# SMART MICRO GRIDS AND BUSINESS MODELS

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**FORWORDS**

This report is a result of the SESP (Smart Energy Systems Research Platform) project, funded by Regional council of Ostrobothnia, municipalities, University of Vaasa and HANKEN School of Economics.

The overall aim of the two-year SESP project (2017-2018) is to build up the new energy system research platform. The platform consists of physical laboratory environment for electricity distribution monitoring, protection, control and simulation, a Big Data collection and management system and business concepts that are based on the developed platform.

The SESP project consists of 9 work packages. Work package 8 is about *New Service Concepts and Business Models and* contributes to the smart energy systems research platform, and Vaasa´s Smart Grid solutions by developing a *system* for *new service development and a framework for understanding, analyzing and developing new business models.*

*WP 8 has listed five deliverables of which this report met up to the first two, to present a* description, of business models in use by focal actors in smart-grid energy systems (D8.1), and an up to date theoretical model for how to frame new business thinking (D8.2).

Companies adding to this report are ABB, Danfoss, MAVIKO, Vaasan Sähköverkot, VAMP and VEO. We are very grateful to all those managers, who so kindly allocated some time to our interviews. The same positive notion goes to those households who gave us their thoughts about micro grids. The field study was carried out by research assistants Annika Pollari, Maria Långskog and Cassandra Björk. Good work, thank you.

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Peter Björk
Work package 8 leader

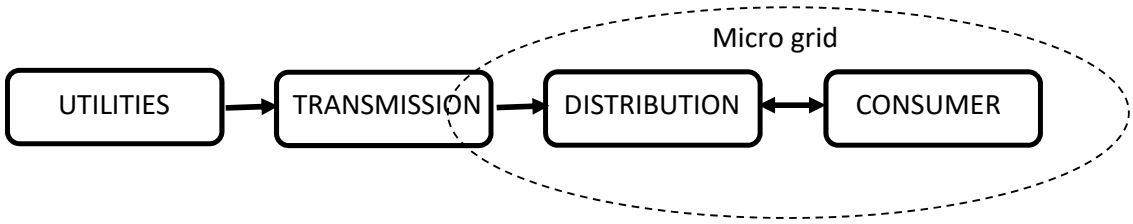
**CONTENTS**

## 1. Introduction

Smart micro grids, power grids or distributed energy networks will come to existence in large scale when the technology is there, the consumers are there, and the business is there, at the same time, and when the regulation, on both international and national level, favours smart electricity systems. On the *demand side*, it can be concluded that there is an increase demand for electricity, end consumers are more environmentally oriented and ask for renewable energy, and solutions that will reduce energy costs. In this, new technology has enabled households to also be energy producer and sell energy, i.e. to become prosumers (producer and consumer). On the *supply side*, new technology has reduced the costs of electric grids, improved their productivity and reliability, and made them wireless (at least to some extent) and more safe and easy to operate. Finally, on the *political* arena, it can be noticed that EU has a strong statement in Energy Efficiency Directive 2012/27/EU Articles 15.4 and 15.8 saying that all types of barriers that might hamper energy efficiency in the member states have to be reduced. This has, for example in Finland, led to intensive discussions about how to structure and operate the current and future national energy system. All this has brought about the option for actors of different types to optimize energy use in micro grids on condition the level of Quality of Service (QoS) is high.

QoS in smart micro grids is dependent on reliable and real time information based on advanced sensing and communication, and safe and secure power distribution networks. Smart micro grids are often presented as networks of interrelated actors, as solutions, at the end of the supply chain of distribution layer energy network, (Figure 1).

Figure 1, Micro grids, layers of actors and activities




Utilities, the first layer, consists of companies producing energy and electricity, most often defined as power plants. These, still today central, energy producers run their production on nuclear power, coal, oil or gas, or a combination of these energy sources. The second layer is the high voltage transmission to be followed by middle and low voltage distribution to, finally, end up in layer number four, the end users, i.e. customers, who by the means of new technology and regulations also may produce energy for immediate use, storage or distribution.

Actors in smart grid networks have to closely monitor how the business landscape is changing, how regulations are updated, and consumer involvement increases. Business models, ideas

for how to do business, have to be updated accordingly. Especially so when the focus is on the emerging micro grids

> *"electrical systems that includes multiple loads and distributed energy resources – both generation and storage – that can be operated in parallel with the broader utility grid or as an electric island"* (ACORE, p. 30)

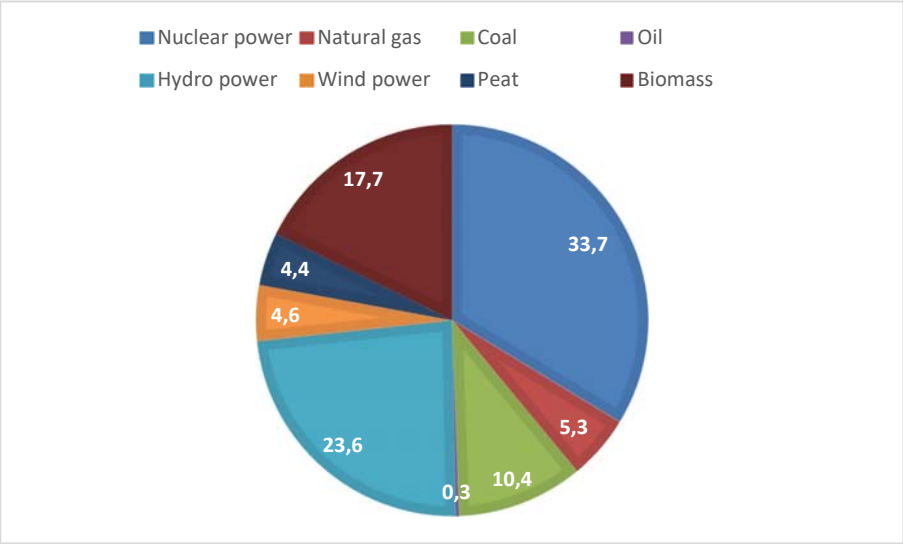
This report presents thoughts and reflections about business models to be used in smart micro grid contexts, in situations where the current power system takes on new features such as being intelligent and adaptive, distributed and consumer oriented. A special focus is on prosumers as actors in smart grids, enabling households to be both a consumer unit and an energy producing micro entity.

Smart micro grid as an emerging concept is presented in the next section, where after the business model concept is defined. This paper does also benefit from reporting empirical data based on personal interviews with a selected number of managers representing central actors within Vaasa Energy Cluster (http://energyvaasa.vaasanseutu.fi/) as well as households. Finally, the emerging landscape for energy business is presented and avenues for future business models are presented.

## 2. Smart micro grids in a context

The energy sector in Finland is in transition. Energy production based on fossil energy sources are to give more place for renewable energy sources and carbon-neutral power systems. However, still today about 55 percent of the electricity production is based on non-renewable resources of which nuclear power plants stands for 33,7 percent (Figure 2).

Figure 2. Electricity production based on energy sources 2016 (%)




Source: Energiateollisuus (modified by the authors)
(https://energia.fi/perustietoa_energia-alasta/energiantuotanto/sahkontuotanto)

In terms of electricity production, Finland is only 50 percent self-sufficient, and therefore part of the European electricity market of which the Nordic electricity market (Noord Pool) has a special role. Reading the report of the Ministry of Economic Affairs and Employment (2016), it becomes very obvious that electricity production in Finland, in the future, will lean on nuclear power and renewable energy sources of which smart micro grids will have their share, but small.

For a sustainable development, Finland (the Finnish Commission on Sustainable Development) has listed eight action areas with objectives. Action area number four (#4) "A carbon-neutral society" is about energy production and consumption:

> *"Our objective is a carbon-neutral society. To achieve this objective, we will follow a national roadmap towards a carbon-neutral society by the year 2050. The central measures to be undertaken for reaching this objective are improved energy-efficiency and more effective utilisation of renewable energy sources.*
>
> *We will develop intelligent and interconnected structures, such as transportation and energy systems, that enable and promote the use of renewable energy sources and energy savings, and we will also encourage households to improve their own energy consumption. We will invest in the development of innovative energy technologies and new businesses".*

Based on energy objectives for 2030 set by EU, Finland aims for decrease in fossil-based energy production by 50 percent, an increase the energy self-sufficiency degree to 55 percent, and secure that more than 50 percent of energy production is based on renewable energy sources.

A smart grid, smart electricity system, is defined by Ministry of Economic Affairs and Employment as:

> *"An extensive functional entity – a service platform – which covers not only the physical transmission and distribution of electricity, but also generation, distributed energy resources, power systems and various smart grid applications. It links the physical transmission of electricity to wholesale and retail markets".*

The vision is that Finland in 2025 will have more distributed and carbon-neutral power systems, which will enable end-users, private households' better possibilities to participate in the electricity market. This vision is shared by our Nordic neighbours:

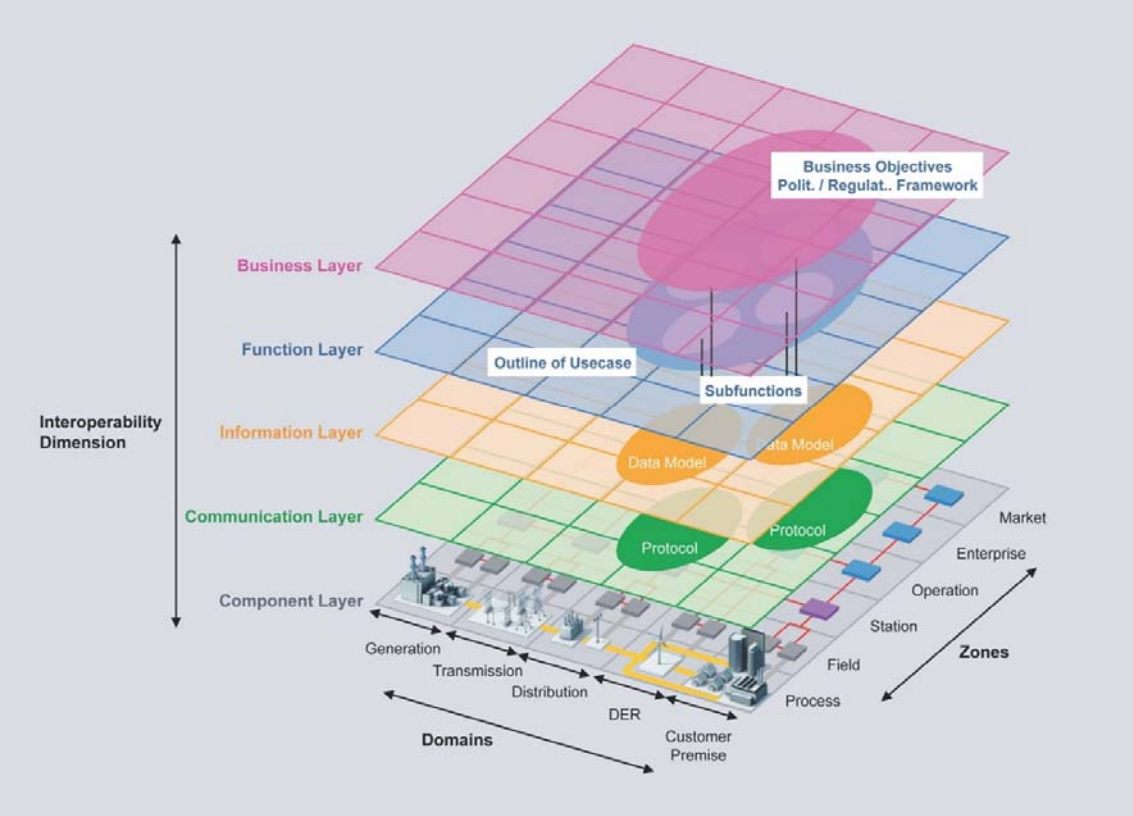
> Sweden: *"The Vision: Sweden is a world leader in the field of smart grids that enable greater customer empowerment, sustainable development, security of supply and growth"*

Norway: *"The vision of the deployment of the smart grid in Norway is to work in a coordinated approach and make the needed development on [several different research topics] to achieve a flexible and reliable future energy supply system"*

Denmark: *"Strategy sets the course for development of a smart grid which can make [ongoing] green transition cheaper, providing savings on electricity bills and help promote new services and products to the benefits of consumers"*

Critical for this path of development is technology, market and customer, simultaneously and integrated, which is illustrated in the Smart grid architecture reference model (Figure 3).

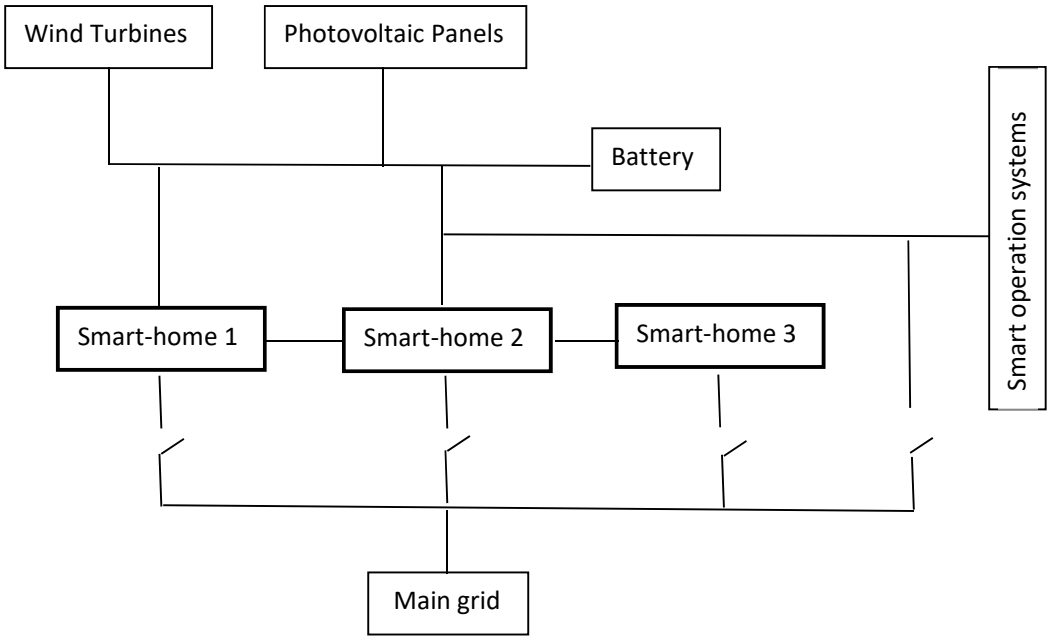
Figure 3. Smart electricity system – reference architecture




Source: CEN-CENELEC-ETSI Smart Grid Architecture Reference Model

The layers, domains and zones presented in Figure 3 illustrate how smart grids are a total solution of which micro grids (including DER, distributed energy resources) only have a small position. In essence a smart micro grid consists of integrated renewable energy resources combined with storage capacity (battery) linked to households as load, which can be islanded from the main grid (Figure 4). For efficiency, reliability and customer convenience, there are smart operation systems, which monitors and control the systems (smart operation systems).

Figure 4. Smart micro grid structure




*Critical voices* on micro grids and reasons for their slow development can be sorted into six different categories, Ignorance about costs, Ignorance about revenue, Disaster preparedness fatigue, Strict regulation, Lack of technology integration, and Household resistance. These voices claim that the cost-benefit/savings relationships have not thoroughly been analysed including a risk analysis. Furthermore, it can be discussed how well different technologies seamlessly communicate with each other as promised, not to forget the end-user's slow adaption process.

**3. Business models**

Business models describes how companies do business, their roles (in networks), their value creating and capturing resources, activities, and flows of knowledge, products, services and information (Timmers, 1998; Kavadias, Ladas & Loch, 2016). Slywotsky (1996) says that a business model describes the entire system for delivering utility to customers and earning a profit from that activity. Business models are stories "that explain how enterprises work" (Margretta, 2002, p. 4). From the very beginning business models were resource and goal oriented, and defined by Chandler (1962, p. 13)

> *"as the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals".*

The advent of electronic commerce and e-business, described by Lee (2001, 349-350) as a "disruption innovation … with disruptive attributes", in the early 1990's challenged companies to rethink their value-chain model (Porter, 1985), and to accept the emergence of a marketspace (in parallel to a marketplace) (Rayport & Sviokla, 1995). Market characteristics, such as, two-way, real time communication, information as a source of revenue, prosumption, and value generation in online communities are to be noticed. Based on these marketspace characteristics, Timmers (1998) identified ten different business models for electronic markets (e-shop, e-procurement, e-auction, e-mall, 3rd party marketplace, virtual communities, value chain service provider, value chain integrator, collaboration platforms, and Information brokers).

Nielsen, Lund and Bukh (2014) present a literature review and categorize business models (and research) into three different categories. The generic models, which describes the company in relation to its external environment, identify the importance of matching company offerings with what is valued by the market (external environment) in an efficient way (optimizing of internal factors) (Normann, 2001). This implies, according to Osterwald and Pigneur (2003), constant product innovation, customer focus, infrastructure and yield management,

> *"Business model is something designed to describe the rationale of how an organization creates, delivers and captures value*" (Osterwalder and Pigneur, 2010, p.14)

General business models describe *"methods for doing business in a sustainable way emphasizing the relationships between firm´s consumers, customers, allies, and suppliers that identifies the major flows of products, information and money, and the major benefits to participants*" (Weill & Vitale, 2001). Specific business model definitions focus on internal aspects and value drivers. Bay (2002, p. 13), for example, defines a business model as

> *"performance drivers, business processes, people and the infrastructure put in place to achieve the company´s business objectives".*

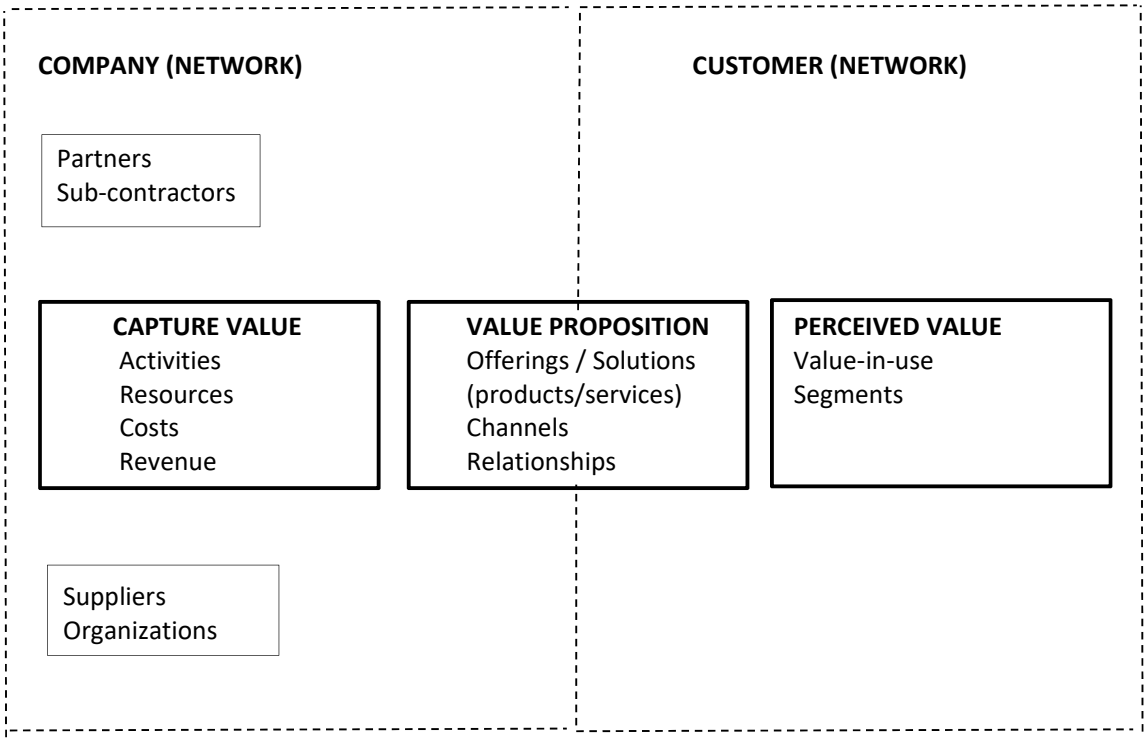
Based on a literature review Nielsen et al., (2014) conclude that companies are value creation systems and that the building blocks of business models include analysis of products, customer interface, infrastructure, and financial and strategy aspects. With a continuance of this, and an emphasis on the value facilitation role of companies identified in service marketing literature the following definition is given.

> *Business models describes how companies make money and create value for its stakeholders by articulating how value is captured and proposed in companies and facilitated as perceived value by customers and others.*

Based on a component analysis of business models including references to Osterwalder and Pigneur (2010), a business model architecture can be presented in nine building blocks, namely: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. Johnson et al. (2008) constructed a business model through four elements: customer value proposition

(CVP), profit formula, key resources, and key processes. Chesbrough (2007) brought forward six parameters required for an innovative business model; value proposition, target market, value chain, revenue mechanism, value network or ecosystem, and competitive strategy. Dubosson-Torbay et al. (2002) argue that a business model is divided into four key constituents, including product innovation, customer relationship, infrastructure management, and financial aspects (costs and revenue). Shafer et al. (2005) grouped the business model elements into four principal categories: strategic choices, value network, value creation, and value capture. Based on these structures, an updated business model can be presented (Figure 5).

Figure 5. A Tripartite business model




The tripartite business model identifies three different value constructs. For analysis companies should analyse how value is captured in activities focusing on resources, costs and revenues. In interactions with customers asked for, appreciated and valuable value propositions are to be offered. On the customer side, companies have to have a thorough understanding of how end-users perceive value-in-use. In a broader context, the whole system of inter-linked actors, partners and suppliers, are to be understood and analysed, taking business cultures, customer uniqueness (in terms of segmentation) and regulations into consideration. The complexity of partners, sub-contractors, suppliers and (other) organizations is to be discerned if we combine Figure 5 with the smart grid architecture presented in Figure 3.

**Business model change**

Business models should be flexible enough to allow for change. Managers may fail to recognize, explore, and exploit new technological and/or market opportunities in time, since

this may require actions that are not consistent with the present business model (Cavalcante, Kesting & Ulhøi, 2011). Factors influencing, and initiating business model change are of many types, such as, previously not identified commercial opportunities within the prevailing business structure, changing consumer preferences, i.e. lagging business models, competitor's actions and new entrants. Table 1 gives an overview of the different types of business model change and key challenges. The table gives a simplified overview of the managerial choices to respond to a change initiative. In practice, different combinations of changes may occur, because a business model consists of many building blocks that will be affected in different ways by a change.

Table 1. Business model change: parameters to consider

| **Type of change** | **Characterization** | **Key challenges** |
|---|---|---|
| Business model creation | Creation of new process | Uncertainty and ambiguity<br>Failure and inefficiency<br>Lack of knowledge and skills<br>Lack of resources |
| Business model extension | Adding new processes | Controlled risk<br>Some shortage of resources |
| Business model revision | Changing existing processes | Uncertainty and ambiguity<br>Lack of knowledge and skills<br>Path dependence, inertia<br>Blinders, cognitive manifestations<br>Resistance |
| Business model termination | Terminating existing processes | Resistance |

Source: Cavalcante et al., 2011, p. 1334

According to Cavalcante et al. (2011), mere extension of the business model works out rather smoothly, while a revision may face different obstacles. The logic of a business model, especially a successful one, can become a source of inertia (Chesbrough, 2011). Focus on current profitable customers inhibits the exploration of new technologies in new segments. Disruptive technologies have the potential to significantly alter the way in which companies operate, but inertia may hinder the companies from adopting the possibilities, which may be lethal to the companies (Vorbach, Wipfler & Schimpf, 2017). This challenge of disruptive technologies is not a technological problem; it is a business model problem (Tongur & Engwall, 2014). Companies are unlikely to change their business models unless they have strong incentives to do so. Even in cases where the need for change is evident, the companies' strategies, mental models, resource restrictions and path dependencies (e.g. regulations) can impede the process of adapting an existing business model to changing market conditions (Vorbach et al., 2017).

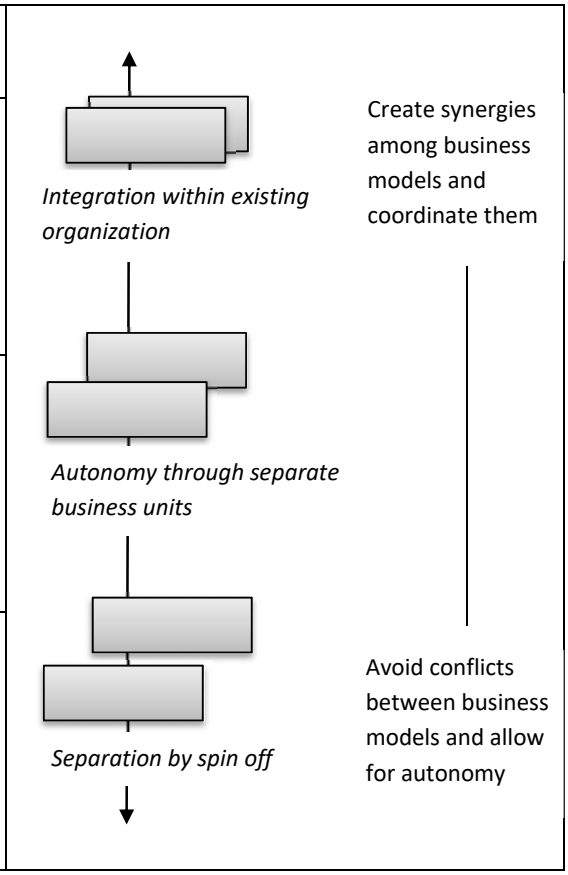
There are two ways to respond to technology shifts: either investing in developing the company's technological core competence, or by emphasizing a new value proposition offered to the customers, including a broader scope than the technological core competence

only (Tongur & Engwall, 2014). A "servitization" strategy enhances the company's ability to match the value proposition with new/changing customer demands. Attention is shifted from the role of the technology itself to the function it provides for its users, addressing the need to sell systems encompassing both products and services. A compound of both technological core competence development and a servitization strategy is relevant to overcome technology shifts (Tongur & Engwall, 2014).

Changing technology and/or market conditions may demand the creation of a new business model operated side-by-side with the existing business model, for instance for the sake of addressing several customer segments (Figure 6). Multiple business models may strengthen the companies' ability to create and capture value, and in that sense gain durable competitive advantage. However, according to Casadeus-Masanell and Tarziján (2012), it is difficult to operate more than one business model at time (see also Osterwalder & Pigneur, 2010). The new business model may be competing with, substituting or complementing the existing model.

Figure 6. Managing multiple business models

| **Similarity of business model building blocks** | **Potential for synergies** | **Potential for conflicts** |
|---|---|---|
| High | High | Low |
| High | Moderate | Low |
| Low | Moderate | High |




Source: Osterwlader & Pigneur, 2010, pp.233 (modified by the authors)

To avoid difficulties, new business model initiatives may be spun off into separate business entities. Another possibility is to more or less integrate the new business model within the established company. The decision how to manage multiple business models is dependent on

the strategic similarities, the potential for synergies and conflicts between the models (Osterwalder & Pigneur, 2010). Figure 6 summarizes the alternatives on how to manage multiple business models. The grey blocks in the figure illustrates multiple business models (including building blocks).

Ultimately, the decision on how to manage multiple business models may evolve over time. Companies have the possibility to consider a step-by-step integration or separation of models. In the model integration process there is always the question about how to do better business, improved competitiveness and to have success.

Kavadias, Ladas and Loch (2016) studied 40 new business models and searched for recurring features linked to success. Six features, linked to four trends, were found. The four long-term trends were; the development of sensors enabling broader data capture, use of AI and machine learning, IoE (internet of everything), and development of nanotechnology and small-scale production systems. The six keys to success identified were; more personalized product or service, a closed-loop process, asset sharing, usage-based pricing, a more collaborative ecosystem, and an agile and adaptive organization. With reference to what smart micro grids are the results of Kavadies et al. (2016) give us reason to argue that companies need to gather customer insight, closely monitor the development and critically assess their current business network for readiness to act.

## 4. Empirical study, Voices from the energy cluster and consumer market

This chapter will report findings from personal in-depth interviews with a selected number of managers representing energy companies belonging to the Energy Cluster of Vaasa, Ostrobothnia, Finland. Based on the tripartite business model developed for this project a questionnaire was crafted (appendix 1). The lengthy interviews, which were tape recorded, have been transcribed for analysis. The informants were first contacted by email to find a suitable time for the interviews, which took place at the offices of the companies in spring 2018. Strategic information is sensitive. Therefore, the findings present in this report is only on a more general level. However, thick enough to meet up to the aim of this report. Consequently, the findings illustrate how the informants think about micro grids, actions in practice, and current and future businesses, driven by the development of micro grids. The six companies included in the study are:

***VAMP***, a member of Schneider Electric, specializes in protection relays and arc flash protection systems for power distribution networks.

***VEO***, a company that offers automation, drives and power distribution solutions for the energy and process industries and provide our products and services to our European customers to meet their local and global needs.

***ABB***, a leading technology company offering solutions for energy grids, automation, and robotics, and driving the development of advanced protection, supervision, control and management products and systems for the complete power delivery process.

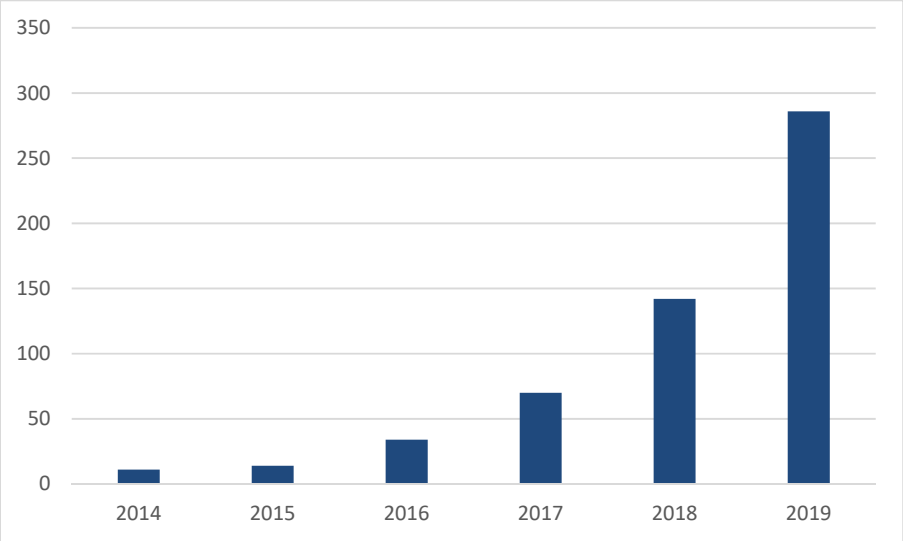
***Danfoss***, a company at the forefront of developing innovative and sustainable technologies for energy generation and distribution, and for increasing efficiency in energy consumption.

***Vaasan Sähköverkot***, with the mission to plan, build and maintain the grid for customers belonging to our area of operation.

***MAVIKO***, an innovative energy service company specialized in energy distribution (a EaaS).

Discussing micro grids with the informants, one can conclude that all informants recognizes a growing potential of micro grids, which statistics from Vaasan Sähköverkot indicates (Figure 7). Even if the number of households selling energy connected to the grid is not high, the growth rate of small-scale energy producer is to be seen.

Figure 7. Number of small energy-producing unites within the area of operation of Vaasan Sähköverkot (2018 and 2019 estimates).




Source: Vaasan Sähköverkot

Asking informants about activities linked to micro grids, their answers became somewhat more nuanced," we follow the development" or" we have already done some adjustment to our products to fit the micro grid" represent two standpoints, one passive and one more active. However, here we have to take into account what businesses the companies are in and how close they are to serve DER (see Figure 3). Taking ABB as an example their" ABB-free@home" solution enables families living in houses to take control of their energy

consumption (lightning, heating/cooling, window blinds, and security) using mobile technologies. This type of services fit the concept of smart micro grids very well.

With a focus on existing and future business models, it can be concluded from the answers of the informants that their main business models will not change in the near future. However, the informants gave the impression that even if they do not flag for radical changes they indicated that the level of readiness for change is growing, a sort of readiness for action is around the corner. Especially two factors influencing change or adaption are followed by the companies, the consumer market, and service development. The informants emphasized a stronger focus on deeper consumer insight and a stronger focus on service development. Overall, they all follow very closely what is developed within the IT and AI sector, and for some, new battery technology might have business implications.

Comparing these findings with theories of business models presented, it can be concluded that value propositions offered on the market will be the same in the near future, no dramatic changes are to be identified in activities and resources. However, the process of servitization is intensified, and with better understanding of customer demands improved value-offerings are to be expected. This brings us to a conclusion that in case there will be any changes in business models, it will be in the form of business model extension (see Table 1).

Having noticed the trend among the interviewed companies of stepping closer into the consumer market (those who are operating on that) and uncovering aspects of importance for business model development, ten end-users living in Vaasa in private owned houses were asked about their interest and willingness to invest in micro grid technologies (appendix 2). A convenience sampling method was used. The questionnaire consisted of four sections, background information of the household was studied using questions in the first section. The energy consumption was measured using questions in the second section and opinion about smart houses in the third. Finally, questions in the fourth section was used to monitor the informant's opinion about micro grids.

Summing up the findings from the interviews and reflecting them on business models, the following notions can be absorbed (appendix 3). A majority (70%) of the informants find micro grid solutions as interesting and are willing to learn more about them, 20% are sceptical, and 10% do not really understand how the system works. The arguments for their interest in micro grids are of two types, energy and cost savings, and" something new" (new technology). When it comes hesitations about joining micro grids, the informants discussed three different aspects, 1) technology in terms functionality, reliability, and security (" does it work?), 2) price and cost of investments, and 3) cooperation problems with neighbours (including jealousness).

## 5. Business models for competitiveness in the energy sector, a prosumer perspective

There is reason for actors in the energy sector to watch out for the transformation to come and to pay close attention the moments when the empowered end-users (households) will become prosumers and involved in both energy load and storage. With an increase of renewable energy load, liberalised energy markets and the development of smart micro grids, the future will bring forth new prosumer services and challenge existing actors to adapt and transform.

Considering energy as a service (EaaS) as a marketable service concept, there is a set of prerequisites, which have to be in place. Summing up the discussions about what kind of new services prosumers may want and need in the future as avenues for new business / business model development or extension of existing services (among actors in operation), the following services can be listed:

*Planning, constructing and maintaining micro energy plant services*

EaaS *solutions*

*Forecasting, Metering and control services*

*Energy storage and battery services*

*Energy security services*

*Contract and agreement services*

Blockchain technology services

These services can be sold separately but combined they will have a lock-in effect on the prosumers on condition the EaaS is of value to the user. The listed services, which can be structured into two layers, platforms and processes (Figure 8), can be handled by one or several companies (jointly).

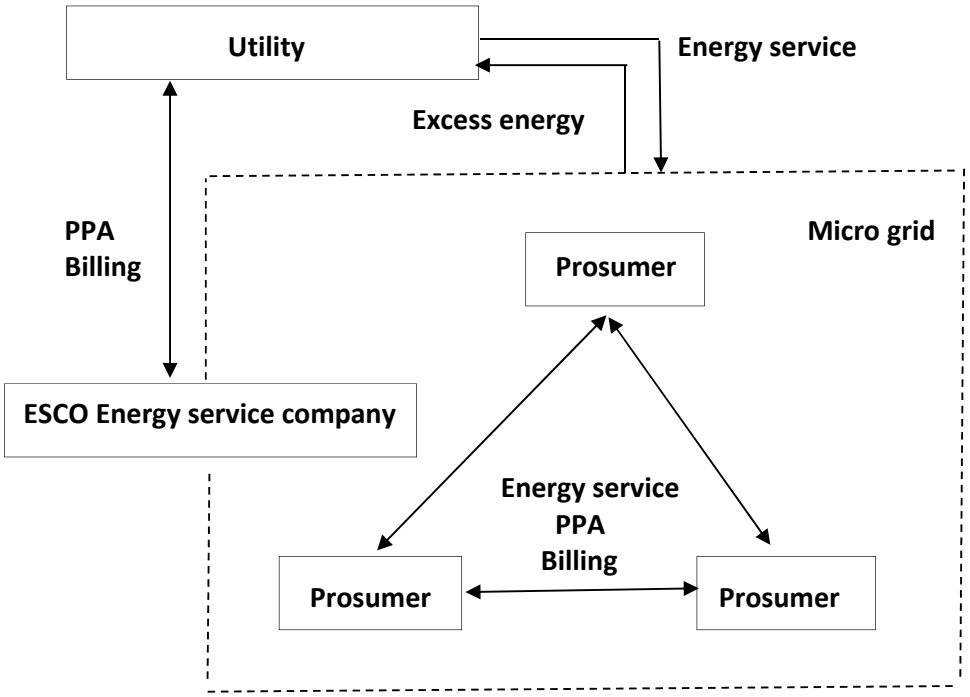
Figure 8. For micro grids, a two-level model of EaaS

| Levels of EaaS | Services | Notes |
|---|---|---|
| | | |
| **Platform** | Micro Energy grid / Energy storage / Hardware | Technology development, test and standardisation drive the development of micro grids.<br><br>In micro grid settings, where different technologies are to be integrated a user demand response approach is critical emphasizing user friendliness. |

| | | |
|---|---|---|
| **Process** | Forecasting, metering and control /Security services /software | For energy system optimizing and efficient person to person trading (P2P) different type of data is to be collected stored, shared and processes.<br><br>In an islanded mode, sales and purchase agreements and billing contracts are to be developed. |

A customer, prosumer may have an interest in finding one "Energy Service Company" (ESCO) described as a "specialist in providing a broad range of comprehensive energy solutions" (Rodríguez-Molina, J., Martínez-Núnez, M., Martínez, J-F. & Pérez-Aguir, W., 2014, p. 6163) (Figure 9)**.**

Figure 9, The role of ESCO in micro grids




The utility provides regular electricity service to the prosumer and provides net metering credit to the host customer. The prosumer (household) receives energy from the utility, own energy source, and from other prosumers in the micro grid. The ESCO install and operate (maintenance and monitoring) the energy sources in the micro grid, all or part of it, handle financing, power purchase agreements (PPA, a legal contract between two parties, an

electricity provider and a power purchaser), and billing. Furthermore, ESCO do also act as a third party in between the utility and prosumers. The Prosumers benefit in this model are, for example, low upfront capital costs, predictable (fixed) monthly cost of electricity, limited system risk, tax credits, and potential increase in property value. For this structure to work and EaaS to be realized, the two levels presented in Figure 7 have to be fully integrated and sound PPAs developed.

By emphasizing the co-ordinating role of ESCO in smart micro grids and applying a prosumer perspective, the business model presented in Figure 5 can be completed as follows: Value will be captured by companies as they drive the development and engage in partnering. Considering the fact that the energy market is highly regulated, the companies should also consider policy makers on both national and EU level as "key partner". As intermediators, in between the grid and the micro grid, the ESCOs will capture value by knowing the energy market, actors and services offered. By this they will have the possibility to bring together and combine different offerings into a unique value proposition and offer EaaS. The key resources of the prosumers in Figure 8 are the DERs, and value-in-use is based on optimizing net energy use with all the benefits of lowering the energy costs, CO2 reduction and independence.

For ESCOs the Value facilitating business model includes two domains of management, Customer driven management and Business network management. The first domain emphasizes a customer-oriented approach founded on customer insight and deep understanding of how value is formed. The second domain directs our attention towards available actors in business networks and their offerings.

In the Value facilitating business model presented in Figure 9, four value facilitating resources are identified; novelty, efficiency, package and lock-in. This model is based on the discussion of Amit and Zott (2001), and Zott, Amit and Massa (2011). Novelty includes a new type of contract between the prosumers and ESCOs. Efficiency brings in convenience and cost savings for the prosumers. EaaS is a set of services, assembled and tailored to meet customers´ demand. Finally, the lock-in mechanism is about strategies to use to keep customers loyal.

Out of a management perspective, there are already business models, which, with slight reinterpretations, might fit actors in the micro grid context. A first list of business models is presented, very much dependent on how the micro grid comes into live, which type of features will be connected to the energy system, regulation and prosumers' behaviour. The following discussion is based on the thoughts of the Founder and CEO of @StartupPro Zwillinger, and McGrath and Clifton.

Business models for actors in smart micro grids:

1. Cost based model

   This is a classic business model. The service company considers each prosumer unit as a project and use a turnkey pricing model.

2. Energy for free, revenue from access to top roofs, backyards and services

   This business model offers prosumers free electricity 24/7 and the company makes money on “surplus energy” produced in the micro grid and system service maintenance contracts (EoS).

3. Freemium, revenue from upgrades

   This business model, which consists of different service packages, gives prosumers access to free electricity during specified time during the day (week / months), and then pay for excess services. On type of upgrade could for example be access to jointly shared battery capacity.

4. Value based business model

   This business model combines different types of services (electricity, security, housekeeping etc.) households may need into a package, modulated the services according to the prosumers demand, and potentially use tiered pricing models.

5. Reverse-auction business model

   Prosumers explain their needs and willingness to pay and the companies bid to meet the requirements of the prosumers.

6. The ESCO broker business model

   Representing the prosumers in a micro grid, the ESCOs can use a cost-plus business model dealing with the Utilities and service providers. In this model handling power purchase agreements, monitoring, reporting and billing can be value adding services.

7. The development to sustain business model

   This business model does not generate revenue in the first phase, but its value comes with business experience and development, and is basically a mix of two business models a made-to-order model (just-in-time) and growth first model. Micro-grids systems are emerging. There are today no company handling the full system. In the future, there might be some powerful companies, which then might add a franchising model to the two first mentioned.

8. The life style business model

   Based on segmentation models there are some low-price elasticity segments, prosumers willing to pay for sustainable solutions, and take pride in P2P (person to

person) solutions and to be part of the sharing economy. In this prosumer insight and segmentation skills are critical.

With a focus on the future and big companies business models for the energy eco-system can be drafted. In this mindset and planning, energy is discussed as an eco-system including load, distribution, storage, use and reproduction and reuse. By taking inspiration from Wärtsila's marine solution "An Oceanic Awakening" and GE's Energy Ecosystem Portfolio, a platform approach interlinking different energy systems can be imagined. In this, with a focus on sustainability, flow of energy, optimization and sharing, new business opportunities will emerge.

**6. Concluding remarks**

This paper argues for an Energy Service Company (ESCO) management solution or a combination of several inter-connected ESCOs offering Energy as a solution (EaaS) services. EaaS for smart micro grids consist of two levels, platform (hardware) and process (software) to which a management, operational level can be added. QoS, out of a prosumer perspective is convenience, reliability, security and cost savings. Today, based on the ten interviews with the households, there is an interest for smart micro grids, but with some resistance. This does not come as a surprise while hard evidence for the functionality of smart micro grids are lacking. Therefore, it seems most prospering, thinking of future development, that a test area is built as a best practice case as they, for example, has done in New York State.

Based on these findings, and the fact that the electricity market is highly regulated, it is not alarming when some of the interviewed companies say that the follow what is happening but do not take much action (yet), in particular those companies, which are closer to Utilities and the main grid than Prosumers and micro grids. For companies close to the households as prosumers the situation is different. Smart homes are already there, or at least it is possible to build and equip a smart house. What is lagging in development is the absence of structure and system for DER and energy storage. When these technology driven components are fully developed, and the regulation allows, and connect to the smart house, then the smart micro grids will come true. But as Kavadias, Ladas and Loch (2016) say,

> *"We usually associate and industry's transformation with the adoption of new technology. But new technologies are often major factors, they have never transformed and industry on their own. What does achieve such transition is a business model that can link a new technology to an emerging market need".*

This puts a lot of pressure on those companies, which want to be part of the smart micro grid dawn. This report frames a business model very much contingent on one or several cooperating ESCOs for a total prosumer solution. Taking into account that this total solution based on EaaS includes both a platform and processes companies with different offerings have to come together. Approaching the end users, the prosumers, eight different business

models were listed, starting from a traditional “Cost based model” ending in a “Life style business model”. In our most radical thinking, the micro grid is only a phase in a development towards GoE (Grid of Everything) linking smart micro grids with smart houses and smart living, where smart stands for energy efficiency, prosumtion, and convenient living out of a consumer perspective. In its most developed phase every household is directly connected to the energy market, which is operated by intelligent computer systems and block chain techniques.

This report has had a focus on households as prosumers, not the industry sector. Today, we can find industry parks and factories, which benefits from the possibility to use islanded energy solutions based on DER. This business area has not been studied in this report.

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Appendix 1. Questionnaire companies

| **Hanken Business Model** | **Interview Questions** | **Business Model Canvas** |
|---|---|---|
| | | |
| **Network** | | |
| Partners | Who are your key partners | Key Partners |
| Sub-contractors | Who are your key sub-contractors | Key Partners |
| Suppliers | Who are your key suppliers | Key Partners |
| NGOrganizations | Who are your key organizations | Key Partners |
| | | |
| **Capture Value** | | |
| Activities | Please explain what business you are in and what you are doing | Key Activities |
| Resources | Which are your main resources | Key Resources |
| Investments / Cost | Please briefly explain the investment structure of the company (where has the company put investment money)? | Investment & Cost Structure |
| Revenues | Please explain how the company earns money (products / services) | Revenue Streams |
| | | |
| **Value Proposition** | | |
| Offerings (Products/Services) | Who are your customers and what are you offering (value proposition) | Value Proposition |
| Channels | How do you deliver your offerings | Channels |
| Relationships | What kind of relationship do you have with your customers (short/long term, strong/weak) | Customer Relationships |
| | | |
| **Perceived Value** | | |
| Value-In-Use | How well do you understand your customers / their processes / and how your products/services fits in | Customer insight |
| Segments | Do you segment your markets (how and what are the benefits) | Customer Segments |
| | | |
| **General questions about Smart energy systems, what will happen in their business sector (and expectations of the project)** | | |
| Future & Insight | Looking into the future (2030 for example) what will happen within your business sector. Will the "new technology of Smart grids" affect your business? | |
| Degrees of Freedom in business development | Regulations and standards, how much do they influence your business development? | |
| Expectation of the project | In terms of new business models, what information do you lack (would like to have)(expectations of this project)? | |

Appendix 2. Questionnaire households (Swedish)

**SESP projektet – smarta energilösningar,**
**undersökning av svenskspråkiga hushåll i Vasa boendes i egnahemshus**

1) **Bakgrundsinformation om hushållet och de boende**

- **Berätta lite om vem som bor i detta hus**
  - Namn, ålder, utbildning, arbete
- **Berätta lite om huset som vi nu befinner oss i**
  - Byggår, storlek, uppvärmningssystem (el, olja, ved, solpanel, jordvärme),
  - hurudan elprodukt har ni (allmän el, natt-el, säsong-el, rörlig elpris)
  - hur länge har ni bott i huset, finns det planer på att flytta inom en snar framtid
- **Hur ser en normal vecka ut för denna familj (från måndag till måndag)**
  - Vem far på jobb när, vart och på vilket sätt (hur många fordon finns det i hushållet)
  - Fritidsintressen (vem, vad vart, hur ofta) (hur tar man sig dit)
  - Lagar man mat hemma / tvättar / städar (eller köper man dessa tjänster)
  - Dator användning och spel, TV - tittande (mycket / lite)
  - Hur ser veckosluten ut (har man några hobbyn om kräver extra mycket energi)

2) **Uppfattning om energiförbrukningen**

- **Hur väl följer nu upp er energiförbrukning** (vem, på vilket sätt, hur ofta)
  - Funder ni på och diskuterar energiförbrukningen i hushållet?
  - Är energiförbrukningen någonting som oroar
- **Vem betalar normalt sätt elräkningen i hushållet**
- **Gör ni någonting (medvetet) för att minska på energiförbrukningen**
  - Med tanke på uppvärmning och vattenförbrukning
  - Användning av bil (buss, cykel)
- **Hur stor var elräkningen i januari och februari i år?**
- **Vet du hur mycket ni i genomsnitt betalar i energiavgift per kilowattimme?**
- **Vet du hur mycket ni i genomsnitt betalar i överföringsavgift per kilowattimme?**
- **När man köper hushållsmaskiner brukar det finnas angiver i vilken energiklass de finns, brukar du se på dem och påverkar denna information ditt beslut**?
- **När du köper nya lampor, funderar du på om det är en halogenlampa, ledlampa eller en vanlig glödlampa?**
- **Inom de närmaste åren, planerar ni någon ny energiinvestering?**
- **Bli er nästa bil en ”elbil” (hybrid)? (varför / varför inte?)**

3) **Åsikter om smarta hus**

”Smarta hus” utnyttjar den senaste tekniken för ett bekvämare och bättre boende (se bild).
Om vi jämför denna bild med ert hus,

- **vilka smarta lösningar finns i ert hus idag**?
- **vilka smarta lösningar planerar ni / vad skulle ni helst vilja ha**
  - för att få detta vad skulle behövas till (vilka hinder finns det)
  - vem kunde tänkas sälja dessa lösningar åt er, hur skall de få någonting sålt åt er
    - hur skall de gå tillväga (skall de ringa/skicka mail/komma på besök ...)
    - Vilket försäljningsargument skall de komma med?

**4) Åsikter om smarta elnät, distribuerad energiproduktion och –konsumtion**

Smarta elnät kan bland annat betyda att man delvis har egen energikälla i form av solpaneler, jordvärme och vindkraftverk som gör att man ibland kan koppla bort sitt hus från elnätet och vara självförsörjande (se bild).

Smarta elnät kan också betyda att man kopplar ihop ett antal hus till en grupp som ”säljer” och ”köper” el av varandra.

- **Vad har ni för tankar om ”Smarta elnät”?**
  - Intresserad – möjligheter – problem
- **Om grannen kommer in och säger att vi skall koppla ihop våra hus och skapa ett smart elnät, vad är er första fråga till grannen?**

Bild 1, Energimärkning på vitvaror

Bild 2, smarta hus = automatisk övervakning och optimering av energiförbrukning

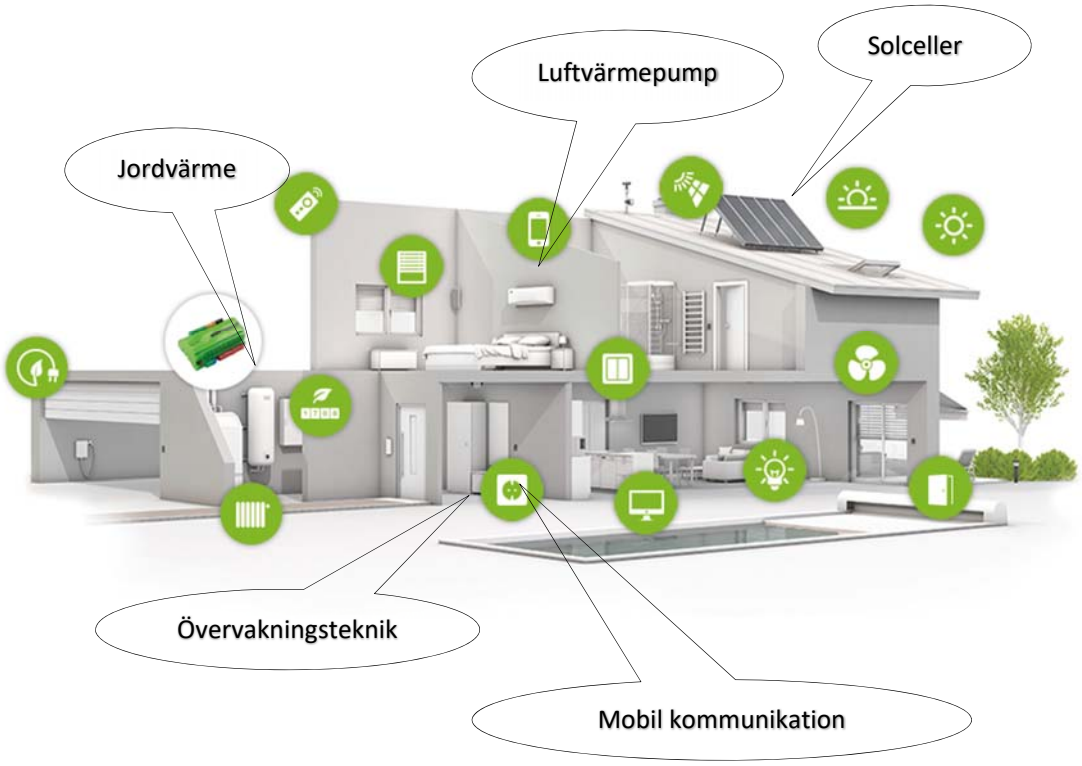
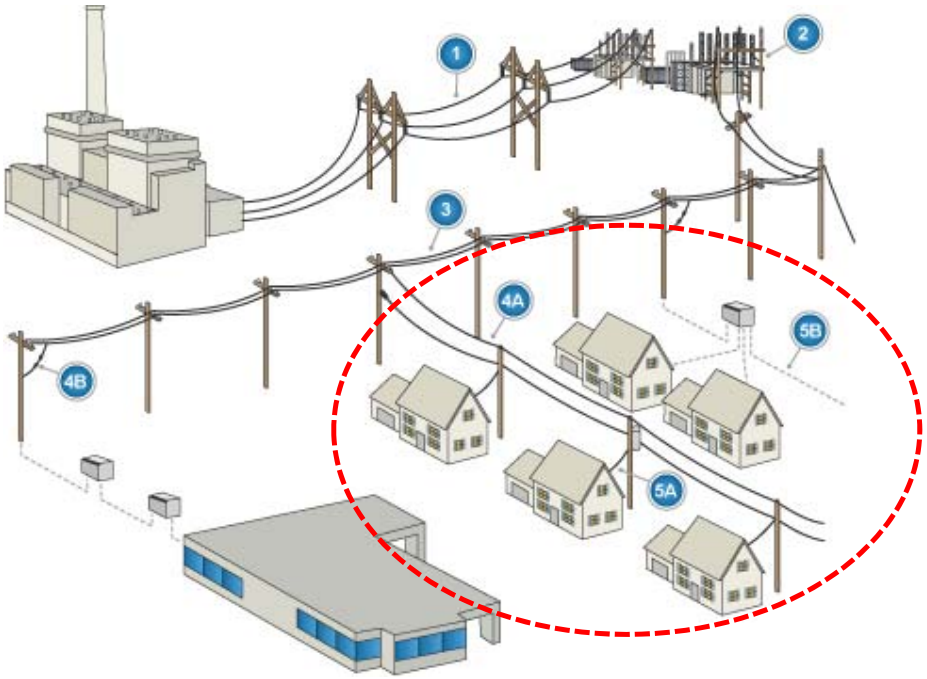


Bild 3, smarta elnät



Appendix 3. Summary of the interviews with households (H) living in a private owned house

| **Sample characteristics and opinion about micro grids** | | | | | | |
|---|---|---|---|---|---|---|
| | ***Household*** | | ***House characteristics*** | | ***Micro grids*** | |
| | Size | Read energy | Built year | Heating system | Interests | Barriers |
| H1 | 2 A + 1 C | Medium | 2012 | Electric heating | "Interesting solution" | Technique + responsibility |
| H2 | 2 A + 2 C | Medium | 2003 | Electric heating | "Not a bad idea" | Price + cooperation |
| H3 | 2 A + 2 C | Medium | 2001 | Electric heating | "Good idea" | Many problems |
| H4 | 2 A + 2 C | Medium | 1998 | Geothermal | "Interesting" | Investments + costs |
| H5 | 2 A | High | 1980 | Electric heating | "I do not understand what it is" | ? |
| H6 | 2 A | Medium | 1994 | Electric heating | "Very good" | How does it work? |
| H7 | 2 A + 2 C | Medium | 2006 | Geothermal | "Very interested" | Technique |
| H8 | 2 A + 1 C | Low | 2005 | Geothermal | "Sceptical" | Does it work? |
| H9 | 2 A + 2 C | Medium | 2015 | Geothermal | "Interested" | Does it work? |
| H10 | 2 A + 3 C | High | 1953 | Electric heating | "Does it work … sceptical" | Looks complicated + jealous |

A = adults; C = children

Low = The family has no interest in following up the energy consumption and do not read information about energy use.

Medium = The family occasionally think of their energy consumption, try to follow the energy consumption, primarily by reading the information Vaasan sähkö sends out annually.

High = The family regularly read their energy consumption and try to reduce their energy consumption

Appendix 4. Workshop, Smart houses

Hanken arranged a round table discussion about “smart homes and buildings” for companies involved in the SESP project. The discussion took place on 5th March 2019. The participants were from Hanken, University of Vaasa and from two companies of Vaasa Energy cluster. The aim of this meeting was to learn more about smart house concept through concrete examples from the service provider.

ABB has solutions and systems for a smart house. ABB’s devices are based on KNX technology. The customers of ABB are private house owners or constructor companies building larger residential blocks with smart technology solutions. The smart systems are tailor-made and can include for example automation of lightning, heating, air-conditioning, blind shade, curtains, awnings, safety and a door telephone. It appeared in the discussion that in general, people put smart tech into their houses to make living more comfortable. In addition, safety is the reason that make people to invest in smart systems. In addition to private housing, the airports, supermarkets and public properties are common sites for automation projects. *Smart Kalasatama* in Helsinki was introduced as an example of innovative living district where smart energy systems will be tested among the other solutions to make living smarter.

For the future business development, smart homes and buildings provide an interesting field to come up with new service concepts and business models. Energy companies and consumers have some common interests of making living smarter, cutting the cost of energy, and using energy more efficiently.

Figure 4 KNX is a globally recognized standard for building automation (www.knx.org)