D2.3 scope).
- **Aggregators**
  - Receive membership income from prosumers/consumers, as it is something that helps them achieve a more ethical/environmental lifestyle and reduce the penalties paid to DSOs for unused reverse power.
  - Potentially sell the service to DSOs (out of D2.3 scope).
  - Potentially provide market information to Retailers (e.g., peak prices or about periods with high renewable generation mix) in order to better estimate expected demand and optimize the purchase of energy under economic and environmental factors (out of D2.3 scope).

Cost streams/cost reductions

- **Prosumer/Consumer**
  - Low initial investment for smart meters and SMX (payable to DSO or Aggregator).
  - Low membership fee to Aggregator for the "green max service".
  - Possible energy bill reduction (shift consumption at times of high green energy mix and penalties paid to DSOs for unused reverse power).
- **Aggregators**
  - Initial economic investment.
  - Rewards/incentives to the prosumers/consumers.

4.2 HLUC – PROSUMER MAX

Summary

The co-operative provides services to prosumers that enable them to better match energy consumption with green energy production, as well as, to DSOs by finding a set of consumers who are willing to conform to DR requests in order to meet certain targets (e.g., excessive green energy is consumed). The main objective of this HLUC is to enable the prosumers to maximize the usage of the power they generate, reducing costs, carbon emissions and reverse power flows. Also, by providing a mix of information and automation (e.g. activating their appliances when their PVs are producing) the Aggregator ensures that prosumers get the best value from their investment in renewable technologies (self-produced energy consumption) and DSOs postpone investments for infrastructure upgrades.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), DRFM Cockpit, EMA App.

Key Actors: Consumer/prosumer, Aggregator, DSO.

Roles Involved

- Power Consumption: Prosumers/Consumers will be customers and users of this product/service. By using social networks to publish achievements and other project results they could also act as intermediaries, fostering membership to the program.
- Aggregator services: The role for the Aggregator is to provide information and services to the prosumers in order for them to maximize the use of self-generated energy. Aggregators will be relying on the DRFM Cockpit to deliver tailored DR campaigns, reports, notices and alarms.
- Power Distribution: DSOs will be end-customers, if they choose to purchase the flexibility being sold by an aggregator in the market.

Value proposition for the prosumer:

With the "prosumer MAX" service, described in this HLUC, prosumers will be **informed** about both **real-time energy consumption** and **production** and the **most suitable time for producing, storing, consuming or feeding energy in the grid**. They will also receive notices when, for example, there is demand for feeding energy to the grid. The prosumers will be also able to put in practice those recommendations received, by the week ahead or the day ahead, about energy-efficient-use of their appliances. The service provided will allow the use of the most suitable communication & information channels for each prosumer, ranging from emails or SMS to apps. All in all, prosumers will **reduce their energy costs** through an improved energy management.

Value proposition for the Aggregator:

The DRFM engine will allow the Aggregator to **perform user-oriented DR campaigns** focused on allocating energy consumption and production when required. It manages the feed-in or consumption respectively to or from the grid. The software module capabilities perform **savings in wasted time in collecting information** about customers who are joining the program, in making energy-saving calculations and in obtaining external information. Through the DRFM cockpit the aggregator will be capable of doing **forecasting and simulations based on business strategies** and

giving feedback about the flexibility capacity accomplished (KPIs) to DSOs or retailers. Also, statistics, forecast and calculations will be performed more easily and with minimal resources, aggregators will broadcast notices and advertising information to customers in a customer-oriented way (consumer's production forecast based on weather information, energy consumption, and request for demand flexibility). They will manage multiple channel communications satisfying the end-customer needs and will offer a guarantee of service. The DRFM functionality runs in an interoperable way with IT already existing such as CRMs, ERPs, Business Intelligence, etc.

Value proposition for the DSO:

The DSO will benefit from the "prosumer max service" by purchasing the demand flexibility based on renewable energy consumption and generation from the aggregators. DSOs will use that service in order to reduce reverse power flows. They also will reduce the risk of outages and economic penalties. They will provide greater network reliability, increased safety and enhanced security. They will improve their operational efficiency of their operational costs.

Revenue streams

- **Prosumers/Consumers**
  - Increased income by selling produced power to the grid (where allowed)
  - Receive rewards/incentives from the Aggregator for participating in the program (assuming that the aggregator sells this flexibility to the DSO).
- **Aggregators**
  - Receive membership income from prosumers.
  - Sell the service to DSOs.
  - Offer Retailers new contracts with SLA terms related to environmental issues (not in scope of this report).
- **Retailer**
  - Optimized purchase of energy under economic and environmental factors due to a more accurate estimation of expected demand (not in scope of this report).
  - Offer of new contracts with SLAs oriented to environmental issues (not in scope of this report).

Cost streams /Cost reductions

- **Prosumer/Consumer**
  - Low initial investment.
  - Low membership fee to Aggregator/Retailer for the "prosumer max service".
  - Reduced energy bill
- **Aggregators**
  - Initial economic investment.
- **DSO**
  - Initial economic investment.

- Purchase the service from the Aggregator/Retailer.
- Reduce the economic penalties for unbalance.
- Reduce the costs for maintenance and troubleshooting tasks.
- Postpone investments (out of D2.3 scope)

4.3 HLUC – SOCIAL HOUSING – ELECTRIC HEAT AUTOMATION

Summary

The purpose of this HLUC is automating electric heating systems to reduce consumer cost and increase grid stability. The Aggregator provides services both to the DSO (grid balancing) and the consumer by advising cost-effective energy consumption schedules. The main objective of this HLUC is to demonstrate the potential of large scale electric heating installations, to play a role in grid balancing and provide opportunities for energy aggregators to enter the market.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), DRFM Cockpit, EMA App.

Key Actors: Consumer/prosumer, Aggregator and DSO.

Roles Involved:

- Power Consumption: Prosumers/Consumers, such as the owners of large buildings, will be customers and users of this product/service. Again, by using social networks to publish achievements and other project results they could also act as intermediaries, fostering membership to the service.
- Aggregator services: The role for the Aggregator is to provide information and services to the prosumers in order for the latter to reduce their energy bills. Aggregators will be relying on the DRFM Cockpit for delivering tailored DR campaigns, reports, notices and alarms.
- Power distribution: DSOs will be end-customers if they purchase the flexibility being sold by an aggregator in the market.

Value proposition for the prosumer:

With the service "electric heat automation service" prosumers will benefit from both **reducing their energy consumption and allocating it at the most cost-effective times in an automatic way**, (automatic load control available for all AEHP models) and getting additionally rewards based on their flexibility provided. That is, lower consumption at times of high energy demand, satisfying their both environmental and economic concerns. The consumers will enjoy the benefits of a **set-it and forget-it solution** that will not require any surveillance. In addition, the end-user will be able to **withdraw any automated actions whenever she feels uncomfortable**. They will be able to assess the most suitable pattern in using their loads (AEHP) based on energy efficiency recommendations, user's comfort and energy cost. With a non-intrusive technology and via a wide range of different communication channels, they will manage value-added information for monitoring their real-time consumption, energy savings or KPI's for their flexibility. Also they will be **kept informed about current energy price and 48 hours** forecasting about the cheapest energy prices (decided on by the consumption pattern from the previous day).

Value proposition for the Aggregator:

The DRFM engine will enable the Aggregators to **perform user-oriented DR campaigns focused on shifting energy demand at off-peak periods** and **trade this demand flexibility**. The software module capabilities perform savings in wasted time in collecting information about customers who have joined the program, in making energy-saving calculations and in obtaining external information. For DR campaigns, through the DRFM cockpit, aggregators will be capable of doing forecasting and simulations based on business strategies and giving feedback about the flexibility capacity accomplished KPIs to DSOs. They will more easily perform statistical analysis, forecasts and calculations to provide energy efficiency recommendations, expected energy consumption and related costs, energy demand, etc. And using minimal resources, they will broadcast notifications and advertising information to customers in a customer-oriented way. They will manage multiple communications channels satisfying end-customer needs and will offer a guaranteed service. The DRFM functionality runs in an interoperable way with already existing IT such as CRMs, ERPs, Business Intelligence, etc.

Value proposition for the DSO:

The DSO will benefit from the "electric heat automation service" by purchasing the demand flexibility from the aggregators in order to improve grid stability. The DSO will also reduce the risk of outages and economic penalties. They will provide greater network reliability, increased safety and enhanced security. They will improve their operational efficiency also their operational costs.

Revenue streams

- **Prosumers/Consumers**
  - Incentives for DR campaign joining (A landlord could make savings on energy usage which could be passed on to the tenants).
- **Aggregators**
  - Receive membership income from prosumers (in the case of a collective housing scenario there may be an income stream from the landlord).
  - Sell the service to DSOs.

Cost streams/cost reductions

- **Prosumer/Consumer**
  - Low initial investment.
  - Low membership fee to Aggregator/ESCO for the service.
- **Aggregators**
  - Initial economic investment.
  - Incentives to customers
- **DSO**
  - Initial economic investment.
  - Purchase the service from the Aggregator.

- Reduce the economic penalties for unbalance.
- Reduce the costs for maintenance and troubleshooting tasks.
- Postpone investments (out of D2.3 scope)

4.4 HLUC – MAINTAINING GRID ASSETS

Summary

The main objective of this HLUC is to provide the DSO with the necessary tools to perform a better and more efficient monitoring and maintenance of the MV/LV grid assets. Through the monitoring and prognosis tools provided by NOBEL GRID the DSO will be able to forecast potential problems in the network and perform appropriate preventive actions.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), G3M Framework

Key Actors: DSO

Roles involved:

- Power distribution: DSOs will be end-customers.

Value proposition for the DSO:

The main goal of any grid operator is to provide power to its customers. For this it needs assets (cables, transformers, circuit breakers etc.). These assets need to be in a sufficient state in order to do what they are meant to do.

Up until now the traditional means for managing grid assets, especially cables, is basically a 'fit and forget' in combination with a 'beep system' of customers calling if a failure results in an outage ('Curative maintenance'). More accessible assets, like transformers, are usually maintained based on periodic manual inspections ('preventive and corrective maintenance'). The 'rules' for this maintenance are usually based on historic data of previous failures and sometimes also on the effect of a possible failure in combination with the 'desired' risk profile vs. maintenance budget ('risk based asset management').

Because grids are usually 'over-' designed and because of the long lifetime of the components, this method proved to be very efficient and is still in general more than adequate. Most failures in the grid are not caused by failing assets due to lack of maintenance, but by events like storms and icing, or cable cuts caused by digging.

However this situation is changing. Major parts of the grids are nearing their (previously) expected lifetime; loads are increasing due to electric mobility and electric heating/cooling; and distributed generation is emerging. Thus the need for more advanced ways of maintaining the grid assets is increasing.

On the other hand the tools to do so are being developed. Models that model the aging of assets under different circumstances become available. Cheap sensor technology is emerging fast as well as the methods to use them. For example with online measurements of partial discharges in cables it is possible to predict a few weeks in advance exactly where and when a cable will fail (with a precision of 1% of the cable length (ref://www.dnvgl.com/services/smart-cable-guard-7253). Similar services are being developed for other assets in the grid. Other gird assets will be monitored online in similar ways.

Specific measurements of smart meters can be used to assess the status of the distribution transformer 'upstream' as well as providing information of the general power flows in the grid. This information than can be used to avoid overcharging of grid components and thus prolong their lifetime. Some of this data might be private and owned by the consumer.

DSOs will enjoy a software module engine and innovative service "maintaining grid assets" part of the G3M, delivered in NOBEL GRID project, for a continuous surveillance and monitoring of the network. The G3M will enable the DSO to:

- Gather all the necessary data regarding the quality of service provided in each of the sectors/lines of the network.
- Monitor both the MV/LV network and the complete set of devices and assets of the line will provide a complete and accurate view of the network status in real time.
- Manage, control and configure the different network assets remotely.
- Monitor the incidents and outages of the network in real time and perform online response to most of them. A set of alarms could be set for certain type of incidents. The incident monitoring will also allow storing the historical incident data so they will allow making quality performance analysis over the time.
- Through the smart grid prognosis tool, the DSO will be able to forecast potential problems in the network and will be more capable to perform the appropriate preventive actions.

Revenue streams

- **DSO**
    - Increasing incomes by increased capacity managed and energy delivered through avoiding problems and congestions and increased performance of the existing network functionality (out of D2.3 scope).

Costs streams/Costs reductions

- **DSO**
    - Initial economic investment.
    - Postpone investment costs (out of D2.3 scope).
    - Reduce the costs for maintenance and troubleshooting tasks.

4.5 HLUC – CONTROLLING THE GRIDS FOR POWER QUALITY & SECURITY

Summary

The main objective of this HLUC is to ensure the power quality and security of the network by providing the DSO with the necessary tools to perform a continuous and online power quality monitoring that will point out abnormal power levels in the network in a more efficient manner, drastically reducing the response time to power quality failures and the maintenance costs.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), G3M Framework

Key Actors: DSO

Roles Involved:

- Power distribution: DSOs will be end-customers.

Value Proposition for the DSO:

DSOs will enjoy a software module engine and innovative service "power quality monitoring" part of the G3M, delivered in NOBEL GRID project. This service will enable a continuous surveillance and monitoring of power quality in the network, so that they can deliver new "**SLAs" in their service contracts, assuring high degree of power quality** by handling real time power level measures from different metering devices along the power grid, and foreseeing potential failures and scheduling preventive maintenance tasks, which has been validated by a previous simulation process (closed-loop control & self-healing automation). The reliability and the security of the service rests on the ability of performing remote real-time reading and monitoring of electrical parameters and energy demand along the LV network; that allows the fullness knowledge of the network status including the households. If a potential hazard it is detected the DSO will be able to deal another G3M engine to request flexibility to reduce demand capacity and also they will be able to run self-healing automation actions.

Revenue streams

- **DSO**
  - The accurate power quality control will allow the DSO to perform power quality contracts (or other type of contracts) which might increase its business opportunities. For example, A Power Distributor (DSO) offering service agreements based on minimum percentage of outages, overcurrent or under voltage situations to the aggregators and retailers, and them in turn to the end consumer (who may be a prosumer). This candidate revenue stream is, however, out of D2.3 scope.
  - Increasing incomes by increased capacity management (out of D2.3 scope)

Costs streams/Costs reductions

- **DSO**
  - Initial economic investment.
  - Postpone investment costs (out of D2.3 scope).
  - Better and more efficient power quality control will imply maintenance cost reduction and therefore an increase of the revenue.
  - Prevention of failures will increase the quality of services and reduce costs.

4.6 HLUC – BLACKOUT AND INCIDENT MANAGEMENT

Summary

Monitoring the incidents of the network and managing them in an efficient and time-responsive way. This high level use case will deal with such type of monitoring in the network by using the NOBEL GRID incident monitoring tool, among others. This is a key issue for the DSO to avoid potential bigger derived problems.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), G3M

Key Actors: DSO

Target Customers and roles:

- Power distribution: DSOs will be end-customers.

Value proposition for the DSO:

The services offered by this use case offer cost savings to DSOs in terms of maintenance, operation and asset life, rather than through direct revenue streams. In particular, by running the "blackout and incident management" service, DSOs will be able to better plan the resources needed for maintenance tasks, to reduce its maintenance costs and the related response-time, and to inform its customers about the causes of an incident. Through the software engine they will be more proactive with problems, and they will be able to take actions rapidly and to plan in advance. They will enjoy an innovative software engine, G3M, compatible and interoperable with DSOs' DMS system, interfacing with existing network data collection and control systems. And through the availability of multiple communication interfaces and standard protocols it will be able to improve the communication channels with the consumers, and also they will be able to better monitor the status of the grid. DSOs will be able to:

- Monitor the **incidents and outages** of the network in real time and perform **online response to most of them**. A set of alarms could be set for certain type of incidents.
- The incident monitoring will also allow **storing the historical incident data** so they will allow making **quality performance analysis** over the time. This type of analysis will be helpful to identify recurrent incidents or failures in the network and provide preventive solutions for them.
- Gathering all the necessary data about incidents in the network and monitoring both the MV/LV network and the complete set of devices of the line that will provide a complete and accurate view of the network status in real time. This will be of great use to the DSO.
- Manage, control and configure the different network devices remotely will help to solve incidents remotely, reducing the operational and maintenance costs and increasing the time-response failure.
- Through the smart grid prognosis tool, the DSO will be able to forecast potential problems in the network and will be more capable to perform the appropriate preventive actions to avoid further problems.

Cost streams/Cost reductions

- **DSO**
  - Initial economic investment (out of D2.3 scope).
  - Better and more efficient incident management will imply maintenance cost reduction.

4.7 HLUC – INCREASE IN POWER QUALITY

Summary

The DSO maximizes the power reliability and comfort for prosumers/consumers. The main objectives are to provide the DSO with the following assets: RES hosting capacity, congestion and overvoltage management, analysis and identification of undesirable situations together with early warning in order to take preventive actions, identification of reverse power flows, localization of

operational limits' violation, full awareness and monitoring, a record file of incidents and power quality indexes.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), G3M, EMA App, DRFM.

Key Actors: DSO, Prosumer

Roles Involved

- Power distribution: DSOs can provide a new service agreement in their SLAs. Note that DSO will be a simulated entity placed in Meltemi.
- *Energy-related aggregator services:* The role for the Aggregator is to provide information and services to the DSO in order for the latter to improve the quality and efficiency of its network.
- Power Generation: Prosumers/Consumers will be customers and users of this product/service. By using social networks for publishing their achievements and other project results they could also act as intermediaries, fostering membership to the program.

Value proposition for the DSO

Main value proposition to DSOs who puts in practice this new service is to **reduce the penalties they must pay if there were outages or blackouts at the network,** that is, a **lack of reliability and quality** in their service, and also the reduction of the **maintenance costs**, due to the work performed to solve the aforementioned incidents. DSOs will be able to know, in real-time, the network status, and will be able to forecast with hours/day ahead what will be the demand capacity, load capacity, PV generation, to detect the potential hazards and those critical nodes on where there would be operational limit violations. They will be warned automatically about these situations and after that, they will be able to make use of complementary tools such as "power losses reduction engine (HLUC 11)" to preventively solve the risks.

Value proposition for Aggregators:

As in previous sections, the DRFM engine will allow the Aggregator to **plan, test, perform and evaluate user-oriented DR campaigns** focused on allocating the energy consumption in an efficient way.

Value Proposition for the prosumer:

Prosumers will benefit from the service provided by their DSO by being continuously informed and assisted in order to **improve their energy production plant performance**. They won't have to worry about when to start the requested actions, because of their systems will be automatic controlled remotely. They will therefore receive a most reliable service and will suffer **lesser damages in their appliances.**

Revenue streams

- **Prosumers/Consumers**
  - Receive rewards/incentives from the Aggregator for participating in the program.
- **Aggregators**
  - Sell the service to DSOs.

Cost streams/cost reductions

- **Prosumer/Consumer**
  - Low initial investment.
  - They will experience less equipment damage
- **DSO**
  - Reduction of the maintenance costs.
  - Reduce the penalties they must to pay if there were outages or blackouts at the network.
  - Initial economic investment (out of D2.3 scope).

4.8 HLUC – THE CO-OPERATIVE POWER PLANT

Summary

The main objective is to create a **co-operative virtual power plant by combining a large amount of small prosumers** and a portfolio of larger DER production and balancing capacity. In this way, the co-operative could combine different roles to empower prosumers in the energy market.

This HLUC is linked to one business use case, namely 'Provide Aggregator Services'. For the demonstration plan and the business models around it, this HLUC may be broken into different business goals that will be demonstrated in this pilot:

- One in which the main business actors are DSO and Co-operative Virtual Power Plant (CoPP): CoPP takes role as Aggregator for the business goal 'increase grid stability'.
- One in which the main actors are CoPP and the energy market. The main goal of this HLUC is to act together on the Wholesale Energy Market based on Real Load Profiles of prosumers and production. The main business actors are the Aggregator, Retailer and Prosumers. The main business goals are: lower emissions, minimize energy bill, maximise profit and optimise energy usage. Practically it will be the aggregator that provides services to the power retailer to help its business in the wholesale market.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), EMA App, DRFM

Key Actors: Aggregator, Retailer, prosumers, DSO

Roles Involved:

- Power consumers/producers: Prosumers/Consumers will be customers in the sense that joining the Aggregator will help them optimize their consumption, but on the same time they also play a key role for the success of an aggregator's DR strategies.
- Power distribution: DSOs will be customer for flexibility services for grid stability
- Power retailer: the aggregator can offer DR and data-services to the retailer to optimize production and consumption portfolio with which the retailer can organize strategy in buying/selling energy from/to the BRP.

Value proposition for the Aggregator:

The DRFM cockpit will enable overview, analysis and actions necessary to be able to organize the community:

- DRFM can receive and integrate information on electricity market (day-ahead, intraday, imbalance pricing, load forecasts, etc.) and weather data with forecasts.
- DRFM gives real time insight about available DR-capacity from the connected DER installations and/or loads within the CoPP.
- DRFM will give alarms in case of available DR-capacity lower then contracted or in case of imbalance with BRP/ARP contract.
- DRFM gives insight in production and production forecast of connected DER-sites and prosumers RE-production.
- DRFM can receive DR-action requests from third parties with whom the CoPP has flexibility contracted and can send the appropriate confirmation signals.
- DRFM can organize DR-action towards all available flexibility resources in the CoPP; DRFM will give feedback on DR-actions: measurement of results.

Value proposition for the power consumers/producers:

The value for the prosumers will be both quantitative as qualitative. They will be customers in the sense that joining the CoPP will help them optimize their consumption. In this way they will be able to have more auto-consumption of their production, less consumption in general and lower CO2-emissions. On the same time they will be partner (and co-owner) of the CoPP and will have financial profit of the flexibility services that will be offered to the power transmission, distribution and retailing.

Revenue streams

- **Prosumers/Consumers**
  - Members, who join the CoPP, can be rewarded (yearly refunding based on merit in the CoPP).
  - As owners of the aggregator, they will profit of all net financial income (out of D2.3 scope).
- **DSO**
- **Power retailing**
  - Higher profit with production/consumption portfolio.
- **Aggregator**
  - Providing balancing capacity and stability services to DSO will be rewarded.
  - Helping the power retailer with its consumption/production portfolio will be rewarded.

Cost streams/cost reductions

- **Prosumer/Consumer**
  - Investment in SMX to join. In D2.3 we assume that this cost is paid to the Aggregator at sign-up, but a leasing formula could be used.
  - If automated DR is necessary, possibly investment in SHID components to communicate with heating/cooling installations (out of D2.3 scope).

- If battery or inverters are involved, possibly investment in SHID components to connect to these (out of D2.3 scope).

- **DSO**
  - Distribution have to invest in organizing and controlling stability services via G3M
  - Power Distribution has to pay Aggregator for its services
  - Reducing operational costs by buying flexibility services
- **Power retailing**
  - Has to invest in DRFM to be able to communicate with and to control aggregator
  - Has to pay for the aggregator services.
  - Cost-reduction generated through the services of the Aggregator.
- **Aggregator**
  - Initial economic investment in the DRFM software
  - Has to invest in commercially contracting prosumers and DSO's
  - Has to invest in hardware needed to deploy its Flexibility services

4.9 HLUC – IMBALANCE REDUCTION THANKS TO THE SMART CITIZENS INVOLVEMENT IN DR

Summary

The DSO reduces the power losses in the power grid thanks to the shifting of the consumption during the periods of reverse power flow in the substations. The main objective is to provide to the customer information about when there is an excess of green energy in the power grid. With different strategies DSO can involve the customers to shift his consumption during reverse power flows in substations. In this way DSO obtains power losses reduction and customers increase their green energy consumption.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), G3M, DRFM, EMA App

Key Actors: DSO, Aggregator, prosumer/consumer

Roles Involved

- Power Distribution: DSOs will be a customer of this service.
- Aggregator services: Aggregators will be coordinating the DR services.
- Power Consumption: Prosumers/Consumers will be responding to DR requests.

Value proposition for the DSO:

When the DSOs have to deal with a huge amount of DER and RES at their networks, they will benefit from G3M software by the analysis engine that, 24/72 hours in advance, it calculates outcomes to determine if there would be a reverse power flow problem, through the real-time status information of the network, the forecasted demand and expected green energy generation. With the value-added information obtained, DSOs will be able to request large-scale consumers directly or through an aggregator (especially when small-scale consumers participate), on the one

hand to shift their energy consumption when the highest green energy production, and on the other hand to reduce the energy generation by those who are producers. They will request the aforementioned flexibility automatically. With these features and capabilities they will **reduce the power losses, will reduce the penalties, they will increase their service quality and network reliability and also they will offer a customer-oriented service based on environmental and social terms.**

Value proposition for the Aggregator:

Aggregators will enjoy a software engine through which to make an evaluation of different flexibility campaigns based on both the different customer groups, and business models or environmental & social parameters. So, they will be able **to identify the most suitable customer/customers for a flexibility requirement**.

For flexibility trading, they will provide the DSOs with forecasted information about the demand capacity, and will guarantee a reliable service that will give periodically feedback to the DSOs about the flexibility achieved. So, through the DRFM cockpit they will also be able to request a higher involvement to accomplish the goals if required.

Hence, they will be able to offer innovative energy services focused on environmental issues. They may increase their customers, and they will be able to preventively act if the expected flexibility there is no achieved.

Value proposition for the prosumer:

They will be able to contract with an energy service provider (DSO, aggregator) that will **reward them** not only **for their efficient energy use**. They will benefit by a tailor-made service through which they will be automatically notified at the highest green-energy-availability times. They will be able to access the information wherever they are by accessing to an online web application, on where they will assess their energy consumption profile, and also their scores in reaching the expected environmental commitment.

Revenue streams

- **Prosumers/Consumers**
  - Receive incentives/rewards from the Aggregator for participating in the DR.
- **Aggregator**
  - Sell the service to DSOs.
  - Sell the service to Retailers (out of D2.3 scope).
  - Receive membership income from prosumers (out of D2.3 scope).
  - Offer of new contracts with SLAs oriented to environmental issues (out of D2.3 scope).
- **DSO**
  - Increasing profit by increased capacity management or energy supply (out of D2.3 scope).

Cost streams/cost reduction

- **Prosumer/Consumer**
  - Low initial investment.

- **Aggregator**
  - Initial economic investment.
  - Provide incentives/rewards to prosumers for participating in Demand Response Programs
- **DSO**
  - Initial economic investment.
  - Reduce the costs for maintenance and troubleshooting tasks.
  - Purchase the service from the Aggregator.
  - Reduce the economic penalties for unbalance
  - Postpone investments (out of D2.3 scope).

4.10 HLUC – EFFICIENT RECOVERY FROM POWER OUTAGE

Summary

The DSO uses the demand flexibility to support system restoration after fault. The main objective is to allow the DSO to solve potential congestion problem caused by a reconfiguration in the network made after an unexpected fault event in the power grid. The DSO will be able to reconfigure the network topology in order to isolate a fault while maintaining the maximum number of consumers under normal supply. The DSO will manage the demand flexibility of the customers to allow network configurations that otherwise are not feasible.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SLAM), G3M, DRFM, EMA App

Key Actors: DSO, Aggregator, Prosumer

Roles Involved

- Power Distribution: DSO will be end-customers. ~~They will provide a new service to their prosumers.~~
- Aggregator Services: Aggregators are the providers of the service to DSOs, i.e. they sell flexibility capacity to the DSOs.
- Power consumption: Prosumers/consumers will be the intermediaries, by responding to DR requests when the find it appropriate.

Value proposition for the DSO:

With this new capability, the DSO will benefit from a minimum flexibility volume through which facing the upcoming incident events at the power network. By using the G3M, if an outage or any other fault occurs, the DSO will be able to **calculate the best process to recover the normal status of the network**. A best process based on both the number of actions to perform (response-time) and customers to be affected. The G3M offers interoperability and compatibility with DMS system and also with the aggregators, so that they automatically receive information about the expected energy demand and flexibility accomplished, as well as, request for flexibility to the aggregators. By these features and capabilities they reduce the penalties, they will increase their service quality and network reliability and also they will offer a customer-oriented service.

Value proposition for the Aggregator:

Aggregators will enjoy a software engine through which they will be able to make an evaluation of **different flexibility campaigns based on both the different customer groups and business models**. So, they will be able to identify the most **suitable customer for a flexibility requirement**.

For flexibility trading, they will provide to the DSOs with forecasted information about the demand capacity, and will guarantee a reliable service that will periodically give feedback to the DSOs/retailers about the flexibility achieved. So, through the DRFM cockpit they also will be able to request more involvement to accomplish the goals if required.

Hence, they will be able to offer a high quality service in the power supply to their customers, to those who the aggregator acts on behalf of, ensuring the quality of the service at critical times.

Value proposition for the prosumer:

They will benefit by a tailor-made service through which they will be **automatically notified when capacity flexibility is required**, and when it has been performed the **automatic load control of their loads**. Being them **rewarded accordingly to their flexibility** in shifting their energy consumption for helping to the most quick network restoration to its normal status. They will be able to access the information wherever they are, by accessing an online web application, on where they will assess their energy consumption profile, and also their scores in reaching the expected flexibility and the overall information about the actions on where they are involved in.

Revenue streams

- **Prosumers/Consumers**
  - Receive rewards/incentives from the aggregator to participate in the DR program.
- **Aggregators**
  - Sell the service to DSOs.
- **DSO**
  - Increasing profit by increased capacity management and energy supplied (out of D2.3 scope).

Cost streams/cost reductions

- **Prosumer/Consumer**
  - Low initial investment.
- **Aggregators**
  - Initial economic investment.
  - Give rewards/incentives to consumers
- **DSO**
  - Purchase the service from the Aggregator.
  - Initial economic investment.
  - Reduce the costs for maintenance and troubleshooting tasks.
  - Reduce the economic penalties for bad quality of service.

4.11 HLUC – POWER LOSSES REDUCTION THANKS TO POWER FACTOR MANAGEMENT

Summary

Then main objective of this HLUC is the **reduction of power losses** in the power grids thanks **Power Factor Management in production plants.** Customers will engaged thanks the possibility of the power losses reduction in their production plants.

High Level Use Case Business Analysis:

NOBEL GRID Products: Smart Meter (SMX), G3M, EMA App

Key Actors: DSO, Prosumer

Target Customers and roles:

- Power distribution: They will provide a new service to their prosumers (reliability agreement).
- Power production/Power consumption: They will be target users (end-users). Both energy producer and consumer.

Value proposition for the DSO:

The DSO will avoid **unbalance at the network**, will **improve the power quality** of the energy supplied and will **better manage the voltage control in its network**.

Through the "power losses reduction" service, DSO will encourage prosumers (owners of PV plants) to be willing to get less performance at their generation plants whilst there is high-current in lines. The G3M engine allows them to continuously monitoring the status of the grid, the real-time voltage level at critical network nodes, and forecasting every 15 minutes, the optimal power factor for each production plant to reach the suitable current level at the lines. The optimal value forecasted it is calculated by a power flow algorithm and a mathematical model of the power grid. The DSO will assure the expected flexibility providing a SMX device to the prosumer through which remotely activate a signal to change the set-point value for power factor for the prosumer plant in an automatic manner.

Value proposition for the prosumer:

The prosumers who own photovoltaic plants will benefit from the "power losses reduction service". Through a state-of-the-art technology device, SMX, for monitoring both the PV's energy production and its performance, they will be rewarded by adjusting their installation performance (power factor) to the DSO's requirements to the correct value to avoid penalties. By joining the service, this is made in an automatic way. Through the SMX the prosumer receives the power factor set-point value to be configured at his power factor regulator of his photovoltaic plant.

Revenue streams

- **DSO**
  - Income from the new service (increased committed reliability) provided to the prosumers (low membership fee).
- **Prosumers**
  - Income from increased performance thanks a better power factor.

Cost streams/cost reductions

- **DSO**

- Initial economic investment.
- Cost reduction due to power losses reduction.
- Postpone investment costs (out of D2.3 scope).

- **Prosumers**
  - Low initial economic investment.
  - Low membership fee.
  - Reduced penalties for reactive power

5 VALUE NETWORK ANALYSIS OF HIGH LEVEL USE CASES

In this section we will perform a value network analysis for each high-level use-case, in order to systematically document the role of each key actor and the flow of goods and information between them.

5.1 HLUC – GREEN ENERGY MAX

The following two figures depict candidate value networks that are specific for this particular HLUC. In Figure 16 we observe that each one of the 7 main roles is performed by a single type of actors, while Figure 17 presents an alternative value network for HLUC 1 where the retailer also performs aggregation services and power is produced by consumers using RERs[5].

Furthermore, some interactions are missing from Figure 16 compared to the generic value network of Figure 1. More specifically, the Aggregator does not manage production from RERs and thus does not process any metering data from RERs in order to send requests for production changes. Neither does the Aggregator sell its capacity flexibility to DSOs for network balancing purposes (this case was left out of scope even though could be a valid revenue stream). In addition, the Aggregator does not trade its DR portfolio in the wholesale energy market and thus does not interact with the Market Operator. The Aggregator handles the day-ahead public energy mix production market information from the wholesale market published by the Market Operator. Retailers do not request flexibility form aggregators at peak pricing periods. Nevertheless they are interacting directly with the market operator to purchase “green” energy.

Note that this is one instance of all possible value networks that could be arise. For example, the role of providing Aggregator services could be played by Retailers as well, who want to take advantage of their existing customer base (ECOPOWER, for example, is an Aggregator/Power retailer). The latter case appears in Figure 17, where changes are denoted with a bold, yellow outline.

[5] One could say that all actors are also consumers of power, but such an addition would increase the complexity of the figure without adding value.

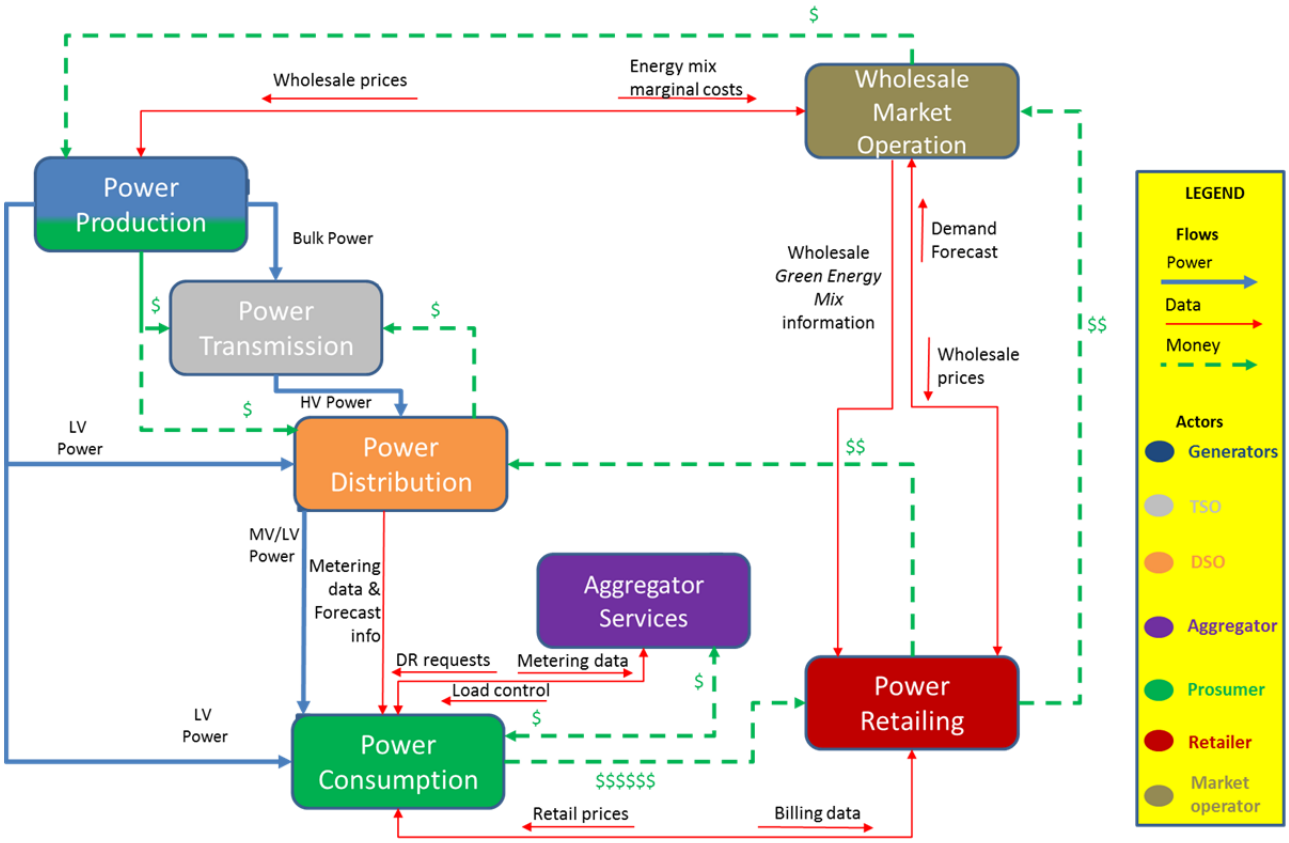

Figure 16: The value network for HLUC 1

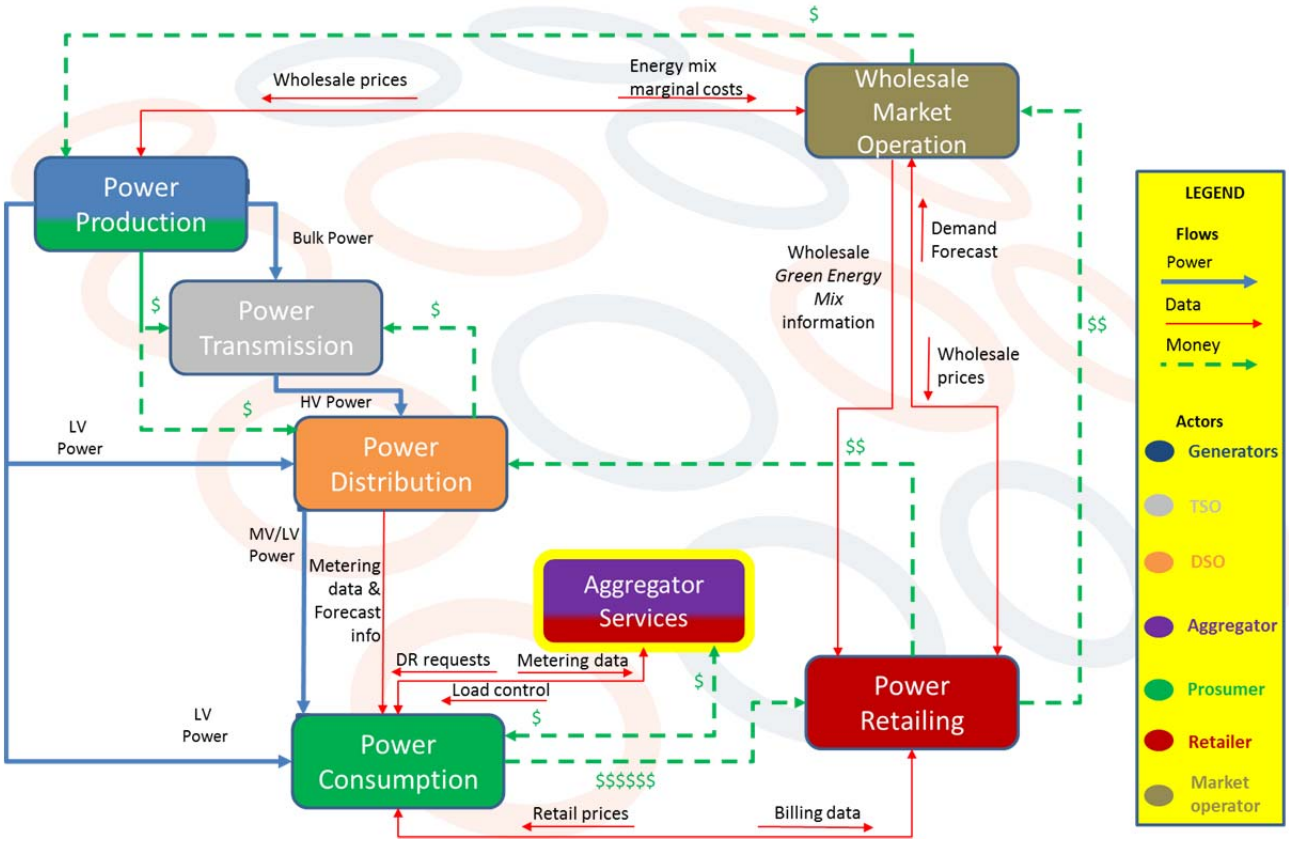

Figure 17: An alternative value network for HLUC 1 (changes are denoted with a bold yellow outline)

5.2 HLUC – PROSUMER MAX

Each of the 7 main roles in is performed by a single type of actor, with the exception of "Power production" that can be taken by both Generators and Prosumers.

Furthermore, some interactions are missing from Figure 18 compared to the generic value network of Figure 1. More specifically, the Aggregator does not manage production from RERs and thus does not process any metering data from RERs in order to send requests for production changes. In addition, the Aggregator does not trade its DR portfolio in the wholesale energy market and thus does not interact with the Market Operator. Finally, note that the Aggregator also manages the remote control of prosumers' appliances via DR requests in order to reduce their energy consumption, specifically controlling energy storage, fitting it to the balancing requirements and grid harmonization issues.

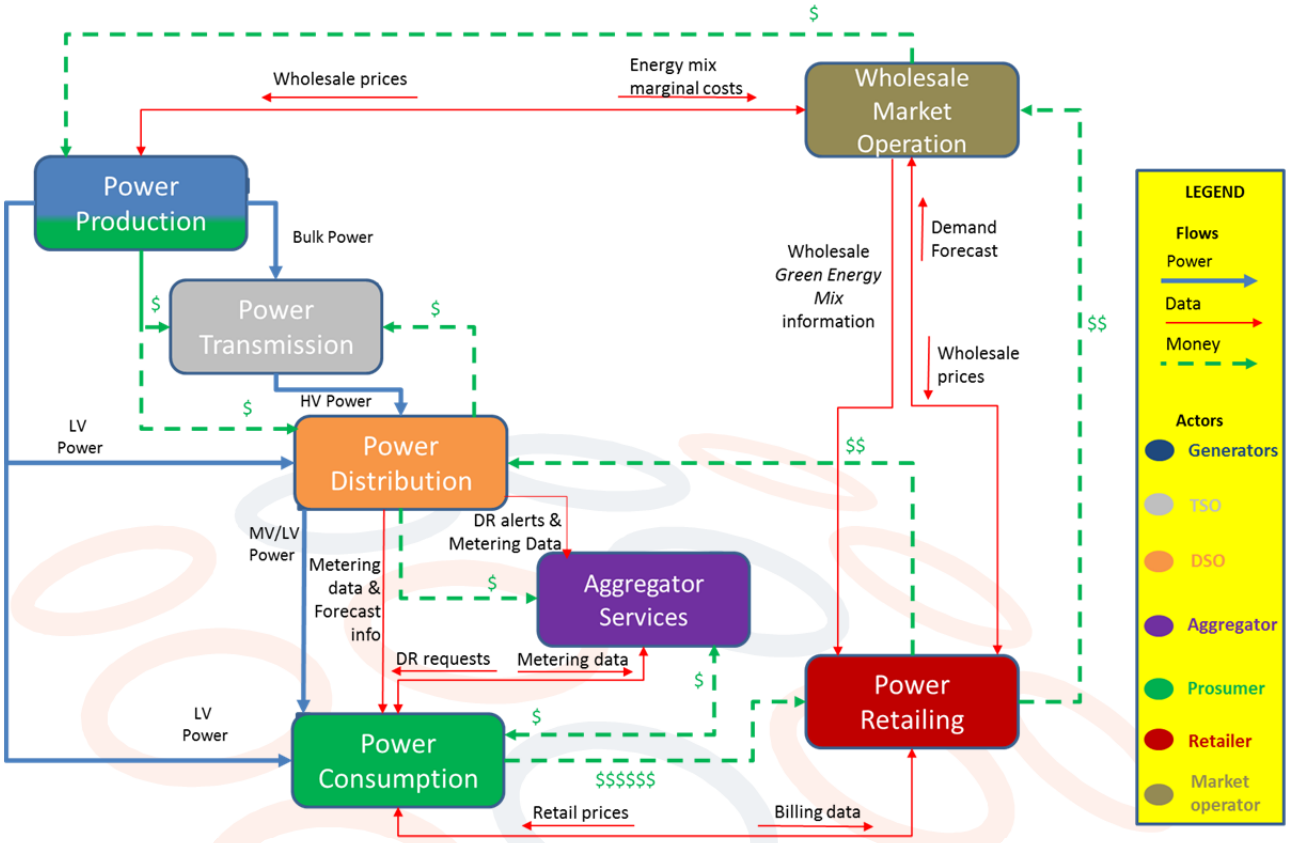

Figure 18: The value network for HLUC 2

Note that this is one instance of all possible value networks that could be arise. For example, the role of providing Aggregator services could be played by Retailers as well, who want to take advantage of their existing customer base (and vice versa). Such a value network appears on the following figure, where the Aggregator services role appears with two colors (purple for Aggregators and red for Retailers).

In the rest of the section we will focus on one candidate value network, i.e. the baseline one. Alternative configurations will be explored in Section 7 by taking into account their economic viability, even though no additional value network diagrams will be provided.

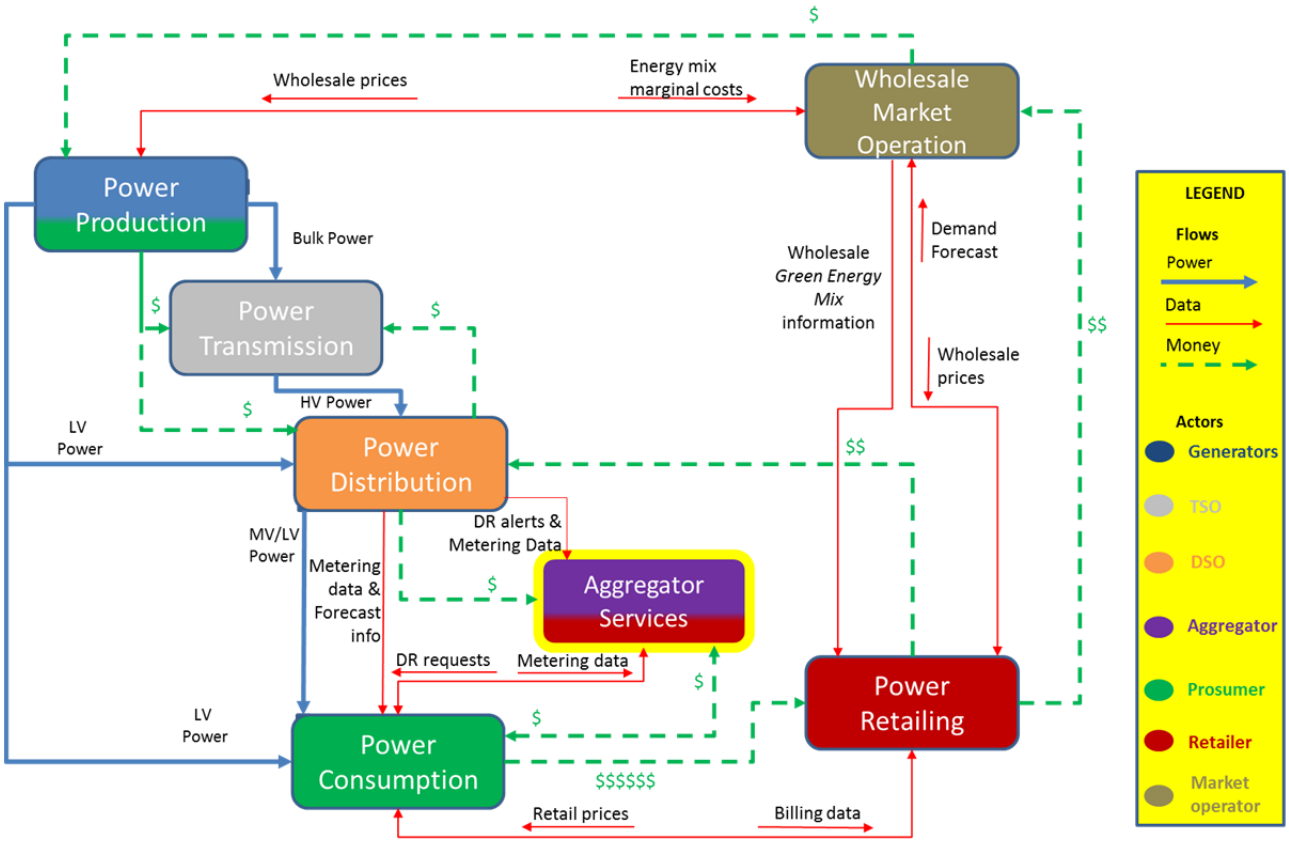

Figure 5: An alternative value network for HLUC 2 (changes are denoted with a bold yellow outline)

5.3 HLUC – SOCIAL HOUSING – ELECTRIC HEAT AUTOMATION

Electric heat automation with heat pumps in combination with heat storage is a relatively cheap source of flexibility that can be used for all stakeholders. This flexibility can be used to procure cheaper energy (i.e. to use the electricity when it is cheapest), to help the grid operator (DSO) when there are grid capacity problems and also by consumers if they prefer to make optimal use of specific energy sources (e.g. Green Energy Max). The aggregator is using the flexibility of the electric heat system to find an (for the individual consumer) optimum between these goals. Some consumers would like to sell their flexibility to the 'highest bidder', the market or the DSO, some consumers might like to use as much solar energy as possible at the cost of a (little) higher energy bill.

The following figure (Figure 19) depicts a candidate value network assuming that the aggregator and the retailer are different actors.

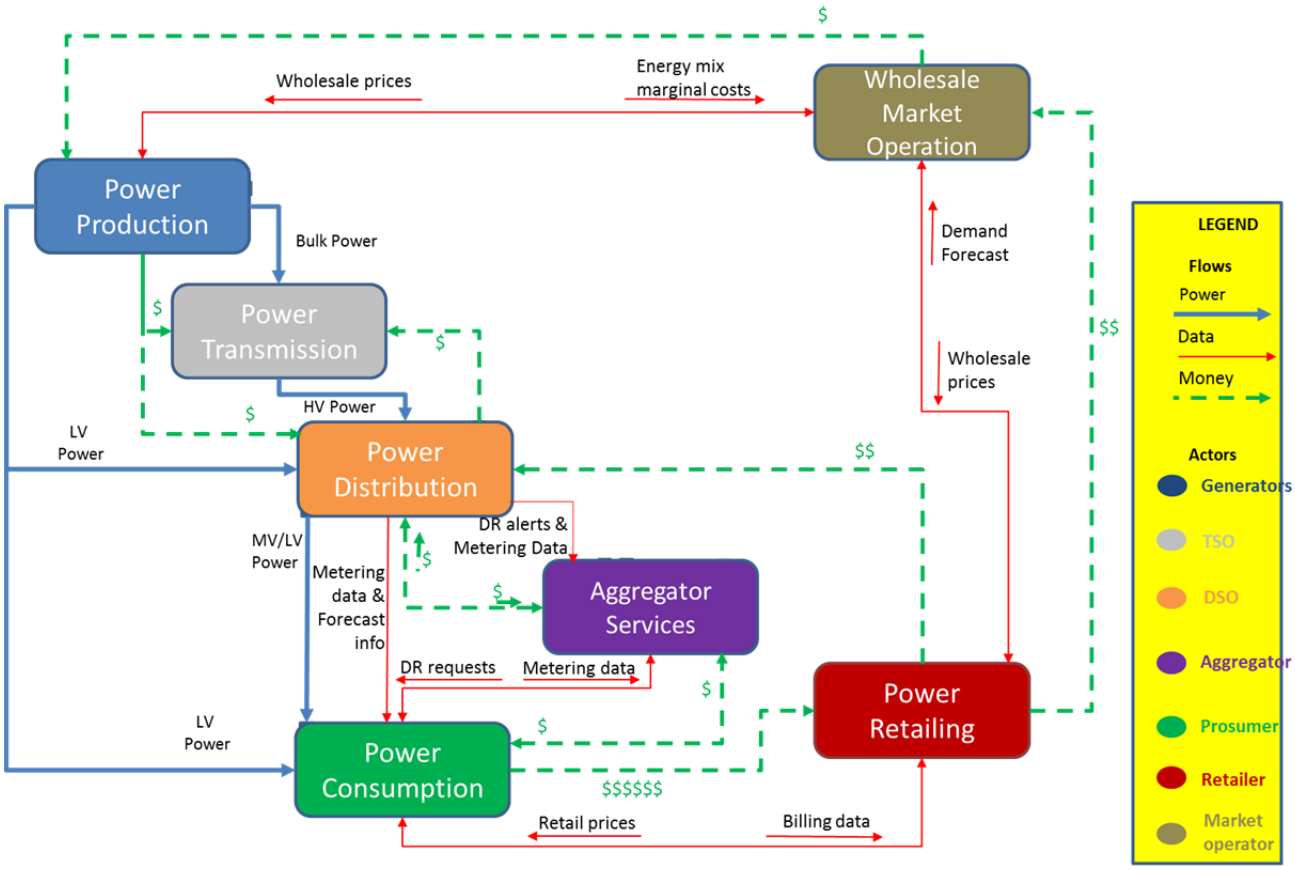

Figure 19: An aggregator optimizing the use of flexibility achieved by automatic heating among stakeholders

5.4 HLUC – MAINTAINING GRID ASSETS

Each of the 7 main roles in the value network shown in Figure 20 is performed by a single type of actor apart from the "Power Production", which can be performed by professional generators and prosumers. Furthermore, some interactions are missing from the figure below compared to the generic value network. More precisely, the Aggregator does not participate in this HLUC and thus its interaction with the DSO, the prosumer and the retailer are not included.

Even though the Aggregator's role is limited in this High-Level Use Case, one could imagine scenarios where it is actively involved. For example, an Aggregator could retrieve measurements of smart meters and disclose it to other stakeholders with the consent from the consumers for assessing the status of the distribution transformer 'upstream', as well as, providing information of the general power flows in the grid. This information than can be used to avoid overcharging of grid components and thus prolong their lifetime. However, such interactions are out of scope of this report.

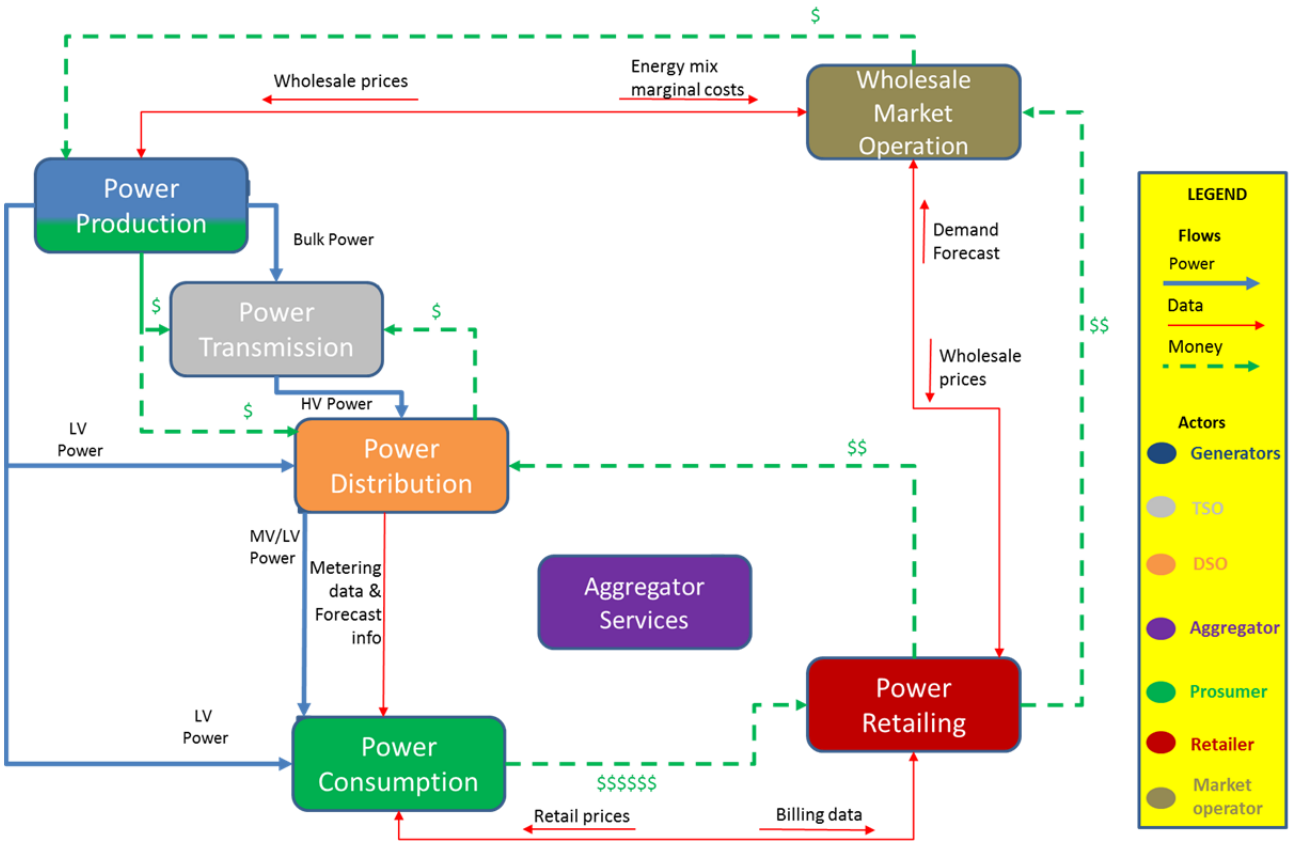

Figure 20: The value network for HLUC 4

As will be shown in Sections 5.5 and 5.6, the baseline value networks for HLUCs 4, 5 and 6 are the same. The only difference are the data elements and their processing by the DSO to achieve its operational targets.

5.5 HLUC – CONTROLLING THE GRIDS FOR POWER QUALITY & SECURITY

The following figure depicts a candidate value network for this particular HLUC. Note that some interactions are missing from the Figure 21 compared to the generic value network. More precisely, and similar to Figure 20 and Figure 22 (see next section), the Aggregator does not participate in this HLUC and thus its interaction with the DSO, the prosumer and the retailer are not included.

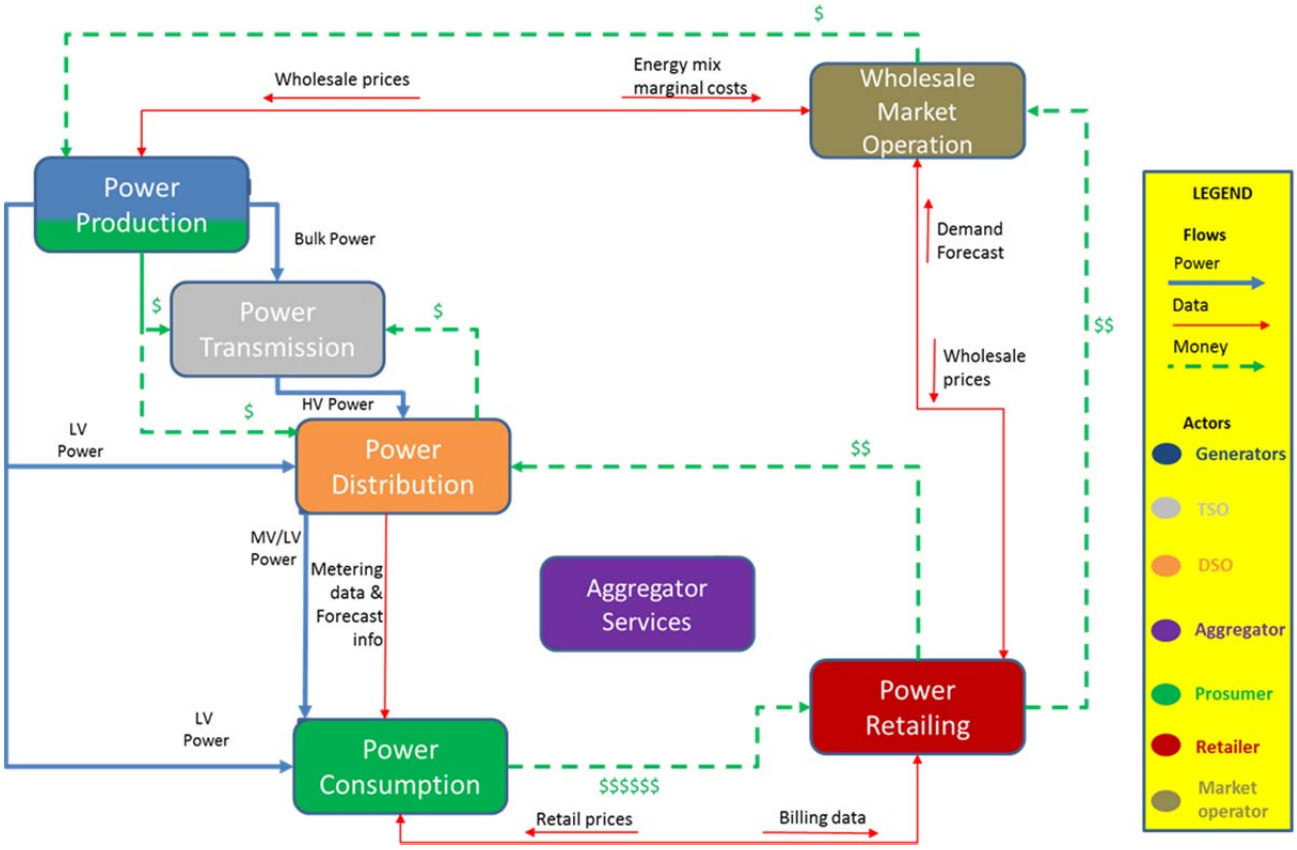

Figure 21: The value network for HLUC 5

5.6 HLUC – BLACKOUT AND INCIDENT MANAGEMENT

The following figure depicts the baseline value network for this particular High level use case, where a Power Distributor (DSO) offers incident reporting, incident management and remote incident resolution through the use of advanced tools and data and analytics, resulting in improved response time, better quality of service and network cost savings for the DSO. Note that the value network is similar to those for HLUC 4 (Figure 20) and HLUC 5 (Figure 21).

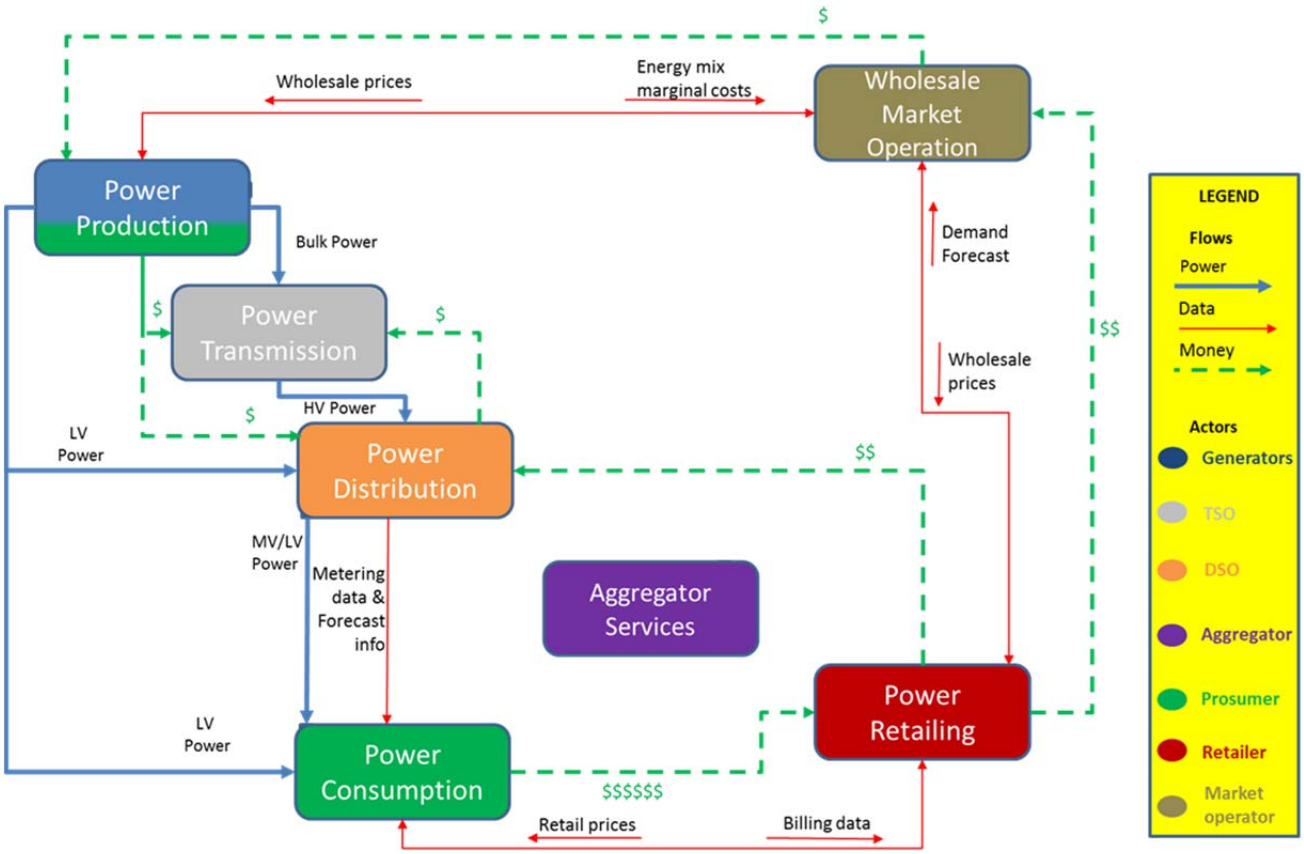

Figure 22: The value network for HLUC 6

5.7 HLUC – INCREASE IN POWER QUALITY

Figure 23 presents a candidate value network for this particular High-level Use-Case. We observe that each of the 7 main roles is performed by a single type of actors, with the exception of the following 2 roles:

- "Power production" that can be taken by both Generators and Prosumers and
- "Aggregator Services" that are performed by standard Aggregators, as well as, DSOs (e.g., in the case of Meltemi).

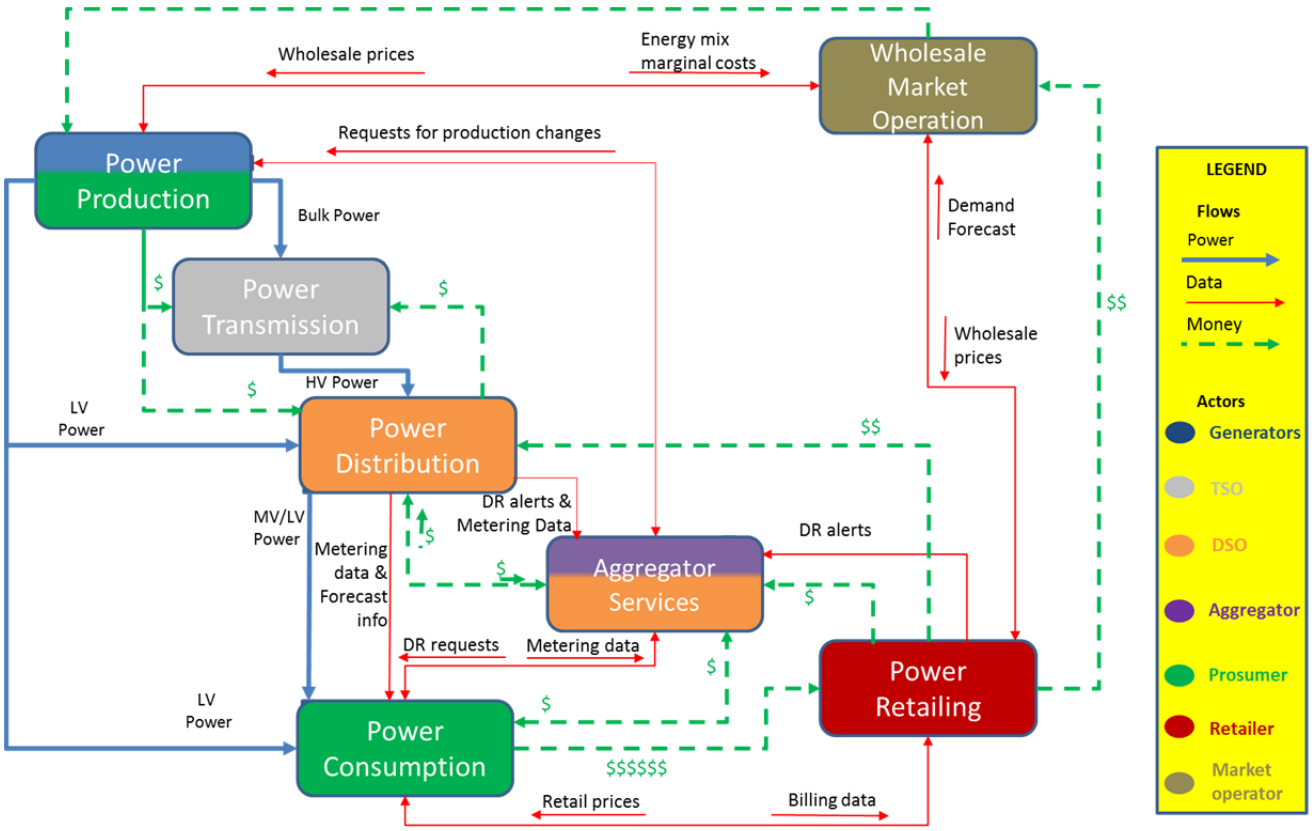

Figure 23: The value network for HLUC 7

5.8 HLUC – THE CO-OPERATIVE POWER PLANT

The following figure depicts the value network that is specific for this particular HLUC. Again, each of the 7 main roles is performed by a single type of actor, with the exception of "Power production" that can be taken by both Generators and Prosumers. Notable changes however are the requests from Aggregators to Prosumers for production changes and the interactions of the Aggregator with the Wholesale Market Operator.

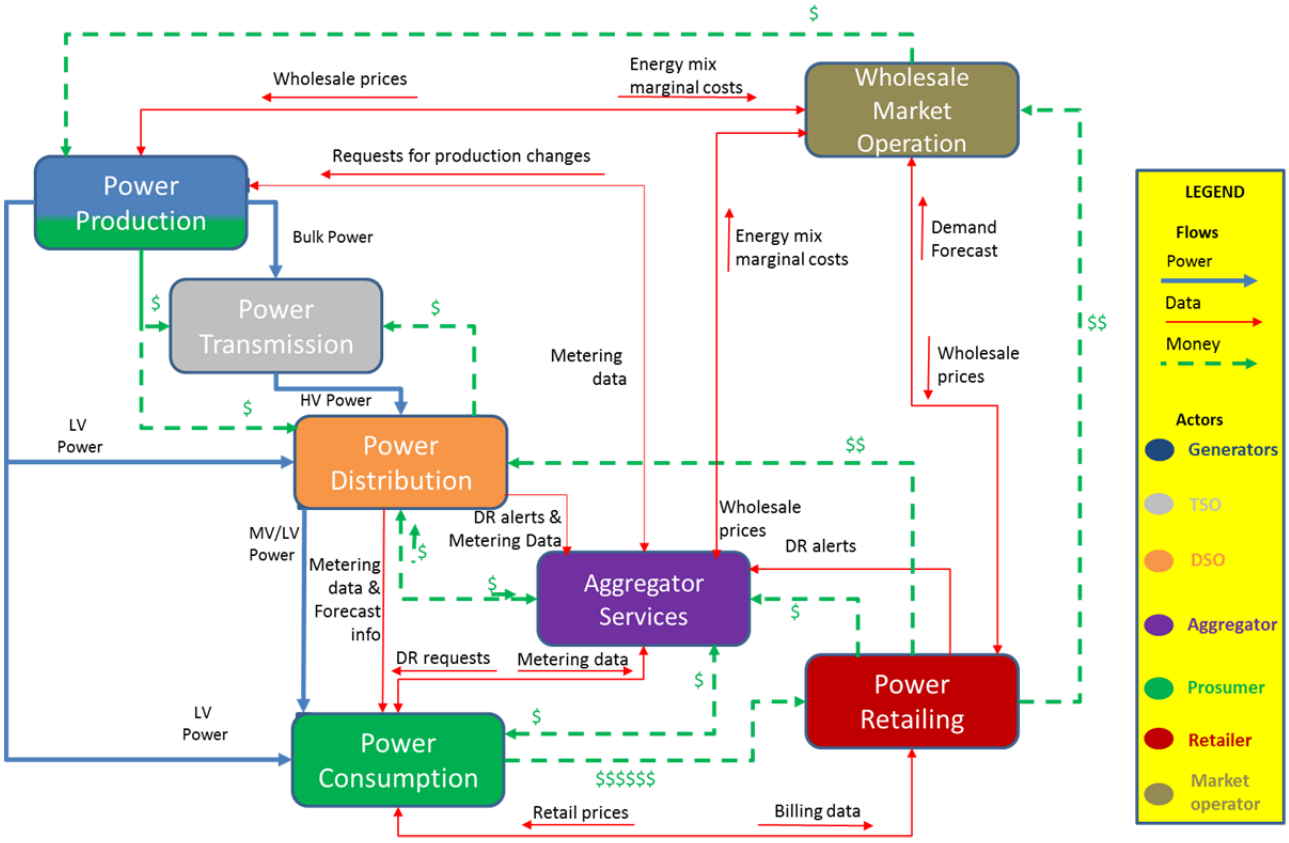

Figure 24: The baseline value network for HLUC 8

5.9 HLUC – IMBALANCE REDUCTION THANKS TO THE SMART CITIZENS INVOLVEMENT IN DR

The following figure depicts the value network that is specific for this particular High level use case. We observe that each of the 7 main roles is performed by a single type of actors, with the exception of "Power production" that can be taken by both Generators and Prosumers.

Furthermore, some interactions are missing compared to the generic value network of Figure 1. More specifically, the Aggregator does not trade its DR portfolio in wholesale energy market and thus does not interact with the Market Operator. Also, the aggregator-retailer interaction is not considered in this HLUC.

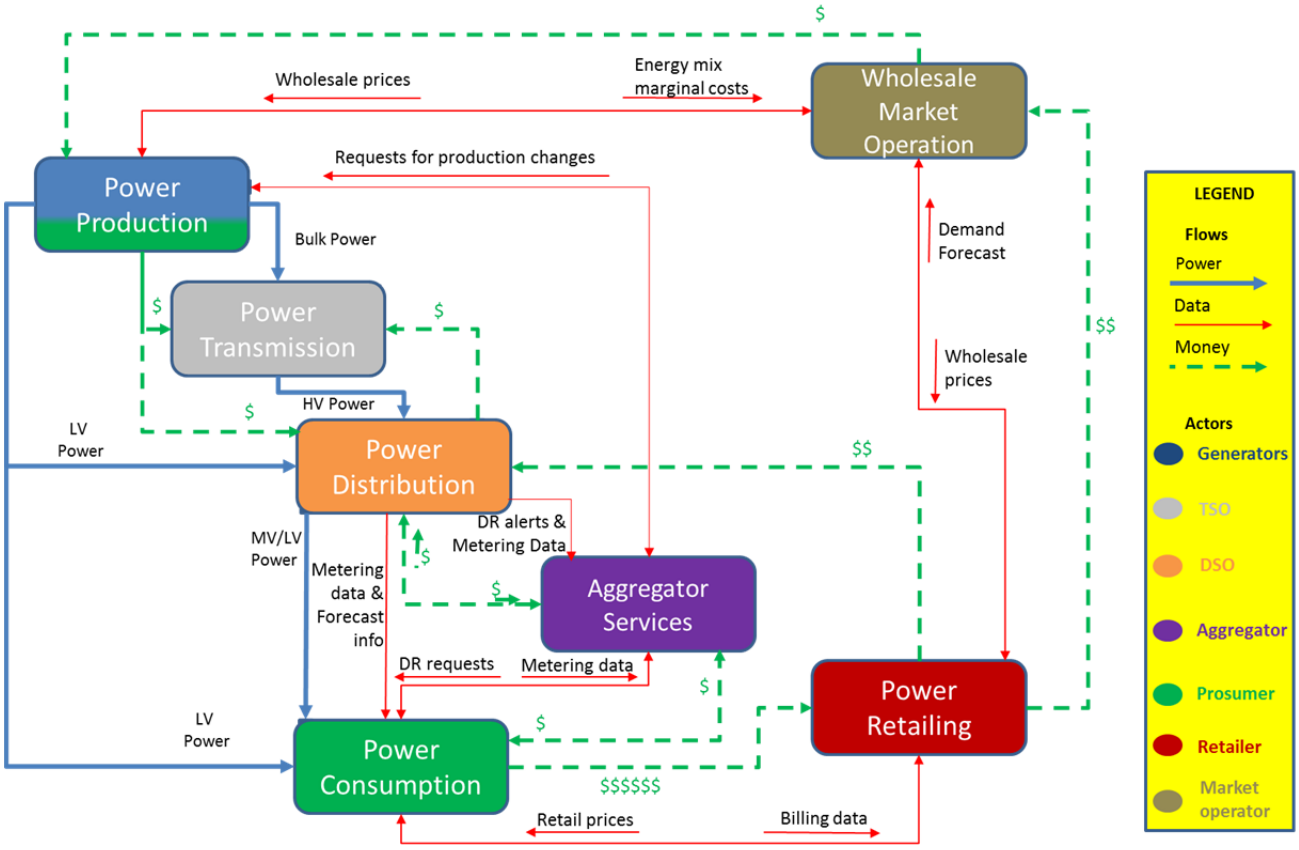

Figure 25: The value network for HLUC 9

5.10 HLUC – EFFICIENT RECOVERY FROM POWER OUTAGE

The following figure depicts the value network that is specific for this particular HLUC. We observe that some interactions are missing compared to the generic value network of Figure 1. More specifically, the Aggregator does not manage production from RES and thus does not process any metering data from RES in order to send requests for production changes. In addition, the Aggregator does not trade its DR portfolio in wholesale energy market and thus does not interact with the Market Operator. Finally, the aggregator-retailer interaction is not considered in this HLUC.

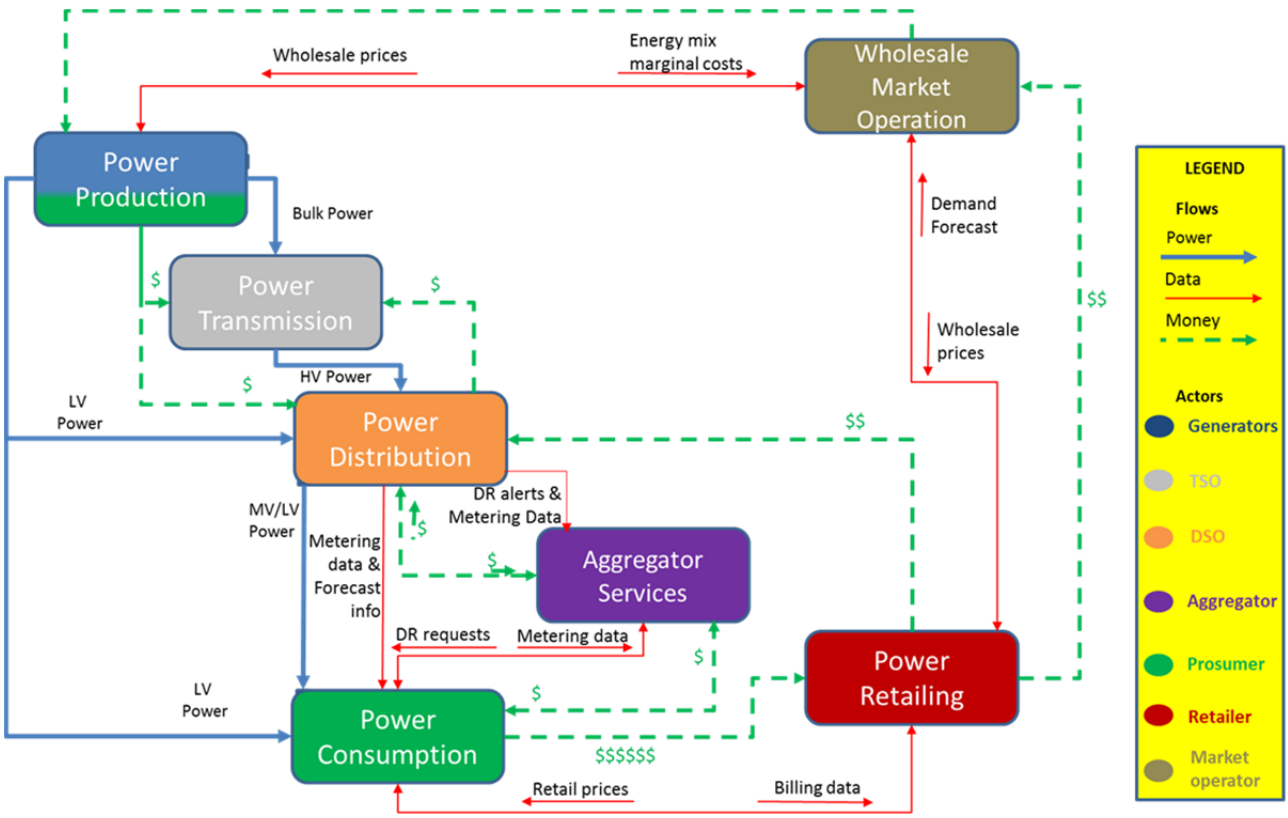

Figure 26: The value network for HLUC 10

5.11 HLUC – POWER LOSSES REDUCTION THANKS TO POWER FACTOR MANAGEMENT

The following figure depicts the value network that is specific for this particular HLUC. We observe that some interactions are missing compared to the generic value network of Figure 1. More specifically, the Aggregator does not participate in this HLUC and thus its interactions are not included.

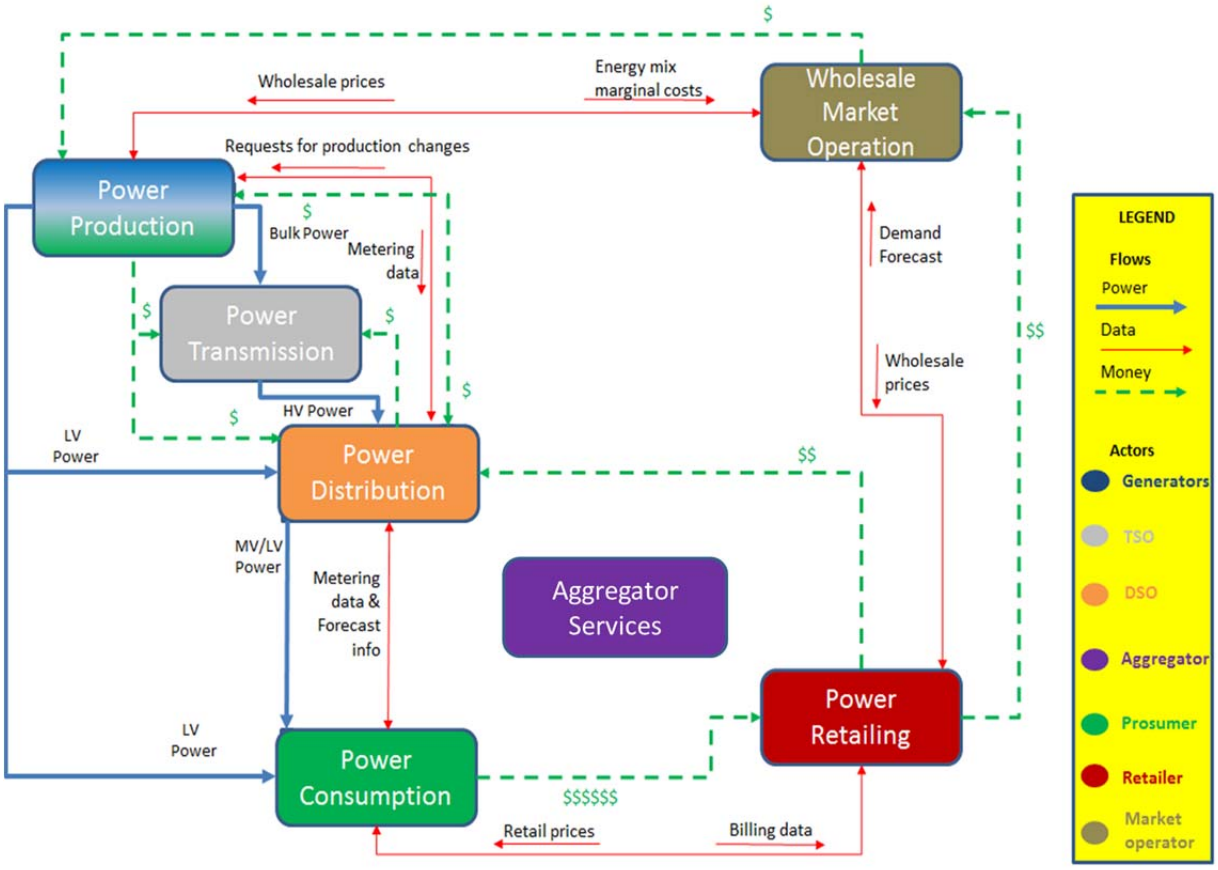

Figure 27: The value network for HLUC 11

6 NOBEL GRID ORIENTED BUSINESS MODELS

Based on the analysis that has been realized in sections 4 and 5, here we will define efficient business models for each one of the core NOBEL GRID actors. As described in Section 3, we follow the Business Modeling Canvas methodology adapted in order to include social (innovation, sustainability, social costs, benefits etc.) aspects, as well.

Note that underlined entries on the tables refer to those business model aspects that are directly relevant to that particular HLUC (i.e., those that are not related to an actor's standard business model). For example, the revenue streams and associated costs that are underlined are those that have been considered when evaluating the attractiveness of each business model. The next version of this deliverable will include additional ones in order to provide more elaborate business models or reflect new regulatory settings. Finally, the value proposition on each canvas refers to end users only, while in the previous section it was targeting each of the main actors.

6.1 HLUC – GREEN ENERGY MAX

In this section we will describe the business models of the Aggregator and the Prosumer that are relevant to the Green Energy Max HLUC (the rest main actors are not involved).

6.1.1 Business model of the DSO

DSO is not involved.

6.1.2 Business model of the Aggregator

Table 6: The Business Model Canvas of HLUC1 for Aggregator

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Prosumers who provide real-time information about production levels	Recruiting householders Aggregating flexibility from householders Running campaigns, offering incentives to prosumers Selling flexibility to DSOs Managing a co-operative i.e. encouraging engagement and participation	Real-time metering data for prosumers High quality forecasting tool in form of DFRM Ability to shift demand usage patterns to match supply Ability to aggregate flexibility	Prosumers – mediated via EMA App Prosumers: face-to-face communication via co-operative meetings and events etc.	Residential consumers environmentally motivated and living in a similar geographical location i.e., a city or city region

	Key Resources DRFM cockpit EMA app Users' consent to access smart meters data Membership network		**Channels** Virtual channels via web, email, mobile etc. As part of wider co-operative membership offer At events and conferences Via Third Parties (such as satisfied customers using social networks)	
Cost Structure Sunk: license to use DFRM cockpit, EMA App, Servers Repetitive (static): licencing fee to use smart meter data (where applicable), Personnel salaries, Internet subscription Repetitive (variable): incentives paid to prosumers for flexibility			**Revenue Streams/ Cost reductions** Fixed (static): Membership fee from consumers Fixed (variable): payment from DSO for flexibility and demand shifting; Non-fixed (variable): sales of additional energy services, e.g., heating installations	
Societal Costs Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment. Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment			**Societal Benefits** Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities	

6.1.3 Business model of the Retailer

Retailer is not involved.

Commercial & Residential end-users who buy the energy produced (and especially those who do it on purpose)

6.1.4 Business model of the Prosumer

Table 7: The Business Model Canvas of HLUC1 for Prosumer

<table>
<tr><td rowspan="2">Key Partners

Other Prosumers belonging to the same community</td><td>Key Activities

Responding to campaigns initiated by the aggregator

Engaging in a householder co-operative, sharing learning experiences etc.</td><td rowspan="2">Value Propositions

Providing demand flexibility to an aggregator</td><td>Customer Relationships

With aggregator via EMA App; and

Via face-to-face communication via co-operative meetings and events etc.</td><td rowspan="2">Customer Segments

Residential consumers environmentally motivated and living in a similar geographical location i.e., a city or city region

Retailers who buy the energy produced</td></tr>
<tr><td>Key Resources

EMA app

Smart meters data

Smart home equipment

Solar panels

Battery storage</td><td>Channels

Via an Aggregator’s platform</td></tr>
<tr><td colspan="3">Cost Structure

Sunk: smart home equipment when purchased outright, solar panels, inverter

Repetitive (static): membership fee to Aggregator, repayments for smart home equipment when purchased from an ESCO</td><td colspan="2">Revenue Streams/ Cost reductions

Fixed (variable): incentive for flexibility and demand shifting from aggregator; solar FIT payments, savings made in energy usage</td></tr>
</table>

Societal Costs	Societal Benefits
Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment. Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment	Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities

6.2 HLUC – PROSUMER MAX

In this section we will describe the business models of a DSO, an Aggregator and a Prosumer that are relevant to the prosumer Max HLUC (the Retailers are not involved).

6.2.1 Business model of the DSO

Table 8: The Business Model Canvas of HLUC2 for DSO

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
TSOs Aggregators Prosumers who are part of an Aggregator and willing to use green energy	Transform, manage and distribute power to end-users Finding aggregators that could bring flexibility to the network Aggregating flexibility from the aggregators Offer incentives for aggregators	Secure and high-quality MV/LV power to end-users Real-time metering consumption and generation information availability High quality forecasting tool in form of DRFM	EMA App as the main tool for communication and exchange of information Data availability to feed the new services created by aggregators to be offered to end consumers	Commercial & Residential end-users who need high quality and stable energy

	Key Resources DRFM cockpit EMA app Smart meters (except from UK) & data for distribution network	Visibility and knowledge of network situation and therefore the DR needs	**Channels** Virtual channels via web, email, mobile etc. At events and conferences Via Third Parties	
Cost Structure Sunk: Smart meters (except from UK), licenses for G3M, DFRM cockpit, EMA App Repetitive (static): Personnel salaries, Network maintenance, servers Repetitive (variable): Wholesale price * KWh, Power losses * penalty, DR requests * Aggregator's price			**Revenue Streams/ Cost reductions** Fixed (variable): 1xConnection fee Repetitive (variable): Commission for power distribution, Reduced economic penalties for imbalances.	
Societal Costs Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment. Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment			**Societal Benefits** Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities	

6.2.2 Business model of the Aggregator

Table 9: The Business Model Canvas of HLUC2 for Aggregator

<table>
<tr>
<td rowspan="2">Key Partners

Prosumers who provide real-time information about production levels</td>
<td>Key Activities

Recruiting householders

Aggregating flexibility from householders

Running campaigns, offering incentives to prosumers

Selling flexibility to DSOs

Managing a co-operative i.e. encouraging engagement and participation</td>
<td rowspan="2">Value Propositions

Real-time metering data for prosumers

High quality forecasting tool in form of DFRM

Ability to shift demand usage patterns to match supply

Ability to aggregate flexibility</td>
<td>Customer Relationships

Prosumers – mediated via EMA App

Prosumers: face-to-face communication via co-operative meetings and events etc.

DSOs: long term relationships (due to monopoly)</td>
<td rowspan="2">Customer Segments

Residential, homeowners, environmentally motivated, living in a similar geographical location i.e. a city or city region

DSOs: virtual monopoly so dependent on local situation</td>
</tr>
<tr>
<td>Key Resources

DRFM cockpit

EMA app

Smart meters & data

Membership network</td>
<td>Channels

Virtual channels via web, email, mobile etc.

As part of wider co-operative membership offer

At events and conferences

Via Third Parties</td>
</tr>
</table>

Cost Structure	Revenue Streams/ Cost reductions
Sunk: DFRM cockpit, EMA App, Servers Repetitive (static): licencing fee to use smart meter data (where applicable), Personnel salaries, Internet subscription Repetitive (variable): incentives paid to prosumers for flexibility	Fixed (static): Membership fee Fixed (variable): payment from DSO for flexibility and demand shifting; Non-fixed (variable): sales of additional energy services, e.g., heating, energy efficiency etc.
Societal Costs	**Societal Benefits**
Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment. Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment	Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities

6.2.3 Business model of the Retailer

Retailer is not involved.

6.2.4 Business model of the Prosumer

Table 10: The Business Model Canvas of HLUC2 for Prosumer

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Other Prosumers members of the community	Responding to campaigns initiated by the aggregator Engaging in a householder co-operative, sharing learning	Providing demand flexibility to an aggregator Generating income via sales of energy and/or	With aggregator via EMA App; and Via face-to-face communication via co-operative meetings and	Commercial & Residential end-users who prefer to use green energy Retailers who buy the energy produced

<table>
<tr><td rowspan="2"></td><td>experiences etc.</td><td rowspan="2">reducing costs through increased energy efficiency</td><td>events etc.</td><td rowspan="2">The local DSO</td></tr>
<tr><td>Key Resources

EMA app

Smart meters & data

Smart home equipment

Solar panels

Battery storage</td><td>Channels

As part of wider co-operative membership offer

At events and conferences</td></tr>
<tr><td colspan="3">Cost Structure

Sunk: smart home equipment when purchased outright

Repetitive (static): membership fee to Aggregator

Fixed: repayments for smart home equipment when purchased from an ESCO</td><td colspan="2">Revenue Streams/ Cost reductions

Fixed (variable): incentive for flexibility and demand shifting from aggregator; solar FIT payments, savings made in energy usage</td></tr>
<tr><td colspan="3">Societal Costs

Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment.

Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment</td><td colspan="2">Societal Benefits

Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities</td></tr>
</table>

6.3 HLUC – SOCIAL HOUSING – ELECTRIC HEAT AUTOMATION

In this section we will describe the business models of a DSO, an Aggregator and a Prosumer that are relevant to the Electric Heat Automation HLUC (the Retailers are not involved).

6.3.1 Business model of the DSO

Table 11: The Business Model Canvas of HLUC3 for DSO

<table>
<tr>
<td rowspan="2">Key Partners

TSOs

Aggregators

Prosumers (i.e. landlords) who are willing to participate in DR schemes</td>
<td>Key Activities

Manage and distribute power to end-users

Analyse metering data to predict supply of renewable energy and demand</td>
<td rowspan="2">Value Propositions

Secure and high-quality MV/LV power to end-users

Reinforce grid stability

Real-time metering data to Retailers, Aggregators</td>
<td>Customer Relationships

Automated relationships via the G3M, DRFM and EMA app (e.g., forecast)</td>
<td rowspan="2">Customer Segments

Commercial & Residential end-users who need high quality and stable energy</td>
</tr>
<tr>
<td>Key Resources

G3M

DRFM

EMA app

Smart meters (except from UK) & data for distribution network

Distribution network

Monopoly rights</td>
<td>Channels

Retailers, who are responsible for managing end-user relationships (e.g., membership fee paid via energy bill)

Aggregators, who increase efficiency of operations by relying on DR techniques</td>
</tr>
</table>

Cost Structure	Revenue Streams/ Cost reductions
Sunk: G3M, Smart meters (apart from UK), licenses for G3M, DFRM cockpit, EMA App Repetitive (static): Personnel salaries, Network maintenance, investment fee Repetitive (variable): Wholesale price * KWh, Power losses * penalty, DR requests * Aggregator's price	Fixed (variable): 1xConnection fee Repetitive (variable): Commission for power distribution, Reduced economic penalties for imbalances.
Societal Costs	**Societal Benefits** Less power losses better environmental performance greater reliability

6.3.2 Business model of the Aggregator

Table 12: The Business Model Canvas of HLUC3 for Aggregator

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Prosumers who provide real-time information about production levels	Recruiting householders/building managers Aggregating flexibility from householders Running automated campaigns, offering incentives to prosumers Selling flexibility to DSOs	Real-time metering data High quality forecasting tool in form of DFRM Ability to automate, shifting demand usage patterns to match supply Ability to aggregate flexibility	With prosumers – mediated via EMA App. Contact with landlords/building managers via virtual methods	Building managers/ landlords living in a shared development or building DSOs

	Key Resources DRFM cockpit EMA app Smart meters & data Smart Heating systems		**Channels** Virtual channels via web, email, mobile etc. At events and conferences Via Third Parties	
Cost Structure Sunk: DFRM cockpit, EMA App, Servers Repetitive (static): licencing fee to use smart meter data (where applicable), Personnel salaries, Internet subscription Repetitive (variable): incentives paid to prosumers/landlords for flexibility			**Revenue Streams/ Cost reductions** Fixed (static): Fee from landlord/building manager Fixed (variable): payment from DSO for flexibility and demand shifting; Non-fixed (variable): sales of additional energy services, e.g. heating, energy efficiency etc.	
Societal Costs Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment			**Societal Benefits** Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities	

6.3.3 Business model of the Retailer

Retailer is not involved.

6.3.4 Business model of the Prosumer

Table 13: The Business Model Canvas of HLUC3 for Prosumer

<table>
<tr>
<td rowspan="2">Key Partners

Other Prosumers (Building managers/landlords) via a co-operative</td>
<td>Key Activities

Responding to campaigns initiated by the aggregator

Engaging in a householder co-operative, sharing learning experiences etc.</td>
<td rowspan="2">Value Propositions

Providing demand flexibility to an aggregator

Generating income via sales of energy and/or reducing costs through increased energy efficiency</td>
<td>Customer Relationships

With aggregator via EMA App; and

Via face-to-face communication via co-operative meetings and events etc.</td>
<td rowspan="2">Customer Segments

Retailers who buy the energy produced

Commercial & Residential end-users who prefer to use green energy

The local DSO who want DR services</td>
</tr>
<tr>
<td>Key Resources

EMA app

Smart meters & data

Smart home equipment

Smart Heating systems

Solar panels

Battery storage</td>
<td>Channels

As part of wider co-operative membership offer

At events and conferences</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Sunk: smart home equipment when purchased outright

Repetitive (static): co-op membership fee

Fixed: repayments for smart home equipment when purchased from an ESCO</td>
<td colspan="2">Revenue Streams/ Cost reductions

Fixed (variable): incentive for flexibility and demand shifting from aggregator; solar FIT payments, savings made in energy usage</td>
</tr>
</table>

Societal Costs	Societal Benefits
Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment. Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment	Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities

6.4 HLUC - MAINTAINING GRID ASSETS

In this section we will describe the business model of a DSO that is relevant to the "Maintaining grid assets" HLUC (the Aggregators, Prosumers and Retailers are not involved).

6.4.1 Business model of the DSO

Table 14: The Business Model Canvas of HLUC4 for DSO

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
TSOs	Manage and distribute power to end-users Power quality monitoring. Analyse network data to better planning of the maintenance tasks	Secure and high-quality MV/LV power to end-users Reinforce grid security and stability with a better monitoring of the	Automated relationships via the G3M.	Commercial & Residential end-users who need high quality and stable energy

	Key Resources G3M Smart meters & data Distribution network	network assets	**Channels** Automatic data gathering	
Cost Structure Sunk: Distribution network, Smart meters			**Revenue Streams/ Cost reductions** Fixed (variable): 1xConnection fee Repetitive (variable): Commission for power distribution, Reduced maintenance costs and troubleshooting tasks, Reduced asset management costs, Reduced penalties for potential black outs and failure avoidance	
Societal Costs			**Societal Benefits** Less power losses	

6.4.2 Business model of the Aggregator

Aggregator is not involved.

6.4.3 Business model of the Retailer

Retailer is not involved.

6.4.4 Business model of the Prosumer

Prosumer is not involved.

6.5 HLUC – CONTROLLING THE GRIDS FOR POWER QUALITY & SECURITY

In this section we will describe the business model of a DSO that is relevant to the "Controlling the grids for power quality & security" HLUC (similarly to Section 6.4 the Aggregators, Prosumers and Retailers are not involved).

6.5.1 Business model of the DSO

Table 15: The Business Model Canvas of HLUC5 for DSO

<table>
<tr>
<td rowspan="2">Key Partners

TSOs</td>
<td>Key Activities

Manage and distribute power to end-users

Ensure the power quality and security of the network Power quality monitoring.

Analyse network data to better planning of the maintenance tasks</td>
<td rowspan="2">Value Propositions

Secure and high-quality MV/LV power to end-users

Reinforce grid security and stability</td>
<td>Customer Relationships

Automated relationships via the G3M.</td>
<td rowspan="2">Customer Segments

Commercial & Residential end-users who need high quality and stable energy</td>
</tr>
<tr>
<td>Key Resources

G3M

Smart meters & data

Distribution network</td>
<td>Channels

Automatic data gathering</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Sunk: Distribution network, Smart meters</td>
<td colspan="2">Revenue Streams/ Cost reductions

Fixed (variable): 1xConnection fee

Repetitive (variable): Commission for power distribution, Reduced maintenance costs and troubleshooting tasks, Reduced</td>
</tr>
</table>

	penalties for potential network instability reduction
Societal Costs	**Societal Benefits** Less power losses Better network stability – improve QoS for end users

6.5.2 Business model of the Aggregator

Aggregator is not involved.

6.5.3 Business model of the Retailer

Retailer is not involved.

6.5.4 Business model of the Prosumer

Prosumer is not involved.

6.6 HLUC – BLACKOUT AND INCIDENT MANAGEMENT

In this section we will describe the business model of a DSO that is relevant to the "Blackout and incident management" HLUC (the Aggregators, Prosumers and Retailers are not involved).

6.6.1 Business model of the DSO

Table 16: The Business Model Canvas of HLUC6 for DSO

Key Partners	**Key Activities**	**Value Propositions**	**Customer Relationships**	**Customer Segments**
TSOs	Ensure the power quality and security of the network Power quality monitoring. Analyse network data to better planning of the maintenance tasks Incident monitoring	Secure and high-quality MV/LV power to end-users Reinforce grid security and stability Direct incident monitoring	Automated relationships via the G3M.	Commercial & Residential end-users who need high quality and stable energy

	Key Resources G3M Smart meters & data Distribution network		**Channels** Automatic data gathering	
Cost Structure Sunk: Distribution network, Smart meters			**Revenue Streams/ Cost reductions** Fixed (variable): 1xConnection fee Repetitive (variable): Commission for power distribution, Reduced penalties for potential black out situations	
Societal Costs			**Societal Benefits** Less black outs – better QoS for end users	

6.6.2 Business model of the Aggregator

Aggregator is not involved.

6.6.3 Business model of the Retailer

Retailer is not involved.

6.6.4 Business model of the Prosumer

Prosumer is not involved.

6.7 HLUC- INCREASE IN POWER QUALITY

In this section we will describe the business models of a DSO, an Aggregator and a Prosumer that are relevant to the "Increase in Power Quality" HLUC (the Retailers are not involved).

6.7.1 Business model of the DSO

Table 17: The Business Model Canvas of HLUC7 for DSO

<table>
<tr>
<td rowspan="2">Key Partners

TSOs

Aggregators

Consumers who are willing to participate in DR schemes</td>
<td>Key Activities

Grid reconfiguration and management to distribute high power quality to end-users

Analyse metering data for predicting supply of renewable energy and demand, incidents, emergencies etc.</td>
<td rowspan="2">Value Propositions

Secure and high-quality MV/LV power to end-users

Forecast data to end-users regarding weather, network congestion, black outs notice etc.

Real-time metering data to Retailers, Aggregators</td>
<td>Customer Relationships

Automated relationships via the G3M, DRFM and EMA app</td>
<td rowspan="2">Customer Segments

Commercial & Residential end-users who need high quality and stable energy</td>
</tr>
<tr>
<td>Key Resources

G3M

DRFM

EMA app

Smart meters & data

Distribution network

Monopoly rights</td>
<td>Channels

Retailers, who are responsible for managing end-user relationships (e.g., membership fee paid via energy bill)

Aggregators, who increase efficiency of operations</td>
</tr>
</table>

Cost Structure	Revenue Streams/ Cost reductions
Sunk: Distribution network, G3M, Smart meters Repetitive (static): investment fee Repetitive (variable): Wholesale price * quantity, Power quality deterioration penalty, DR requests * Aggregator's price	Fixed (variable): 1xConnection fee, Repetitive (variable): Commission for power distribution, Reduced maintenance costs and troubleshooting tasks, Reduced penalties for potential black outs and failure avoidance
Societal Costs	**Societal Benefits** Less black outs, better power quality and less damage equipment

6.7.2 Business model of the Aggregator

Table 18: The Business Model Canvas of HLUC7 for Aggregator

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Prosumers who provide real-time information about production levels	Recruiting householders Aggregating flexibility from householders Running campaigns, offering incentives to prosumers and encouraging engagement and participation Selling flexibility to DSOs	Real-time metering data for prosumers and DSOs High quality forecasting tool in form of DFRM Ability to shift demand usage patterns to match supply Ability to aggregate flexibility	Prosumers – mediated via EMA App Prosumers: face-to-face communication via co-operative meetings and events etc. DSOs: long term relationships, working with DSOs to build products and services	Residential, homeowners, living in a similar geographical location, i.e. a city or city region DSOs

	Key Resources DRFM cockpit EMA app Smart meters & data Membership network		**Channels** Virtual channels via web, email, mobile etc. As part of wider co-operative membership offer At events and conferences Via Third Parties	
Cost Structure Sunk: Smart meters, DFRM cockpit, EMA App, Servers Repetitive (static): licencing fee to use smart meter data (where applicable), Personnel salaries, Internet subscription Repetitive (variable): incentives paid to prosumers for flexibility			**Revenue Streams/ Cost reductions** Fixed (variable): payment from DSO for flexibility and demand shifting; Non-fixed (variable): sales of additional energy services, e.g. heating, energy efficiency etc.	
Societal Costs Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment. Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment			**Societal Benefits** Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities	

6.7.3 Business model of the Retailer

Retailer is not involved.

6.7.4 Business model of the Prosumer

Table 19: The Business Model Canvas of HLUC7 for Prosumer

<table>
<tr>
<td rowspan="2">Key Partners

Other Prosumers via a co-operative</td>
<td>Key Activities

Responding to campaigns initiated by the aggregator

Engaging in a householder co-operative, sharing learning experiences etc.</td>
<td rowspan="2">Value Propositions

Providing demand flexibility to an aggregator

Generating income via sales of energy and/or reducing costs through increased energy efficiency</td>
<td>Customer Relationships

With aggregator via EMA App; and

Via face-to-face communication via co-operative meetings and events etc.</td>
<td rowspan="2">Customer Segments

Commercial & Residential end-users who prefer to use green energy

Retailers who buy the energy produced

The local DSO</td>
</tr>
<tr>
<td>Key Resources

EMA app

Smart meters & data

Smart home equipment

Solar panels

Battery storage</td>
<td>Channels

As part of wider co-operative membership offer

At events and conferences</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Sunk: smart home equipment when purchased outright

Repetitive (static): co-op membership fee

Fixed: repayments for smart home equipment when purchased from an ESCO</td>
<td colspan="2">Revenue Streams/ Cost reductions

Fixed (variable): incentive for flexibility and demand shifting from aggregator; solar FIT payments, savings made in energy usage</td>
</tr>
</table>

Societal Costs	Societal Benefits
Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment. Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment	Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities

6.8 HLUC – THE CO-OPERATIVE POWER PLANT

In this section we will describe the business models of all main NOBEL GRID actors that are relevant to the "The Co-operative Power Plant" HLUC.

6.8.1 Business model of the DSO

Table 20: The Business Model Canvas of HLUC8 for DSO

<table>
<tr>
<td rowspan="2">Key Partners

TSOs

Aggregators

Connected Prosumers who decide to adjust their production levels.

Consumers who are willing to participate in DR schemes</td>
<td>Key Activities

Analyse and act to organize the CoPP.

Participate in the energy market</td>
<td rowspan="2">Value Propositions

Secure and high-quality MV/LV power to end-users

Forecast data to end-users regarding electricity market and weather

Real-time metering data to Retailers, Aggregators</td>
<td>Customer Relationships

Automated relationships via the G3M, DRFM and EMA app (e.g., forecast)</td>
<td rowspan="2">Customer Segments

Commercial & Residential end-users who need high quality and stable energy</td>
</tr>
<tr>
<td>Key Resources

DRFM

EMA app

Smart meters & data

Distribution network

Monopoly rights</td>
<td>Channels

Retailers, who are responsible for managing end-user relationships (e.g., membership fee paid via energy bill)

Aggregators, who increase</td>
</tr>
</table>

			efficiency of operations by relying on DR techniques	
Cost Structure Sunk: Distribution network, G3M, Smart meters Repetitive (static): Personnel salaries, Network maintenance Repetitive (variable): Wholesale price * quantity, Power losses * penalty, DR requests * Aggregator's price			**Revenue Streams/ Cost reductions** Fixed (variable): 1xConnection fee Repetitive (variable): Commission for power distribution, Reduced economic penalties for imbalances.	
Societal Costs			**Societal Benefits** Less power losses Active participation in the market	

6.8.2 Business model of the Aggregator

Table 21: The Business Model Canvas of HLUC8 for Aggregator

Key Partners	**Key Activities**	**Value Propositions**	**Customer Relationships**	**Customer Segments**
Prosumers who produce energy and provide real-time information about production levels	Recruiting householders/building managers Aggregating flexibility from householders Running automated campaigns, offering incentives to prosumers	Real-time metering data High quality forecasting tool in form of DFRM Ability to shift demand usage patterns to match supply Ability to aggregate	Prosumers –via EMA App Prosumers: face-to-face communication via co-operative meetings and events etc. DSOs: long term relationships (due to	Residential, living in a shared development or building DSOs: virtual monopoly so dependent on local situation Power Retailing

<table>
<tr><td rowspan="3"></td><td>Selling flexibility to DSOs and power retailers</td><td rowspan="3">flexibility

Ability to save prosumers money</td><td>monopoly)</td><td rowspan="3"></td></tr>
<tr><td rowspan="2">Key Resources

DRFM cockpit

EMA app

Smart meters & data

Membership network (customer base)</td><td rowspan="2">Channels

Virtual channels via web, email, mobile etc.

At events and conferences

Via Third Parties

As part of wider co-operative membership offer</td></tr>
<tr><td></td></tr>
<tr><td colspan="3">Cost Structure

Sunk: DFRM cockpit, EMA App, Servers

Repetitive (static): licencing fee to use smart meter data (where applicable), Personnel salaries, Internet subscription

Repetitive (variable): incentives paid to prosumers for flexibility</td><td colspan="2">Revenue Streams/ Cost reductions

Fixed (static): Membership fee

Non-fixed (variable): payment from DSO for flexibility and demand shifting, sales of portfolio to BRP, sales of additional energy services, e.g., heating, energy efficiency etc.</td></tr>
<tr><td colspan="3">Societal Costs

Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment</td><td colspan="2">Societal Benefits

Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities</td></tr>
</table>

6.8.3 Business model of the Retailer

Table 22: The Business Model Canvas of HLUC8 for Retailer

<table>
<tr>
<td rowspan="2">Key Partners

Prosumers

DSOs

BRP</td>
<td>Key Activities

Optimize production/consumption portfolio on the wholesale market</td>
<td rowspan="2">Value Propositions

Better prices for production sold to the BRP

Lower cost of balanced energy for sale to customers</td>
<td>Customer Relationships

Better prices for prosumers</td>
<td rowspan="2">Customer Segments

Commercial & Residential end-users</td>
</tr>
<tr>
<td>Key Resources

DRFM cockpit

Aggregator’s DR portfolio

EMA app

Smart meters & data</td>
<td>Channels

Wholesale market through BRP</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Sunk: Smart meters

Repetitive (static): static fee for services of Aggregator

Repetitive (variable): variable fee for services of Aggregator</td>
<td colspan="2">Revenue Streams/ Cost reductions

Repetitive (variable): lower energy price of production/consumption portfolio</td>
</tr>
<tr>
<td colspan="3">Societal Costs</td>
<td colspan="2">Societal Benefits

Cheaper and greener energy

More efficient homes

Active participation in the market</td>
</tr>
</table>

6.8.4 Business model of the Prosumer

Table 23: The Business Model Canvas of HLUC8 for Prosumer

<table>
<tr>
<td rowspan="2">Key Partners

Other Prosumers via a co-operative</td>
<td>Key Activities

Join the CoPP and provide necessary services according to SLA

Indirectly through Aggregator Participate in the energy market</td>
<td rowspan="2">Value Propositions

Lower energy cost

Financial reward for cooperation in CoPP</td>
<td>Customer Relationships

Automated relationships via the EMA app (e.g., forecast) and feedback to aggregator</td>
<td rowspan="2">Customer Segments

The local DSO

Commercial & Residential end-users who prefer to use green energy

Retailers who buy the energy produced</td>
</tr>
<tr>
<td>Key Resources

EMA app

Smart meters & data</td>
<td>Channels

Directly with Aggregator or indirectly through e.g., a retailer who is linked to the aggregator</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Sunk: Smart meter (SMX or SLAM), SHID for automated DR

Repetitive (static): maintenance

Repetitive (variable): comfort losses</td>
<td colspan="2">Revenue Streams/ Cost reductions

Repetitive (variable): Commission for joining CoPP and lower energy price because of better insight and time shifting of consumption</td>
</tr>
<tr>
<td colspan="3">Societal Costs</td>
<td colspan="2">Societal Benefits

Greener energy

More efficient homes

Active participation in the market</td>
</tr>
</table>

6.9 HLUC – IMBALANCE REDUCTION THANKS TO THE SMART CITIZENS INVOLVEMENT IN DR

In this section we will describe the business models of a DSO, an Aggregator and a Prosumer that are relevant to the Electric Heat Automation HLUC (again, the Retailers are not involved).

6.9.1 Business model of the DSO

Table 24: The Business Model Canvas of HLUC9 for DSO

<table>
<tr>
<td rowspan="2">Key Partners

TSOs

Aggregators

Consumers who are willing to participate in DR schemes</td>
<td>Key Activities

Transform, manage and distribute power to end-users

Analyse metering data for predicting supply of renewable energy and demand</td>
<td rowspan="2">Value Propositions

Secure and high-quality MV/LV power to end-users

Forecast data to end-users regarding availability of green energy

Real-time metering data to Retailers, Aggregators</td>
<td>Customer Relationships

Automated relationships via the G3M, DRFM and EMA app (e.g., forecast) and gamification techniques</td>
<td rowspan="2">Customer Segments

Commercial & Residential end-users who need high quality and stable energy</td>
</tr>
<tr>
<td>Key Resources

G3M

DRFM

EMA app

Smart meters & data

Distribution network

Monopoly rights</td>
<td>Channels

Retailers, who are responsible for managing end-user relationships (e.g., membership fee paid via energy bill)

Aggregators, who increase efficiency of operations by relying on DR techniques</td>
</tr>
</table>

Cost Structure	Revenue Streams/ Cost reductions
Sunk: Distribution network, G3M, Smart meters Repetitive (static): Personnel salaries, Network maintenance Repetitive (variable): Wholesale price * quantity, Power losses * penalty, DR requests * Aggregator's price	Fixed (variable): 1xConnection fee Repetitive (variable): Commission for power distribution, Reduced economic penalties for imbalances.
Societal Costs	**Societal Benefits**
Less privacy for end-users While technological progress increases the efficiency with which a resource is used the rate of consumption of that resource rises because of increasing demand (Jevons paradox)	Less power losses

6.9.2 Business model of the Aggregator

Table 25: The Business Model Canvas of HLUC9 for Aggregator

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Commercial & Residential end-users who would like to know in real time info about outages and would like to gain money reward for providing flexibility	Find a set of end-users who are willing to conform to DR requests so that a certain target is met (e.g., excessive green energy is consumed) Send DR requests to end-users (or to their equipment directly)	DR services to reduce power losses Increased green energy consumption Reduced energy bills	Two-Sided Platform where DSOs & retailers eventually find end-users who are willing to conform to DR requests	DSOs who want to reduce costs by reducing reverse flows and power losses and/or create an eco-friendly brand Retailers who want to reduce costs by minimizing demand when wholesale prices are high Prosumers/consumers who want to consume green

	Key Resources DRFM EMA app Profiles of eco-friendly end-users		**Channels** Own channel (web-based)	energy.
Cost Structure Sunk: Software, Servers Repetitive (static): licencing fee to use smart meter data (where applicable), Personnel salaries, Internet subscription			**Revenue Streams/ Cost reductions** Repetitive (variable): DR requests * price	
Societal Costs End-users need to be educated about the advantages of conforming to DR requests and how metering data is used			**Societal Benefits** Consumers obtain social responsibility by verifying that Smart Grid technologies are effective Consumers enjoy increased social approval for consuming green energy	

6.9.3 Business model of the Retailer

Retailer is not involved.

6.9.4 Business model of the prosumer

Table 26: The Business Model Canvas of HLUC1 for Prosumer

Key Partners	**Key Activities**	**Value Propositions**	**Customer Relationships**	**Customer Segments**
Other Prosumers belonging to the same community	Responding to campaigns initiated by the aggregator Engaging in a householder co-operative, sharing learning experiences	Providing demand flexibility to an aggregator	With aggregator via EMA App; and Via face-to-face communication via co-operative meetings and	DSOs who want to reduce costs by reducing reverse flows and power losses and/or create an eco-friendly brand Retailers who want to reduce costs by

<table>
<tr><td></td><td>etc.</td><td></td><td>events etc.</td><td>minimizing demand when wholesale prices are high</td></tr>
<tr><td></td><td>Key Resources

EMA app

Smart meters data

Smart home equipment

Solar panels

Battery storage</td><td></td><td>Channels

As part of wider co-operative membership offer

At events and conferences</td><td>Commercial & Residential end-users who buy the energy produced (and especially those who do it on purpose)</td></tr>
<tr><td colspan="3">Cost Structure

Sunk: smart home equipment when purchased outright, solar panels, inverter

Repetitive (static): membership fee to Aggregator, repayments for smart home equipment when purchased from an ESCO</td><td colspan="2">Revenue Streams/ Cost reductions

Fixed (variable): incentive for flexibility and demand shifting from aggregator; solar FIT payments, savings made in energy usage</td></tr>
<tr><td colspan="3">Societal Costs

Potential to increase inequality through favouring higher income householders with quantities levels of smart equipment.

Potential to encourage greater resource use and embedded carbon usage through purchase of more technology and disposing of older (but still functional) equipment</td><td colspan="2">Societal Benefits

Lower grid intensity, less over-generation of power, reduced energy usage, less black outs, lower overall carbon emissions, reduced effects of climate change and pollution, co-operation between householders, increased resilience of communities</td></tr>
</table>

6.10 HLUC – DSO: EFFICIENT RECOVERY FROM POWER OUTAGE

In this section we will describe the business models of a DSO, an Aggregator and a Prosumer that are relevant to the "DSO: Efficient Recovery from Power Outage" HLUC (again, the Retailers are not involved).

6.10.1 Business model of the DSO

Table 27: The Business Model Canvas of HLUC10 for DSO

<table>
<tr>
<td rowspan="2">Key Partners

TSOs

Aggregators

Consumers who are willing to participate in DR schemes</td>
<td>Key Activities

Transform, manage and distribute power from the producer plant to the end-user

Increase resilience in Smart Grid

Analyse metering data for predicting supply of flexibility needed</td>
<td rowspan="2">Value Propositions

Social reward in providing flexibility

Enhance stability of the grid</td>
<td>Customer Relationships

Automated relationships via the G3M, DRFM and smart meter, EMA APP</td>
<td rowspan="2">Customer Segments

Commercial & Residential end-users who need high quality and stable energy</td>
</tr>
<tr>
<td>Key Resources

G3M

DRFM

EMA APP

Smart meters & data

Distribution network

Monopoly rights</td>
<td>Channels

Directly by an agreement / by an Aggregator

EMA APP, smart meter</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Sunk: Distribution network, G3M, EMA APP, DRFM, Smart meters

Repetitive (static): Personnel salaries, Network maintenance</td>
<td colspan="2">Revenue Streams/ Cost reductions

Fixed (variable): 1xConnection fee

Repetitive (variable): Commission for power distribution, Penalty reduction for potential black outs, Benefit from Energy Authority due to failure avoidance,</td>
</tr>
</table>

Repetitive (variable): Wholesale price * quantity, Power losses * penalty	Reduced maintenance costs and troubleshooting tasks
Societal Costs Less privacy	**Societal Benefits** customers aware of their consumption , Assuring service continuity

6.10.2 Business model of the Aggregator

Table 28: The Business Model Canvas of HLUC10 for Aggregator

<table>
<tr><td rowspan="2">Key Partners

Commercial & Residential end-users who would like to know in real time info about outages and would like to gain money reward for providing flexibility</td><td>Key Activities

Find a set of end-users who are willing to conform to DR requests so that a certain target is met (e.g., excessive green energy is consumed, enhance resilience of the smart grid)

Send DR requests to end-users (or to their equipment directly)</td><td rowspan="2">Value Propositions

Reward for flexibility provided</td><td>Customer Relationships

Automated relationships via EMA APP</td><td rowspan="2">Customer Segments

DSOs who need DR flexibility in order to recover from power outage</td></tr>
<tr><td>Key Resources

DRFM</td><td>Channels

Own channel (web-based)</td></tr>
</table>

	EMA app Profiled end-users			
Cost Structure Sunk: Software, Servers Repetitive (static): licencing fee to use smart meter data (where applicable), Personnel salaries, Internet subscription			**Revenue Streams/ Cost reductions** Repetitive (fix): Payment from stakeholder	
Societal Costs Less privacy Delegate on appliances control			**Societal Benefits** Increase the security Increase stability of the grid	

6.10.3 Business model of the Retailer

Retailer is not involved.

6.10.4 Business model of the prosumer

Table 29: The Business Model Canvas of HLUC10 for Prosumer

Key Partners Aggregator	**Key Activities** Plan production Manage orders Serve customers	**Value Propositions** Supply products using stable grid	**Customer Relationships** Personal Assistance	**Customer Segments** DSOs who need DR flexibility in order to recover from power outage Commercial & Residential end-users who buy the energy produced (and especially those who do it on purpose)
	Key Resources Plant Service provided		**Channels** Own production channel	

Cost Structure	Revenue Streams/ Cost reductions
Repetitive (static): retail electricity price, DR membership, Internet subscription	Rewards/incentives directly from DSO or through the Aggregator for their demand flexibility.
Societal Costs	**Societal Benefits**
Less privacy Risk of no process execution due to less stability	Less power losses No interruption guarantee more employed activity

6.11 HLUC – POWER LOSSES REDUCTION THANKS TO POWER FACTOR MANAGEMENT

In this section we will describe the business models of a DSO, an Aggregator and a Prosumer that are relevant to the "Power losses reduction thanks to Power Factor management" HLUC (the Aggregators and Retailers are not involved).

6.11.1 Business model of the DSO

Table 30: The Business Model Canvas of HLUC11 for DSO

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
TSOs Producer who accept the power factor to be managed in real time	Transform, manage and distribute power from the producer plant to the end-user Power losses reduction in the grid Analyse metering data for predicting supply of renewable energy and demand	Secure and high-quality MV/LV power to end-users Real-time power factor management of producer plant	Automated relationships via the G3M, DRFM and smart meter	Commercial & Residential end-users who need high quality and stable energy

	Key Resources G3M DRFM Smart meters & data Distribution network Monopoly rights		**Channels** Directly by an agreement	
Cost Structure Sunk: Distribution network, G3M, DRFM, Smart meters Repetitive (static): Personnel salaries, Network maintenance Repetitive (variable): Wholesale price * quantity, Power losses * penalty			**Revenue Streams/ Cost reductions** Fixed (variable): 1xConnection fee Repetitive (variable): Commission for power distribution, Reduced maintenance costs and troubleshooting tasks and reduced penalties for power losses	
Societal Costs While technological progress increases the efficiency with which a resource is used the rate of consumption of that resource rises because of increasing demand (Jevons paradox)			**Societal Benefits** Less power losses	

6.11.2 Business model of the Aggregator

Aggregator is not involved.

6.11.3 Business model of the Retailer

Retailer is not involved.

6.11.4 Business model of the prosumer

Table 31: The Business Model Canvas of HLUC11 for Prosumer

<table>
<tr>
<td rowspan="2">Key Partners

DSO who supplies connection to the grid</td>
<td>Key Activities

Plan production

Losses reduction</td>
<td rowspan="2">Value Propositions

Maximize power production</td>
<td>Customer Relationships

Contract</td>
<td rowspan="2">Customer Segments

<u>The local DSO</u>

Commercial & Residential end-users who prefer to use green energy

Retailers who buy the energy produced</td>
</tr>
<tr>
<td>Key Resources

Availability of primary energy to be transformed in electrical energy</td>
<td>Channels

The grid</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Repetitive (static): retail electricity price, losses, Internet subscription, devices for the power factor management</td>
<td colspan="2">Revenue Streams/ Cost reductions

Less power losses</td>
</tr>
<tr>
<td colspan="3">Societal Costs

Less privacy</td>
<td colspan="2">Societal Benefits

Less power losses</td>
</tr>
</table>

7 DISCUSSION ON PROPOSED BUSINESS MODELS FOR THE NOBEL GRID PILOT SITES

This section will investigate the expected profitability of the business models, as defined in section 6 and according to the assumptions taken for costs and revenues, for each one of the NOBEL GRID PILOT sites. Note that the purpose is not to screen the unprofitable business models but to raise awareness of possible socioeconomic issues so that the necessary adjustments are made and shed some light on the key factors that will drive adoption of NOBEL GRID products.

This has been accomplished by preparing, for each main role (DSO, Aggregator, Retailer, and Prosumer), a set of business plans and then consider which ones should be adopted based on their profitability on a 5-year period on each pilot site. More details about our methodology can be found in Section 3.

Note that a certain business model could become economically viable to additional pilot sites by increasing, for example, the prices that consumers have to pay, while adjusting the number of subscribers according to their expected price elasticity. Another case would be that highly-profitable providers along the value chain/network subsidise less attractive, but necessary, roles. Performing a sensitivity analysis of the economic viability will be part of the next version of this deliverable, and thus is out of scope of this report. However, a first attempt to understand whether a scenario can become attractive for all actors after a set of cross subsidies are introduced is made at Section 9.2.

Before we proceed with the analysis of the business plans we would like to describe some key assumptions for the Prosumer and Aggregator business plans.

The lifetime of the assets that Prosumers buy is more than 5 years, for example inverters last 10 years and solar panels 20 years. This means that Prosumers could buy used equipment or sell new ones and get an additional revenue at the end of the evaluation period. We decided to take the first approach, and thus the cost of the inverters and panels was considered to be 50% and 25% of the retail price for a new one.

Unlike other roles in scope of the NOBEL GRID project, the Aggregator's business model is relatively speculative and subject to a high degree of estimates at this stage. In contrast to long established energy supply chain models such as retailers or DSOs, the Aggregator is currently a theoretical entity, untried and untested in the domestic sector due to regulatory restrictions and the current state of domestic technology.

Despite this, the evolving technological and policy environment suggests that domestic aggregators have a dominant role to play in future energy systems. As a result, in developing a viable aggregator business plan to pilot within the NOBEL GRID project, we had to make a set of assumptions and to choose between two distinct possible aggregator models.

The two basic models for how an aggregator might generate income from aggregating and selling demand flexibility are the following:

i) Leveraging relatively large amounts of demand flexibility (hundreds of Euros/year) over a relatively small number of households (thousands and tens of thousands of homes)

ii) Leveraging relatively small amounts of demand flexibility (a few Euros a year) over relatively large numbers of households i.e. millions of homes

In developing an aggregator business model, we have chosen the former, an aggregator working with a few thousand or tens of thousands of members to leverage large amounts of flexibility. This is due to the nature of the partners involved in NOBEL GRID. In the main, the partners are small scale DSOs, retailers and aggregators, with a relatively strong and local connection to their users. In many cases the co-operative membership model limit partners in order to be small, local and engaged with members.

The small organisational sizes lends itself to testing more innovative energy measures and in turn, these are more likely to deliver larger and more flexible demand loads.

The aggregator business plan developed in this document assumes that these relatively large levels of demand response flexibility are possible to leverage on a consistent basis – something that at present is relatively speculative.

Our contention is that greater levels of user participation are more likely using a co-operative aggregator – as users are more willing to be involved in an intermediary where the costs and benefits are socialized and where householders have high levels of trust in the intermediary i.e. through not for profit status.

The overall model for an aggregator is 'lite' i.e. low on staffing and overheads. This is because, in a competitive market, many of the resources gained from demand flexibility need to be passed back to the end user as an incentive reward.

7.1 VALENCIA (SPAIN)

The following figure presents the expected IRR of standard business model per role in Valencia

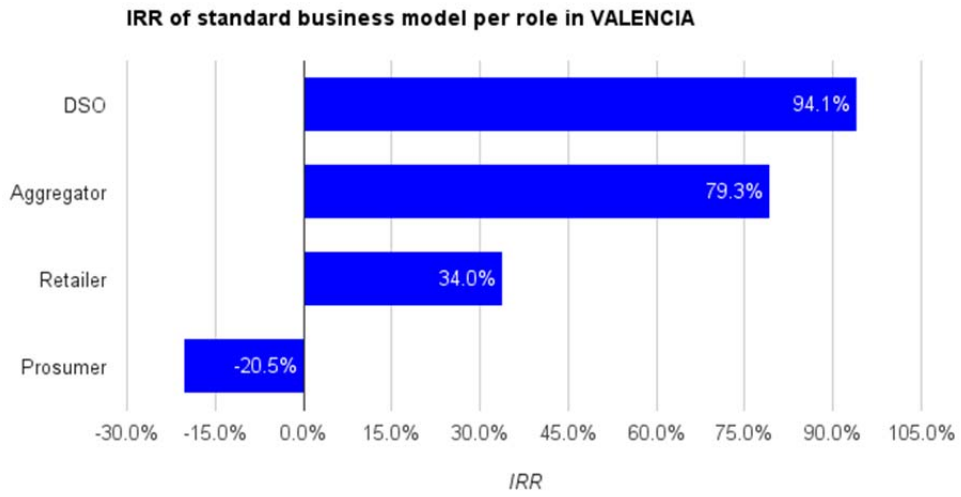

Figure 28. The expected IRR of standard business model per role in Valencia

The following figure presents the evolution of expected free cash flows of the standard business model for each role in Valencia

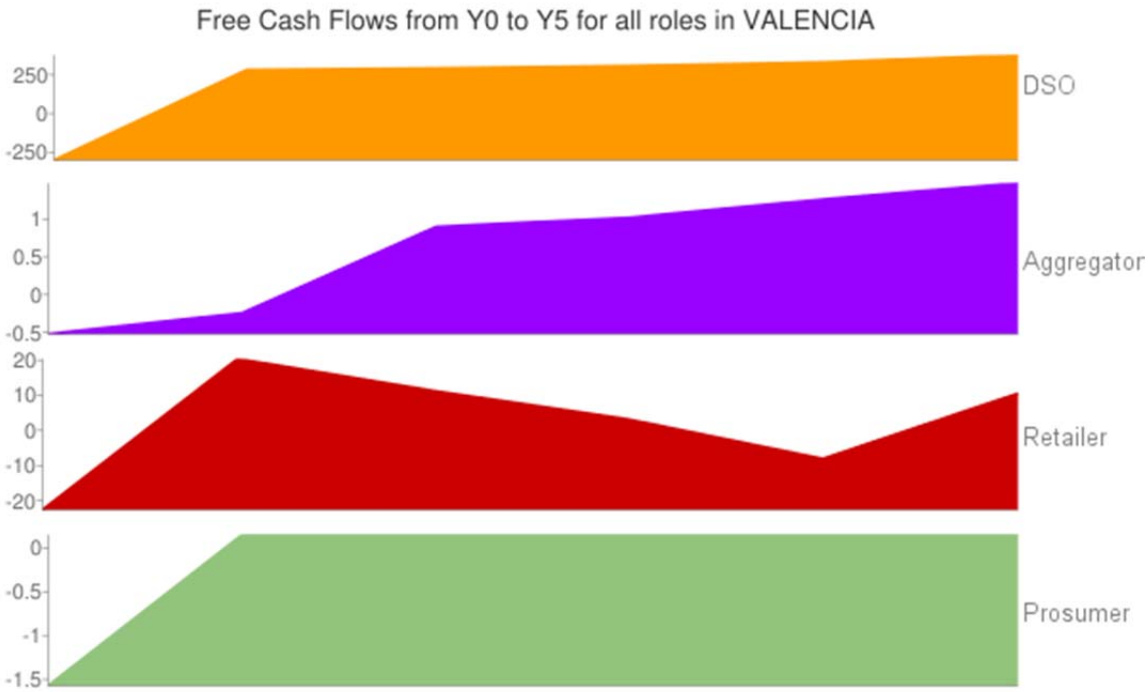

Figure 29. The evolution of expected free cash flows of the standard business model for each role in Valencia (in '000 Euros)

The following figure presents the expected number of competitors for the standard business model per role in Valencia

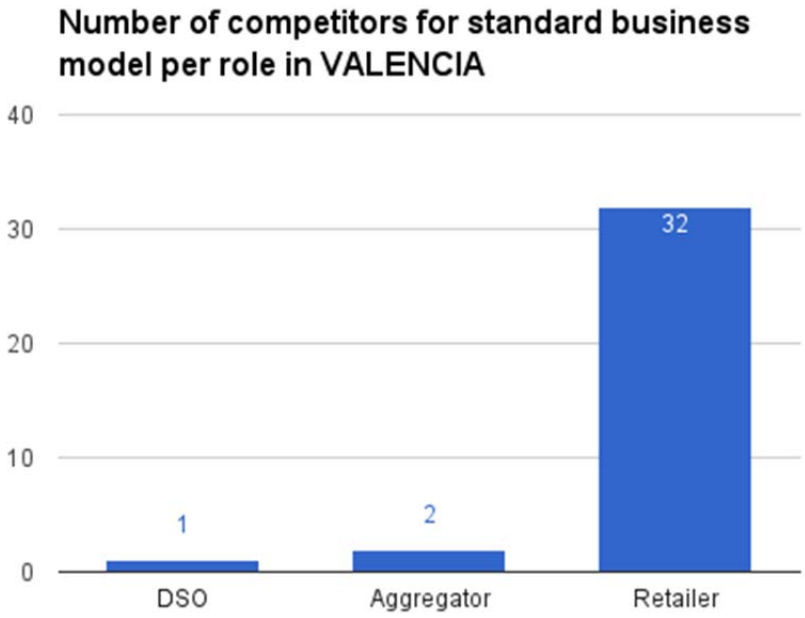

Figure 30. The expected number of competitors for the standard business model per role in Valencia

The following table provides the expected Free Cash Flows of a DSO in Valencia for the standard/baseline business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 32. The expected Free Cash Flows of a DSO in Valencia (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€303.0	€282.4	€293.8	€309.0	€332.1	€378.8	94.1%
HLUC2	-€1.8	€1.8	€1.8	€1.8	€1.8	€1.8	99.2%
HLUC3	-€1.8	€1.8	€1.8	€1.8	€1.8	€1.8	93.9%
HLUC4	-€3.0	€1.8	€1.8	€1.8	€1.8	€1.8	53.4%
HLUC5	-€3.0	€1.8	€1.8	€1.8	€1.8	€1.8	53.4%
HLUC6	-€3.0	€1.8	€1.8	€1.8	€1.8	€1.8	53.4%
HLUC7	-€1.8	€0.9	€0.9	€0.9	€0.9	€0.9	44.0%
HLUC8	-€3.0	€2.5	€2.5	€2.5	€2.5	€2.5	79.1%
HLUC9	-€3.2	€1.9	€1.9	€1.9	€1.9	€1.9	52.3%
HLUC10	-€3.2	€1.2	€1.2	€1.2	€1.2	€1.2	25.6%
HLUC11	-€3.2	€1.5	€1.5	€1.5	€1.5	€1.5	35.8%
Desirable HLUCs only	-€326.9	€298.3	€309.7	€324.9	€348.0	€394.7	91.7%
Overall	-€330.1	€299.6	€310.9	€326.1	€349.2	€395.9	91.2%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a DSO in Valencia should expand its service portfolio by adding to the baseline business model all relevant NOBEL GRID HLUCs apart from HLUC10. If these HLUCs are deployed only then the IRR will be 91.1%. However, the Overall scenario has a very high IRR as well (91.2%) and thus all NOBEL GRID HLUCs where DSOs are involved could be selected.

The following table provides the expected Free Cash Flows of an Aggregator in Valencia for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 33. The expected Free Cash Flows of an Aggregator in Valencia (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€0.5	-€0.2	€0.9	€1.0	€1.3	€1.5	79.3%
HLUC1	-€0.2	€0.0	€0.0	€0.0	€0.0	€0.0	-25.2%
HLUC2	-€0.2	€0.1	€0.1	€0.1	€0.1	€0.1	16.0%
HLUC3	-€0.2	€0.1	€0.1	€0.1	€0.1	€0.1	41.0%
HLUC7	-€0.2	€0.1	€0.1	€0.1	€0.1	€0.1	38.1%
HLUC8	-€0.5	€0.0	€0.0	€0.0	€0.0	€0.0	-21.4%
HLUC9	-€0.2	€0.1	€0.1	€0.1	€0.1	€0.1	68.6%
HLUC10	-€0.2	€0.1	€0.1	€0.1	€0.1	€0.1	26.4%
Desirable HLUCs only	-€1.1	€0.1	€1.2	€1.4	€1.6	€1.8	68.1%
Overall	-€2.2	€0.3	€1.4	€1.6	€1.8	€2.0	42.8%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then an Aggregator in Valencia should expand its service portfolio by adding to the baseline business model the following HLUCs: HLUC3, HLUC7 and HLUC9. The expected, aggregate Free Cash Flows and the IRR over a 5-year period in that case would be 68.1%, while it would be still profitable to deploy all NOBEL GRID HLUCs (yielding 42.8%).

The following table provides the expected Free Cash Flows of a Retailer in Valencia for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 34. The expected Free Cash Flows of a Retailer in Valencia (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€22.7	€20.3	€11.3	€3.1	-€8.1	€10.5	34.0%
HLUC8	-€0.03	€0.02	€0.02	€0.02	€0.02	€0.02	66.1%
Desirable HLUCs only	-€22.7	€20.4	€11.3	€3.2	-€8.1	€10.5	34.1%
Overall	-€22.7	€20.4	€11.3	€3.2	-€8.1	€10.5	34.1%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a Retailer in Valencia should expand its service portfolio by adding to the baseline business model HLUC8 (the only one that is involved). The expected, aggregate Free Cash Flows and the IRR over a 5-year period in that case would be 34.1%. Note that the decrease in Free Cash Flows at Year 4 is mainly attributed to the need for more personnel and the associated rise in personnel cost[6].

The following table provides the expected Free Cash Flows of a Prosumer in Valencia for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 35. The expected Free Cash Flows of a Prosumer in Valencia (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€1.58	€0.15	€0.15	€0.15	€0.15	€0.15	-20.50%
HLUC1	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	293.69%
HLUC2	-€0.01	€0.02	€0.02	€0.02	€0.02	€0.02	489.93%
HLUC3	-€0.01	€0.05	€0.05	€0.05	€0.05	€0.05	979.99%
HLUC7	-€0.10	€0.49	€0.49	€0.49	€0.49	€0.49	487.93%
HLUC8	-€0.01	€0.02	€0.02	€0.02	€0.02	€0.02	489.93%
HLUC9	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	195.12%
HLUC10	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	133.28%
HLUC11	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	199.17%
Desirable HLUCs only	-€1.68	€0.64	€0.64	€0.64	€0.64	€0.64	26.20%
Overall	-€1.68	€0.70	€0.70	€0.70	€0.70	€0.70	31.08%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a new Prosumer in Valencia would have the incentive to install PV on its rooftop only if the NOBEL GRID HLUCs are in place. The reason is that even if it expanded its service portfolio by adding HLUC7 to the baseline business model, the expected aggregate Free Cash Flows and the IRR over a 5-year period would almost meet the target. The same applies for all the NOBEL GRID HLUCs where the prosumer would be involved, but in that case would reach the threshold due to the positive impact of the HLUCs other than HLUC7 (these bring some extra revenues even though no investments are required).

The following two tables assess the attractiveness of an Aggregator and a Retailer in Valencia respectively, in adopting additional roles. We have assumed that the number of providers for each role has reached the maximum ones (as shown in Figure 30). We can observe that, in Valencia, an

[6] This trend appears on the rest pilot sites, as well.

Aggregator would have the economic incentive to expand their business by becoming a Prosumer. As expected, the rest 2 combinations are less attractive (due to the worst-case scenario examined[7]) but, still, very close to the IRR threshold of 30%. On the other hand, a Retailer would find adopting the Aggregator and Prosumer roles a lucrative investment.

Table 36. The expected Free Cash Flows (in '000 Euros) and IRR of an Aggregator's expansion options in Valencia

Roles	Year						IRR
	0	1	2	3	4	5	
Aggregator & Retailer	-€23.6	€19.4	€11.3	€3.1	-€8.6	€10.4	27%
Aggregator & Prosumer	-€2.8	€0.7	€1.9	€2.0	€2.2	€2.5	48%
Aggregator & Retailer & Prosumer	-€25.3	€20.0	€11.9	€3.7	-€8.0	€11.1	27%

Table 37. The expected Free Cash Flows (in '000 Euros) and IRR of a Retailer's expansion options in Valencia

Roles	Year						IRR
	0	1	2	3	4	5	
Retailer & Aggregator	-€23.2	€19.8	€11.4	€3.3	-€7.8	€10.9	32%
Retailer & Prosumer	-€24.4	€21.0	€11.9	€3.8	-€7.5	€11.2	33%
Retailer & Aggregator & Prosumer	-€24.9	€20.5	€12.0	€3.9	-€7.2	€11.6	31%

The following binary table indicates whether there are any roles that would not have the incentive to deploy a certain scenario. Note that some roles are not involved in a particular scenario and thus their incentives are ignored (this is marked with "0" on the respective cell). HLUC1 (Aggregators and Prosumers are only involved), HLUC2, HLUC10 (where DSOs, Aggregators and Prosumers participate) and HLUC8 (all roles are involved) are the scenarios that are not viable on an end-to-end basis. It seems that the Retailer is always willing to engage in Smart Grid scenarios and thus no incentives are necessary. The same applies for Prosumers that have already invested in renewable energy. More specifically, apart from HLUC10 where both the DSO and Aggregator have no incentive to participate, in the rest HLUCs there is only one role that would not find profitable to be engaged. In these cases, we would need to examine whether any transfer of welfare exists that would make it viable for all participants. This is important because in the worst case scenario[8] a certain HLUC may not find its way on the market.

Table 38. The end-to-end economic viability of High-level Use-Cases in Valencia

	baseline	HLUC 1	HLUC 2	HLUC 3	HLUC 4	HLUC 5	HLUC 6	HLUC 7	HLUC 8	HLUC 9	HLUC 10	HLUC 11	Baseline + all HLUCs
DSO	1	1	1	1	1	1	1	1	1	1	0	1	1
Aggregator	1	0	0	1	1	1	1	1	0	1	0	1	1
Retailer	1	1	1	1	1	1	1	1	1	1	1	1	1
Prosumer	0	1	1	1	1	1	1	1	1	1	1	1	1
e2e viability	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**1**

[7] If any of the markets for Aggregators or Retailers has not reached the equilibrium point, then the investment opportunities would be more promising.

[8] We have assumed that all actors are rational entities and thus would engage in a certain HLUC if it was profitable enough. This means that the number of providers will be high and thus revenues and market shares lower.

In conclusion, all baseline business models apart from the prosumer's role are profitable in Valencia. Prosumers, however, could adopt all relevant NOBEL GRID High-level Use-cases and obtain a high return on investment. For the rest roles, NOBEL GRID scenarios are attractive and there is a case where the return on investment is increased. This is evidenced from the last column of Table 38 where all roles eventually should be willing to adopt NOBEL GRID products.

7.2 FLANDERS (BELGIUM)

The following figure presents the expected IRR of standard business model per role in Flanders

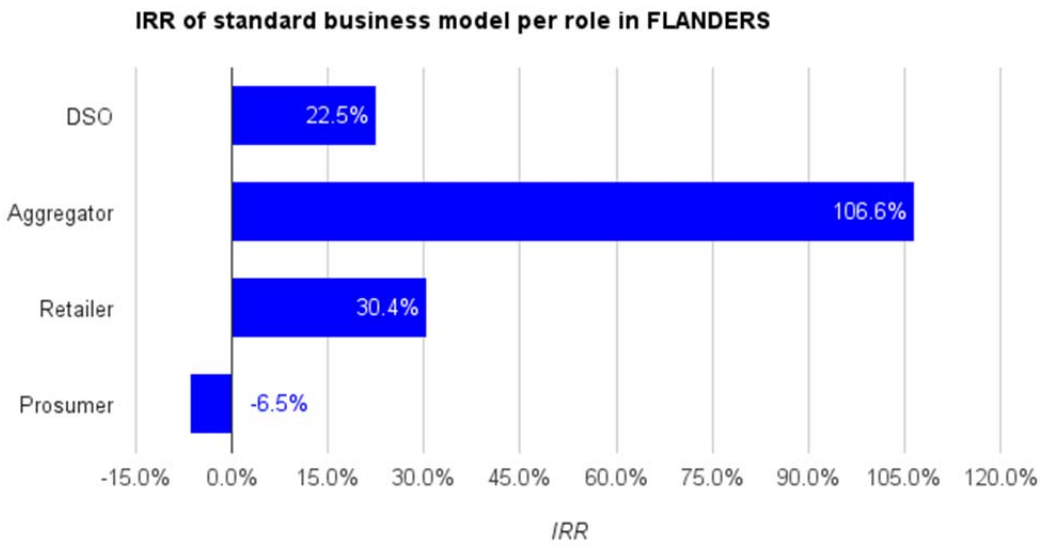

Figure 31. The expected IRR of standard business model per role in Flanders

The following figure presents the evolution of expected free cash flows of the standard business model for each role in Flanders

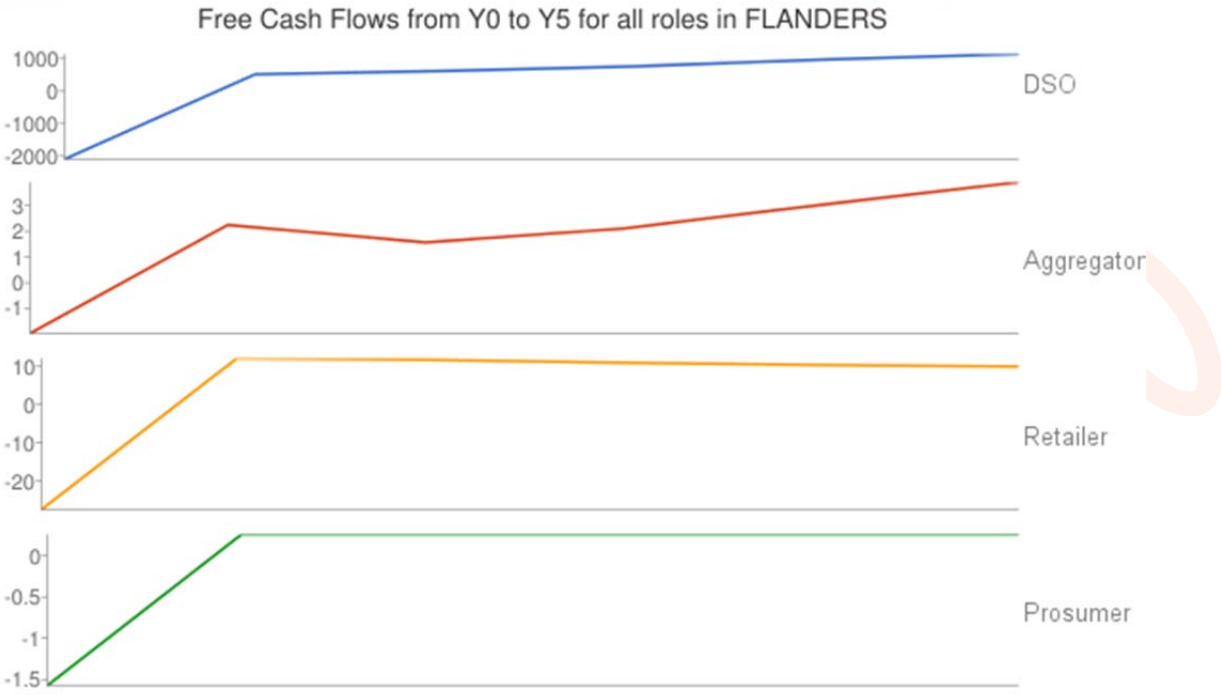

Figure 32. The evolution of expected free cash flows of the standard business model for each role in Flanders

The following figure presents the number of expected competitors for standard business model per role in Flanders

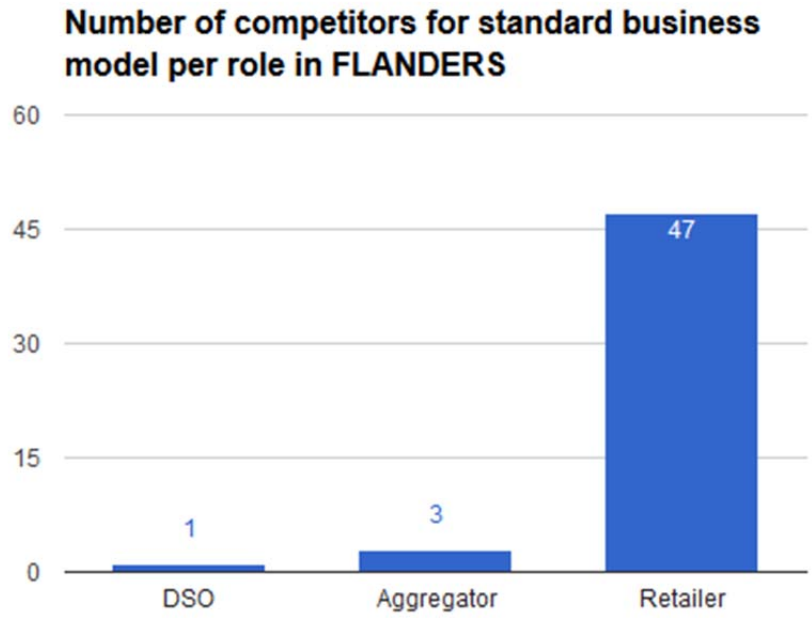

Figure 33. The expected number of competitors for the standard business model per role in Flanders

The following table provides the expected Free Cash Flows of a DSO in Flanders for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 39. The expected Free Cash Flows of a DSO in Flanders (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€2,095.8	€517.3	€622.0	€762.6	€974.8	€1,140.6	22.5%
HLUC2	-€12.5	€11.7	€11.7	€11.7	€11.7	€11.7	89.9%
HLUC3	-€12.5	€11.1	€11.1	€11.1	€11.1	€11.1	85.1%
HLUC4	-€20.8	€11.7	€11.7	€11.7	€11.7	€11.7	48.4%
HLUC5	-€20.8	€11.7	€11.7	€11.7	€11.7	€11.7	48.4%
HLUC6	-€20.8	€11.7	€11.7	€11.7	€11.7	€11.7	48.4%
HLUC7	-€12.5	€6.1	€6.1	€6.1	€6.1	€6.1	39.9%
HLUC8	-€20.8	€15.9	€15.9	€15.9	€15.9	€15.9	71.7%
HLUC9	-€22.4	€12.4	€12.4	€12.4	€12.4	€12.4	47.4%
HLUC10	-€22.4	€8.0	€8.0	€8.0	€8.0	€8.0	23.1%
HLUC11	-€22.4	€9.6	€9.6	€9.6	€9.6	€9.6	32.4%
Desirable HLUCs only	-€2,260.9	€619.1	€723.9	€864.4	€1,076.6	€1,242.4	24.78%
Overall	-€2,283.3	€627.1	€731.9	€872.4	€1,084.7	€1,250.4	24.76%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a DSO in Flanders has a less attractive baseline business model compared to the rest countries due to the high corporate tax rate. Thus, such a DSO would be positive in expanding its service portfolio and add

all HLUCs apart from HLUC10, yielding a 24.78% rate of return. The expected, aggregate Free Cash Flows and the IRR over a 5-year period for the Overall scenario is very close to the previous one (24.76%).

The following table provides the expected Free Cash Flows of an Aggregator in Flanders for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 40. The expected Free Cash Flows of an Aggregator in Flanders (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€2.0	€2.2	€1.6	€2.1	€3.0	€3.9	106.6%
HLUC1	-€0.6	€0.0	€0.0	€0.0	€0.0	€0.0	N/A
HLUC2	-€0.6	€0.1	€0.1	€0.1	€0.1	€0.1	-16.7%
HLUC3	-€0.6	€0.3	€0.3	€0.3	€0.3	€0.3	35.7%
HLUC7	-€0.6	€0.2	€0.2	€0.2	€0.2	€0.2	26.5%
HLUC8	-€1.4	-€0.5	-€0.5	-€0.5	-€0.5	-€0.5	N/A
HLUC9	-€0.6	€0.7	€0.7	€0.7	€0.7	€0.7	115.3%
HLUC10	-€0.6	€0.2	€0.2	€0.2	€0.2	€0.2	31.7%
Desirable HLUCs only	-€3.7	€3.4	€2.7	€3.3	€4.2	€5.1	87.2%
Overall	-€6.8	€3.2	€2.5	€3.1	€4.0	€4.8	38.8%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then an Aggregator in Flanders should expand its service portfolio by adding to the baseline business model the following HLUCs: HLUC3, HLUC9, and HLUC10. Note that if the Aggregator's annual revenue per customer received from DSOs for the services in HLUC8 is €20 (as used for the rest pilot sites) then an Aggregator would not find profitable to offer this particular service. However, as will be discussed in Section 9.2, increasing the annual revenue to €28 per user would lead to a "win-win" situation for both the Aggregator and the DSO. Furthermore, the expected, aggregate Free Cash Flows and the IRR in that case is very high (96.3%), while deploying all NOBEL GRID HLUCs where Aggregators are involved is still higher than the threshold but not so attractive.

The following table provides the expected Free Cash Flows of a Retailer in Flanders for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it could be involved.

Table 41. The expected Free Cash Flows of a Retailer in Flanders (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€27.4	€12.1	€11.7	€11.0	€10.4	€10.0	30.4%
HLUC8	-€0.1	€0.1	€0.1	€0.1	€0.1	€0.1	84.2%
Desirable HLUCs only	-€27.6	€12.3	€11.9	€11.1	€10.5	€10.1	30.7%
Overall	-€27.6	€12.3	€11.9	€11.1	€10.5	€10.1	30.7%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a Retailer in Flanders should expand its service portfolio by adding to the baseline business model the HLUC8 (the only that it is involved). The expected, aggregate Free Cash Flows and the IRR over a 5-year period in that case would be 30.7% and thus the NOBEL GRID would have a positive effect.

The following table provides the expected Free Cash Flows of a Prosumer in Flanders for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it could be involved.

Table 42. The expected Free Cash Flows of a Prosumer in Flanders (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€1.58	€0.26	€0.26	€0.26	€0.26	€0.26	-6.5%
HLUC1	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	278.9%
HLUC2	-€0.01	€0.02	€0.02	€0.02	€0.02	€0.02	465.4%
HLUC3	-€0.01	€0.05	€0.05	€0.05	€0.05	€0.05	931.0%
HLUC7	-€0.10	€0.49	€0.49	€0.49	€0.49	€0.49	487.9%
HLUC8	-€0.01	€0.02	€0.02	€0.02	€0.02	€0.02	489.9%
HLUC9	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	195.1%
HLUC10	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	133.3%
HLUC11	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	199.2%
Desirable HLUCs only	-€1.68	€0.65	€0.65	€0.65	€0.65	€0.65	26.8%
Overall	-€1.68	€0.71	€0.71	€0.71	€0.71	€0.71	31.6%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then no new Prosumer in Flanders would have the incentive to install PV on its rooftop. The reason is that even if it expanded its service portfolio by adding HLUC7 to the baseline business model, the expected aggregate Free Cash Flows and the IRR over a 5-year period would not meet the target. It would be profitable, however, for a new prosumer to deploy all the NOBEL GRID HLUCs where its role is involved due to the (marginally) positive impact on free cash flows of the HLUCs other than HLUC7.

The following two tables assess the attractiveness of an Aggregator and a Retailer respectively, in Flanders to adopt additional roles. We can observe that an Aggregator in Flanders would have an economic incentive to expand its business by becoming a Retailer and a Prosumer at the same time. On the other hand, a Retailer in Flanders would have the economic incentive to expand their business by becoming a Prosumer only (the rest options are less attractive).

Table 43. The expected Free Cash Flows (in '000 Euros) and IRR of an Aggregator's expansion options in Flanders

	Year						
Roles	0	1	2	3	4	5	IRR
Aggregator & Retailer	-€31.2	€15.4	€14.3	€14.0	€14.4	€14.8	37%
Aggregator & Prosumer	-€5.3	€4.2	€3.5	€4.0	€4.9	€5.8	72%
Aggregator & Retailer & Prosumer	-€32.9	€16.1	€15.0	€14.8	€15.1	€15.6	37%

Table 44. The expected Free Cash Flows (in '000 Euros) and IRR of a Retailer's expansion options in Flanders

	Year						
Roles	0	1	2	3	4	5	IRR
Retailer & Aggregator	-€30.1	€11.9	€10.8	€10.3	€10.4	€10.5	24%
Retailer & Prosumer	-€29.2	€13.0	€12.6	€11.9	€11.3	€10.9	31%
Retailer & Aggregator & Prosumer	-€31.8	€12.7	€11.6	€11.1	€11.1	€11.2	24%

The following binary table indicates whether there are any roles that would not have the incentive to deploy a certain scenario. HLUC1 (Aggregators and Prosumers are only involved), HLUC2, HLUC7 and HLUC10 (where DSOs, Aggregators and Prosumers participate), as well as, HLUC8 (all roles are involved) are the scenarios that are not viable on an end-to-end basis. Again, the Retailer role and Prosumers, who have already invested in renewable energy, are always willing to engage in Smart Grid scenarios and thus no additional incentive mechanisms would have to be designed. More specifically, in all these HLUCs there is a single role only that would not find profitable to be engaged and thus we could examine whether any transfer of welfare exists leading to a "win-win" situation.

Table 45. The end-to-end economic viability of High-level Use-Cases in Flanders

	baseline	HLUC 1	HLUC 2	HLUC 3	HLUC 4	HLUC 5	HLUC 6	HLUC 7	HLUC 8	HLUC 9	HLUC 10	HLUC 11	Baseline + all HLUCs
DSO	0	1	1	1	1	1	1	1	1	1	0	1	0
Aggregator	1	0	0	1	1	1	1	0	0	1	1	1	1
Retailer	1	1	1	1	1	1	1	1	1	1	1	1	1
Prosumer	0	1	1	1	1	1	1	1	1	1	1	1	1
e2e viability	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**1**	**0**

In conclusion, all baseline business models apart from the DSO and prosumer's are profitable in Flanders. In Table 42 we observe, however, that Prosumers could adopt all relevant NOBEL GRID High-level Use-cases and obtain a high return on investment. The DSO on the other hand fails to reach the minimum selection threshold of 30% mainly due to the high corporate tax rate. In any case, NOBEL GRID scenarios are attractive and for most roles (apart from Aggregators) the return on investment is increased compared to that of the baseline model.

In terms of role popularity for expansion opportunities in market equilibrium, we observed that the Prosumer role is ranked first (since both Aggregators and Retailers would find it profitable to deploy photovoltaic panels) followed by the Retailer role (since Aggregators would probably agree to lower their return on investment and offer retailing services).

7.3 MANCHESTER (UK)

The following figure presents the expected IRR of standard business model per role in Manchester

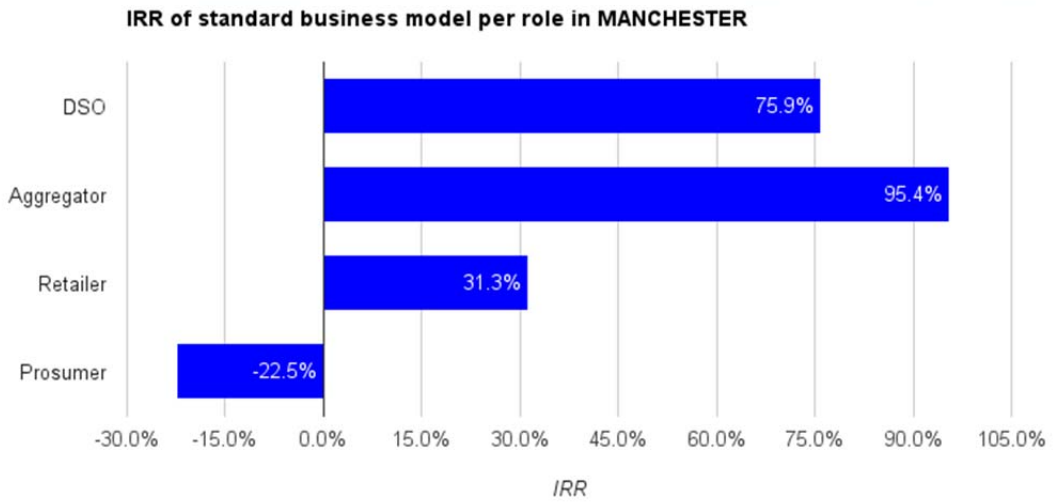

Figure 34. The expected IRR of standard business model per role in Manchester

The following figure presents the evolution of expected free cash flows of the standard business model for each role in Manchester

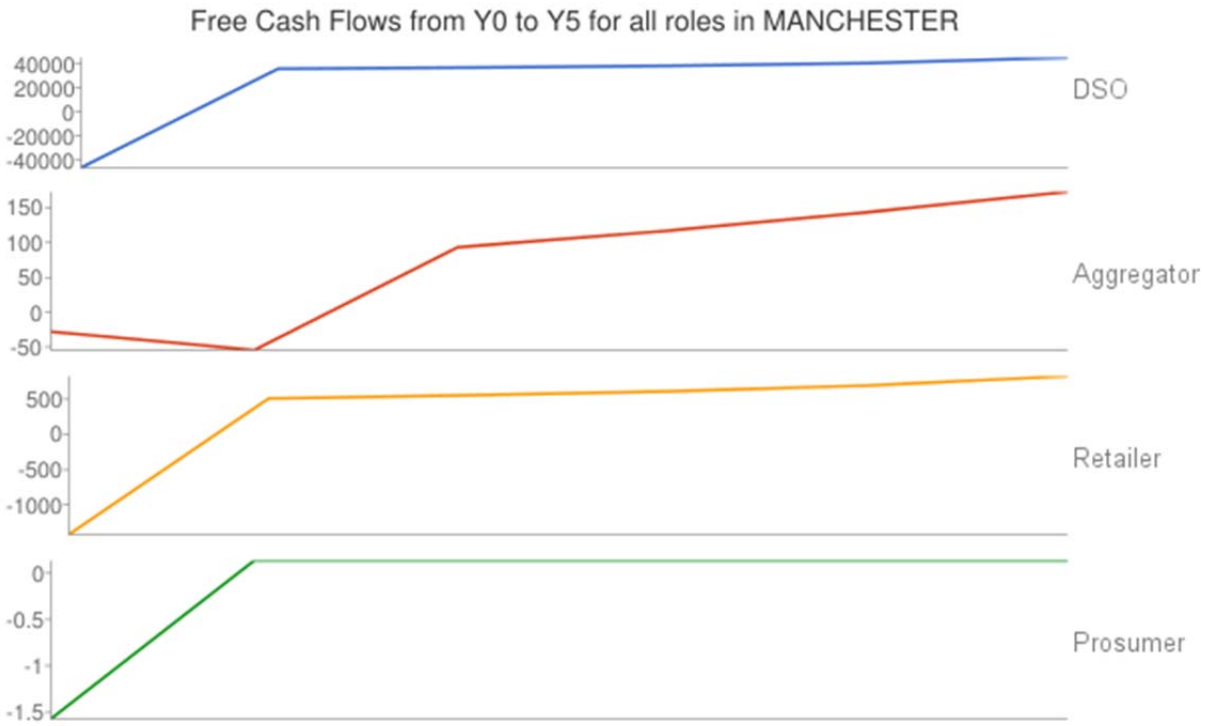

Figure 35. The evolution of expected free cash flows of the standard business model for each role in Manchester

The following figure presents the number of expected competitors for standard business model per role in Manchester

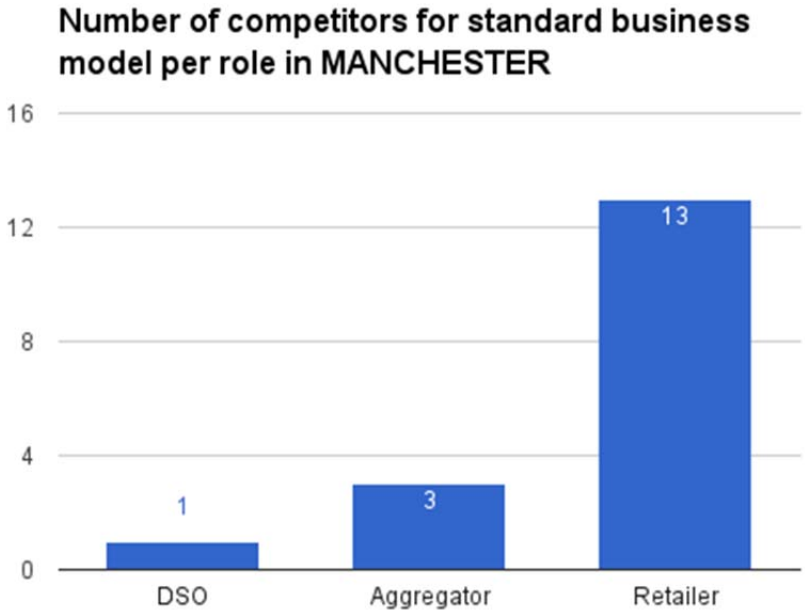

Figure 36. The expected number of competitors for the standard business model per role in Manchester

The following table provides the expected Free Cash Flows of a DSO in Manchester for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 46. The expected Free Cash Flows of a DSO in Manchester (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€46,200.0	€35,783.0	€36,851.0	€38,307.0	€40,539.0	€45,099.0	75.9%
HLUC2	-€360.0	€388.8	€388.8	€388.8	€388.8	€388.8	105.0%
HLUC3	-€360.0	€369.6	€369.6	€369.6	€369.6	€369.6	99.4%
HLUC4	-€600.0	€379.2	€379.2	€379.2	€379.2	€379.2	56.5%
HLUC5	-€600.0	€379.2	€379.2	€379.2	€379.2	€379.2	56.5%
HLUC6	-€600.0	€379.2	€379.2	€379.2	€379.2	€379.2	56.5%
HLUC7	-€360.0	€196.8	€196.8	€196.8	€196.8	€196.8	46.6%
HLUC8	-€600.0	€527.2	€527.2	€527.2	€527.2	€527.2	83.7%
HLUC9	-€648.0	€403.2	€403.2	€403.2	€403.2	€403.2	55.3%
HLUC10	-€648.0	€251.5	€251.5	€251.5	€251.5	€251.5	27.1%
HLUC11	-€648.0	€307.2	€307.2	€307.2	€307.2	€307.2	37.9%
Desirable HLUCs only	-€50,976.0	€39,113.4	€40,181.4	€41,637.4	€43,869.4	€48,429.4	74.8%
Overall	-€51,624.0	€39,364.9	€40,432.9	€41,888.9	€44,120.9	€48,680.9	74.3%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a DSO in Manchester should expand its service portfolio by adding to the baseline business model all the HLUCs. The expected, aggregate Free Cash Flows and the IRR over a 5-year period in that case would be 74.8%, while the Overall scenario has a slightly less attractive rate of return (74.3%).

The following table provides the expected Free Cash Flows of an Aggregator in Manchester for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 47. The expected Free Cash Flows of an Aggregator in Manchester (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€28.0	-€54.4	€93.2	€116.2	€143.1	€172.9	95.4%
HLUC1	-€2.0	€4.1	€4.1	€4.1	€4.1	€4.1	204.0%
HLUC2	-€2.0	€6.2	€6.2	€6.2	€6.2	€6.2	307.9%
HLUC3	-€2.0	€12.6	€12.6	€12.6	€12.6	€12.6	632.0%
HLUC7	-€2.0	€11.7	€11.7	€11.7	€11.7	€11.7	584.0%
HLUC8	-€5.0	-€1.7	-€1.7	-€1.7	-€1.7	-€1.7	N/A
HLUC9	-€2.0	€22.2	€22.2	€22.2	€22.2	€22.2	1112.1%
HLUC10	-€2.0	€11.2	€11.2	€11.2	€11.2	€11.2	561.4%
Desirable HLUCs only	-€40.0	€13.6	€161.3	€184.2	€211.2	€241.0	176.0%
Overall	-€45.0	€11.9	€159.6	€182.5	€209.5	€239.3	160.4%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then an Aggregator in Manchester should expand its service portfolio by adding to the baseline business model the

following all HLUCs apart from HLUC8. We observe that the return on investment for each individual HLUC is very high, which is mainly attributed to the low corporate tax rate in UK and the large customer base. The expected, aggregate Free Cash Flows and the IRR over a 5-year period would be very high (176.0%), while the Overall scenario has a slightly less attractive rate of return (160.4%).

The following table provides the expected Free Cash Flows of a Retailer in Manchester for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 48. The expected Free Cash Flows of a Retailer in Manchester (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€1,424.4	€509.5	€555.6	€610.2	€693.4	€826.1	31.3%
HLUC8	-€6.9	€8.3	€8.3	€8.3	€8.3	€8.3	117.8%
Desirable HLUCs only	-€1,431.3	€517.8	€563.9	€618.5	€701.7	€834.4	31.8%
Overall	-€1,431.3	€517.8	€563.9	€618.5	€701.7	€834.4	31.8%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a Retailer in Manchester should expand its service portfolio by adding to the baseline business model the only HLUCs that it is involved (HLUC8). The expected, aggregate Free Cash Flows and the IRR over a 5-year period in that case would be 31.8%, and thus NOBEL GRID would have a positive effect on its financial results.

The following table provides the expected Free Cash Flows of a Prosumer in Manchester for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 49. The expected Free Cash Flows of a Prosumer in Manchester (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€1.58	€0.14	€0.14	€0.14	€0.14	€0.14	-22.5%
HLUC1	€0	€0.01	€0.01	€0.01	€0.01	€0.01	N/A
HLUC2	€0	€0.02	€0.02	€0.02	€0.02	€0.02	N/A
HLUC3	€0	€0.04	€0.04	€0.04	€0.04	€0.04	N/A
HLUC7	-€0.10	€0.49	€0.49	€0.49	€0.49	€0.49	487.9%
HLUC8	€0	€0.02	€0.02	€0.02	€0.02	€0.02	N/A
HLUC9	€0	€0	€0	€0	€0	€0	N/A
HLUC10	€0	€0	€0	€0	€0	€0	N/A
HLUC11	€0	€0	€0	€0	€0	€0	N/A
Desirable HLUCs only	-€1.68	€0.63	€0.63	€0.63	€0.63	€0.63	25.2%
Overall	-€1.68	€0.68	€0.68	€0.68	€0.68	€0.68	29.7%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then no new Prosumers in Manchester would have the incentive to install PV on their rooftop with the baseline model in mind only. When taking into account the positive impact of the NOBEL GRID HLUCs then expanding their service portfolio by including HLUC7 to the baseline business model would increase significantly the expected aggregate Free Cash Flows and the IRR over a 5-year period.

And similar to Valencia and Flanders, deploying all the NOBEL GRID HLUCs where their role is involved would almost reach the selection threshold. Furthermore, as will be described in Section 9.2, members of cooperative schemes may have a lower IRR threshold and thus agree to adopt NOBEL GRID HLUCs.

The following two tables assess the attractiveness of an Aggregator and a Retailer in Manchester respectively, in adopting additional roles. We can observe that, in Manchester, both an Aggregator and a Retailer would have an economic incentive to expand their business and become rivals in each other's market, as well as, becoming a Prosumer.

Table 50. The expected Free Cash Flows (in '000 Euros) and IRR of an Aggregator's expansion options in Manchester

Roles	Year						IRR
	0	1	2	3	4	5	
Aggregator & Retailer	-€1,445.5	€508.7	€698.0	€769.8	€872.7	€1,017.5	39%
Aggregator & Prosumer	-€41.7	€14.2	€161.9	€184.8	€211.8	€241.6	172%
Aggregator & Retailer & Prosumer	-€1,447.2	€509.3	€698.7	€770.4	€873.4	€1,018.2	39%

Table 51. The expected Free Cash Flows (in '000 Euros) and IRR of a Retailer's expansion options in Manchester

Roles	Year						IRR
	0	1	2	3	4	5	
Retailer & Aggregator	-€1,469.3	€451.4	€591.6	€659.9	€759.9	€911.3	31.2%
Retailer & Prosumer	-€1,433.0	€518.4	€564.5	€619.1	€702.3	€835.1	31.7%
Retailer & Aggregator & Prosumer	-€1,471.0	€452.0	€592.3	€660.6	€760.5	€911.9	31.2%

The following binary table indicates whether there are any roles that would not have the incentive to deploy a certain scenario. HLUC8 (where all roles are involved) and HLUC10 (where DSOs, Aggregators and Prosumers participate) are the scenarios that are not viable on an end-to-end basis. Again, the Retailer role and existing Prosumers willing to engage in Smart Grid scenarios and thus no additional incentive mechanisms would have to be designed. More specifically, in all these HLUCs there is only a single role that would not be profitably delivered and thus we could examine whether any transfer of benefit can exist leading to an "all-win" situation.

Table 52. The end-to-end economic viability of High-level Use-Cases in Manchester

	baseline	HLUC 1	HLUC 2	HLUC 3	HLUC 4	HLUC 5	HLUC 6	HLUC 7	HLUC 8	HLUC 9	HLUC 10	HLUC 11	Baseline + all HLUCs
DSO	1	1	1	1	1	1	1	1	1	1	0	1	1
Aggregator	1	1	1	1	1	1	1	1	0	1	1	1	1
Retailer	1	1	1	1	1	1	1	1	1	1	1	1	1
Prosumer	0	1	1	1	1	1	1	1	1	1	1	1	1
e2e viability	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**1**

In conclusion, all baseline business models apart from the prosumer's role are profitable in Manchester. Similarly to Valencia and Flanders, Prosumers could adopt all relevant NOBEL GRID High-level Use-cases and obtain a high return on investment. In any case, NOBEL GRID scenarios are attractive and in most cases the return on investment is increased compared to the baseline

model (the exception being the Aggregator's role). This is evidenced from the last column of Table 52, where all roles eventually should be willing to adopt NOBEL GRID products.

In terms of role popularity for expansion opportunities in market equilibrium, we observed that the Prosumer role is ranked first (since both Aggregators and Retailers would find it profitable to deploy photovoltaic panels). Finally, both the Retailer and the Aggregator roles could be adopted by one complimentary role (Aggregators and Retailers respectively).

7.4 TERNI (ITALY)

The following figure presents the expected IRR of standard business model per role in Terni

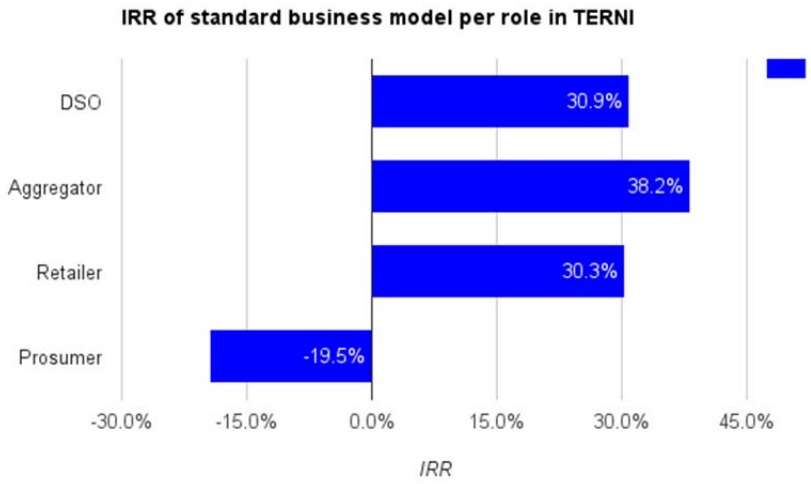

Figure 37. The expected IRR of standard business model per role in Terni

The following figure presents the evolution of expected free cash flows of the standard business model for each role in Terni

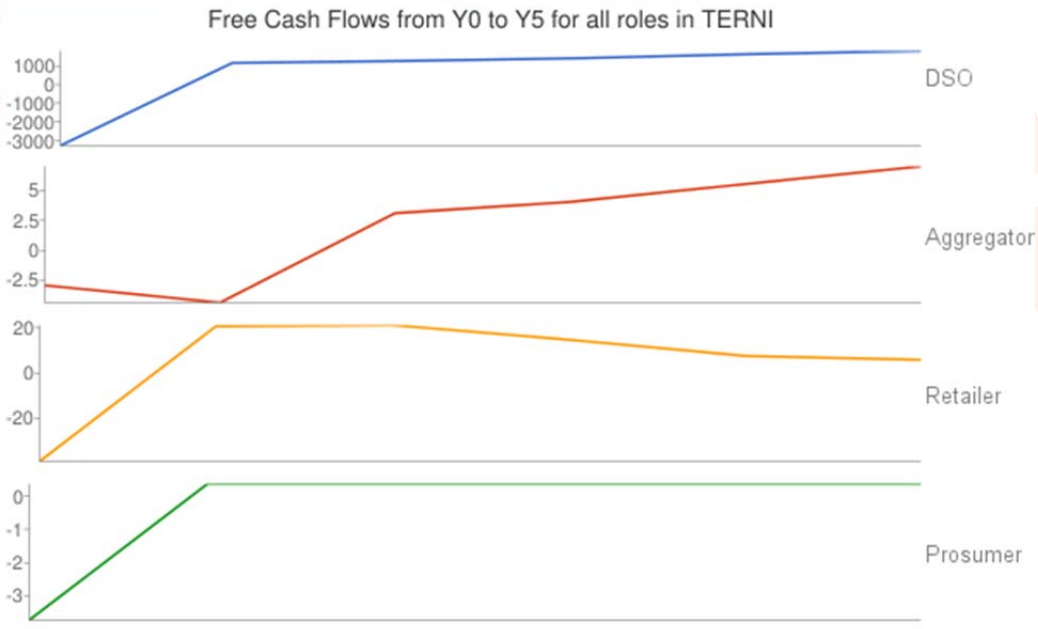

Figure 38. The evolution of expected free cash flows of the standard business model for each role in Terni

The following figure presents the number of expected competitors for standard business model per role in Terni

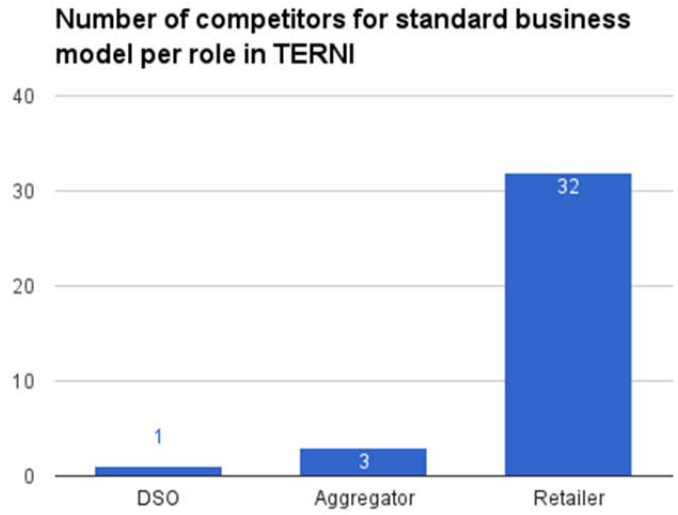

Figure 39. The expected number of competitors for the standard business model per role in Terni

The following table provides the expected Free Cash Flows of a DSO in Terni for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 53. The expected Free Cash Flows of a DSO in Terni (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€3,270.5	€1,156.2	€1,262.7	€1,406.4	€1,624.6	€1,799.7	30.9%
HLUC2	-€15.0	€20.8	€20.8	€20.8	€20.8	€20.8	136.7%
HLUC3	-€15.0	€19.8	€19.8	€19.8	€19.8	€19.8	129.7%
HLUC4	-€28.0	€20.3	€20.3	€20.3	€20.3	€20.3	67.1%
HLUC5	-€28.0	€20.3	€20.3	€20.3	€20.3	€20.3	67.1%
HLUC6	-€28.0	€20.3	€20.3	€20.3	€20.3	€20.3	67.1%
HLUC7	-€19.5	€10.5	€10.5	€10.5	€10.5	€10.5	45.6%
HLUC8	-€28.0	€28.2	€28.2	€28.2	€28.2	€28.2	97.2%
HLUC9	-€30.6	€21.6	€21.6	€21.6	€21.6	€21.6	64.9%
HLUC10	-€30.6	€13.6	€13.6	€13.6	€13.6	€13.6	34.3%
HLUC11	-€30.6	€16.6	€16.6	€16.6	€16.6	€16.6	45.9%
Desirable HLUCs only	-€3,523.8	€1,348.2	€1,454.7	€1,598.4	€1,816.6	€1,991.7	33.7%
Overall	-€3,523.8	€1,348.2	€1,454.7	€1,598.4	€1,816.6	€1,991.7	33.7%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a DSO in Terni should expand its service portfolio by adding to the baseline business model all HLUCs. The expected, aggregate Free Cash Flows and the IRR over a 5-year period in that case would be 33.7%.

The following table provides the expected Free Cash Flows of an Aggregator in Terni for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 54. The expected Free Cash Flows of an Aggregator in Terni (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€2.9	-€4.4	€3.1	€4.1	€5.6	€7.0	38.2%
HLUC1	-€0.8	-€0.1	-€0.1	-€0.1	-€0.1	-€0.1	N/A
HLUC2	-€0.8	€0.1	€0.1	€0.1	€0.1	€0.1	-23.8%
HLUC3	-€0.8	€0.4	€0.4	€0.4	€0.4	€0.4	37.9%
HLUC7	-€0.8	€0.3	€0.3	€0.3	€0.3	€0.3	29.96%
HLUC8	-€2.0	-€13.1	-€13.1	-€13.1	-€13.1	-€13.1	N/A
HLUC9	-€0.8	€0.9	€0.9	€0.9	€0.9	€0.9	108.7%
HLUC10	-€0.8	€0.3	€0.3	€0.3	€0.3	€0.3	30.3%
Desirable HLUCs only	-€6.2	-€2.4	€5.1	€6.0	€7.5	€9.0	42.9%
Overall	-€9.8	-€15.5	-€8.0	-€7.0	-€5.5	-€4.1	N/A

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then an Aggregator in Terni should expand its service portfolio by adding to the baseline business model the following HLUCs: HLUC3, HLUC7, HLUC9 and HLUC10. The expected, aggregate Free Cash Flows and the IRR over a 5-year period would be 42.9%. However, the Overall scenario is not attractive mainly because in HLUC8 the Aggregator has to provide a reward to the Prosumer that is significantly higher than the average aggregator's wholesale price in Spain, Belgium and the UK. If not, the latter will choose to provide its power to the pool and receive the high wholesale price that has been set in Italy.

The following table provides the expected Free Cash Flows of a Retailer in Terni for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 55. The expected Free Cash Flows of a Retailer in Terni (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€39.0	€20.6	€21.1	€14.7	€7.5	€5.8	30.3%
HLUC8	-€0.3	€0.3	€0.3	€0.3	€0.3	€0.3	96.1%
Desirable HLUCs only	-€39.3	€20.8	€21.4	€14.9	€7.8	€6.1	30.9%
Overall	-€39.3	€20.8	€21.4	€14.9	€7.8	€6.1	30.9%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a Retailer in Terni should expand its service portfolio by adding to the baseline business model the only HLUC that it is involved (i.e., HLUC8). The expected, aggregate Free Cash Flows and the IRR over a 5-year period in that case would be 30.9%, and thus NOBEL GRID would be beneficial.

The following table provides the expected Free Cash Flows of a Prosumer in Terni for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved. We observe that no new Prosumer in Terni would have the incentive to install PV on its rooftop. The reason is that even if it expanded its service portfolio by adding HLUC7 to the baseline business model, the expected aggregate Free Cash Flows and the IRR over a 5-year period would not meet the target. The same applies for all the NOBEL GRID HLUCs where the prosumer would be involved (even though it would be slightly higher).

Table 56. The expected Free Cash Flows of a Prosumer in Terni (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€3.73	€0.37	€0.37	€0.37	€0.37	€0.37	-19.51%
HLUC1	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	264.19%
HLUC2	-€0.01	€0.02	€0.02	€0.02	€0.02	€0.02	440.90%
HLUC3	-€0.01	€0.04	€0.04	€0.04	€0.04	€0.04	881.99%
HLUC7	-€0.10	€0.49	€0.49	€0.49	€0.49	€0.49	487.93%
HLUC8	-€0.01	€0.06	€0.06	€0.06	€0.06	€0.06	1298.50%
HLUC9	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	195.12%
HLUC10	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	133.28%
HLUC11	-€0.01	€0.01	€0.01	€0.01	€0.01	€0.01	199.17%
Desirable HLUCs only	-€3.83	€0.86	€0.86	€0.86	€0.86	€0.86	3.98%
Overall	-€3.83	€0.96	€0.96	€0.96	€0.96	€0.96	8.04%

The following two tables assess the attractiveness of an Aggregator and a Retailer in Terni respectively, in adopting additional roles. We can observe that an Aggregator in Terni would have an economic incentive to expand its business by becoming a Retailer and a Prosumer at the same time. On the other hand, a Retailer in Terni could consider expanding its business by becoming a Prosumer only if no other better opportunity exists.

Table 57: The expected Free Cash Flows (in '000 Euros) and IRR of an Aggregator's expansion options in Terni

	Year						
Roles	0	1	2	3	4	5	IRR
Aggregator & Retailer	-€45.4	€17.7	€25.7	€20.3	€14.6	€14.4	32%
Aggregator & Prosumer	-€10.0	-€1.6	€5.9	€6.9	€8.4	€9.8	34%
Aggregator & Retailer & Prosumer	-€49.3	€18.6	€26.5	€21.1	€15.5	€15.2	30%

Table 58: The expected Free Cash Flows (in '000 Euros) and IRR of a Retailer's expansion options in Terni

	Year						
Roles	0	1	2	3	4	5	IRR
Retailer & Aggregator	-€43.0	€15.0	€20.2	€14.2	€8.0	€7.2	18%
Retailer & Prosumer	-€43.1	€21.7	€22.2	€15.8	€8.7	€6.9	28%
Retailer & Aggregator & Prosumer	-€46.8	€15.9	€21.0	€15.1	€8.9	€8.1	17%

The following binary table indicates whether there are any roles that would not have the incentive to deploy a certain scenario. In contrast to previous pilot sites where at least one of the DSO or the Aggregator had low return on investment, in Terni this happens only for the Aggregator's role for HLUC1 (where Aggregators and Prosumers are only involved), HLUC2 and HLUC10 (DSOs, Aggregators and Prosumers participate), as well as, HLUC8 (all roles are involved) are the scenarios that are not viable on an end-to-end basis. For these HLUCs we could examine whether additional incentive mechanisms would have to be designed leading to a "win-win" situation. Again, the Retailer role Prosumers that have already invested in renewable energy are always willing to engage in Smart Grid scenarios.

Table 59. The end-to-end economic viability of High-level Use-Cases in Terni

	baseline	HLUC 1	HLUC 2	HLUC 3	HLUC 4	HLUC 5	HLUC 6	HLUC 7	HLUC 8	HLUC 9	HLUC 10	HLUC 11	Baseline + all HLUCs
DSO	1	1	1	1	1	1	1	1	1	1	1	1	1
Aggregator	1	0	0	1	1	1	1	1	0	1	1	1	0
Retailer	1	1	1	1	1	1	1	1	1	1	1	1	1
Prosumer	0	1	1	1	1	1	1	1	1	1	1	1	0
e2e viability	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**0**

In conclusion, all baseline business models apart from the prosumer's role are profitable in Terni. In Table 56 we observe, however, that Prosumers could adopt all relevant NOBEL GRID High-level Use-cases and obtain a high return on investment. NOBEL GRID scenarios are attractive and in most cases the return on investment is increased compared to the baseline model (exception being the Aggregator's role[9]). In terms of role popularity for expansion opportunities in market equilibrium, we observed that the Prosumer role would rank first followed by the Retailer one. Even though only Aggregators would have the incentive to diversify their service portfolio by including both roles, the tie-breaking criterion was the rate of return.

7.5 MELTEMI (GREECE)

The following figure presents the expected IRR of standard business model per role in Meltemi

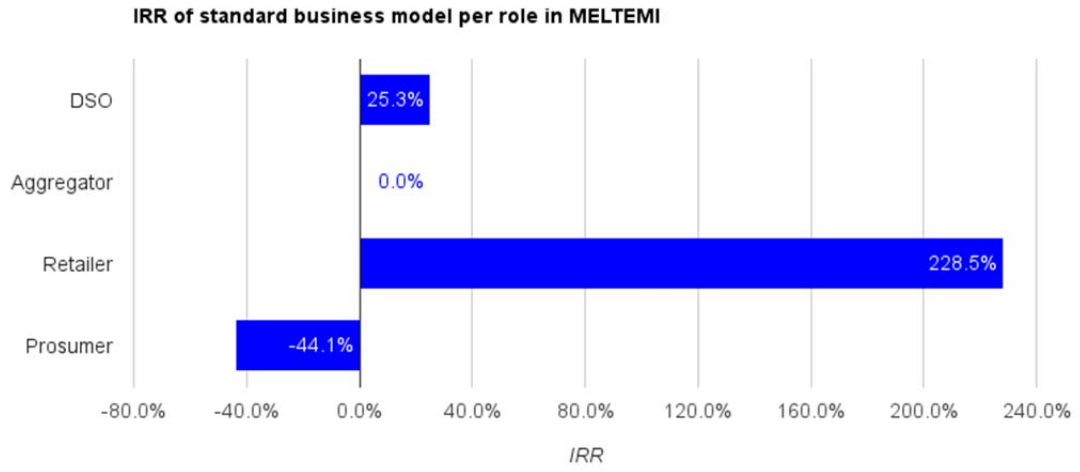

Figure 40. The expected IRR of standard business model per role in Meltemi

The following figure presents the evolution of expected free cash flows of the standard business model for each role in Meltemi

[9] As already mentioned, an Aggregator in Terni should offer prosumers a payment for participation in HLUC8 that is higher than the wholesale price in Italy, which is significantly higher than the previous pilot sites. As a consequence, the HLUC8 is not attractive for the Aggregator. If, however, we focus on the attractive HLUCs only, then Aggregators would benefit from NOBEL GRID products.

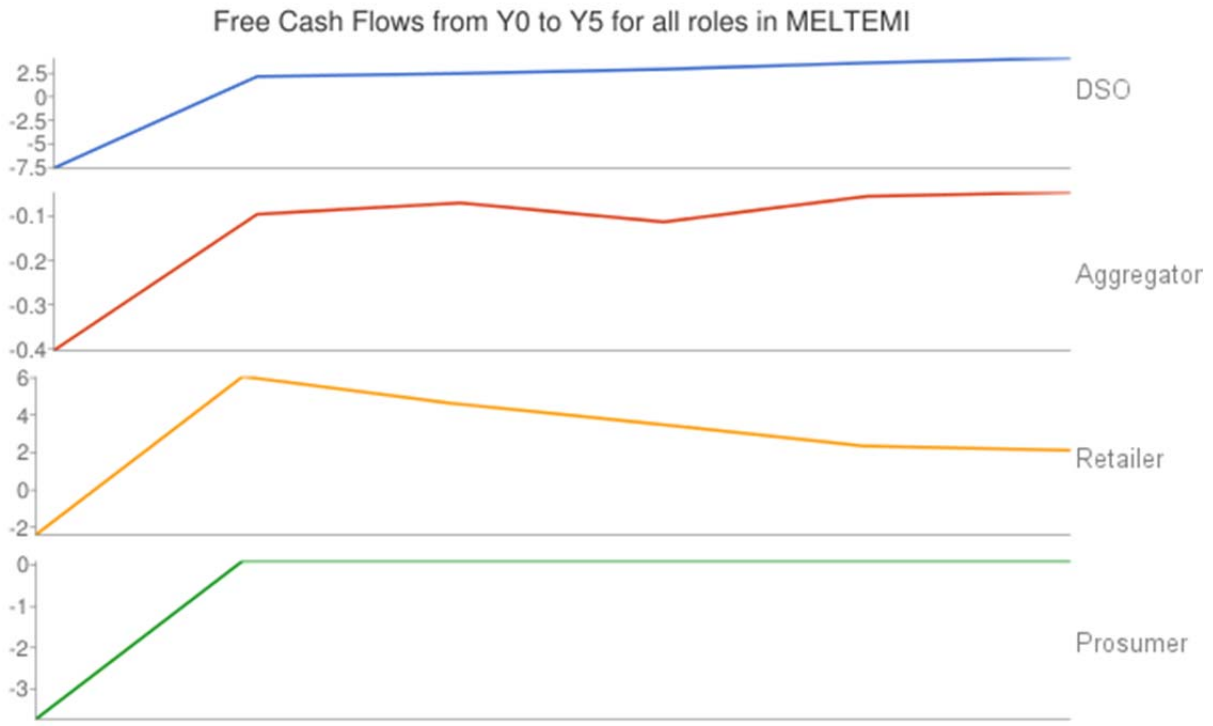

Figure 41. The evolution of expected free cash flows of the standard business model for each role in Meltemi

The following figure presents the number of expected competitors for standard business model per role in Meltemi

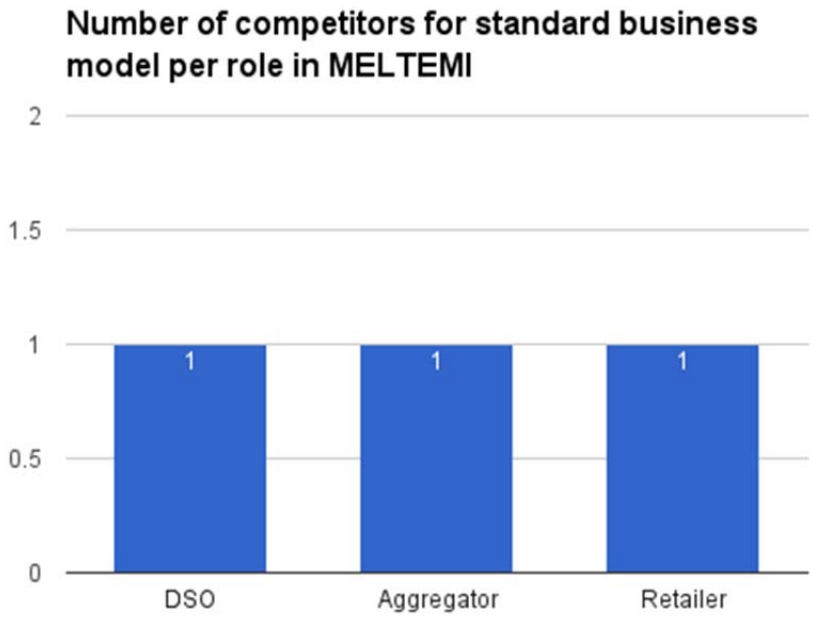

Figure 42. The expected number of competitors for the standard business model per role in Meltemi

The following table provides the expected Free Cash Flows of a DSO in Meltemi for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 60. The expected Free Cash Flows of a DSO in Meltemi (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€7.6	€2.2	€2.5	€2.9	€3.6	€4.1	25.3%
HLUC2	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	94.6%
HLUC3	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	89.6%
HLUC4	-€0.1	€0.0	€0.0	€0.0	€0.0	€0.0	50.9%
HLUC5	-€0.1	€0.0	€0.0	€0.0	€0.0	€0.0	50.9%
HLUC6	-€0.1	€0.0	€0.0	€0.0	€0.0	€0.0	50.9%
HLUC7	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	42.0%
HLUC8	-€0.1	€0.1	€0.1	€0.1	€0.1	€0.0	75.4%
HLUC9	-€0.1	€0.0	€0.0	€0.0	€0.0	€0.1	49.9%
HLUC10	-€0.1	€0.0	€0.0	€0.0	€0.0	€0.0	24.4%
HLUC11	-€0.1	€0.0	€0.0	€0.0	€0.0	€0.0	34.1%
Desirable HLUCs only	-€8.2	€2.5	€2.9	€3.3	€4.0	€4.5	27.6%
Overall (baseline + all relevant HLUCs)	-€8.3	€2.6	€2.9	€3.3	€4.0	€4.5	27.6%

If we set the minimum IRR threshold for approving a certain business model to 30%, then the baseline model for a DSO in Meltemi is profitable but not highly attractive. On the other hand, such a DSO would should expand its service portfolio by adding to the baseline business model all HLUCs but HLUC10. The expected, aggregate Free Cash Flows and the IRR over a 5-year period in that case would be 27.6%, while the Overall scenario has a similar rate of return.

The following table provides the expected Free Cash Flows of an Aggregator in Meltemi for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 61. The expected Free Cash Flows of an Aggregator in Meltemi (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€0.4	-€0.1	-€0.1	-€0.1	-€0.1	€0.0	N/A
HLUC1	-€0.2	€0.0	€0.0	€0.0	€0.0	€0.0	N/A
HLUC2	-€0.2	€0.0	€0.0	€0.0	€0.0	€0.0	N/A
HLUC3	-€0.2	€0.0	€0.0	€0.0	€0.0	€0.0	N/A
HLUC7	-€0.2	€0.0	€0.0	€0.0	€0.0	€0.0	N/A
HLUC8	-€0.5	-€0.1	-€0.1	-€0.1	-€0.1	-€0.1	N/A
HLUC9	-€0.2	€0.0	€0.0	€0.0	€0.0	€0.0	N/A
HLUC10	-€0.2	€0.0	€0.0	€0.0	€0.0	€0.0	N/A
Desirable HLUCs only	-€0.4	-€0.1	-€0.1	-€0.1	-€0.1	€0.0	N/A
Overall	-€2.1	-€0.4	-€0.4	-€0.4	-€0.4	-€0.4	N/A

We observe that no Aggregator would find it viable to operate in Meltemi since all free cash flows are negative. This is attributed to the small customer base, which is not able to recover the necessary capital expenditures. Furthermore, no combination of HLUCs would be attractive. Note that the wholesale price that has been set in Greece is, like in Italy, high compared to Spain, Belgium and the UK. Thus, the Aggregator would have to provide a reward to the Prosumer that is significantly higher than the average aggregator's wholesale price in order to attract prosumers in HLUC8.

The following table provides the expected Free Cash Flows of a Retailer in Meltemi for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved.

Table 62. The expected Free Cash Flows of a Retailer in Meltemi (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€2.4	€6.1	€4.6	€3.5	€2.4	€2.1	228.5%
HLUC8	-€0.60	-€0.03	-€0.03	-€0.03	-€0.03	-€0.03	N/A
Desirable HLUCs only	-€2.4	€6.1	€4.6	€3.5	€2.4	€2.1	228.5%
Overall	-€3.0	€6.0	€4.6	€3.5	€2.3	€2.1	176.6%

If we set the minimum IRR threshold for approving a certain HLUC to 30%, then a Retailer in Meltemi should not expand its service portfolio. If, however, we consider the overall IRR then the Retailer would achieve a rate of return that is significantly higher than the threshold (which is attributed to the high IRR of the standard business model).

The following table provides the expected Free Cash Flows of a Prosumer in Meltemi for the standard business model, as well as, the NOBEL GRID High-Level Use-Cases that it would be involved. If we set the minimum IRR threshold for approving a certain HLUC to 30%, then no new Prosumer in Meltemi would have the incentive to install PV on its rooftop. The reason is that even if it expanded its service portfolio by adding HLUC7 to the baseline business model, the expected aggregate Free Cash Flows and the IRR over a 5-year period would not meet the target. The same applies for all the NOBEL GRID HLUCs where the prosumer would be involved, but in that case would be slightly higher due to the positive impact of the HLUCs other than HLUC7.

Table 63. The expected Free Cash Flows of a Prosumer in Meltemi (in '000 Euros)

	Year						
	0	1	2	3	4	5	IRR
baseline	-€3.7	€0.1	€0.1	€0.1	€0.1	€0.1	-44.1%
HLUC1	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	293.7%
HLUC2	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	489.9%
HLUC3	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	980.0%
HLUC7	-€0.1	€0.5	€0.5	€0.5	€0.5	€0.5	487.9%
HLUC8	€0.0	€0.1	€0.1	€0.1	€0.1	€0.1	1466.2%
HLUC9	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	195.1%
HLUC10	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	133.3%
HLUC11	€0.0	€0.0	€0.0	€0.0	€0.0	€0.0	199.2%
Desirable HLUCs only	-€3.8	€0.6	€0.6	€0.6	€0.6	€0.6	-8.4%
Overall	-€3.8	€0.7	€0.7	€0.7	€0.7	€0.7	-3.1%

The following two tables assess the attractiveness of an Aggregator and a Retailer in Meltemi respectively, in adopting additional roles. We can observe that an Aggregator in Meltemi should not expand its business. On the other hand, a Retailer in Meltemi would have an economic incentive to expand its business by becoming both a Retailer and a Prosumer. The reason for the asymmetrical outcomes is that the Retailer role requires significantly more capital expenditures than the Aggregator's and the maximum number of retailers has already been reached.

Table 64. The expected Free Cash Flows (in '000 Euros) and IRR of an Aggregator's expansion options in Meltemi

Roles	Year						IRR
	0	1	2	3	4	5	
Aggregator & Retailer	-€2.8	-€3.9	-€5.6	-€6.9	-€8.1	-€8.0	NA
Aggregator & Prosumer	-€4.3	€0.7	€0.7	€0.7	€0.7	€0.7	-6%
Aggregator & Retailer & Prosumer	-€6.7	-€3.2	-€4.9	-€6.1	-€7.3	-€7.2	NA

Table 65. The expected Free Cash Flows (in '000 Euros) and IRR of a Retailer's expansion options in Meltemi

Roles	Year						IRR
	0	1	2	3	4	5	
Retailer & Aggregator	-€2.8	€5.9	€4.5	€3.3	€2.2	€2.0	187%
Retailer & Prosumer	-€6.3	€6.8	€5.4	€4.3	€3.1	€2.9	87%
Retailer & Aggregator & Prosumer	-€6.7	€6.7	€5.3	€4.1	€3.0	€2.8	77%

The following binary table indicates whether there are any roles that would not have the incentive to deploy a certain scenario. In this case, apart from the scenarios where only DSOs are involved (namely HLUC4, HLUC5, HLUC6), the only viable scenario on an end-to-end basis is HLUC11 (where DSOs and Prosumers participate). Thus, for the rest High-level Use-cases we should examine whether there is any transfer of welfare that would make a scenario viable for all participants.

Table 66. The end-to-end economic viability of High-level Use-Cases in Meltemi

	baseline	HLUC 1	HLUC 2	HLUC 3	HLUC 4	HLUC 5	HLUC 6	HLUC 7	HLUC 8	HLUC 9	HLUC 10	HLUC 11	Baseline + all HLUCs
DSO	0	1	1	1	1	1	1	1	1	1	0	1	0
Aggregator	0	0	0	0	1	1	1	0	0	0	0	1	0
Retailer	1	1	1	1	1	1	1	1	0	1	1	1	1
Prosumer	0	1	1	1	1	1	1	1	1	1	1	1	0
e2e viability	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**

In conclusion, all baseline business models apart from the Retailer role are not attractive in Meltemi, mainly due to the small customer base. In Table 63 we observe, however, that Prosumers could adopt all relevant NOBEL GRID High-level Use-cases and obtain a high return on investment. Similarly, NOBEL GRID scenarios are attractive for the DSO and Retailer and in most cases the return on investment is increased. On the other hand, the Aggregators are the only entities that in absence of any additional incentive mechanism they are not interested in deploying NOBEL GRID products.

In terms of role popularity for expansion opportunities in market equilibrium, we observed that the Aggregator's role would rank first followed by the Prosumer one. Even though only Retailers would have the incentive to diversify their service portfolio by including both roles, the tie-breaking criterion was the rate of return.

8 EMERGING BUSINESS MODELS

The purpose of this section is to discuss a set of emerging business models in smart grids, which although are out of NOBEL GRID scope, they are expected to have a significant effect on future industry.

8.1 DRIVERS AND AREAS FOR BUSINESS MODELLING INNOVATION

Today the energy industry faces relentless pressure to reassess its business models to accommodate transformations occurring in several key areas such as the emergence of new technologies, governmental policy shifts, the changing consumer demands, etc. The future business model transformations identified in our research aim to give rise to technology, industry, enterprise and revenue model innovation, delivering new products, services, processes and new business models. We envisage that industry model innovators will formulate the infrastructure, rules and standards for transactions among providers and customers in business areas that will include not only traditional energy generation and delivery, but other related products and services enabled by new technologies.

The potential provided through the combination of the innovative solutions due to be integrated in the 'smart grid' are at present unimaginable. Only time and further advances in application will reveal the true potential of new possibilities and new business models. In that sense, one thing is clear: the pace and opportunities posed through advancement in smart grid technology will severely disrupt current business models and the balance of power in the electricity grid. In the same way as internet democratised knowledge and access to information, it can be expected that as an extension, ICT technologies will democratise electricity grids, surely resulting in more secure, stable and resilient grids; especially that offered through distributed generation, virtual cooperation, increased autonomy and local energy security and sovereignty.

Following current trends in the electricity market, we have found three possible future areas and drivers for business modelling innovation:

1. Community co-operation paradigms
2. Virtual Power plants
3. Vehicle-to-Grid technology

8.1.1 The community co-operation paradigm

These types of models exploit a wide range of very important benefits to the energy system i.e. helping to build stronger communities with greater cohesion, as well as engaging people actively and positively with a new energy system that increases public support for the energy transition required.

In addition, community energy models could result in helping to increase the support for vulnerable and fuel poor members of communities (suffering from energy poverty) through the collaborative and collective action of community members. For example today in many jurisdictions the poor are even penalised for not having sufficient income to have a fixed contract; therefore are obliged to pay higher tariffs through pre-pay metering systems directly managed by the DSO.

In future, through the creation of flexible collaborative action groups, community members can donate a part of their self-generated electricity (in KWh or cash equivalent) to a specially created NGO that distributes the banked energy (acting as an aggregator and retailer) to those in need. In addition, there could be tax incentives for contributors due to the donation made to the charitable cause. In Spain for example, today there is no net-metering and therefore any excess electricity production is involuntarily "donated" to retailers who tend to be large corporations that benefit from these surpluses without paying out any contribution.

At the DSO level, access to information technology, data, real-time analytics, and sophisticated applications could create a new area of public services as part of the grid-balancing activities. Currently the reverse flow of excess electricity in the distribution grid is being lost as there is no flexible and intelligent facility to direct this excess supply to adequate use. As such what is currently denominated excess supply, is in effect an efficiency in the electricity system that can be leveraged through the smart grid. The value from this excess supply could be realised in the form of donations or as low-cost electricity offers to the specific users in the grid, that could be considered as a form of 'Supply Response' (SR), for example directing the excess supply to public administrations, municipalities, public utility or services companies, or even ultimately to private sector industry, as such acting as a subsidy which could benefit from tax breaks, if managed carefully through public policies and regulations.

Such efficiencies indeed demonstrate the great potential smart grids have in deriving value from the existing traditional grids that have large volumes of built-in inefficiency and rigidity.

8.1.2 Virtual Power Plants (VPPs)

Several recent trends are creating an environment conducive to VPPs. These include the increasing penetration of smart meters and other smart grid technologies, growth in variable renewable generation, and emerging markets for ancillary services. The end goal for this market is the mixed asset VPP segment, as it brings distributed generation (DG) and demand response (DR) together to provide a synergistic sharing of grid resources.

Opportunities arise when prosumers have the option to aggregate production through ICT based tools which facilitate the aggregation, organisation and management of dispersed, decentralised actors under a single entity. As an example, dispersed prosumers or actors across multiple, municipalities, provinces or regions could organize into a VPP, effectively acting as an aggregator as well as a retailer or even an ESCO. As an example of real possible applications of such novel organisations, the association of biomass producers who produce local decentralized bio-energy and generate electricity which is injected into the grid. Such electricity feed could be destined for example specifically to vehicle charging stations as part of a wider network of fuelling stations. One possible business model would be for such organisations or cooperatives to sell on the produced electricity to the existing network of vehicle fuelling stations who chose to provide green vehicle charge-points alongside conventional vehicle fuels. As such new innovative revenue models may arise with the introduction of new business models.

8.1.3 Vehicle to Grid models

The exploitation of distributed generation based on intermittent renewable energy sources (RES) has increased the load and generation profile variability. The resort to distributed energy storage systems (DESSs) is usually proposed to compensate the volatility introduced by RES. In particular, plug-in electric vehicles (EVs) are considered one of the most interesting solutions for providing

DESSs with the aim of exploiting RES production and matching the distributed electrical generation to the local demand.

Vehicle-to-grid (V2G) describes a system in which plug-in electric vehicles, such as electric cars or plug-in hybrids, communicate with the power grid to sell demand response services by either returning electricity to the grid or by throttling their charging rate. Also back-up power solutions could also help in the correct balance of the grid load. This is only one example of potential business models with new actors applying distributed storage systems.

8.2 OPPORTUNITIES FOR CO-OPERATIVES

Over the scope of a democratic economy that leads a social and environmental growth, co-operatives struggle for the provision of decentralized energy service, in the energy market, through democratic and participative structures for communities. Main principles being subscribed by co-operatives summarize in: open and voluntary membership, democratic member control, member economic participation, training and education, co-operation with other co-operatives, concern for community and independency or autonomy. All aforementioned issues shape the way forward, by where co-operatives will go for a more active participation and more effective penetration in the energy market.

Due to the so diverse nature of co-operatives matching the market roles they play, from energy service providers to active market stakeholders such us retailers or energy suppliers, there is a wide portfolio of emerging business models applying electric co-operatives, energy service co-operatives or energy communities.

So, possibilities for new business roles and services for co-operatives under the scope of sharing/collaborative economy and circular economy, amongst others, are:

- Integrated energy service provisioning: retrofit, renewable sources, energy efficiency projects, financing, subcontracting, etc.
- Research and design consultancy: hydro, solar, biomass, geo-thermal, etc.
- Accreditation service for installers: PV, wind, retrofit, etc.
- Cooperative development of finance mechanisms for renewable energy and housing retrofitting
- Specialization in effective retrofit packages for the fuel poor (low and moderate income groups). Integral service: advisory and project study, installation, energy efficiency consultancy, financial mechanism)
- Central cooperative service provisioning: for information provision, coordination, bulk buying and back office services for consumer groups and smaller cooperatives and social enterprises
- Act as a unique selling point-democratic energy service provider: such as energy efficiency devices, energy monitors or displays, auto-production PVs kits, etc.
- Co-operation with other co-operatives: selling and procurement, specialist assistance to cooperatives and social enterprises, public sector bodies and social housing organizations
- Addressing community share issues: linking up, networks for good practice, validation of environmental return, underwriting by larger investors

- Loans aggregation service for households retrofitting projects and energy efficiency projects or services. Offering a lower financial interest for each one of the partners, co-operatives, energy communities, etc.

In the next section we highlight some new roles that the co-operatives can undertake and the associated models.

8.2.1 Data Service Provisioning (new role)

Integration of technology and processes that will lead to possible specialization of business models in the energy sector by providing information, enhanced analytic data about energy consumption behaviour, habits and patterns from its members to third-party stakeholders such as retailers or aggregators. Also we include the information based service delivery through which co-operatives give advice based on measurements or comparisons to its members or third party entities.

8.2.2 Super aggregators (new role)

It would be feasible to have a hierarchy of aggregators i.e. a super-aggregator that aggregates several aggregators for deploying the aforementioned tasks. This is a new category of aggregator that is formed with the establishment of the Meter Data Agent, as a responsibility distinct to retailing and distribution. Moving into a “Smart Grid” world, and with the “Internet of Things” just around the corner, the escalating load of data might easily become deafening noise, if not for the ability that some companies are exploring to mine the masses of customer consumption data to turn it into something useful i.e. aggregated insights. Feeding these insights into techniques to help achieve desirable outcomes (such as moderating peak demand) are the types of objectives that might focus on. The reader can find more details about the super-aggregator model at different market niches in (23), (24).

8.2.3 Deployment of shared local infrastructure (aggregator’s and distributor’s roles)

Microgrids or CHP-Unit for empowering renewable energy use for power and heating households, buildings and commercial/official buildings or premises. Microgrids could run in ‘island mode’ in case of black-outs. Co-operatives are able to deploy also shared communications infrastructures for AMI or new Smart Grid networks or upgrades.

This model applies to both off-grid and on-grid functionality. Essentially, a co-operative could offer a Microgrid as a Service or, in general, an Infrastructure as a Service. Through this model the co-operative owns and finances the microgrid, for example, on behalf of subscribed customers or power purchasers. This is a way to increase their customer base, improve the capitalization and eliminate the direct financial risk to customers/members.

In this case, the co-operative could assume both the market role of aggregator and distributor, depending on the business model variant. For example, the co-operative could take the aggregator role if it provides a “pay as you go model/ fee for service model”, where the co-operative is billing for service maintenance or energy/security trading.

If the business model would be the traditional IaaS (Infrastructure as a Service) the co-operative will not only act as an aggregator but also as a distributor, because it will own the infrastructure. Alternatively, it may rent the lines to a DSO and thus only provide the service to its members (in that case the co-operative does not perform directly the distributor role as the main activities would be performed by the DSO). Examples for the last model could be for example public-private partnerships (PPP) between municipalities and DSOs.

8.2.4 Products/services customer-oriented sourcing based (retailer’s role)

Possibilities to specific sourcing and real time sourcing: every individual source is measured and registered ('certified'). Co-operatives set up community platforms where participants can buy and sell their energy from and to others including other co-operatives (e.g. to buy energy from the wind turbine they invested in). This can be done in real-time, so demand control will match of a specific source as much as possible (source can be a specific solar panel from a neighbour or family member to all local energy or all solar energy in the country, etc.).

This new business model may be an example of peer-to-peer model on where co-operatives are able to perform several market roles simultaneously. On the one hand the "minimalistic" retailer role due to their ability in trading electricity to the co-operative's members and on the other hand the aggregator role, this last case, because of the co-operative's energy-related service portfolio (P2P platform for example) and also for sale the aggregated generated energy to the platform participants and third parties on behalf the co-operative members or community members.

Prosumers could be served by an additional (typical) retailer for the excess demand that is not covered by the sourcing based platform. Also, co-operatives could establish bilateral contracts with this (typical) retailers for supply this energy and include this service inside the "available energy capacity" to be purchased into the platform.

8.2.5 Energy Broker (aggregator's role)

Here the co-operative undertakes the responsibility of purchasing bulk energy in wholesale market according to the aggregated capacity demand of its members. Thus, co-operative members benefit from lower energy prices. Normally, in success stories both in Europe and globally, the partnership model through an "energy supplier" is supported. The full service includes not only the purchase of energy in the wholesale market but also energy marketing and customer service or after-sale service that it is outsourced to a "supplier". Innovative services today also include offerings for buying products / services related to energy efficiency (consumption monitors, application monitoring, audits, etc.) as well as equipment such as PV panels or solar thermal. The primary market role for this business model would be the aggregator one, but the co-operative could also assume the "fully-fledged" retailer role.

8.2.6 "Green certificates" trading (new role)

It is related to establishing a new business model focused on trading "Green certificates" from a base of aggregated green energy by the co-operative that is performing an aggregator role. Certificates provide a tool for trading and meeting renewable energy obligations among consumers and/or producers, and also a means for voluntary green power purchases.

The "green certificates" trading, or exchange, does not only have to be exclusive for wholesale markets, but also at the retail market level i.e. in the same way as the CO2 certificates or the emission-rights purchase. The new business model is aimed at trading green certificates to those who want to demonstrate their improved CO2 footprint or for those who have to balance their renewable energy consumption for not exceeding their CO2 rights. Moreover, the benefits from the "green certificates" could be reinvested in the community generation mix or in funds for poor customers.

For example, imagine a docklands in a city that through their logistic activities, cargo activities and moreover have to buy CO2 rights. It could be possible to establish a circular economy between the sea authority, the city council or municipality and the co-operative to re-invest the benefits, in the municipality, from the trading to other industries of the non-used CO2 rights by the sea authority, thanks to the green certificate purchased to the co-operative. This model maybe require a new

incentive mechanism or tax incentive to industries/companies, etc. for lowering their tax obligations for investing part of their profit in the community and fostering the "green certificates" purchase.

8.2.7 A wholesale model of the Aggregator role

This is a business model oriented to a “wholesale model of the aggregator” that could be the way for a hierarchical aggregation. For example, TERC co-operative (Toronto-Canada), offers services dedicated to set-up and management of new and existing renewable co-operatives offering legal and financial templates, models and software developed for managing co-operative members and securities. The idea is to help renewable energy cooperatives focus their resources on expanding their projects instead of administration and member management.

8.2.8 Social landlords or poor fuel tenants/consumers (aggregator role)

This is an opportunity to develop a model and services that can effectively address the rising fuel costs of their tenants and to achieve a model(s) that can tackle fuel poverty problems ((25), (26)). A start can be made with the housing cooperative sector. Services could include: bulk buying, advice and consultancy and technical assistance. Co-operative assumes here the aggregator role and various services such as:

- Poor fuel consumer protection and “green economy and social justice”: Cooperative subsidizes the investment for household's retrofitting through member’s fees or contributions. Co-operative leads the advisory, project management, the massive recruitment of engineering for the project and members are rewarded in their bill by a fixed % on the energy savings during the estimated time that should be for return of investment. Also, member’s incomes can be used to offer free additional services such as energy efficiency advisory, etc.
- Energy efficiency improvement measures in social housing or vulnerable energy consumers to offer not only the loan but all the necessary services (integral) advisory, consultancy, project study, contractors and consulting for monitoring energy efficiency savings. Examples of this model are "Wessex Home Improvement Loans" and “Energyextra service” by ART Homes & Black Country Housing Association. The latter currently offers energy advice, discounted energy efficient appliances and energy from a preferred supplier (Scottish and Southern Energy) for 40,000 tenants. Or the case of Dundee which has 14,000 tenants and it uses the affinity deal income to fund free energy advice services and some grant funded measures.

8.3 OPPORTUNITIES FOR DSO’S

The DSO’s can undertake new roles and provide new services, giving rise to novel innovative business models. For example:

- **Data Service provisioning.** Integration of technology and processes that will lead to possible specialization of business models in the energy sector. This will require more flexibility from the grid operator in market facilitation, e.g. in providing data and protecting data. The same role can be undertaken by the aggregators as we have seen before.
- **Integration of processes**. DSO departments need to work closer together, or even organized differently (e.g. from functional to procedural, regional or product-market. For example: customers (=connections) are the primary responsibility of the department ‘Customer Relations’. However, customers will become an active ‘Asset’ form an asset

management point of view within strategic investment decisions, instead of only a 'load risk', because operational load management (the responsibility of the Operations Department) is an alternative for investments (the responsibility of the Asset Management Department).

- **Regulated services.** A lot of knowledge of (industrial) customers regarding their operations can lead to the cooperation between the grid operator and a few customers to increase the security of supply. E.g. they can build a collective 'back-up' installation in the local grid (or use an existing CHP-unit). 'Operations' together with 'Customer Relations' can agree with these customers to operate a small part of the grid in 'island mode' in case of a Black Out. The installation might be a commercial CHP unit that will serve as Back-up unit that will keep part of the grid operational in case of a calamity (thus outside normal market circumstances). This increases security of supply.
- **Market development of local energy markets (from a DSO point of view).** Direct control of local flexibility resources (like storage and demand control) will be very difficult from a regulatory point of view, because it can be in conflict with the principles on which the regulatory framework is being build. However, incentives to which market parties (including consumers) voluntarily can respond (like designed within the USEF framework) can work fine within the regulatory framework. However this requires an integration of operational processes and customer processes within a DSO. The risks of the investment a customer makes to respond to DSO incentives needs to be covered. If the commercial market circumstances will be favourable enough to cover the risks, then there will be no problem. However, if the business case for demand response and local storage depend mainly on the grid, then the grid operator will have to act to reduce the risks of the investments of the customers to provide flexibility (one of the main risks is that the DSO is strengthening the grid anyway and local flexibility in no longer necessary). So, to develop flexibility for the grid these risks will have to be taken away. This can be done through guarantees from the DSO. However, this is problematic both from a regulatory point of view as from a governance point of view, because it will take away the freedom of the DSO to optimize grid planning. A solution could be that customer relations in close cooperation with Asset Management will publish the local grid investment plans (that is binding except under defined circumstances). This will enable customers to assess the risk themselves and decide whether or not to make an investment in e.g. local storage.
- **Optimization of operations**. Besides Risk based Asset Management it is possible to implement Risk based Operations. With 'faster than real life' simulations it is possible to use simulations and assess risks within operations. This becomes possible because the simulations can be relative imprecise because they will be continuously recalibrated by real measured data. This can be used to minimized grid losses, optimize workforce deployment, reduce risks of outages, reduce the consequences of an (potential) outage, etc.

8.4 OPPORTUNITIES FOR RETAILERS

There are numerous opportunities for retailers to diversify and make products and services more specific and customer oriented:

- **Price and risk based.** Opportunities to include risk and overall price into propositions. Prosumers selling their energy can set their risk profile. From fixed bills (e.g. 'energy bundles' with capacity limitation only, so energy is 'free') to dynamic pricing with 5 minute

prices or less (with everything in between, like dynamic pricing with a price cap or bill cap e.g. the bill will never exceed the 'standard bill' etc.)

- **Sourcing based.** Opportunities to provide specific sourcing and real time sourcing. Every individual source is measured and registered ('certified'). Retailers can set up platforms where participants can buy and sell their energy from and to others. E.g. to 'buy' energy from the wind turbine they invested in. This can also be done 'real time', so demand control will match generation of a specific source as much as possible (source can be a specific solar panel from a neighbour or family member to all local energy or all solar energy in the 'Netherlands' etc.).
- **Information based.** Giving advice based on measurements, comparisons etc.

9 INCENTIVE MECHANISMS

Along with the definition of Nobel grid Business models the supportive incentive mechanisms are defined as part of the overall business view of the project. Indeed, in most cases, prosumers will have to be incentivised by Aggregators in order to participate in the envisaged markets by offering their resources and gaining economic benefits in return, thus creating new business role in the energy provisioning value chain. There are several ways of participating in a market and various incentives, not only monetary but also societal, that motivate consumers to take part in. The market mechanisms could play a significant role in enabling the residential prosumers to take advantage of their energy flexibility in exchange e.g. for lower prices or other value added services. The commercial prosumers on the other hand are mostly "heavyweights" when it comes to energy production or consumption and modifications thereto. It is expected that by being able to control/reschedule energy hungry processes, they may benefit from lower electricity prices, but more importantly they could sell this flexibility to the market, which could result in a new source of revenue for them. Towards this direction, we need to identify the incentive schemas among Prosumers-Aggregators towards the prompt evaluation of NOBEL GRID innovative business models. A state of the art analysis follows, highlighting the current status on the definition and deployment of incentives schemas for implementation of Demand Response Strategies, while an initial selection of the best fitted incentives mechanisms is considered for the scope of NOBEL GRID project. Furthermore, an initial set of suggestions regarding the incentive mechanisms considered to be more appropriate for the trial sites is provided in section 9.2.

9.1 STATE-OF-THE-ART

Within NOBEL GRID, two different classes of demand response strategies are examined:

- Manual driven demand response strategies (mainly Price and Incentive Based)
- Automatically driven demand response strategies

This high level taxonomy of demand response strategies triggers the definition of the best fitted incentives mechanisms for each class.

9.1.1 Price Based and Incentive Based Demand Response Mechanisms

This section comprises a state-of-the-art analysis of the various price-based and incentive-based mechanisms that are applied in today's energy markets in order not only to motivate consumer's participation but also to enhance consumer's conformance in the DR programs. Before that, we provide some of the Behavioral Economic (BE) concepts that should be considered when designing time-varying tariffs in order to proliferate their adoption and efficacy (27).

- **Endowment effect:** Bill payers currently enjoy the benefit of being insulated from variable rates during the day. Proper design and marketing of the dynamic tariffs will be critical for overcoming consumers' resistance to changing the cost-benefit structure of the way they consume electricity. Individuals are attached to their routines and daily habits and may be inflexible to modify them, or demand high compensation to do so.
- **Status-quo bias:** Research shows that when presented with a utility bill with a default choice, most consumers will not change it (28). Those who object to having the dynamic tariff either as a default or mandatory option argue that most households will remain on the default plan even if it is not optimal for their consumption patterns. Vulnerable households, such as the elderly and disabled, will not be able to vary their load and will be losers under the dynamic tariffs, if that is set as a default (29).

- **Time-varying discount rates:** Introducing dynamic tariffs raises concerns about short-term cost versus the "lag" in long-term gain (30). Dynamic pricing will result in a "rate shock", as bills of some consumers will skyrocket in the near term, before behavioural adjustments, or before households acquire enabling technologies or replace old appliances with ones that better accommodate varying tariffs. Even if the long term costs of smart meter infrastructure proves to be beneficial, the long term may be really distant (31). Since individuals tend to have higher discount rates for the future, they may not think that the costs are worth the benefits, especially if the savings are initially small or nil.
- **Loss aversion**: If individuals value (negatively) losses more than they value gains, rate increases during peak periods may have to be compensated with larger rate decreases during off-peak periods.
- **Concern for Fairness:** Opponents of mandatory dynamic tariffs cite fairness considerations towards the vulnerable. It is argued that vulnerable households (elderly, disabled, and poor) will not be able to shift consumption to off peak, since they have minimal electricity consumption to begin with and are often homebound. On the other hand, proponents for the dynamic tariffs state that it is not fair that "peaky" households are being subsidized by "less peaky" households through flat tariffs (32).

Furthermore, two major studies in the United Kingdom by the Office of Gas and Electricity Markets and the Office of Fair Trading have provided us with insights on how the consumer decision making progress is affected by the BE concepts discussed above. According to OFGEM (33), low consumer capacity has the greatest impact on consumers' ability to assess different offers. However, as the table shows, all of the identified themes may explain some consumer behaviour at all stages of the decision making process.

Table 67: Behavioural factors affecting the consumer decision making process

Bias	What does it mean?	How does it affect the decision making process?		
		Access	Assess	Act
Limited consumer capacity	Consumers have difficulties assessing many different options and large amounts of information about them.	Consumers' awareness of the challenges they face means that they do not search at all.	Consumers adopt filters or shortcuts to navigate the information (eg 'rules of thumb', 'reference points').	Consumers switch to an option that is 'better' instead of the best one for them.
Status quo bias	Consumers prefer the current option.	Consumers do not search for alternative deals beyond their current package and/or provider.	Consumers over-emphasise knowledge of existing package and/or provider.	Consumers do not switch away from current package and/or provider.
Loss aversion	Consumers attach more weight to monetary losses than to monetary gains and avoid risk taking behaviour.	Consumers search less when energy prices fall than when they rise.	Consumers give too much weight to possible losses relative to potential gains.	Consumers postpone making a decision.
Time inconsistency	Their preference for immediate gains means that they place too much weight on costs incurred now compared to future savings.	Consumers do not search for new or alternative energy deals.	Consumers over emphasise short-term discounts.	Consumers do not make a decision.

Price-based demand response: refers to changes in usage by customers in response to changes in the prices they pay and include real-time pricing, critical-peak pricing, and time-of-use rates. If the price differentials between hours or time periods are significant, customers can respond to the

price structure with significant changes in energy use, reducing their electricity bills if they adjust the timing of their electricity usage to take advantage of lower-priced periods and/or avoid consuming when prices are higher. Modifications of customers' load use are entirely voluntary.

Price-based mechanisms: Each price-based demand response program is characterized by a specific price-based incentive mechanism. The various price-based incentive mechanisms are as follows:

- **Time-Of-Use rate (TOU):** a rate with different unit prices for usage during different blocks of time, usually defined for a 24 hour day. TOU rates reflect the average cost of generating and delivering power during those time periods (i.e. off-peak, mid-peak, on-peak).
- **Real-time-pricing (RTP):** A rate in which the price for electricity typically fluctuates hourly reflecting changes in the wholesale price of electricity. According to RTP program of Southern California Edison (SCE) (34), usually, energy charges vary each hour based on the following factors: (i) time of day: higher rates at midday, (ii) summer season: rate variation according to temperature, (iii) weekdays and weekend rates vary, (iv) daily maximum temperature and (v) for businesses of monthly demand over 500kW rates vary also by voltage (35). RTP enables end-users to help ease the demand on the power system and take advantage of hourly rate changes to reduce their energy bills. Customers are typically notified of RTP prices on a day ahead or hour-ahead basis.
- **Critical Peak Pricing (CPP):** CPP rates are a hybrid of the TOU and RTP mechanism design. The basic rate structure is that of TOU. However, provision is made for replacing the normal peak price with a much higher CPP event price under specific trigger conditions (e.g. when system reliability is jeopardized or supply prices are very high).

  The CPP program of SCE offers customers rate discounts during non-critical peak periods, and is designed to encourage customers to **voluntary shift or reduce their electricity use during critical peak periods** in the summer season, when rates are higher and the power grid is under the most strain.
  A CPP event may be called (between 9 and 15 times per summer) when demand for energy significantly increases. SCE contacts the participants of the CPP program the day before a CPP event to request a reduction in energy usage during the event period. During CPP events, energy charges increase significantly. By reducing electricity usage during the CPP event, the participants avoid these higher prices and benefit from lower electricity bills.
  CCP process can be also automated. Automated Demand Response makes it even easier for customers to participate in CPP events by automating the load reduction process based on the end-user's load reduction strategy, eliminating the need for manual intervention. (36), (37)

Incentive-based demand response programs are established by utilities, load serving entities, or a regional grid operator. These programs give customers load reduction incentives that are separate from, or additional to, their retail electricity rate, which may be fixed (based on average costs) or time-varying. The load reductions are needed and requested either when the grid operator thinks reliability conditions are compromised or when prices are too high. Most demand response programs specify a method for establishing customers' baseline energy consumption level, so observers can measure and verify the magnitude of their load response. Some demand response programs penalize customers that enroll but fail to respond or fulfil their contractual commitments when events are declared.

For example, in the day-ahead demand response program of NYISO If the customer's bid for a certain amount of load reduction is accepted and the customer fully curtails the load, he receives payment for his accepted bid, based on the greater of the bid price or the day-ahead LBMP. If the customer fails to fully curtail the load, he will pay the higher of the day-ahead price (LBMP) or the real-time price for the amount of incomplete scheduled load reduction (38). Also, in Optional Binding mandatory curtailment program of SCE, penalties (in the form of excess energy charges) apply if the customer fails to achieve the required circuit load reduction of up to 15 % (39).

Incentive-based mechanisms: The various incentive-based mechanisms tailored to the respective incentive-based programs are as follows:

- **Demand Bidding (Day-ahead demand response program):** The mechanism allows demand-side resources to offer bids to curtail their load in the same way as generators do and if selected for load reduction they receive the wholesale clearing price. This kind of demand response programs are mainly offered to large-scale consumers or aggregated entities.

  NYISO Day-ahead demand response program (DADRP) (40): DADRP allows energy users to bid their load reductions, or "negawatts", into the Day-Ahead energy market as generators do. Offers determined to be economically attractive are paid at the market clearing price. DADRP allows flexible loads to effectively increase the amount of supply in the market and moderate prices.

  More precisely, customers specify the hours of the next day they would be willing to reduce electricity use, the amount of that reduction, and the compensation required. That bid is submitted by the DADRP provider to the NYISO. The bid is then evaluated by NYISO and compared with supply bids submitted by generators. If a demand reduction bid is selected, or scheduled, NYISO expects the customer to reduce consumption during the appointed time. In turn, the customer is paid the day-ahead market-clearing price for the demand-reduction amount scheduled. If the customer does not reduce its load as scheduled, consumption during the scheduled curtailment is billed at the higher of the day-ahead price or the real-time price. End-consumers that participate in the program must have a minimum resource size of 1MW.

  Incentive mechanisms for Ancillary Services Program: Customers bid load curtailment offers in the market as operating reserves. If their bids are accepted, then they are paid the markets price for committing to be on standby. If their load curtailment is needed, then they are called by the system operator and may be paid the spot market price.

- **Inventive mechanisms for emergency demand response programs**: Incentive payments are provided to customers when an emergency event is called. Such an event is called on shortage situations to maintain the reliability of the bulk power grid. The participants can receive both energy payments for load reductions during emergency events as well as capacity payments for participating and they should be able to respond within few hours from the notice. Penalties in case of failure are also applied in some emergency demand response programs. In the sequel we give more details on the mechanism design of two programs of this type.

  NYISO Emergency Demand Response Program (EDRP) (41): EDRP allows wholesale electricity market participants to subscribe retail end users able to provide Load Reduction (Demand Side Resources) by curtailing Load or by shifting Load when called upon by the NYISO during

emergency conditions. The wholesale market participants are Load-Serving Entities (LSEs), individual retail customers taking service as an LSE, Aggregators of retail end users and Curtailment Program End Use Customers[10].Companies, mostly industrial and commercial, sign up to take part in the programs with minimum Resource Size (capability of load reduction) 100 kW. Small customer aggregation must be at least 500kW Participants should be capable of responding within two hours of notice from the NYISO. The response is purely voluntary and no penalties for non-conformance are applied. The participants are paid the greater of real-time marginal price or $500/MWh only for the actual energy (kWh) reduction provided (4 hour guaranteed minimum).

PJM Emergency Load Response Program (ELRP) (42): ELRP is designed to provide a mechanism by which end-use customers may be compensated by PJM for reducing load during an emergency event. The Emergency Program offers market participants two options for engagement: (i) a Full Option Program and (ii) an Energy Only Option Program. The full Option Program allows participants to receive energy payments for load reductions during emergency events as well as capacity payments for participating in the Reliability Pricing Model (PJM's Forward Capacity Market). Participation is mandatory and failure to reduce load will result in a compliance test failure charge. The Energy Only Option restricts end-use customers to receive energy payments only for load reductions during an emergency event. Participation is voluntary. In the Energy Only Option Program, participants submit a minimum dispatch price for load reductions during emergency events, which include shutdown costs, and a minimum duration time. In the Full Option Program, participants also submit minimum dispatch prices for emergency events, but more importantly these resources are considered committed capacity resources and receive capacity payments for being willing to curtail consumption when required. Capacity payments are in the form of $/kW per unit of time (i.e., $/kW-month or $/kW-year) and are the reason why this program is more profitable than the Economic Program. Participation during an emergency event or capacity testing is mandatory and failure to reduce will result in a compliance test failure charge.

- **Incentive mechanisms for interruptible/curtailable service:** Curtailment options integrated into retail tariffs that provide a rate discount or bill credit for agreeing to reduce load during system contingencies. Penalties may be assessed for failure to curtail the load.

9.1.2 Automated Demand Response incentive mechanisms

The goal of the section is to define different incentives mechanisms to enable the participation of end users (consumers) on Automated Demand Response programmes. There are two different frameworks defined in bibliography for auto DR compensation, also supported by OPENADR protocol (43).

- Price driven Auto Demand Response
- Context driven Auto Demand Response

The next schema depicts the system view towards the implementation of auto DR strategies

[10]End-use customers whose Load is normally served by an LSE but who wish to participate directly with the NYISO solely for purposes of the EDRP.

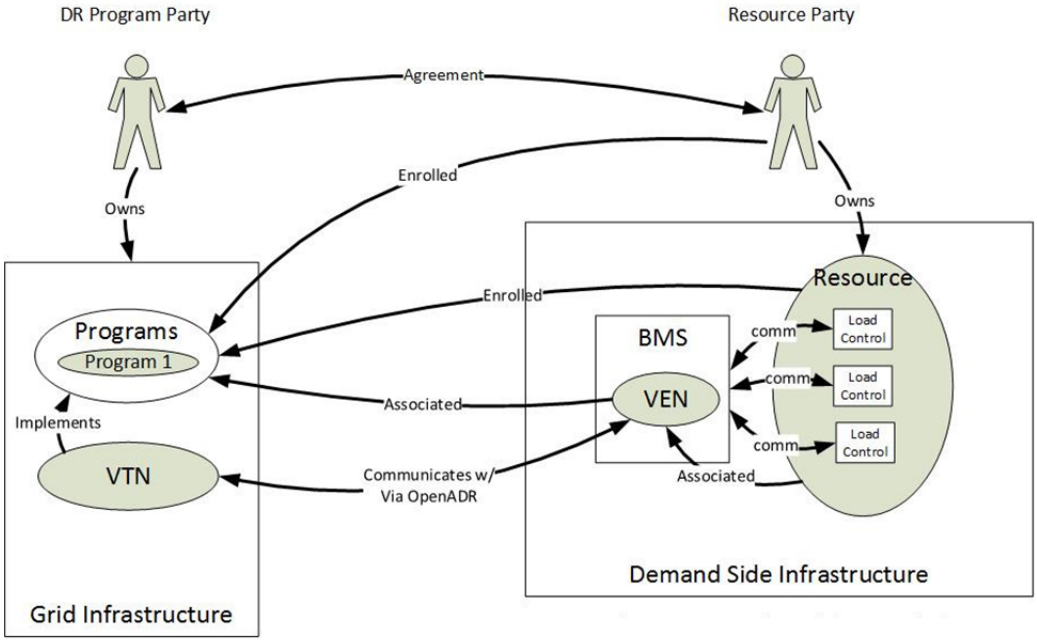

Figure 43 Auto DR system overview based on OpenADR Alliance (OpenADR, 2015)

The Resource Party is responsible for enrolling their own Resources into the DR Programs and interacts directly with the Resources via a Virtual End Node (VEN) that resides within the Demand Side Infrastructure (NOBEL GRID Approach). The VEN is owned by the Resource Party though is running on the Building Management System (BMS) layer of Demand Side. Thus, the VEN is instantiated in an entity like a centralized BMS that can implement DR logic and interact with Compound Resource and their many different load controllers from a more centralized location. Examples include large buildings with a BMS that control many different loads in a building (e.g. lighting, Heating, Ventilating, and Air Conditioning - HVAC, industrial processes, etc.) to campuses that may have multiple facilities with a centralized control system. There are 2 types of event signals associated to VEN.

The 1st type (Price driven Auto Demand Response) is a **simple signal** with levels on reduction of load to be mapped to **the pricing impact of the event**. In this case a price curve (ELECTRICITY_PRICE signal) is delivered on VEN and then a model based approach is considered for the activation of additional loads on DR event. There are different **optimization-based home energy management controllers** defined in bibliography, incorporating several classes of domestic appliances including deferrable, curtailable, thermal, and critical ones. The **operations of the appliances** are controlled **in response to dynamic price signals** to reduce the consumer's electricity bill whilst minimizing the daily volume of curtailed energy, and therefore considering the user's comfort level. The next figure depicts this **control logic** incorporated in Demand Side Infrastructures.

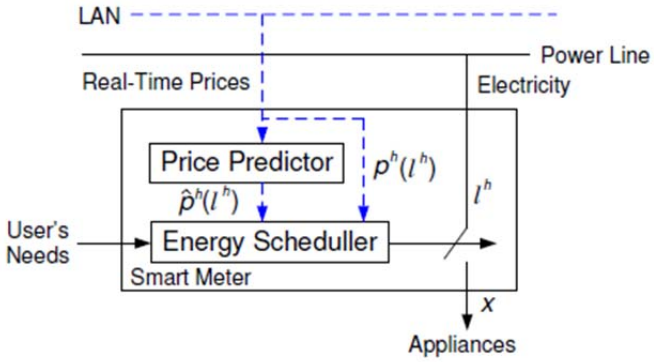

Figure 44 Price driven Auto Demand Response

In the case examined, there is a need to define **price based device operational profiles** that set the baseline for the implementation of Demand Response Strategies. Though, it is difficult to define price based operational profiles in a consistent way and without a long training period.

The 2nd type (Context driven Auto Demand Response) of Auto DR signal is the one examined in NOBEL GRID Project. In this case, a SIMPLE signal is mapped to the amount of load shed and thus the amount of flexibility requested. The role of the Demand Side controller is to select the optimal strategy taking into account the requested signal about demand modification. In addition to the SIMPLE signal with the BID_LOAD, a BID_PRICE signal may be included in the payload with signal types of **price**, and units of **currencyPerKW/ currencyPerKWh** respectively. The BID_LOAD reflects the requested load shed up to capacity amount bid by the aggregator, and the BID_PRICE would reflect the incentive bid by the aggregator/customer. Therefore, in this second type of DR signal, the BID_LOAD is considered as part of the optimization process, while BID_PRICE values are considered only for the compensation of DR services offered to the Aggregators.

By defining, the type of DR signal delivered by the Aggregator to Demand Side, the different types of incentives are considered:

- Customers may be offered **discounted energy prices** during non-peak times as an incentive to participate in the program.
- Customers receive two types of incentives. First, they receive a **capacity payment** for holding a specific amount of load shed capacity available for DR events during a future time window. Second, if an event is called during the future time window an **energy payment** may be made for load shed over the duration of the event.
- Customers may be provided with a **free Smart Home Intelligent Controller - SHIC** (namely Programmable Controllable Thermostat or PCT) or offered discounts/rebates on customer purchased SHIDS as an incentive to enroll in the DR program. Furthermore, customers may receive an ongoing **annual stipend** for continued enrolment in the program. Less common would be **ongoing incentives** paid to customers based upon **actual energy reduction** during events.

In the aforementioned incentive schemas, limitations about the eligibility of end users to participate on DR programmes are considered. The next paragraph provides indicative paradigms of the aforementioned incentive schemas:

Predetermined demand response **kW savings** are available for standard technologies such as lighting controls, temperature reset controls for HVAC, and duty-cycling of HVAC compressors and supply fans. In California (44), offices and retail stores with 100-400 kW of peak demand can

qualify for Auto-DR programmes with the following incentives (Incentive Rate ($/dispatchable kW):

- Automated Demand Response: $200
- Advanced Technology HVAC: $350
- Advanced Technology Lighting: $400

Note that the different type of technology is incentivized and this is the core of Title 24 code implementation, while for the verification process at least a sub metering device owned by the Aggregator should be installed in premises.

Smart HVAC programs are also exist for residential sites and provide an **annual stipend** (up to $150 per year on Bring your own Device - BYOD programmes (45)) or a **free SHIC** for enrolment in the program. Then, if there is an energy shortage, the utility company send a signal to the SHIC directing the device to run at a lower capacity.

From the available market programmes, Demand Bidding Program (DBP) and Capacity Bidding Program (CBP) which are considered as the most active DR programmes in the U.S. a combination of **capacity payment** and actual **energy payment** is mainly considered. The capacity and energy payments vary among aggregators as each aggregator pays for incentives to their customers based on bilateral agreements.

The aforementioned analysis, provides a review on the literature towards the definition of Automated Demand Response compensation schemas. The goal of the next section is to discuss potential incentive types to be considered for pilot test sites in NOBEL GRID project.

9.2 SUGGESTIONS FOR THE TRIAL SITES

The figure below presents the taxonomy of the incentive mechanisms that can be implemented to motivate consumer/prosumer participation and enhance their participation in DR strategies. Initially, the basis for the design of a successful demand response incentive mechanism is to make consumers aware of their energy consumption behaviour. When consumers see how much they are consuming, for example, through a visual representation that makes them understand how and when they use energy, they may be motivated to use energy more efficiently (though many complex social and behavioural factors may influence this). Thus, information, and particularly visual, in the form of graphs schematic presentations etc., can encourage consumers to change their energy consumption profile following a more energy efficient pattern.

Figure 45: Incentive mechanisms taxonomy

Within this context, appropriate information about, for example, the impact of consumer energy use on CO2 emissions and non-renewable resource usage can stimulate consumer environmental awareness, motivating them to participate in DR campaigns. Particularly, if the consumers are

more environmentally conscious (e.g. members of RES cooperatives), the aforementioned non-monetary incentives can serve as standalone mechanism.

However, this is not the case for everyone. In order to increase the efficiency of mechanisms, additional types of incentives need to be applied to reinforcing participation. Appropriately designed monetary incentives can be implemented to achieve this. As already explained in detail, monetary incentives can take various forms, such as different tariffs between peak and off-peak consumption, discounts, bill rebates, redeemable points to use electricity at later time or to purchase energy efficient appliances, and in some cases they can even take the form of fines.

In addition, social pressure, i.e. the pressure exerted by any type of social comparison, group behaviour or competition, including motivation for personal improvement, can form a type of motivation. For instance, the peak-shaving performance of energy consumers can be compared to that of other people in their neighbourhood or shared within their social network using social media. This motivation can also take the form of self-comparison, i.e. tracking performance over time, measuring progress against targets set in the past.

Cooperation among consumers in order to achieve a common goal can also constitute a strong incentive. For example, residential energy consumers may not be aiming to reduce their personal carbon footprint, but rather they are members of a bigger community aiming for a more challenging goal, such as reducing peak consumption over an entire district and thus removing the need for an entire CO2-intensive peak power plant. Consumers can also be motivated by the fact that the rewards for their collaborative effort are ploughed back into the community in the form of projects such as road maintenance, a new community facility or new park.

Both monetary and societal based incentives constitute stand-alone incentive mechanisms. For example, in the case of less environmentally conscious consumers and/or profit oriented entities, appropriate monetary incentives can be sufficient for participating in a demand response scheme. In case of consumers with strong geographical and/or thematic social networks, societal based incentives could work alone effectively.

Based on the aforementioned analysis and taking into account the special characteristic of the members of each NOBEL GRID pilot site, we provide below suggestions on appropriate types of incentives that can be implemented in each pilot site. This approach is addressed for both manual and auto driven Demand Response Programmes examined in the project. The goal is to go beyond the current status (basically money-based incentive models) and examine innovative schemas addressing specifically the main pilot stakeholders of the project.

To begin with, the cooperatives of CCOOP and ECOPOWER have a very clear environmental orientation with very environmentally conscious members. Taking this into account, they could employ incentive mechanisms based on presenting in a graphically appealing way end-user's consumption patterns and information regarding the impact of their consumption on e.g. CO2 emissions and non-renewable resource usage. In addition, co-operatives deliver a great level of social participation, i.e. a higher level of participation for a shared cause. Also, as cooperative structures, their members are inherently more engaged, and thus CCOOP and ECOPOWER could focus more on social-based incentive mechanisms e.g., using gamification techniques or collaborative campaigns for increasing demand flexibility, rather than on monetary mechanisms. This means, for example, that if an aggregator in Meltemi was forwarding 50% of its flexibility demand revenues to its customers, then in Manchester it could be 35%. Of course, the rest 15% could be spent on social-based mechanisms (not for increasing profits). Nevertheless, the business

plan analyses performed in Section 7 assumed that all Aggregators shared half of their revenues with participants in DR programs.

Note that a lot of co-operatives, including CCOOP and Alginet, are not 'profit-driven'. Indeed, any profit they do make is re-invested in co-operative assets and/or in charitable causes, e.g. richer people with more smart technology might be better able to offer flexibility and so profit more from DR, yet their profit can be invested in such a way that other members benefit from it too.

Since Alginet is a cooperative DSO, societal-based incentives could work along with appropriate information regarding members' energy behaviour and green energy. However, it could be argued that its members are less willing to be actively involved in a DR process compared to CCOOP members that are very environmentally conscious, and thus, additional monetary incentives might be necessary. Similarly, participants of the ASM Terni public could be further motivated by monetary-based incentives. Finally, in Meltemi eco village, as a constrained community, setting social pressure could constitute a strong incentive - always combined with the other types of incentives in order to capture all consumer types.

Apart from incentives to end users, the need to redistribute the revenues amongst providers has been identified in Section 7. In Valencia, for example, HLUCs exist where at least one role would not be profitable. In these cases, we would need to examine whether there can be employed any transfer of benefit that would make it viable for all participants. Similar incentive issues were present for the rest pilot sites, as well.

In the following we will assume that a combination of appropriate social and economic incentive mechanisms can achieve a certain goal of DR strategies (e.g., enough demand is shifted to non-critical periods) and will focus on the incentives of the rest involved providers. This means that enough prosumers and consumers are willing and able to enroll to Aggregator's services (e.g., are environmentally conscious, can control equipment, etc), as well as they can identify lucrative opportunities (i.e., are economic rational entities). Furthermore, we will focus on the HLUCs that will be demonstrated in each pilot site.

HLUCs 1, 2 and 3 will be tested and evaluated in Manchester, and according to Table 52 no additional incentive mechanisms are needed.

Similarly, the HLUCs 4, 5 and 6 will be deployed in Valencia and according to Table 38 the DSO, who is the only active role, would find these attractive.

HLUC 7 will be implemented in Meltemi, but not all involved roles are expected to find it attractive due to small market size. Looking at Table 66, we observe that Aggregators would need increased revenues to reach the threshold of 30% IRR. However, even if we increase the annual average revenue per user (ARPU) from €100 to €150 we can see on Table 68 this increase will not be sufficient, while in that case according to Table 69 the HLUC7 will no longer be attractive for the DSO.

Table 68: Aggregator's Free Cash Flows from HLUC 7 in Meltemi with and without increased annual ARPU from DSO

Aggregator's annual ARPU (received from DSO)	Aggregator's Free Cash Flows from HLUC 7						IRR
	Y0	Y1	Y2	Y3	Y4	Y5	
€100	-€0.200	-€0.030	-€0.030	-€0.030	-€0.030	-€0.030	0%
€150	-€0.200	-€0.023	-€0.023	-€0.023	-€0.023	-€0.023	0%

Table 69: DSO's Free Cash Flows from HLUC 7 in Meltemi with increased annual payment to Aggregators

Aggregator's annual ARPU (received from DSO)	DSO's Free Cash Flows from HLUC 7						IRR
	Y0	Y1	Y2	Y3	Y4	Y5	
€100	-€0.045	€0.023	€0.023	€0.023	€0.023	€0.023	42.0%
€150	-€0.045	€0.012	€0.012	€0.012	€0.012	€0.012	11.1%

The same result holds if we consider the extreme case of Aggregators receiving the maximum payment from DSO, as well as, accepting the maximum payment from Prosumers before the latter are no more interested in HLUC 7. The respective Free Cash Flows for Aggregator and Prosumers appear on Tables 70 and 71 below. Keep in mind that, in principle, Prosumers could be willing to pay (instead of get paid) if their benefit from increased power quality due to HLUC 7 is high (since this scenario requires the involvement of Aggregators). This demonstrates the significance of market size on Aggregator's business models, given that HLUC 7 is profitable for Aggregators in the rest pilot sites. Note, however, that the business model for HLUC 7 in Valencia (see Table 38), Manchester (see Table 52) and Terni (see Table 59) is expected to be profitable for all involved actors and thus this scenario should be demonstrated in Meltemi.

Table 70: Aggregator's Free Cash Flows from HLUC 7 in Meltemi with increased annual ARPU from DSO and receiving payments from Prosumers

Annual Aggregator's revenues from DSO	Annual Aggregator's payment to Prosumers	Aggregator's Free Cash Flows from HLUC 7						IRR
		Y0	Y1	Y2	Y3	Y4	Y5	
€150	€75	-€0.200	-€0.030	-€0.030	-€0.030	-€0.030	-€0.030	0%
€150	-€600	-€0.20	€0.08	€0.08	€0.08	€0.08	€0.08	28.5%

Table 71: Prosumer's Free Cash Flows from HLUC 7 in Meltemi with payments from/to an Aggregator

Annual Aggregator's revenues from DSO	Annual Aggregator's payment to Prosumers	Prosumer's Free Cash Flows from HLUC 7						IRR
		Y0	Y1	Y2	Y3	Y4	Y5	
€150	€75	-€0.10	€0.49	€0.49	€0.49	€0.49	€0.49	487.9%
€150	-€600	-€0.100	€0.037	€0.037	€0.037	€0.037	€0.037	24.8%

HLUC 8 will be evaluated in Flanders, where according to Table 45 the end-to-end viability of this scenario is restricted by Aggregators. However, in that case the Aggregator could negotiate a higher price with the DSO, which would be attractive to both of them. In the following two tables we observe the expected Free Cash Flows and IRR for the Aggregator and DSO when the payment is set to €20 (default) and €28, respectively. It appears that this HLUC can indeed be rendered incentive-compatible for all actors.

Table 72: Aggregator's Free Cash Flows and IRR from HLUC 8 in Flanders with / without additional incentive mechanism

Aggregator's annual ARPU (received from DSO)	Aggregator's Free Cash Flows from HLUC 7						IRR
	Y0	Y1	Y2	Y3	Y4	Y5	
€20	-€1.4	-€0.5	-€0.5	-€0.5	-€0.5	-€0.5	0%
€28	-€1.4	€0.6	€0.6	€0.6	€0.6	€0.6	34.7%

Table 73: DSO's Free Cash Flows from HLUC 8 and IRR in Flanders with/without additional incentive mechanism

Aggregator's annual ARPU (received from DSO)	DSO's Free Cash Flows from HLUC 7						IRR
	Y0	Y1	Y2	Y3	Y4	Y5	
€20	-€20.8	€15.9	€15.9	€15.9	€15.9	€15.9	71.7%
€28	-€20.8	€11.5	€11.5	€11.5	€11.5	€11.5	47.4%

HLUC 9, 10 and 11 will be demonstrated in Terni and according to Table 59 no additional incentive mechanisms are needed.

10 CONCLUSIONS

In this deliverable we performed an initial assessment of the economic viability of candidate business models for the main NOBEL GRID actors, namely DSOs, Aggregators, Retailers and Prosumers and for each of the five (5) pilot sites. This study can be considered as the first step towards identifying the major socio-economic factors that will determine the adoption of NOBEL GRID products by providers, as well as, consumers' engagement in Demand-Response strategies.

In order to accomplish this, we described a generic value network for smart grids taking into account the distinction between roles and actors. More specifically, we identified seven (7) key roles, as follows: 1) Power Producer, 2) Power Transmitter, 3) Power Distributor, 4) Power Retailer, 5) Power Consumer, 6) Wholesale Market Operator and 7) Aggregator. Depending on the regulatory setting, one role can be performed by multiple actors, even if they have significant differences in terms of size, core market, etc. For example, power can be produced by companies or prosumers using renewable energy sources. Furthermore, one actor can be involved in one or multiple roles; for example a retailer could also act as an aggregator.

Then, we defined a "standard" business model[11] for each actor and considered a set of 11 candidate extensions, called NOBEL GRID High-Level Use-Cases (HLUC). Each HLUC involves several NOBEL GRID products and provides value to at least one actor. We analyzed these HLUCs in order to detail the key actors and products involved and then prepared candidate value networks for presenting the main interactions between the roles in a comprehensive way. The importance of the Aggregator's role in smart grids can be evidenced in the generic value network, by looking at the exchanged information and money flows.

While these value networks are ideal for giving us a bird's eye view of the industry, they provide no insight on the attractiveness of each scenario to each actor involved. For this purpose, we utilized the Business Modelling Canvas methodology, which was extended to consider social (innovation, sustainability, social costs, benefits etc.) aspects, as well. In that way, among others, the main value proposition, infrastructure used, customers, and finances for each HLUC/service and for each one of the four (4) key NOBEL GRID actors can be easily documented, which allows decision makers to quickly understand the business case.

In particular, the above business model analysis eventually allowed us to develop a business plan for each actor and HLUC by taking also into account the key differences among the pilot sites, such as population and regulation. Quantifying the financial aspects for all these combinations was made possible by following an efficient approach that relies on defining the costs and revenues for each actor's business model in a single location and using "scaling factors" for calculating the costs and revenues for the rest pilot sites.

We observed that in none of the 5 pilot sites studied it is currently (i.e. prior to the NOBEL GRID approach, tools, and High-Level Use-Cases) economically viable for an entity to adopt the "standard" business model of the Prosumer role. However, members of cooperative schemes and other environmentally conscious citizens could set a lower IRR threshold and thus agree to become Prosumers. The rest of the roles are attractive in most cases but with differences in the highest acceptable competition level (maximum number of players being active). Notable

[11] For example, we assumed that each Prosumer has installed Photovoltaic panels on their rooftop, instead of e.g. wind turbines, and selects how much of the produced power will be locally consumed or contributed to the pool.

exceptions to this conclusion apply to the following roles, who cannot be profitable even under a monopoly situation:

- the DSO in Flanders, attributed to the high corporate tax rate compared to other sites, and
- the DSO and Aggregator in Meltemi, mainly due to the small customer base.

As far as the effects of NOBEL GRID High-level Use-cases on the key actors are concerned, we noticed a positive impact in most cases. In particular we observed the following:

- New entities adopting the Prosumer role could adopt all relevant HLUCs and obtain a high return on investment (more than 30%). Interestingly, this is true for all pilot sites.
- For the DSO role, most NOBEL GRID High-Level Use-Cases (HLUC 2, HLUC3, HLUC4, HLUC5, HLUC6, HLUC7, HLUC8, HLUC9 and HLUC11) are beneficial in all pilot sites. While HLUC10 is very attractive in Terni only, it is profitable in the rest pilot sites as well. Nevertheless, the HLUCs are not profitable enough for making the "standard" business model of the DSO in Flanders and Meltemi a lucrative one.
- For the Aggregator role we noticed that at least one NOBEL GRID High-Level Use-Case is attractive in all pilot sites except for Meltemi. In particular, HLUC3 and HLUC9 are beneficial in Valencia, Flanders, Manchester and Terni, while HLUC10 is attractive in Flanders, Manchester and Terni. Similarly, HLUC7 is considered lucrative in Valencia, Manchester and Terni, while HLUC1, HLUC2 are very attractive only in Manchester. In general, an Aggregator in Flanders, Manchester and Terni would have the financial incentive to deploy all NOBEL GRID HLUCs. In Terni, an Aggregator would be better off providing HLUCs selectively due to the high rewards that should be given to Prosumers under HLUC8[12].
- Finally, for the Retailer role, the single relevant High-Level Use-Case (i.e., HLUC8) is beneficial for all pilot sites apart from Meltemi. Furthermore, adding HLUC8 to the service portfolio slightly improves the return on investment in all of these pilot sites.

As expected from the above results, there are HLUCs where at least one actor in a certain pilot site would not be willing to participate (i.e., such HLUCs are not incentive compatible). In other words, the end-to-end attractiveness of some HLUCs is not guaranteed in all cases and for this reason additional incentive mechanisms may be needed. More specifically, all actors would be voluntarily engaged in HLUCs 4, 5 and 6 (where a single actor is involved), as well as, in HLUC11 (where DSOs and Prosumers participate) across all pilot sites. Apart from these, each pilot site has additional HLUCs that are locally incentive-compatible (e.g., in Valencia the HLUC3, HLUC7 and HLUC9).

Given that each of the HLUCs will be demonstrated and evaluated in a specific subset of the pilot sites, we investigated whether additional incentive mechanisms would be necessary in these cases. The incentive mechanisms targeted not only consumers enrolled to Demand Response programs, but the rest actors of the value network as well.

In the former case we performed an initial selection of the best fitted incentives mechanisms for each pilot site according to a set of socio-economic aspects. In particular, given that the cooperatives of CCOOP and ECOPOWER have a very clear environmental orientation, with very environmentally conscious members, these pilot sites could focus more on social-based incentive

[12] As explained in section 7.4, an Aggregator should pay prosumers a higher price than the regulated wholesale price, which is significantly higher in Italy and Greece compared to Spain, Belgium and the UK.

mechanisms e.g., using gamification techniques or collaborative campaigns for increasing demand flexibility, rather than on monetary mechanisms. For the rest pilot sites the importance of financial incentives is expected to be higher. For example, although Alginet is a cooperative DSO it could be argued that its members are less willing to be actively involved in a DR process compared to CCOOP members, and thus, additional monetary incentives might be necessary.

In the latter case, incentive mechanisms for providers were deemed to be necessary for HLUC7 and HLUC 8, only. Due to the small market size in Meltemi no transfer of payments from DSOs and Prosumers to Aggregators was found that could make the HLUC7 attractive on an "end-to-end" basis. Nevertheless, the business model for HLUC 7 in Valencia, Manchester and Terni is expected to be profitable for all involved actors and thus this scenario should indeed be demonstrated (in Meltemi). On the other hand, if an Aggregator's annual average revenue per user (ARPU) from the DSO in Flanders were higher than the rest of the pilot sites (e.g., €28 instead of €20) then this would lead to an "all-win" situation.

When it comes to the expansion opportunities of entities acting as Aggregators and Retailers in each of the pilot sites, we observe the following:

- in Valencia, an Aggregator would have the economic incentive to expand its business by becoming a Prosumer. As expected, the remaining two combinations ("Aggregator and Retailer" as well as "Aggregator and Retailer and Prosumer" are less attractive (due to the worst-case scenario examined) but, still, very close to the IRR threshold of 30%. On the other hand, a Retailer would find adopting the Aggregator and Prosumer roles a lucrative investment.
- an Aggregator in Flanders and Terni would have an economic incentive to expand its business by becoming a Retailer and a Prosumer at the same time. On the other hand, a Retailer in Flanders would have an economic incentive to expand its business by becoming a Prosumer, only. The option of becoming an Aggregator is less attractive, but still profitable.
- in Manchester, both an Aggregator and a Retailer would have an economic incentive to expand their business and become rivals in each other's market, as well as, becoming a Prosumer, despite the additional competition arising this way.
- in Meltemi, an Aggregator should not expand its business. If, however, we consider the overall IRR, then a Retailer would achieve an adequate rate of return by adopting the roles of Aggregator and Prosumer. Note, however, that this is attributed to the high IRR of the standard business model and not to the individual profitability of the rest of the roles.

In the next version of this deliverable, D2.6 to be issued at the end of the project, we will take advantage of the business plan tool flexibility in order to incorporate actual economic data from the pilot sites trials and, eventually, validate the positive outcomes of this study. Furthermore, we would like to perform a sensitivity analysis of the financial results obtained. For example, we can examine the impact of some key assumptions on the results obtained. Furthermore, we can study the need for additional incentive mechanisms for the HLUCs not for a single pilot site, but for the rest as well. This will provide valuable input towards the definition of partner's final exploitation plans and producing final business plans fully exploiting the added value of NOBEL GRID products.

Furthermore, we should highlight again that the attractiveness of NOBEL GRID HLUCs to providers is subject to the number of consumers and prosumers willing to enroll to such programmes and

adjust their consumption and/or production to real-time signals. Thus, the incentive schemes towards consumers and prosumers will have to carefully defined and evaluated in D2.6.

11 REFERENCES AND ACRONYMS

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11.2 ACRONYMS

Table 74. Acronyms

Acronyms List	
AD	Active Demand
BE	Behavioral Economics
BRP	Balance Responsible Party
BM	Business Model
BMS	Building Management System
BYOD	Bring your own Device
CBP	Capacity Bidding Program
CAPEX	Capital Expenditure
CPP	Critical Peak Pricing
CVVP	Commercial Virtual Power Plan
DADRP	Day-Ahead Demand Response Program
DBP	Demand Bidding Program
DER	Distributed Energy Resources
DESSs	Distributed Energy Storage Systems
DG	Distributed Generation
DR	Demand Response
DSO	Distribution System Operator
EDRP	Emergency Demand Response Program
EEX	Energy Exchange
ELRP	Emergency Load Response Program
ESCOs	Energy Service Companies
HV	High Voltage
HLUC	High Level Use Case
HVAC	Heating, Ventilating, and Air Conditioning
ICT	Information and Communication Technologies
IRR	Internal Rate of Return
KPIs	Key Performance Indicators
LV	Low Voltage
LSE	Load Serving Entities
MV	Medium Voltage
NYISO	New York Independent System Operator
OLA	Operational Level Aggreement
PCT	Programmable Controllable Thermostat

PDP	Peak Day Program
PJM	Pennsylvania Jersey Maryland
RES	Renewable Energy Sources
RTP	Real-Time-Pricing
SCE	Southern California Edison
SGAM	Smart Grid Architecture Model
SLA	Service Level Aggreement
SHIC	Smart Home Intelligent Controller
TOU	Time-Of-Use
TSO	Transmission System Operator
V2G	Vehicle-to-Grid
VPP	Virtual Power Plan
VEN	Virtual End Node

12 ANNEX A – The Business Plans

This section documents the Business Plan template that was used for assessing the attractiveness of different energy market setups and added-value services. The template was used for all major NOBEL GRID roles (DSO, Aggregator, Retailer and Prosumer) and for all five pilot sites. Thus, the purpose was to cover all important cost items and allow for ad-hoc extensions by utilizing a number of placeholders. Similarly, a number of revenue streams could be specified so that the profits and losses were to be computed.

The operating period was set to 5 years, which means that any lump sum investments before the service roll-out, as well as all on-going costs, should be amortized by the revenues achieved and allow for a minimum acceptable profit to be realized.

It is organized as follows: we start with the Business Plan template for the standard business model of a certain role e.g., the standard costs and revenues of a DSO distributing energy to end points. Then in section 12.2 we specify the respective costs and revenues stemming from the NOBEL GRID High-level Use-Cases (HLUCs), where applicable. Finally, we describe the table of scaling factors used for replicating a business plan across pilot sites in section 12.3.

12.1 THE BUSINESS PLAN FOR THE STANDARD BUSINESS MODEL PER ROLE

In this section we will describe the business plan template for the standard business model per role, while the individual business plans for each of the key NOBEL GRID actors appear in sections 12.2.1 (DSO), 12.2.2 (Aggregator), 12.2.3 (Retailer) and 12.2.4 (Prosumer).

The template included both capital and operational expenditures (CAPEX and OPEX respectively) and, for each one of those, further subcategories were supported. For example, the user could provide figures for recurrent ICT costs under OPEX. It allows for ad-hoc costs by utilizing the "Other" placeholders that could be found in every cost category. For example, for the DSO role in Terni the 'rights of way' license fees had to be included.

Similarly, three revenue streams could be specified, which depend on the expected overall market size, the expected market share and the average revenue per user (ARPU).

The user could provide input values to all grey cells, while the orange cells were automatically computed. For example, the annual cost for ICT infrastructure maintenance was computed as a fixed percentage on the ICT Infrastructure CAPEX of that role.

Finally, the "Financial Results" section computes the Internal Rate of Return (IRR) that is eventually used for assessing the profitability of a business model. More specifically, the IRR is computed based on the annual Free Cash Flows (FCF), which depend on the EBITDA (Earnings Before Interest Taxes Depreciation and Amortization), Income Tax and CAPEX. More specifically,

Annual FCF= annual EBITDA- annual Income Tax – annual CAPEX

while EBITDA= annual revenues – annual OPEX

and Income Tax = EBIT * corporate tax rate, that is country-specific.

Finally, in order to calculate EBIT (Earnings Before Interest Taxes) we need to subtract the Depreciation and Amortization (D&A) from EBITDA. D&A is the spreading out of capital expenses for tangible and intangible assets respectively, over a time period for accounting and tax purposes. In our case we use a linear approach for a 5-year period; the assessment period.

One important factor for the expected revenues in non-monopolistic settings is the competition level and, in particular, the effects of the number of providers on a new provider's market share. Our approach was to treat mature markets separately from new ones. In particular, we assumed that a new retailer would slowly increase its market share, which is a decreasing function on the number of competitors and an increasing function on time. The exact formula is the following

$$\begin{cases} 1 - \dfrac{e^{-a\,c\,(1+y)^{years}}}{c-1} \;\; if\; c > 1 \\ \\ 1 \; if\; c = 1 \end{cases}$$

where:

- $a \in [0,1]$ is a parameter for the effect of competition (we used 6%)
- c is the number of providers in the market (with the newcomer in question)
- y is the effect of time on the newcomer's market share (we used 20%)
- $years$ is the number of time elapsed from the provider's establishment.

On the other hand, the Aggregator is currently a theoretical entity and thus no established players have dominated the market. This allows all new aggregators to compete on an equal basis and thus we assume that their market share will be equal and given by the following formula

$$1/c$$

, where c is the number of providers in the market.

12.1.1 DSO

				Baseline Business Model (existing)					
				Year					
				0	1	2	3	4	5
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit	**1570**	**1570**	**1570**	**1570**	**1570**	**1570**
		License Fees	*K Eur/year*	50	50	50	50	50	50
		to Regulator	*K Eur/year*						
		Other	*K Eur/year*	50	50	50	50	50	50
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*	240	240	240	240	240	240
		DRFM	*K Eur/year*						
		Other	*K Eur/year*	240	240	240	240	240	240
		Buildings owned	*K Eur/year*	80	80	80	80	80	80
		Buildings	*K Eur/year*						
		Other	*K Eur/year*	80	80	80	80	80	80
		Operations Equipment	*K Eur/year*	660	660	660	660	660	660

		Transformers	*K Eur/year*	60	60	60	60	60	60
		Poles	*K Eur/year*						
		Lines	*K Eur/year*	100	100	100	100	100	100
		Vehicles	*K Eur/year*						
		Smart meters	*K Eur/year*	500	500	500	500	500	500
		Solar panels	*K Eur/year*						
		Inverters	*K Eur/year*						
		Wind Turbines	*K Eur/year*						
		Other	*K Eur/year*						
		Information & Communications Technology	*K Eur/year*	40	40	40	40	40	40
		Servers	*K Eur/year*	20	20	20	20	20	20
		Workstations	*K Eur/year*	10	10	10	10	10	10
		Other	*K Eur/year*	10	10	10	10	10	10
		Services	*K Eur/year*	500	500	500	500	500	500
		Installation	*K Eur/year*	100	100	100	100	100	100
		Digging & Ducting	*K Eur/year*	300	300	300	300	300	300
		Other	*K Eur/year*	100	100	100	100	100	100
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit	**955**	**7860.8**	**7866**	**7871**	**7876**	**7881**
		Wholesale Power	*K Eur/year*	0	1500	1500	1500	1500	1500
		from TSOs	*K Eur/year*	0	1350	1350	1350	1350	1350
		from producers	*K Eur/year*	0	0	0	0	0	0
		Other	*K Eur/year*	0	150	150	150	150	150
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*	0	3880	3880	3880	3880	3880
		Managers	*K Eur/year*	0	130	130	130	130	130
		FTEs	*FTE/month*		2	2	2	2	2
		FTE cost	*K Eur/year*		65	65	65	65	65
		Senior Employees	*K Eur/year*	0	3500	3500	3500	3500	3500
		FTEs	*FTE/month*		70	70	70	70	70
		FTE cost	*K Eur/year*		50	50	50	50	50
		Junior Employees	*K Eur/year*	0	250	250	250	250	250
		FTEs	*FTE/month*		10	10	10	10	10
		FTE cost	*K Eur/year*		25	25	25	25	25
		Maintenance	*K Eur/year*	600	647.8	647.8	647.8	647.8	647.8
		SW support and central system operations	*K Eur/year*	0					
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*	0	4	4	4	4	4
% on SW CAPEX	10%	SW maintenance	*K Eur/year*	0	24	24	24	24	24
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*	0	19.8	19.8	19.8	19.8	19.8
		Digging & Ducting	*K Eur/year*	100	100	100	100	100	100
		Other	*K Eur/year*	500	500	500	500	500	500
		Building Rental	*K Eur/year*	100	100	100	100	100	100
		Offices	*K Eur/year*	100	100	100	100	100	100
		Size	*K Square*	8 €	8	8 €	8 €	8 €	8 €

			meters							
		Rent	*K Eur /K Square meter/year*		€12.5	12.5	€12.5	€12.5	€12.5	€12.5
		Warehouses	*K Eur/year*		0	0	0	0	0	0
		Size	*K Square meters*							
		Rent	*K Eur /K Square meter/year*							
		Other	*K Eur/year*		0	0	0	0	0	0
		Size	*K Square meters*							
		Rent	*K Eur /K Square meter/year*							
		ICT costs	*K Eur/year*		55	410	415	420	425	430
		SW licenses	*K Eur/year*		0	350	350	350	350	350
		Data Services	*K Eur/year*		5	10	15	20	25	30
		Calling Services	*K Eur/year*		50	50	50	50	50	50
		Data Analytics	*K Eur/year*							
		Other	*K Eur/year*							
		Marketing	*K Eur/year*		0	5	5	5	5	5
		Advertisements	*K Eur/year*		0	5	5	5	5	5
		Incentives	*K Eur/year*		0					
		Other	*K Eur/year*		0					
		Consulting	*K Eur/year*		200	100	100	100	100	100
		Financial	*K Eur/year*		100	100	100	100	100	100
		Legal	*K Eur/year*							
		Technical	*K Eur/year*		100					
		Other	*K Eur/year*							
		Logistics	*K Eur/year*		0	400	400	400	400	400
		Fuel	*K Eur/year*		0	50	50	50	50	50
		Other	*K Eur/year*		0	350	350	350	350	350
		General Administration Costs	*K Eur/year*		0	300	300	300	300	300
		Billing	*K Eur/year*		0	300	300	300	300	300
		Office supplies	*K Eur/year*		0					
		Other	*K Eur/year*		0					
		Penalties	*K Eur/year*		0	0	0	0	0	0
		to Market Facilitators	*K Eur/year*		0					
		Other	*K Eur/year*		0					
		Membership Fees	*K Eur/year*		0	300	300	300	300	300
		to Market Facilitators	*K Eur/year*		0					
		Other	*K Eur/year*		0	300	300	300	300	300
% on Revenues	2%	**Bad debt**	*K Eur/year*		0	218	218	218	218	218
Revenue Driver	Revenue Driver Input	**REVENUES**	Unit		**0**	**10900**	**10900**	**10900**	**10900**	**10900**
		Product1	*K Eur/year*		0	10500	10500	10500	10500	10500
		Market Size	*K subscribers*			50	50	50	50	50
		Market Share of Actor	*% of Market*		0%	100%	100%	100%	100%	100%

			Size						
		Average Revenue Per User (ARPU)	*Eur/year*		210	210	210	210	210
		Product2	*K Eur/year*	0	400	400	400	400	400
		Market Size	*K subscribers*		50	50	50	50	50
		Market Share of Actor	*% of Market Size*	0%	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*		8	8	8	8	8
		Product3	*K Eur/year*	0	0	0	0	0	0
		Market Size	*K subscribers*						
		Market Share of Actor	*% of Market Size*	0%					
		Average Revenue Per User (ARPU)	*Eur/year*						
Parameter	Parameter Input	**FINANCIAL RESULTS**							
		EBITDA	*K Eur/year*	-955	3039.2	3034	3029	3024	3019
Amortization Years	5	**D&A**	*K Eur/year*		628	€1,021	€1,544	€2,329	€3,899
		EBIT	*K Eur/year*	-955	2411.2	2014	1485	695	-880
Tax	20%	**Income Tax**	*K Eur/year*	0	530.5	443.14	326.7806667	152.9806667	0
		Free Cash Flows	*K Eur/year*	-2,525	938.7	1021	1132	1301	1449
		Internal Rate on Investment (IRR)	%	33%					

12.1.2 Aggregator

				Baseline Business Model (existing)					
				Year					
				0	1	2	3	4	5
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit	**€14**	**€1,206**	**€126**	**€139**	**€151**	**€166**
		License Fees	*K Eur/year*	0	€5	€5	€6	€6	€6
		to Regulator	*K Eur/year*		€5	€5	€6	€6	€6
		Other	*K Eur/year*						
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*	€10	0	0	0	0	0
		DRFM	*K Eur/year*	€10					
		Other	*K Eur/year*						
		Buildings owned	*K Eur/year*	0	0	0	0	0	0
		Buildings	*K Eur/year*						
		Other	*K Eur/year*						
		Operations Equipment	*K Eur/year*	0	1200	120	132	145.2	159.72
		Transformers	*K Eur/year*						
		Poles	*K Eur/year*						
		Lines	*K Eur/year*						
		Vehicles	*K Eur/year*						

		Smart meters	*K Eur/year*							
		Solar panels	*K Eur/year*							
		Inverters	*K Eur/year*							
		Wind Turbines	*K Eur/year*							
		Other	*K Eur/year*			1200	120	132	145.2	159.72
		Information & Communications Technology	*K Eur/year*		€4	€1	€1	€1	€1	€1
		Servers	*K Eur/year*		€2	€1	€1	€1	€1	€1
		Workstations	*K Eur/year*		€2			€1		
		Other	*K Eur/year*							
		Services	*K Eur/year*		0	0	0	0	0	0
		Installation	*K Eur/year*							
		Digging & Ducting	*K Eur/year*							
		Other	*K Eur/year*							
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit		**€0**	**€733**	**€770**	**€841**	**€919**	**€1,004**
		Wholesale Power	*K Eur/year*			0	0	0	0	0
		from TSOs	*K Eur/year*		0					
		from producers	*K Eur/year*		0					
		Other	*K Eur/year*		0					
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*		€0	€82	€86	€90	€95	€100
		Managers	*K Eur/year*			€7	€7	€8	€8	€9
		FTEs	*FTE/month*			0.2	0.2	0.2	0.2	0.2
		FTE cost	*K Eur/year*			€35	€37	€39	€41	€43
		Senior Employees	*K Eur/year*		0	0	0	0	0	0
		FTEs	*FTE/month*							
		FTE cost	*K Eur/year*							
		Junior Employees	*K Eur/year*		€0	€75	€79	€83	€87	€91
		FTEs	*FTE/month*			3	3	3	3	3
		FTE cost	*K Eur/year*			€25	€26	€28	€29	€30
		Maintenance	*K Eur/year*		0	201.4	221.4	243.4	267.6	294.22
		SW support and central system operations	*K Eur/year*		0					
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*			€0	€0	€0	€0	€0
% on SW CAPEX	10%	SW maintenance	*K Eur/year*			€1	€1	€1	€1	€1
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*			0	0	0	0	0
		Digging & Ducting	*K Eur/year*							
		Other	*K Eur/year*			200	220	242	266.2	292.82
		Building Rental	*K Eur/year*		€0	€6.25	€7	€7	€7	€8
		Offices	*K Eur/year*		€0	€6.25	€7	€7	€7	€8

		Size	*K Square meters*		0.5	0.5	0.5	0.5	0.5
		Rent	*K Eur /K Square meter/year*		€12.50	€13	€14	€14	€15
		Warehouses	*K Eur/year*	0	0	0	0	0	0
		Size	*K Square meters*						
		Rent	*K Eur /K Square meter/year*						
		Other	*K Eur/year*	0	0	0	0	0	0
		Size	*K Square meters*						
		Rent	*K Eur /K Square meter/year*						
		ICT costs	*K Eur/year*	0	0	0	0	0	0
		SW licenses	*K Eur/year*						
		Data Services	*K Eur/year*						
		Calling Services	*K Eur/year*						
		Data Analytics	*K Eur/year*						
		Other	*K Eur/year*						
		Marketing	*K Eur/year*	0	€20	€21	€22	€23	€24
		Advertisements	*K Eur/year*	0	€20	€21	€22	€23	€24
		Incentives	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		Consulting	*K Eur/year*	0	€3	€3	€3	€3	€4
		Financial	*K Eur/year*		€2	€2	€2	€2	€2
		Legal	*K Eur/year*		€2	€2	€2	€2	€2
		Technical	*K Eur/year*						
		Other	*K Eur/year*						
		Logistics	*K Eur/year*	0	0	0	0	0	0
		Fuel	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		General Administration Costs	*K Eur/year*	0	0	0	0	0	0
		Billing	*K Eur/year*	0					
		Office supplies	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		Penalties	*K Eur/year*	0	0	0	0	0	0
		to Market Facilitators	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		Membership Fees	*K Eur/year*	0	375	412.5	453.75	499.125	549.0375
		to Market Facilitators	*K Eur/year*	0					
		Other	*K Eur/year*	0	375	412.5	453.75	499.125	549.0375
% on Revenues	2%	**Bad debt**	*K Eur/year*	0	€45	€20	€21	€24	€26
Revenue Driver	**Revenue Driver Input**	**REVENUES**	**Unit**	**0**	**€2,250**	**€975**	**€1,073**	**€1,180**	**€1,298**
		Product1	*K Eur/year*	0	€750	€825	€908	€998	€1,098
		Market Size	*K*		10	11	12.1	13.31	14.641

			subscribers							
		Market Share of Actor	*% of Market Size*	0%	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*		€75	€75	€75	€75	€75
		Product2	*K Eur/year*	0	€1,500	150	165	181.5	199.65
		Market Size	*K subscribers*		10	11	12.1	13.31	14.641
		Market Share of Actor	*% of Market Size*	0%	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*		€150	€150	€150	€150	€150
		Product3	*K Eur/year*	0	0	0	0	0	0
		Market Size	*K subscribers*						
		Market Share of Actor	*% of Market Size*	0%					
		Average Revenue Per User (ARPU)	*Eur/year*						
Parameter	Parameter Input	**FINANCIAL RESULTS**							
		EBITDA	*K Eur/year*	€0	€1,517	€205	€231	€261	€293
Amortization Years	5	**D&A**	*K Eur/year*		€244	€275	€322	€397	€564
		EBIT	*K Eur/year*	€0	€1,273	-€71	-€90	-€137	-€270
Tax	20%	**Income Tax**	*K Eur/year*	0	€255	€0	€0	€0	€0
		Free Cash Flows	*K Eur/year*	-€14	€57	€79	€93	€109	€127
		Internal Rate on Investment (IRR)	%	441%					

12.1.3 Retailer

				Baseline Business Model (existing)					
				Year					
				0	1	2	3	4	5
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit	**51.5**	**46.5**	**46.5**	**89**	**106.2**	**-310.7**
		License Fees	*K Eur/year*	42.5	42.5	42.5	85	102.2	-314.7
		to Regulator	*K Eur/year*	2	2	2	4	5	-15
		Other	*K Eur/year*	40.5	40.5	40.5	81	97.2	-299.7
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*	0	0	0	0	0	0
		DRFM	*K Eur/year*						
		Other	*K Eur/year*						
		Buildings owned	*K Eur/year*	0	0	0	0	0	0
		Buildings	*K Eur/year*						
		Other	*K Eur/year*						
		Operations Equipment	*K Eur/year*	0	0	0	0	0	0
		Transformers	*K Eur/year*						
		Poles	*K Eur/year*						

		Lines	*K Eur/year*						
		Vehicles	*K Eur/year*						
		Smart meters	*K Eur/year*						
		Solar panels	*K Eur/year*						
		Inverters	*K Eur/year*						
		Wind Turbines	*K Eur/year*						
		Other	*K Eur/year*						
		Information & Communications Technology	*K Eur/year*	9	4	4	4	4	4
		Servers	*K Eur/year*	4	2	2	2	2	2
		Workstations	*K Eur/year*	5	2	2	2	2	2
		Other	*K Eur/year*						
		Services	*K Eur/year*	0	0	0	0	0	0
		Installation	*K Eur/year*						
		Digging & Ducting	*K Eur/year*						
		Other	*K Eur/year*						
					0.5	0.5	0.5	1	1.20
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit	**44**	**1884.62**	**2251.19**	**2606.21**	**3310.45**	**4130.478**
		Wholesale Power	*K Eur/year*		331	662	993	1655	2449.4
		from TSOs	*K Eur/year*	0	40.5	81	121.5	202.5	299.7
		from producers	*K Eur/year*	0	115	230	345	575	851
		Other	*K Eur/year*	0	175.5	351	526.5	877.5	1298.7
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*	0	47.8	67.8	83.3	99.8	102.8
		Managers	*K Eur/year*	0	18	37	38	39	40
		FTEs	*FTE/month*		0.5	1	1	1	1
		FTE cost	*K Eur/year*		36	37	38	39	40
		Senior Employees	*K Eur/year*	0	4.8	4.8	4.8	4.8	4.8
		FTEs	*FTE/month*		0.2	0.2	0.2	0.2	0.2
		FTE cost	*K Eur/year*		30	30	30	30	30
		Junior Employees	*K Eur/year*	0	25	26	40.5	56	58
		FTEs	*FTE/month*		1	1	1.5	2	2
		FTE cost	*K Eur/year*		25	26	27	28	29
		Maintenance	*K Eur/year*	0	1	1.9	1.9	1.9	1.9
		SW support and central system operations	*K Eur/year*	0					
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*		0.5	0.9	0.9	0.9	0.9
% on SW CAPEX	10%	SW maintenance	*K Eur/year*		0.5	1	1	1	1
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*		0	0	0	0	0
		Digging & Ducting	*K Eur/year*						

		Other	*K Eur/year*						
		Building Rental	*K Eur/year*	0	3.75	3.75	4	4	4.25
		Offices	*K Eur/year*	0	3.75	3.75	4	4	4.25
		Size	*K Square meters*		0.05	0.05	0.05	0.05	0.05
		Rent	*K Eur /K Square meter/year*		75	75	80	80	85
		Warehouses	*K Eur/year*	0	0	0	0	0	0
		Size	*K Square meters*						
		Rent	*K Eur /K Square meter/year*						
		Other	*K Eur/year*	0	0	0	0	0	0
		Size	*K Square meters*						
		Rent	*K Eur /K Square meter/year*						
		ICT costs	*K Eur/year*	9	6	6	6	6	6
		SW licenses	*K Eur/year*	5	2	2	2	2	2
		Data Services	*K Eur/year*	3	3	3	3	3	3
		Calling Services	*K Eur/year*	1	1	1	1	1	1
		Data Analytics	*K Eur/year*						
		Other	*K Eur/year*						
		Marketing	*K Eur/year*	20	20	20	20	20	20
		Advertisements	*K Eur/year*	20	20	20	20	20	20
		Incentives	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		Consulting	*K Eur/year*	10	2	2	2	2	2
		Financial	*K Eur/year*	5	1	1	1	1	1
		Legal	*K Eur/year*	5	1	1	1	1	1
		Technical	*K Eur/year*						
		Other	*K Eur/year*						
		Logistics	*K Eur/year*	0	13.7	13.7	13.7	13.7	13.7
		Fuel	*K Eur/year*	0	13.7	13.7	13.7	13.7	13.7
		Other	*K Eur/year*	0					
		General Administration Costs	*K Eur/year*	5	2	1.5	1.5	1.5	1.5
		Billing	*K Eur/year*	0	1	1	1	1	1
		Office supplies	*K Eur/year*	5	1	0.5	0.5	0.5	0.5
		Other	*K Eur/year*	0					
		Penalties	*K Eur/year*	0	6.9	13.8	13.8	23	25.53
		to Market Facilitators	*K Eur/year*	0	6.9	13.8	13.8	23	25.53
		Other	*K Eur/year*	0					
		Membership Fees	*K Eur/year*	0	1442.2	1442.2	1442.2	1442.2	1442.2
		to Market Facilitators	*K Eur/year*	0					
		Other	*K Eur/year*	0	1442.2	1442.2	1442.2	1442.2	1442.2
% on Revenues	2%	**Bad debt**	*K Eur/year*	0	8.27	16.54	24.81	41.35	61.198
Revenue Driver	Revenue Driver	**REVENUES**	Unit	**0**	**413.5**	**827**	**1240.5**	**2067.5**	**3059.9**

	Input								
		Product1	*K Eur/year*	0	413.5	827	1240.5	2067.5	3059.9
		Market Size	*K subscribers*		10	10	10	10	10
		Market Share of Actor	*% of Market Size*	0%	5%	10%	15%	25%	37%
		Average Revenue Per User (ARPU)	*Eur/year*		827	827	827	827	827
		Product2	*K Eur/year*	0	0	0	0	0	0
		Market Size	*K subscribers*						
		Market Share of Actor	*% of Market Size*	0%					
		Average Revenue Per User (ARPU)	*Eur/year*						
		Product3	*K Eur/year*	0	0	0	0	0	0
		Market Size	*K subscribers*						
		Market Share of Actor	*% of Market Size*	0%					
		Average Revenue Per User (ARPU)	*Eur/year*						
Parameter	Parameter Input	**FINANCIAL RESULTS**							
		EBITDA	*K Eur/year*	-44	-1471.12	-1424.19	-1365.71	-1242.95	-1070.578
Amortization Years	5	**D&A**	*K Eur/year*		10.3	10.3	10.3	10.3	10.3
		EBIT	*K Eur/year*	-44	-1481.42	-1434.49	-1376.01	-1253.25	-1080.878
Tax	20%	**Income Tax**	*K Eur/year*	0	0	0	0	0	0
		Free Cash Flows	*K Eur/year*	-95.5	-1517.62	-1470.69	-1454.71	-1349.15	-759.878
		Internal Rate on Investment (IRR)	%	NA					

12.1.4 Prosumer

				Baseline Business Model (existing)					
				Year					
				0	1	2	3	4	5
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit	**1.575**	**0**	**0**	**0**	**0**	**0**
		License Fees	*K Eur/year*	0	0	0	0	0	0
		to Regulator	*K Eur/year*						
		Other	*K Eur/year*						
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*	0	0	0	0	0	0
		DRFM	*K Eur/year*						
		Other	*K Eur/year*						
		Buildings owned	*K Eur/year*	0	0	0	0	0	0
		Buildings	*K Eur/year*						
		Other	*K Eur/year*						

		Operations Equipment	*K Eur/year*	1.075	0	0	0	0	0
		Transformers	*K Eur/year*						
		Poles	*K Eur/year*						
		Lines	*K Eur/year*						
		Vehicles	*K Eur/year*						
		Smart meters	*K Eur/year*						
		Solar panels	*K Eur/year*	0.875					
		Inverters	*K Eur/year*	0.2					
		Wind Turbines	*K Eur/year*						
		Other	*K Eur/year*						
		Information & Communications Technology	*K Eur/year*	0	0	0	0	0	0
		Servers	*K Eur/year*						
		Workstations	*K Eur/year*						
		Other	*K Eur/year*						
		Services	*K Eur/year*	0.5	0	0	0	0	0
		Installation	*K Eur/year*	0.5					
		Digging & Ducting	*K Eur/year*						
		Other	*K Eur/year*						
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit	**0**	**0.27475**	**0.27475**	**0.27475**	**0.27475**	**0.27475**
		Wholesale Power	*K Eur/year*		0	0	0	0	0
		from TSOs	*K Eur/year*	0					
		from producers	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*	0	0	0	0	0	0
		Managers	*K Eur/year*	0	0	0	0	0	0
		FTEs	*FTE/month*						
		FTE cost	*K Eur/year*						
		Senior Employees	*K Eur/year*	0	0	0	0	0	0
		FTEs	*FTE/month*						
		FTE cost	*K Eur/year*						
		Junior Employees	*K Eur/year*	0	0	0	0	0	0
		FTEs	*FTE/month*						
		FTE cost	*K Eur/year*						
		Maintenance	*K Eur/year*	0	0.03225	0.03225	0.03225	0.03225	0.03225
		SW support and central system operations	*K Eur/year*	0					
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*		0	0	0	0	0
% on SW CAPEX	10%	SW maintenance	*K Eur/year*		0	0	0	0	0

% on equipment CAPEX	3%	Spare part costs	*K Eur/year*		0.03225	0.03225	0.03225	0.03225	0.03225
		Digging & Ducting	*K Eur/year*						
		Other	*K Eur/year*						
		Building Rental	*K Eur/year*	0	0	0	0	0	0
		Offices	*K Eur/year*	0	0	0	0	0	0
		Size	*K Square meters*						
		Rent	*K Eur /K Square meter/year*						
		Warehouses	*K Eur/year*	0	0	0	0	0	0
		Size	*K Square meters*						
		Rent	*K Eur /K Square meter/year*						
		Other	*K Eur/year*	0	0	0	0	0	0
		Size	*K Square meters*						
		Rent	*K Eur /K Square meter/year*						
		ICT costs	*K Eur/year*	0	0	0	0	0	0
		SW licenses	*K Eur/year*						
		Data Services	*K Eur/year*						
		Calling Services	*K Eur/year*						
		Data Analytics	*K Eur/year*						
		Other	*K Eur/year*						
		Marketing	*K Eur/year*	0	0	0	0	0	0
		Advertisements	*K Eur/year*	0					
		Incentives	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		Consulting	*K Eur/year*	0	0	0	0	0	0
		Financial	*K Eur/year*						
		Legal	*K Eur/year*						
		Technical	*K Eur/year*						
		Other	*K Eur/year*						
		Logistics	*K Eur/year*	0	0	0	0	0	0
		Fuel	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		General Administration Costs	*K Eur/year*	0	0	0	0	0	0
		Billing	*K Eur/year*	0					
		Office supplies	*K Eur/year*	0					
		Other	*K Eur/year*	0					
		Penalties	*K Eur/year*	0	0.2425	0.2425	0.2425	0.2425	0.2425
		to Market Facilitators	*K Eur/year*	0					
		Other	*K Eur/year*	0	0.2425	0.2425	0.2425	0.2425	0.2425
		Membership Fees	*K Eur/year*	0	0	0	0	0	0
		to Market Facilitators	*K Eur/year*	0					
		Other	*K Eur/year*	0					

% on Revenues	2%	**Bad debt**	*K Eur/year*	0	0	0	0	0	0
Revenue Driver	Revenue Driver Input	**REVENUES**	Unit	**0**	**0.69325**	**0.69325**	**0.69325**	**0.69325**	**0.69325**
		Product1	*K Eur/year*	0	0	0	0	0	0
		Market Size	*K subscribers*						
		Market Share of Actor	*% of Market Size*	0%					
		Average Revenue Per User (ARPU)	*Eur/year*						
		Product2	*K Eur/year*	0	0	0	0	0	0
		Market Size	*K subscribers*						
		Market Share of Actor	*% of Market Size*	0%					
		Average Revenue Per User (ARPU)	*Eur/year*						
		Power generation	*K Eur/year*	0	0.162	0.162	0.162	0.162	0.162
		Power generated	*KW/year*	0	1080	1080	1080	1080	1080
		Wholesale Price	*Eur/KWh*	0.15	0.15	0.15	0.15	0.15	0.15
		Reduced Costs	Eur/year	0	531.25	531.25	531.25	531.25	531.25
		Reduced Consumption (due to own production)	*KWh/year*		2125	2125	2125	2125	2125
		Retail Price	*Eur/KWh*		0.25	0.25	0.25	0.25	0.25
Parameter	Parameter Input	**FINANCIAL RESULTS**							
		EBITDA	*K Eur/year*	0	0.4185	0.4185	0.4185	0.4185	0.4185
Amortization Years	5	**D&A**	*K Eur/year*		0.315	0.315	0.315	0.315	0.315
		EBIT	*K Eur/year*	0	0.1035	0.1035	0.1035	0.1035	0.1035
Tax	20%	**Income Tax**	*K Eur/year*	0	0	0	0	0	0
		Free Cash Flows	*K Eur/year*	-1.575	0.4185	0.4185	0.4185	0.4185	0.4185
		Internal Rate on Investment (IRR)	%	10%					

12.2 THE BUSINESS PLAN FOR EACH HLUC PER ROLE

In this section we will describe the business plan template for the business model of each role adopting a certain HLUC. Sections 12.2.1, 12.2.2, 12.2.3 and 12.2.4 detail the individual business plans for each of the key NOBEL GRID actors (DSO, Aggregator, Retailer and Prosumer respectively).

The reference business plan for each High-level Use-Case has exactly the same format as for the standard business model, but in order to keep the model tractable we assume that the CAPEX costs take place only at Y0 (just before service roll-out) while OPEX costs and revenues are constant across time. These simplifications help reduce the inputs that a user would have to enter. It is important to note that these costs and revenues, and consequently the financial results, are in addition to costs of actor's standard business model.

12.2.1 DSO

				Extra Costs/Revenues per year when HLUC# is adopted (in addition to costs of actor's Baseline business model)											
				HLUC											
				1	2	3	4	5	6	7	8	9	10	11	12
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit	**0**	**15**	**15**	**25**	**25**	**25**	**15**	**25**	**27**	**27**	**16**	**27**
		License Fees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		to Regulator	*K Eur/year*												
		Other	*K Eur/year*												
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*	0	0	0	10	10	10	15	10	2	2	1	2
		DRFM	*K Eur/year*									1	1	1	1
		Other	*K Eur/year*				10	10	10	15	10	1	1		1
		Buildings owned	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Buildings	*K Eur/year*												
		Other	*K Eur/year*												
		Operations Equipment	*K Eur/year*	0	0	0	0	0	0	0	0	5	5	0	5
		Transformers	*K Eur/year*												
		Poles	*K Eur/year*												
		Lines	*K Eur/year*												
		Vehicles	*K Eur/year*												
		Smart meters	*K Eur/year*												
		Solar panels	*K Eur/year*												
		Inverters	*K Eur/year*												
		Wind Turbines	*K Eur/year*												
		Other	*K Eur/year*									5	5		5
		Information & Communications Technology	*K Eur/year*	0	15	15	15	15	15	0	15	15	15	15	15
		Servers	*K Eur/year*		10	10	10	10	10	0	10	10	10	10	10
		Workstations	*K Eur/year*		2.5	2.5	2.5	2.5	2.5	0	2.5	2.5	2.5	2.5	2.5
		Other	*K Eur/year*		2.5	2.5	2.5	2.5	2.5	0	2.5	2.5	2.5	2.5	2.5
		Services	*K Eur/year*	0	0	0	0	0	0	0	0	5	5	0	5
		Installation	*K Eur/year*							0					
		Digging & Ducting	*K Eur/year*							0					
		Other	*K Eur/year*									5	5		5
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit	**€0**	**-€4**	**-€9**	**-€20**	**-€20**	**-€20**	**-19.5**	**-€28**	**-€20**	**-€12**	**-€17**	**-€15**
		Wholesale Power	*K Eur/year*	0	-20	-25	0	0	0	-10	-50	-20	-5	0	-5
		from TSOs	*K Eur/year*		-20	-25				-10	-50	-20	-5		-5

		from producers	*K Eur/year*												
		Other	*K Eur/year*												
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*	€0	€0	€0	€0	€0	€0	9	€0	€0	€0	€0	€0
		Managers	*K Eur/year*	€0	€0	€0	€0	€0	€0	6.5	€0	0	0	0	0
		FTEs	*FTE/month*							0.1					
		FTE cost	*K Eur/year*	€65	€65	€65	€65	€65	€65	€65	€65	€65	€65	€65	€65
		Senior Employees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		FTEs	*FTE/month*							0					
		FTE cost	*K Eur/year*	€50	€50	€50	€50	€50	€50	€50	€50	€50	€50	€50	€50
		Junior Employees	*K Eur/year*	€0	€0	€0	€0	€0	€0	2.5	€0	€0	€0	€0	€0
		FTEs	*FTE/month*							0.1					
		FTE cost	*K Eur/year*	€25	€25	€25	€25	€25	€25	€25	€25	€25	€25	€25	€25
		Maintenance	*K Eur/year*	0	1.5	1.5	0.96	0.96	0.96	1.5	2.5	1.85	1.85	1.6	1.85
		SW support and central system operations	*K Eur/year*												
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*	0	1.5	1.5	-0.04	-0.04	-0.04	0	1.5	1.5	1.5	1.5	1.5
% on SW CAPEX	10%	SW maintenance	*K Eur/year*	0	0	0	1	1	1	1.5	1	0.2	0.2	0.1	0.2
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*	0	0	0	0	0	0	0	0	0.15	0.15	0	0.15
		Digging & Ducting	*K Eur/year*												
		Other	*K Eur/year*												
		Building Rental	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Offices	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square meters*												
		Rent	*K Eur /K Square meter/year*												
		Warehouses	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square meters*												
		Rent	*K Eur /K Square meter/year*												
		Other	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square meters*												
		Rent	*K Eur /K Square meter/year*												
		ICT costs	*K Eur/year*	0	0	0	0	0	0	1	0	5	5	0	5
		SW licenses	*K Eur/year*							0					
		Data Services	*K Eur/year*									5	5		5
		Calling Services	*K Eur/year*							0					

		Data Analytics	*K Eur/year*								1					
		Other	*K Eur/year*													
		Marketing	*K Eur/year*	0	0	0	0	0	0	0	0	1	1	0	1
		Advertisements	*K Eur/year*							0		1	1		1
		Incentives	*K Eur/year*							0					
		Other	*K Eur/year*												
		Consulting	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Financial	*K Eur/year*												
		Legal	*K Eur/year*												
		Technical	*K Eur/year*												
		Other	*K Eur/year*												
		Logistics	*K Eur/year*	0	0	0	-20	-20	-20	-20	0	-18.5	-18.5	-18.5	-18.5
		Fuel	*K Eur/year*				-2.5	-2.5	-2.5	-2.5		-2	-2	-2	-2
		Other	*K Eur/year*				-17.5	-17.5	-17.5	-17.5		-16.5	-16.5	-16.5	-16.5
		General Administration Costs	*K Eur/year*	0	0	0	0	0	0	0	0	2	2	0	2
		Billing	*K Eur/year*												
		Office supplies	*K Eur/year*												
		Other	*K Eur/year*									2	2		2
		Penalties	*K Eur/year*	0	-5	-5	-1	-1	-1	-1	0	-1	-5	0	-1
		to Market Facilitators	*K Eur/year*				-1	-1	-1	-1		-1	-5		-1
		Other	*K Eur/year*		-5	-5									
		Membership Fees	*K Eur/year*	0	20	20	0	0	0	0	20	10	6.9	0	0
		to Market Facilitators	*K Eur/year*												
		Other	*K Eur/year*		20	20					20	10	6.9		
% on Revenues	2%	**Bad debt**	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
Revenue Driver	**Revenue Driver Input**	**REVENUES**	Unit	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Product1	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Market Size	*K subscribers*							1	50	50	50		50
		Market Share of Actor	*% of Market Size*							100%	100%	100%	100%		20%
		Average Revenue Per User (ARPU)	*Eur/year*							0	0	0	0		0
		Product2	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Market Size	*K subscribers*												
		Market Share of Actor	*% of Market Size*												
		Average Revenue Per User (ARPU)	*Eur/year*												
		Product3	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Market Size	*K subscribers*	1	1	1	1	1	1	1	1	1	1	1	1

		Market Share of Actor	*% of Market Size*	100 %	100 %	100 %	100 %	100 %	100 %	100%	100 %	100 %	100%	100 %	100 %
		Average Revenue Per User (ARPU)	*Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
Parameter	Parameter Input	**FINANCIAL RESULTS**															
		EBITDA	*K Eur/year*	€0	€4	€9	€20	€20	€20	€20	€28	€20	€12	€17	€15
Amortization Years	5	**D&A**	*K Eur/year*	0	3	3	5	5	5	3	5	5.4	5.4	3.2	5.4
		EBIT	*K Eur/year*	€0	€1	€6	€15	€15	€15	€17	€23	€14	€6	€14	€9
Tax	20%	**Income Tax**	*K Eur/year*	0	0.11	1.21	3.3088	3.3088	3.3088	3.63	4.95	3.135	1.397	3.014	2.035
		Free Cash Flows	*K Eur/year*	€0	€3	€7	€17	€17	€17	€16	€23	€17	€10	€14	€13
		Internal Rate on Investment (IRR)	%	N/A	4%	39%	61%	61%	61%	103%	86%	54%	27%	83%	37%

12.2.2 Aggregator

				Extra Costs/Revenues per year when HLUC# is adopted (in addition to costs of actor's Baseline business model)											
				HLUC											
				1	2	3	4	5	6	7	8	9	10	11	12
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit	**€2**	**€2**	**€2**	**0**	**0**	**0**	**2**	**5**	**2**	**2**	**2**	**2**
		License Fees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		to Regulator	*K Eur/year*												
		Other	*K Eur/year*												
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*	€0	€0	€0	0	0	0	0	0	0	0	0	0
		DRFM	*K Eur/year*	€0	€0	€0					0				
		Other	*K Eur/year*												
		Buildings owned	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Buildings	*K Eur/year*												
		Other	*K Eur/year*												
		Operations Equipment	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Transformers	*K Eur/year*												
		Poles	*K Eur/year*												
		Lines	*K Eur/year*												
		Vehicles	*K Eur/year*												
		Smart meters	*K Eur/year*												
		Solar panels	*K Eur/year*												
		Inverters	*K Eur/year*												
		Wind Turbines	*K Eur/year*												
		Other	*K Eur/year*												
		Information &	*K Eur/year*	2	2	2	0	0	0	2	2	2	2	2	2

		Communications Technology													
		Servers	*K Eur/year*	1	1	1				1	1	1	1	1	1
		Workstations	*K Eur/year*	1	1	1				1	1	1	1	1	1
		Other	*K Eur/year*	0	0	0				0	0	0	0	0	0
		Services	*K Eur/year*	0	0	0	0	0	0	0	3	0	0	0	0
		Installation	*K Eur/year*								3				
		Digging & Ducting	*K Eur/year*												
		Other	*K Eur/year*												
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit	**€20**	**€32**	**€65**	**€0**	**€0**	**€0**	**65.8**	**€262**	**€60**	**€44**	**€2**	**€8**
		Wholesale Power	*K Eur/year*	0	0	0	0	0	0	0	125	0	0	0	0
		from TSOs	*K Eur/year*												
		from producers	*K Eur/year*								125				
		Other	*K Eur/year*												
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*	€3	€3	€5	€0	€0	€0	8.5	€29	€0	€0	€0	€0
		Managers	*K Eur/year*	€0	€0	€0	€0	€0	€0	3.5	€4	€0	€0	€0	€0
		FTEs	*FTE/month*							0.1	0.1				
		FTE cost	*K Eur/year*	€35	€35	€35	€35	€35	€35	€35	€35	€35	€35	€35	€35
		Senior Employees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		FTEs	*FTE/month*												
		FTE cost	*K Eur/year*												
		Junior Employees	*K Eur/year*	€3	€3	€5	€0	€0	€0	5	€25	0	0	0	0
		FTEs	*FTE/month*	0.1	0.1	0.2				0.2	1				
		FTE cost	*K Eur/year*	€25	€25	€25	€25	€25	€25	€25	€25	€25	€25	€25	€25
		Maintenance	*K Eur/year*	0.2	0.2	0.2	0	0	0	0.2	0.2	0.2	0.2	0.2	0.2
		SW support and central system operations	*K Eur/year*												
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*	0.2	0.2	0.2	0	0	0	0.2	0.2	0.2	0.2	0.2	0.2
% on SW CAPEX	10%	SW maintenance	*K Eur/year*	€0	€0	€0	0	0	0	0	0	0	0	0	0
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Digging & Ducting	*K Eur/year*												
		Other	*K Eur/year*												
		Building Rental	*K Eur/year*	2.1	2.1	2.1	0	0	0	2.1	2.1	2.1	2.1	2.1	2.1
		Offices	*K Eur/year*	2.1	2.1	2.1	0	0	0	2.1	2.1	2.1	2.1	2.1	2.1
		Size	*K Square meters*	0.015	0.015	0.015				0.015	0.015	0.015	0.015	0.015	0.015
		Rent	*K Eur /K Square meter/year*	140	140	140				140	140	140	140	140	140
		Warehouses	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0

		Size	*K Square meters*													
		Rent	*K Eur /K Square meter/year*													
		Other	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Size	*K Square meters*													
		Rent	*K Eur /K Square meter/year*													
		ICT costs	*K Eur/year*	0	6	6	0	0	0	3	0.2	6	6	0	6	
		SW licenses	*K Eur/year*								0.1					
		Data Services	*K Eur/year*		2	2				1		2	2		2	
		Calling Services	*K Eur/year*		2	2				1	0.1	2	2		2	
		Data Analytics	*K Eur/year*		2	2				1		2	2		2	
		Other	*K Eur/year*													
		Marketing	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Advertisements	*K Eur/year*							0	0					
		Incentives	*K Eur/year*							0						
		Other	*K Eur/year*													
		Consulting	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Financial	*K Eur/year*													
		Legal	*K Eur/year*													
		Technical	*K Eur/year*													
		Other	*K Eur/year*													
		Logistics	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Fuel	*K Eur/year*													
		Other	*K Eur/year*													
		General Administration Costs	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Billing	*K Eur/year*													
		Office supplies	*K Eur/year*													
		Other	*K Eur/year*													
		Penalties	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		to Market Facilitators	*K Eur/year*													
		Other	*K Eur/year*													
		Membership Fees	*K Eur/year*	15	20	50	0	0	0	50	100	50	34.5	0	0	
		to Market Facilitators	*K Eur/year*													
		Other	*K Eur/year*	€15	€20	€50				50	100	50	34.5			
% on Revenues	2%	**Bad debt**	*K Eur/year*	€1	€1	€2	0	0	0	2	6.05875	2	1.38	0	0	
Revenue Driver	Revenue Driver Input	**REVENUES**	Unit	**€30**	**€40**	**€100**	**0**	**0**	**0**	**100**	**302.9375**	**100**	**69**	**0**	**0**	
		Product1	*K Eur/year*	€30	€40	€100	0	0	0	100	200	100	69	0	0	
		Market Size	*K subscribers*	1	0.8	1				1	10	10	10			
		Market Share of Actor	*% of Market Size*	100%	100%	100%				100%	100%	100%	100%			
		Average Revenue Per User (ARPU)	*Eur/year*	€30	€50	€100				100	20	10	6.9			
		Product2	*K Eur/year*	0	0	0	0	0	0	0	90	0	0	0	0	

		Market Size	*K subscribers*								10					
		Market Share of Actor	*% of Market Size*								100 %					
		Average Revenue Per User (ARPU)	*Eur/year*								9					
		Product3	*K Eur/year*	0	0	0	0	0	0	0	12.9375	0	0	0	0
		Market Size	*K subscribers*								1					
		Market Share of Actor	*% of Market Size*								100 %					
		Average Revenue Per User (ARPU)	*Eur/year*								12.9375					
Parameter	Parameter Input	**FINANCIAL RESULTS**														
		EBITDA	*K Eur/year*	€10	€8	€35	€0	€0	€0	€34	€41	€40	€25	-€2	-€8
Amortization Years	5	**D&A**	*K Eur/year*	€0	€0	€0	0	0	0	0.4	1	0.4	0.4	0.4	0.4
		EBIT	*K Eur/year*	€9	€8	€34	€0	€0	€0	€34	€40	€39	€24	-€3	-€9
Tax	20%	**Income Tax**	*K Eur/year*	1.84	1.6	6.86	0	0	0	6.76	7.97575	7.864	4.884	0	0
		Free Cash Flows	*K Eur/year*	€8	€7	€28	€0	€0	€0	€27	€33	€32	€20	-€2	-€8
		Internal Rate on Investment (IRR)	%	388 %	340 %	1392 %	N/A	N/A	N/A	1372 %	658 %	1592 %	997 %	NA	NA

12.2.3 Retailer

				Extra Costs/Revenues per year when HLUC# is adopted (in addition to costs of actor's Baseline business model)											
				HLUC											
				1	2	3	4	5	6	7	8	9	10	11	12
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**0**	**0**	**0**
		License Fees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		to Regulator	*K Eur/year*												
		Other	*K Eur/year*												
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		DRFM	*K Eur/year*												
		Other	*K Eur/year*												
		Buildings owned	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Buildings	*K Eur/year*												
		Other	*K Eur/year*												
		Operations Equipment	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Transformers	*K Eur/year*												
		Poles	*K Eur/year*												
		Lines	*K Eur/year*												
		Vehicles	*K Eur/year*												
		Smart meters	*K Eur/year*												

		Solar panels	*K Eur/year*												
		Inverters	*K Eur/year*												
		Wind Turbines	*K Eur/year*												
		Other	*K Eur/year*												
		Information & Communications Technology	*K Eur/year*	2	0	0	0	0	0	0	2	2	0	0	0
		Servers	*K Eur/year*	1							1	1			
		Workstations	*K Eur/year*	1							1	1			
		Other	*K Eur/year*	0							0	0			
		Services	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Installation	*K Eur/year*												
		Digging & Ducting	*K Eur/year*												
		Other	*K Eur/year*												
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit	**2.2**	**0**	**0**	**0**	**0**	**0**	**0**	**-1.8**	**0.2**	**0**	**0**	**0**
		Wholesale Power	*K Eur/year*	0	0	0	0	0	0	0	-2	0	0	0	0
		from TSOs	*K Eur/year*												
		from producers	*K Eur/year*								-20				
		Other	*K Eur/year*								18				
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Managers	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		FTEs	*FTE/month*												
		FTE cost	*K Eur/year*	36	36	36	36	36	36	36	36	36	36	36	36
		Senior Employees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		FTEs	*FTE/month*												
		FTE cost	*K Eur/year*	30	30	30	30	30	30	30	30	30	30	30	30
		Junior Employees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		FTEs	*FTE/month*												
		FTE cost	*K Eur/year*	25	25	25	25	25	25	25	25	25	25	25	25
		Maintenance	*K Eur/year*	0.2	0	0	0	0	0	0	0.2	0.2	0	0	0
		SW support and central system operations	*K Eur/year*												
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*	0.2	0	0	0	0	0	0	0.2	0.2	0	0	0
% on SW CAPEX	10%	SW maintenance	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Digging & Ducting	*K Eur/year*												
		Other	*K Eur/year*												
		Building Rental	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Offices	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square*												

			meters												
		Rent	*K Eur /K Square meter/year*												
		Warehouses	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square meters*												
		Rent	*K Eur /K Square meter/year*												
		Other	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square meters*												
		Rent	*K Eur /K Square meter/year*												
		ICT costs	*K Eur/year*	2	0	0	0	0	0	0	0	0	0	0	0
		SW licenses	*K Eur/year*												
		Data Services	*K Eur/year*	1											
		Calling Services	*K Eur/year*												
		Data Analytics	*K Eur/year*	1											
		Other	*K Eur/year*												
		Marketing	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Advertisements	*K Eur/year*												
		Incentives	*K Eur/year*												
		Other	*K Eur/year*												
		Consulting	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Financial	*K Eur/year*												
		Legal	*K Eur/year*												
		Technical	*K Eur/year*												
		Other	*K Eur/year*												
		Logistics	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Fuel	*K Eur/year*												
		Other	*K Eur/year*												
		General Administration Costs	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Billing	*K Eur/year*												
		Office supplies	*K Eur/year*												
		Other	*K Eur/year*												
		Penalties	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		to Market Facilitators	*K Eur/year*												
		Other	*K Eur/year*												
		Membership Fees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		to Market Facilitators	*K Eur/year*												
		Other	*K Eur/year*												
% on Revenues	2%	**Bad debt**	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
Revenue Driver	Revenue Driver Input	**REVENUES**	Unit	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		Product1	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Market Size	*K subscribers*	10	10	10	10	10		10	10	10	10	10	

		Market Share of Actor	*% of Market Size*	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
		Average Revenue Per User (ARPU)	*Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Product2	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Market Size	*K subscribers*												
		Market Share of Actor	*% of Market Size*												
		Average Revenue Per User (ARPU)	*Eur/year*												
		Product3	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Market Size	*K subscribers*												
		Market Share of Actor	*% of Market Size*												
		Average Revenue Per User (ARPU)	*Eur/year*												
Parameter	Parameter Input	**FINANCIAL RESULTS**													
		EBITDA	*K Eur/year*	-2.2	0	0	0	0	0	0	1.8	-0.2	0	0	0
Amortization Years	5	**D&A**	*K Eur/year*	0.4	0	0	0	0	0	0	0.4	0.4	0	0	0
		EBIT	*K Eur/year*	-2.6	0	0	0	0	0	0	1.4	-0.6	0	0	0
Tax	20%	**Income Tax**	*K Eur/year*	0	0	0	0	0	0	0	0.28	0	0	0	0
		Free Cash Flows	*K Eur/year*	-2.2	0	0	0	0	0	0	1.52	-0.2	0	0	0
		Internal Rate on Investment (IRR)	%	NA	N/A	N/A	N/A	N/A	N/A	N/A	71%	NA	N/A	N/A	N/A

12.2.4 Prosumer

				Extra Costs/Revenues per year when HLUC# is adopted (in addition to costs of actor's Baseline business model)											
				HLUC											
				1	2	3	4	5	6	7	8	9	10	11	12
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**
		License Fees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		to Regulator	*K Eur/year*												
		Other	*K Eur/year*							0					
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*	0	0	0	0	0	0	0.1	0	0	0	0	0
		DRFM	*K Eur/year*												
		Other	*K Eur/year*							0.1					
		Buildings owned	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Buildings	*K Eur/year*												
		Other	*K Eur/year*												
		Operations Equipment	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Transformers	*K Eur/year*												
		Poles	*K Eur/year*												

		Lines	*K Eur/year*													
		Vehicles	*K Eur/year*													
		Smart meters	*K Eur/year*													
		Solar panels	*K Eur/year*													
		Inverters	*K Eur/year*													
		Wind Turbines	*K Eur/year*													
		Other	*K Eur/year*													
		Information & Communications Technology	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Servers	*K Eur/year*													
		Workstations	*K Eur/year*							0						
		Other	*K Eur/year*													
		Services	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Installation	*K Eur/year*							0						
		Digging & Ducting	*K Eur/year*													
		Other	*K Eur/year*													
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit	€0	€0	€0	0	0	0	-0.39	0	0	0	0	-0.01	
		Wholesale Power	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		from TSOs	*K Eur/year*													
		from producers	*K Eur/year*													
		Other	*K Eur/year*													
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Managers	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		FTEs	*FTE/month*													
		FTE cost	*K Eur/year*													
		Senior Employees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		FTEs	*FTE/month*													
		FTE cost	*K Eur/year*													
		Junior Employees	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		FTEs	*FTE/month*													
		FTE cost	*K Eur/year*													
		Maintenance	*K Eur/year*	0	0	0	0	0	0	0.01	0	0	0	0	0	
		SW support and central system operations	*K Eur/year*													
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
% on SW CAPEX	10%	SW maintenance	*K Eur/year*	0	0	0	0	0	0	0.01	0	0	0	0	0	
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0	
		Digging & Ducting	*K Eur/year*													

		Other	*K Eur/year*												
		Building Rental	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Offices	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square meters*												
		Rent	*K Eur /K Square meter/year*												
		Warehouses	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square meters*												
		Rent	*K Eur /K Square meter/year*												
		Other	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Size	*K Square meters*												
		Rent	*K Eur /K Square meter/year*												
		ICT costs	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	-0.01
		SW licenses	*K Eur/year*												
		Data Services	*K Eur/year*												
		Calling Services	*K Eur/year*												
		Data Analytics	*K Eur/year*												
		Other	*K Eur/year*												-0.01
		Marketing	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Advertisements	*K Eur/year*												
		Incentives	*K Eur/year*												
		Other	*K Eur/year*												
		Consulting	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Financial	*K Eur/year*												
		Legal	*K Eur/year*												
		Technical	*K Eur/year*												
		Other	*K Eur/year*												
		Logistics	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Fuel	*K Eur/year*												
		Other	*K Eur/year*												
		General Administration Costs	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Billing	*K Eur/year*												
		Office supplies	*K Eur/year*												
		Other	*K Eur/year*												
		Penalties	*K Eur/year*	0	0	0	0	0	0	-0.5	0	0	0	0	0
		to Market Facilitators	*K Eur/year*							-0.5					
		Other	*K Eur/year*												
		Membership Fees	*K Eur/year*	0	0	0	0	0	0	0.1	0	0	0	0	0
		to Market Facilitators	*K Eur/year*												
		Other	*K Eur/year*							0.1					
% on Revenues	2%	**Bad debt**	*K Eur/year*	€0	€0	€0	0	0	0	0	0	0	0	0	0
Revenue Driver	**Revenue Driv**	**REVENUES**	**Unit**	**€23**	**€40**	**€80**	**0**	**0**	**0**	**0**	**41.275**	**0**	**0**	**0**	**0**

	er Input														
		Product1	*K Eur/year*	€23	€40	€80	0	0	0	0	0.025	0	0	0	0
		Market Size	*K subscribers*							0	0.001				
		Market Share of Actor	*% of Market Size*							100%	100%	100%	100 %		100%
		Average Revenue Per User (ARPU)	*Eur/year*							0	25				
		Product2	*K Eur/year*	0	0	0	0	0	0	0	0	0	0	0	0
		Market Size	*K subscribers*												
		Market Share of Actor	*% of Market Size*												
		Average Revenue Per User (ARPU)	*Eur/year*												
		Power generation	*K Eur/year*	0	0	0	0	0	0	0	41.25	0	0	0	0
		Power generated	*KW/year*								250				
		Wholesale Price	*Eur/KWh*								0.165				
		Reduced Costs	Eur/year	0	0	0	0	0	0	0	0	0	0	0	0
		Reduced Consumption (due to own production)	*KWh/year*												
		Retail Price	*Eur/KWh*												
Parameter	Parameter Input	**FINANCIAL RESULTS**													
		EBITDA	*K Eur/year*	€23	€40	€80	0	0	0	0.39	41.275	0	0	0	0.01
Amortization Years	5	**D&A**	*K Eur/year*	0	0	0	0	0	0	0.02	0	0	0	0	0
		EBIT	*K Eur/year*	€23	€40	€80	0	0	0	0.37	41.275	0	0	0	0.01
Tax	20%	**Income Tax**	*K Eur/year*	€0	€0	€0	0	0	0	0	0	0	0	0	0
		Free Cash Flows	*K Eur/year*	€23	€40	€80	0	0	0	0.39	41.275	0	0	0	0.01
		Internal Rate on Investment (IRR)	%	NA	NA	NA	N/A	N/A	N/A	390%	NA	N/A	N/A	N/A	NA

12.3 THE SCALING FACTORS TABLES PER PILOT SITE AND ROLE

The table of scaling factors used for replicating a business plan across pilot sites is presented below. As described in section 3, scaling factors were used in order to keep the input values to manageable level. More specifically, one actor would provide detailed cost and revenue information for a single pilot site and the rest would be computed by multiplying that value with the scaling facto of the destination pilot site. For example, by multiplying the cost item for DSO licences in Italy with the scaling factor for DSO licenses between Italy and Greece we could calculate the cost of DSO licenses in Greece. The benefit of this approach is in aggregating cost (or revenue) items into categories and using a single scaling factor for this category in a certain location. Furthermore, most cost and revenue items are proportional to the market size and thus can be easily estimated.

In case a certain ad-hoc cost applied to a certain pilot site but not to the reference pilot site we used as a reference value the one that came from the former pilot site.

The Scaling Factors tables per pilot site and role that were used appear in the following subsections.

12.3.1 The Scaling Factors table for DSO

				Scaling factors amongst pilot sites (%)				
				PILOT SITES				
				Valencia	Flanders	Manchester	Terni	Meltemi
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit					
		License Fees	*K Eur/year*					
		to Regulator	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*					
		DRFM	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Buildings owned	*K Eur/year*					
		Buildings	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Operations Equipment	*K Eur/year*					
		Transformers	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Poles	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Lines	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Vehicles	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Smart meters	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Solar panels	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Inverters	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Wind Turbines	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Information & Communications Technology	*K Eur/year*					
		Servers	*K Eur/year*	12%	83%	2400%	100%	0.30%
		Workstations	*K Eur/year*	12%	83%	2400%	100%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	100%	0.30%
		Services	*K Eur/year*					
		Installation	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Digging & Ducting	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit					
		Wholesale Power	*K Eur/year*					
		from TSOs	*K Eur/year*	12%	83%	2400%	130%	0.30%
		from producers	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*					
		Managers	*K Eur/year*					
		FTEs	*FTE/month*	12%	83%	2400%	130%	0.30%

		FTE cost	*K Eur/year*					
		Senior Employees	*K Eur/year*					
		FTEs	*FTE/month*	12%	83%	2400%	130%	0.30%
		FTE cost	*K Eur/year*					
		Junior Employees	*K Eur/year*					
		FTEs	*FTE/month*	12%	83%	2400%	130%	0.30%
		FTE cost	*K Eur/year*					
		Maintenance	*K Eur/year*					
		SW support and central system operations	*K Eur/year*	12%	83%	2400%	130%	0.30%
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*					
% on SW CAPEX	10%	SW maintenance	*K Eur/year*					
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*					
		Digging & Ducting	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Building Rental	*K Eur/year*					
		Offices	*K Eur/year*					
		Size	*K Square meters*	12%	83%	2400%	130%	0.30%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		Warehouses	*K Eur/year*					
		Size	*K Square meters*	12%	83%	2400%	130%	0.30%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*					
		Size	*K Square meters*	12%	83%	2400%	130%	0.30%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		ICT costs	*K Eur/year*					
		SW licenses	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Data Services	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Calling Services	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Data Analytics	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Marketing	*K Eur/year*					
		Advertisements	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Incentives	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Consulting	*K Eur/year*					

		Financial	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Legal	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Technical	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Logistics	*K Eur/year*					
		Fuel	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		General Administration Costs	*K Eur/year*					
		Billing	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Office supplies	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Penalties	*K Eur/year*					
		to Market Facilitators	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Membership Fees	*K Eur/year*					
		to Market Facilitators	*K Eur/year*	12%	83%	2400%	130%	0.30%
		Other	*K Eur/year*	12%	83%	2400%	130%	0.30%
% on Revenues	2%	**Bad debt**	*K Eur/year*					
Revenue Driver	Revenue Driver Input	**REVENUES**	Unit					
		Product1	*K Eur/year*					
		Market Size	*K subscribers*	12%	83%	2400%	130%	0.30%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	120%	100%	100%	100%	100%
		Product2	*K Eur/year*					
		Market Size	*K subscribers*	12%	83%	2400%	130%	0.30%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
		Product3	*K Eur/year*					
		Market Size	*K subscribers*	12%	83%	2400%	130%	0.30%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
Parameter	Parameter Input	**FINANCIAL RESULTS**						
		EBITDA	*K Eur/year*					

Amortization Years	5	**D&A**	*K Eur/year*					
		EBIT	*K Eur/year*					
Tax	20%	**Income Tax**	*K Eur/year*	114%	150%	91%	100%	132%
		Free Cash Flows	*K Eur/year*					
		Internal Rate on Investment (IRR)	%					

12.3.2 The Scaling Factors table for Aggregator

				Scaling factors amongst pilot sites (%)				
				PILOT SITES				
				Valencia	Flanders	Manchester	Terni	Meltemi
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit					
		License Fees	*K Eur/year*					
		to Regulator	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*					
		DRFM	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Buildings owned	*K Eur/year*					
		Buildings	*K Eur/year*	10%	28.25%	99.99%	40.55%	10%
		Other	*K Eur/year*	10%	28.25%	99.99%	40.55%	10%
		Operations Equipment	*K Eur/year*					
		Transformers	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Poles	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Lines	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Vehicles	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Smart meters	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Solar panels	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Inverters	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Wind Turbines	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Information & Communications Technology	*K Eur/year*					
		Servers	*K Eur/year*	10%	28.25%	99.99%	40.55%	10%
		Workstations	*K Eur/year*	10%	28.25%	99.99%	40.55%	10%
		Other	*K Eur/year*	10%	28.25%	99.99%	40.55%	10%
		Services	*K Eur/year*					
		Installation	*K Eur/year*	10%	28.25%	99.99%	40.55%	10%
		Digging & Ducting	*K Eur/year*	10%	28.25%	99.99%	40.55%	10%

		Other	*K Eur/year*	10%	28.25%	99.99%	40.55%	10%
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit				0.429	
		Wholesale Power	*K Eur/year*	0	0	0	3.3	3.98464
		from TSOs	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		from producers	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*					
		Managers	*K Eur/year*					
		FTEs	*FTE/month*	1.20%	8.30%	240%	13%	0.03%
		FTE cost	*K Eur/year*					
		Senior Employees	*K Eur/year*					
		FTEs	*FTE/month*	1.20%	8.30%	240%	13%	0.03%
		FTE cost	*K Eur/year*					
		Junior Employees	*K Eur/year*					
		FTEs	*FTE/month*	1.20%	8.30%	240%	13%	0.03%
		FTE cost	*K Eur/year*					
		Maintenance	*K Eur/year*					
		SW support and central system operations	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*					
% on SW CAPEX	10%	SW maintenance	*K Eur/year*					
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*					
		Digging & Ducting	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Building Rental	*K Eur/year*					
		Offices	*K Eur/year*					
		Size	*K Square meters*	10%	28.25%	99.99%	40.55%	10%
		Rent	*K Eur /K Square meter/year*	10%	28.25%	99.99%	40.55%	10%
		Warehouses	*K Eur/year*					
		Size	*K Square meters*	10%	28.25%	99.99%	40.55%	10%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%

		Other	*K Eur/year*					
		Size	*K Square meters*	10%	28.25%	99.99%	40.55%	10%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		ICT costs	*K Eur/year*					
		SW licenses	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Data Services	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Calling Services	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Data Analytics	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Marketing	*K Eur/year*					
		Advertisements	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Incentives	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Consulting	*K Eur/year*					
		Financial	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Legal	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Technical	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Logistics	*K Eur/year*					
		Fuel	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		General Administration Costs	*K Eur/year*					
		Billing	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Office supplies	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Penalties	*K Eur/year*					
		to Market Facilitators	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Membership Fees	*K Eur/year*					
		to Market Facilitators	*K Eur/year*	1.20%	8.30%	240%	13%	0.03%
		Other	*K Eur/year*	100%	95%	85%	90%	100%
% on Revenues	2%	**Bad debt**	*K Eur/year*					
Revenue Driver	Revenue Driver Input	**REVENUES**	Unit					
		Product1	*K Eur/year*					
		Market Size	*K subscribers*	1.20%	8.30%	240%	13%	0.03%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
		Product2	*K Eur/year*					
		Market Size	*K subscriber*	1.20%	8.30%	240%	13%	0.03%

			s					
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
		Product3	*K Eur/year*					
		Market Size	*K subscribers*	1.20%	8.30%	240%	13%	0.03%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
Parameter	Parameter Input	**FINANCIAL RESULTS**						
		EBITDA	*K Eur/year*					
Amortization Years	5	**D&A**	*K Eur/year*					
		EBIT	*K Eur/year*					
Tax	20%	**Income Tax**	*K Eur/year*	113.64%	150%	90.91%	100%	131.82%
		Free Cash Flows	*K Eur/year*					
		Internal Rate on Investment (IRR)	%					

12.3.3 The Scaling Factors table for Retailer

				Scaling factors amongst pilot sites (%)				
				PILOT SITES				
				Valencia	Flanders	Manchester	Terni	Meltemi
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit					
		License Fees	*K Eur/year*					
		to Regulator	*K Eur/year*	60%	0%	0%	0%	0%
		Other	*K Eur/year*	60%	0%	0%	0%	0%
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*					
		DRFM	*K Eur/year*	100%	0%	0%	0%	0%
		Other	*K Eur/year*	100%	0%	0%	0%	0%
		Buildings owned	*K Eur/year*					
		Buildings	*K Eur/year*	60%	0%	0%	0%	0%
		Other	*K Eur/year*	60%	0%	0%	0%	0%
		Operations Equipment	*K Eur/year*					

		Transformers	*K Eur/year*	60%	0%	0%	0%	0%
		Poles	*K Eur/year*	60%	0%	0%	0%	0%
		Lines	*K Eur/year*	60%	0%	0%	0%	0%
		Vehicles	*K Eur/year*	60%	0%	0%	0%	0%
		Smart meters	*K Eur/year*	60%	0%	0%	0%	0%
		Solar panels	*K Eur/year*	60%	0%	0%	0%	0%
		Inverters	*K Eur/year*	60%	0%	0%	0%	0%
		Wind Turbines	*K Eur/year*	60%	0%	0%	0%	0%
		Other	*K Eur/year*	60%	0%	0%	0%	0%
		Information & Communications Technology	*K Eur/year*					
		Servers	*K Eur/year*	60%	311%	7650%	488%	30%
		Workstations	*K Eur/year*	60%	311%	7650%	488%	30%
		Other	*K Eur/year*	60%	311%	7650%	488%	30%
		Services	*K Eur/year*					
		Installation	*K Eur/year*	60%	0%	0%	0%	0%
		Digging & Ducting	*K Eur/year*	60%	0%	0%	0%	0%
		Other	*K Eur/year*	60%	0%	0%	0%	0%
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit					
		Wholesale Power	*K Eur/year*					
		from TSOs	*K Eur/year*	60%	0%	0%	0%	0%
		from producers	*K Eur/year*	60%	0%	0%	0%	0%
		Other	*K Eur/year*	60%	562%	562%	562%	30%
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*					
		Managers	*K Eur/year*					
		FTEs	*FTE/month*	80%	311%	9000%	171%	10%
		FTE cost	*K Eur/year*					
		Senior Employees	*K Eur/year*					
		FTEs	*FTE/month*	0%	311%	9000%	488%	10%
		FTE cost	*K Eur/year*					
		Junior Employees	*K Eur/year*					
		FTEs	*FTE/month*	80%	311%	9000%	2067%	10%
		FTE cost	*K Eur/year*					
		Maintenance	*K Eur/year*					
		SW support and central system operations	*K Eur/year*	80%	0%	0%	0%	10%
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*					
% on SW CAPEX	10%	SW maintenance	*K Eur/year*					

% on equipment CAPEX	3%	Spare part costs	*K Eur/year*					
		Digging & Ducting	*K Eur/year*	60%	0%	0%	0%	2%
		Other	*K Eur/year*	60%	0%	0%	0%	2%
		Building Rental	*K Eur/year*					
		Offices	*K Eur/year*					
		Size	*K Square meters*	80%	208%	6000%	325%	10%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		Warehouses	*K Eur/year*					
		Size	*K Square meters*	80%	0%	0%	0%	0%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*					
		Size	*K Square meters*	80%	0%	0%	0%	0%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		ICT costs	*K Eur/year*					
		SW licenses	*K Eur/year*	80%	311%	9000%	488%	10%
		Data Services	*K Eur/year*	80%	311%	9000%	366%	10%
		Calling Services	*K Eur/year*	80%	311%	9000%	366%	10%
		Data Analytics	*K Eur/year*	80%	311%	9000%	366%	10%
		Other	*K Eur/year*	80%	311%	9000%	366%	10%
		Marketing	*K Eur/year*					
		Advertisements	*K Eur/year*	60%	311%	9000%	1446%	10%
		Incentives	*K Eur/year*	60%	0%	0%	0%	0%
		Other	*K Eur/year*	60%	0%	0%	0%	0%
		Consulting	*K Eur/year*					
		Financial	*K Eur/year*	80%	0%	0%	0%	0%
		Legal	*K Eur/year*	80%	0%	0%	0%	0%
		Technical	*K Eur/year*	80%	0%	0%	0%	0%
		Other	*K Eur/year*	80%	0%	0%	0%	0%
		Logistics	*K Eur/year*					
		Fuel	*K Eur/year*	0%	311%	9000%	488%	2%
		Other	*K Eur/year*	60%	311%	9000%	0%	2%
		General Administration Costs	*K Eur/year*					
		Billing	*K Eur/year*	60%	0%	0%	0%	0%
		Office supplies	*K Eur/year*	60%	0%	0%	0%	0%
		Other	*K Eur/year*	60%	0%	0%	0%	0%
		Penalties	*K Eur/year*					
		to Market Facilitators	*K Eur/year*	60%	0%	0%	0%	0%
		Other	*K Eur/year*	60%	0%	0%	0%	0%
		Membership Fees	*K Eur/year*					
		to Market Facilitators	*K Eur/year*	60%	0%	0%	0%	0%

		Other	*K Eur/year*	0%	311%	9000%	488%	1%
% on Revenues	2%	**Bad debt**	*K Eur/year*	100%	0%	0%	0%	0%
Revenue Driver	Revenue Driver Input	**REVENUES**	Unit					
		Product1	*K Eur/year*					
		Market Size	*K subscribers*	60%	415%	12000%	650%	2%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	256%	256%	256%	40%
		Product2	*K Eur/year*					
		Market Size	*K subscribers*	60%	415%	12000%	650%	2%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
		Product3	*K Eur/year*					
		Market Size	*K subscribers*	60%	415%	12000%	650%	2%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
Parameter	Parameter Input	**FINANCIAL RESULTS**						
		EBITDA	*K Eur/year*					
Amortization Years	5	**D&A**	*K Eur/year*					
		EBIT	*K Eur/year*					
Tax	20%	**Income Tax**	*K Eur/year*	125%	165%	100%	110%	145%
		Free Cash Flows	*K Eur/year*					
		Internal Rate on Investment (IRR)	%					

12.3.4 The Scaling Factors table for Prosumer

				Scaling factors amongst pilot sites (%)				
				PILOT SITES				
				Valencia	Flanders	Manchester	Terni	Meltemi
Cost Driver	Cost Driver Input	**CAPEX (Capital Expenditures)**	Unit					
		License Fees	*K Eur/year*					
		to Regulator	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		SW (one time licenses, proprietary SW, etc.)	*K Eur/year*					
		DRFM	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Buildings owned	*K Eur/year*					
		Buildings	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Operations Equipment	*K Eur/year*					
		Transformers	*K Eur/year*	100%	100%	100%	100%	100%
		Poles	*K Eur/year*	100%	100%	100%	100%	100%
		Lines	*K Eur/year*	100%	100%	100%	100%	100%
		Vehicles	*K Eur/year*	100%	100%	100%	100%	100%
		Smart meters	*K Eur/year*	100%	100%	100%	100%	100%
		Solar panels	*K Eur/year*	100%	100%	100%	300%	300%
		Inverters	*K Eur/year*	100%	100%	100%	300%	300%
		Wind Turbines	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	300%	300%
		Information & Communications Technology	*K Eur/year*					
		Servers	*K Eur/year*	100%	100%	100%	100%	100%
		Workstations	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Services	*K Eur/year*					
		Installation	*K Eur/year*	100%	100%	100%	100%	100%
		Digging & Ducting	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
Cost Driver	Cost Driver Input	**OPEX (Operational Expenditures)**	Unit					
		Wholesale Power	*K Eur/year*					
		from TSOs	*K Eur/year*	100%	100%	100%	100%	100%
		from producers	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Business Operations, Proj. Mgnt & Administration	*K Eur/year*					
		Managers	*K Eur/year*					
		FTEs	*FTE/month*	100%	100%	100%	100%	100%
		FTE cost	*K Eur/year*					

		Senior Employees	*K Eur/year*					
		FTEs	*FTE/month*	100%	100%	100%	100%	100%
		FTE cost	*K Eur/year*					
		Junior Employees	*K Eur/year*					
		FTEs	*FTE/month*	100%	100%	100%	100%	100%
		FTE cost	*K Eur/year*					
		Maintenance	*K Eur/year*					
		SW support and central system operations	*K Eur/year*	100%	100%	100%	100%	100%
% on ICT Infrastructure CAPEX	10%	ICT infrastructure maintenance	*K Eur/year*					
% on SW CAPEX	10%	SW maintenance	*K Eur/year*					
% on equipment CAPEX	3%	Spare part costs	*K Eur/year*					
		Digging & Ducting	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Building Rental	*K Eur/year*					
		Offices	*K Eur/year*					
		Size	*K Square meters*	100%	100%	100%	100%	100%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		Warehouses	*K Eur/year*					
		Size	*K Square meters*	100%	100%	100%	100%	100%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*					
		Size	*K Square meters*	100%	100%	100%	100%	100%
		Rent	*K Eur /K Square meter/year*	100%	100%	100%	100%	100%
		ICT costs	*K Eur/year*					
		SW licenses	*K Eur/year*	100%	100%	100%	100%	100%
		Data Services	*K Eur/year*	100%	100%	100%	100%	100%
		Calling Services	*K Eur/year*	100%	100%	100%	100%	100%
		Data Analytics	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Marketing	*K Eur/year*					
		Advertisements	*K Eur/year*	100%	100%	100%	100%	100%
		Incentives	*K Eur/year*	100%	100%	100%	100%	100%

		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Consulting	*K Eur/year*					
		Financial	*K Eur/year*	100%	100%	100%	100%	100%
		Legal	*K Eur/year*	100%	100%	100%	100%	100%
		Technical	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Logistics	*K Eur/year*					
		Fuel	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		General Administration Costs	*K Eur/year*					
		Billing	*K Eur/year*	100%	100%	100%	100%	100%
		Office supplies	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
		Penalties	*K Eur/year*					
		to Market Facilitators	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	0%	0%	0%
		Membership Fees	*K Eur/year*					
		to Market Facilitators	*K Eur/year*	100%	100%	100%	100%	100%
		Other	*K Eur/year*	100%	100%	100%	100%	100%
% on Revenues	2%	**Bad debt**	*K Eur/year*					
Revenue Driver	Revenue Driver Input	**REVENUES**	Unit					
		Product1	*K Eur/year*					
		Market Size	*K subscribers*	100%	100%	100%	100%	100%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
		Product2	*K Eur/year*					
		Market Size	*K subscribers*	100%	100%	100%	100%	100%
		Market Share of Actor	*% of Market Size*	100%	100%	100%	100%	100%
		Average Revenue Per User (ARPU)	*Eur/year*	100%	100%	100%	100%	100%
		Power generation	*K Eur/year*					
		Power generated	*KW/year*	100%	100%	100%	100%	100%
		Wholesale Price	*Eur/KWh*	0%	0%	0%	100%	120.75%
		Reduced Costs	Eur/year					
		Reduced Consumption (due to own production)	*KWh/year*	80%	100%	40%	76.24%	76.24%
		Retail Price	*Eur/KWh*	100%	100%	80%	76.24%	92%

Parameter	Parameter Input	**FINANCIAL RESULTS**						
		EBITDA	*K Eur/year*					
Amortization Years	5	**D&A**	*K Eur/year*					
		EBIT	*K Eur/year*					
Tax	20%	**Income Tax**	*K Eur/year*	100%	100%	100%	100%	100%
		Free Cash Flows	*K Eur/year*					
		Internal Rate on Investment (IRR)	%	100%	100%	100%	100%	100%