TAMPERE UNIVERSITY OF TECHNOLOGY

PETTERI BAUMGARTNER

DEMAND RESPONSE ECOSYSTEMS IN THE NORDIC ELECTRICITY MARKETS

Master of Science Thesis

Prof. Saku Mäkinen and Assoc. Prof. Marko Seppänen have been appointed as the examiners at the Council Meeting of the Department of Industrial Management on September 4, 2013.

ABSTRACT

TAMPERE UNIVERSITY OF TECHNOLOGY
Master's Degree Program in Industrial Engineering and Management

BAUMGARTNER, PETTERI: DEMAND RESPONSE ECOSYSTEMS IN THE NORDIC ELECTRICITY MARKETS
Master of Science Thesis, 96 pages, 4 appendices (10 pages)
January 2014
Major: Industrial Management
Examiners: Professor Saku Mäkinen and Associate Professor Marko Seppänen
Keywords: demand response, business ecosystem, smart grid, electricity market

The business ecosystem concept was introduced in the early '90s. Since then the concept has been used to describe cooperative value creation in various industries, but not until the late '00s, the concept has been attracted a significantly wider interest among scholars. However, while the business ecosystem concept is exploited a lot in the literature nowadays, smart grid applications such as demand response have drawn little enthusiasm for the concept. Yet demand response is considered, indeed, an important ingredient of the emerging smart grid paradigm as well as the business ecosystem concept quite important to smart grid research. Hence, this thesis aims at affording some views on the demand response ecosystems.

The research comprises a rigorous investigation into the nature of electricity markets in the Nordic countries and conceptualization of business ecosystems. Thus, a narrative review of the majority of relevant papers known to the author was conducted. The literature review is supplemented with additional empirical enquiry into the perceptions of experts to deepen the understanding and knowledge of the issues on deregulated electricity markets. The focus is on the value creation procedure that changes with demand response, rendering the roles of the actors and interlinks between them—i.e., rendering the ecosystem structure. Quintessential is the maturation of the ecosystem; what kind of ecosystem would be attractive to every actor.

The results indicate that the business ecosystem level approach opens new avenues to understand and address the issues impeding demand response emergence on the deregulated electricity markets. Essential is to identify the end customer of the value proposition in this particular ecosystem, not forgetting the intermediaries and complementors. Regulatory restrictions should thoroughly be taken into account, too, when they govern the market. The main findings implicate that the consumer cannot be considered as the end customer of demand response services. Such services are probably more beneficial to the suppliers or distribution system operators than to consumers. Additionally, companies ought to delay launching their offers until regulation and regulators are account for the role of demand response—e.g., whether it should be a part of regulated operations or deregulated. Consequently, the findings generally support the view that the business ecosystem concept can shed light on the debate on demand response.

TIIVISTELMÄ

TAMPEREEN TEKNILLINEN YLIOPISTO
Tuotantotalouden koulutusohjelma

BAUMGARTNER, PETTERI: KYSYNTÄJOUSTON EKOSYSTEEMIT POHJOISMAISILLA SÄHKÖMARKKINOILLA
Diplomityö, 96 sivua, 4 liitettä (10 sivua)
Tammikuu 2014
Pääaine: Teollisuustalous
Tarkastajat: professori Saku Mäkinen ja yliopistotutkija Marko Seppänen
Avainsanat: kysyntäjousto, liiketoimintaekosysteemi, älykäs sähköverkko, sähkömarkkinat

Käsite liiketoimintaekosysteemi esiteltiin ensimmäisen kerran 1990-luvun alussa. Siitä lähtien käsitettä on käytetty kuvaamaan yhteistoiminnallista arvonluontiprosessia useilla eri toimialoilla. Käsite herätti suurempaa mielenkiintoa tutkijoiden keskuudessa kuitenkin vasta 2000-luvulla. Vaikka nykyään liiketoimintaekosysteemejä käsitellään kirjallisuudessa melko laajalti, sitä ei ole juuri sovellettu älykkäiden sähköverkkojen saralla tai kysyntäjoustosta puhuttaessa. Tästä huolimatta kysyntäjousto on nähty eräänä tärkeimmistä sovellutuksista älykkäisiin sähköverkkoihin liittyen ja liiketoimintaekosysteemit tärkeänä osana älysähköverkkotutkimusta. Näin ollen tämä diplomityö pyrkii tarjoamaan joitakin näkemyksiä kysyntäjoustoon liittyvistä ekosysteemeistä.

Tutkimus käsittää laaja-alaisen tarkastelun pohjoismaisiin sähkömarkkinoihin sekä liiketoimintaekosysteemi käsitteeseen. Edellä mainittu tarkastelu pohjautuu kerronnalliseen kirjallisuuskatsaukseen. Ymmärrystä tarkasteltavaan aiheeseen on syvennetty empiirisellä tutkimuksella, joka sisältää usean alan ammattilaisen näkemyksiä niin markkinoihin kuin kysyntäjoustoon liittyen. Tutkimus keskittyy arvonluontiprosessiin, joka muuttuu liiketoimintaympäristön muuttuessa. Kysyntäjousto muuttaa liiketoimintaympäristöä ja näin ollen myös toimijoiden välisiä suhteita – toisin sanottuna kysyntäjousto muokkaa sähkönmyynti- ja siirtoekosysteeemin rakennetta. Olennaista uudessa ekosysteemissä on, että se olisi kaikille osapuolille houkutteleva.

Tutkimustulokset osoittavat, että liiketoimintaekosysteemitason tarkastelu avaa uusia näkemyksiä kysyntäjoustoon liittyvien ongelmien havaitsemisessa. Erityisesti kysyntäjouston kannalta on oleellista tunnistaa tarjooman loppuasiakas. Tämän lisäksi myös lainsäädännölliset rajoitukset tulee huomioida sikäli kuin niillä on merkittävä vaikutus markkinoiden toimintaan. Tulosten perusteella näyttää siltä, että sähkönkuluttaja ei ole kysyntäjouston loppuasiakas, sillä esimerkiksi sähkönmyyjä tai siirtoyhtiö hyötyisi siitä enemmän. Lisäksi havaittiin, että yritysten tulisi maltilla tuoda markkinoille kysyntäjoustotuotteita nyt, kun lainsäännöllinen näkemys kysyntäjoustoon liittyen on vajavainen. Yleisesti tulokset tukevat näkemystä, jonka mukaan ekosysteemitason tarkastelu tällä liiketoiminta-alueella on tärkeää ja voi tuoda selvyyttä joihinkin ongelmiin.

PREFACE

This thesis is carried out as part of Smart Grids and Energy Markets (SGEM) research program, which develops new services and solutions for future smart grids and energy markets. Moreover, the research is executed under the Center for Innovation and Technology Research (CITER) organization, which is one contributor to the SGEM program. The aim of the SGEM research program is to develop international smart grid solutions that can be demonstrated in a real environment.

As for me, I was thrown into cold water. The subject was difficult for the industrial management student since it required a broad understanding of electricity markets. Thus, it took a relatively long period of time from me to gain a sufficient grasp of the subject. All in all, I survived from this ordeal due to the great help and support I got from my colleagues.

Consequently, I would first like to take this opportunity sincerely to thank Associate Professor Marko Seppänen for his inspiring attitude toward this study and for all the help and support I have got from him. Without Marko, the thesis would never have been completed. Professor Pertti Järventausta and Ph.D. student Joni Markkula also helped me through the thesis by providing their golden knowledge on energy markets and challenging my thoughts and ideas during the process. I also would like to thank Professor Saku Mäkinen, who permitted this thesis. My colleagues at the Department of Industrial Management, I thank you for providing a pleasant working environment and. Last but not least, I would like to thank all my colleagues in the SGEM program for being an invaluable source of information. Especially, the big thanks belong to Joni Aalto, Vesa Koivisto, Jan Segerstam, and Petri Trygg.

Toward new challenges.

In Tampere on January 23, 2014

____

Petteri Baumgartner

TABLE OF CONTENTS

ABBREVIATIONS AND NOTATIONS

AMI	Advanced metering infrastructure
AMR	Automated/automatic meter reading
BM	Balancing market
BRP	Balance responsible party
CEO	Chief executive officer
DA	Day-ahead market (see Elspot)
DG	Distributed generation
DOE	U.S. Department of Energy
DR	Demand response
DRM	Digital rights managements
DSM	Demand-side management
DSO	Distribution system operator
Elbas	Electrical balancing adjustment system
Elspot	Electrical spot market
EMV	Finnish Energy Market Authority (Energiamarkkinavirasto)
ESCo	Energy service company
EU	European Union
EV	Electric vehicle
EMS	Energy management system
HEMS	Home energy management system
IBP	Incentive-based program
ICT	Information and communications technology
ID	Intra-day market (see Elbas)
IEA	International Energy Agency
OED	Norwegian Ministry of Petroleum and Energy (Olje- og energidepartementet)

NordREG	Nordic Energy Regulators
NVE	Norwegian Water Resources and Energy Directorate (Norges vassdrags- og energidirektorat)
OS	Operating system
PBP	Price-based program
PC	Personal computer
SGEM	Smart Grids and Energy Markets
TSO	Transmission system operator
VAT	Value added tax

1 INTRODUCTION

One of the things to understand at the outset is simply, what does the value chain or ecosystem look like today? What are the different pieces? How much money is there to be made in those different pieces? What kinds of capabilities does your firm have or might it be able to acquire or build upon to go into different parts of that value chain or ecosystem?

(Hopkins, 2011, p. 60)

1.1 Background

The National Academy of Engineering (2000) nominated electrification the greatest engineering achievement of the twentieth century. In developed countries, under 0.05 percent of the population lives without electricity (International Energy Agency, 2012) leading to the consideration that electrification and energy are commonly taken for granted. In the same breath, the number of people without electricity access in the whole world will lower from nineteen percent in 2010 to twelve percent in 2030 (International Energy Agency, 2012). However, the existing electric power infrastructure was not designed to meet the challenges of the twenty-first century (Depuru, Wang, & Devabhaktuni, 2011; Gellings, 2011; Hammons, 2008; International Energy Agency, 2011; SGMM, 2010; Wang & Lu, 2013). Smart grids and smart grid applications such as demand response (DR) could become, if not the greatest, at least a remarkable engineering achievement of the present century.

The promising potential notwithstanding, there are many issues yet to be resolved for smart grid initiatives to take off. Changing tack is imperative since “current trends in energy supply and use are patently unsustainable—economically, environmentally, and socially” (Tanaka, 2011, p. 1). Thus, sustainability is a significant driver toward smarter electricity grids and solutions. To address the sustainability challenges, the European Union (EU), for example, has set the energy and emission targets for 2020. In the EU’s climate and energy policy, so-called “20-20-20” targets aim for a reduction in greenhouse gas emissions, increase in the use of renewable energy sources, and improvement in energy efficiency (European Union, 2007). In the smart grid environment, demand-side management (DSM), including DR and energy efficiency, has clearly been shown to be a potential approach to address the challenges concerning the electricity supply and consumption (Malik & Bouzguenda, 2011; Strbac, 2008; U.S. Department of Energy, 2006). However, even if more sustainable energy environment could be technically achieved by utilizing DSM, still a full utilization of smart grid with its applications seems distant.

The full utilization of the smart grid concept will probably presume a very different approach to managing the relationship between electricity consumers, utilities, and other participants compared to the status quo. In addition, in a global context, the benefits of DR in particular are quite different in regions with deregulated, organized energy markets (e.g., the Nordic countries) than in regions with vertically integrated utilities (e.g., the United States of America) providing monopoly electricity services to end-users (Heffner, 2009). In short, DR refers to a load shifting or shedding from critical times to the moments of lower consumption. The importance of DR increases as more renewable energy sources (RES) are integrated into the grid causing more fluctuation of supply. Furthermore, energy efficiency can be generally improved in many ways without the consumers' active participation (Environmental Protection Agency, 2012), but DR typically requires customer behavioral changes as its benefits are achieved by stimuli at the consumption end (U.S. Department of Energy, 2006). One can assume that interest in DR keeps growing as electricity consumption grows and renewable energy sources are increasingly exploited.

This thesis examines the relationships between various participants (later referred also as actors, elements, or players) in the emerging smart grid environment. Borrowing from a business ecosystem concept (Iansiti & Levien, 2004a; J. F. Moore, 1993, 1996; Teece, 2007), it deals with DR in the organized energy markets focusing on the economic constraints on the development of viable business opportunities in this field. Firstly, the thesis aims to afford a visualized ecosystem depiction to identify the problematic nodes impeding the implementation of DR applications. Due to the structure of the deregulated energy markets and need for the consumers actively to participate, the business models are considered to appear differently in comparison to the situation as it stands. Secondly, the thesis endeavors to provide alternatives how to overcome possible obstacles in order to develop a functioning demand response ecosystem in the deregulated energy markets. Theoretical approaches are complemented with experts' perceptions and the results of workshops organized in the SGEM program.

1.2 Research context

Ginsberg et al. argue "at least for smart grids, employing an innovation [or business] ecosystem strategy appears quite important" (2010, p. 2792). Additionally, Cowan notes one element of smart grid being an "identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services" (2013, p. 68). The business ecosystem mindset is actually a useful tool to analyze unreasonable and unnecessary barriers concerning the smart grid implementation, and also whether the issues lie in the cooperation of firms. The cooperation of firms is a vital asset in the pursuit of a flourishing business ecosystem, thus exploiting the ecosystem framework seems equally important in DR study, as well. Further, the utilization of DR requires a new approach to how various elements converge in order to achieve viable DR businesses.

The new approach utilized in this study stems from Adner's perception: "what matters here [in ecosystem] are the elements, not their ownership" (2012, p. 87). In this study, the elements and their relationships are examined to provide new insights into the future of electricity markets and DR ecosystems. The motivation stems from a global need for more modern solutions concerning the whole energy environment than we have utilized so far. This thesis is carried out as part of Smart Grids and Energy Markets (SGEM) research program which aims at developing international smart grid solution to be demonstrated in a real environment utilizing Finnish R&D (research and development) infrastructure.

1.3 Aim and objectives

The purpose of this study is to propose a viable value blueprint for a business taking advantage of DR via employing the business ecosystem framework, which focuses on the interaction between firms, regulatory authorities, and customers. The purpose of the study wells from a research question, thus making the question an important part of the research study. The research question should have both substance and form (Yin, 2009, p. 10). The substance tells the reader what the study is about, and the form qualifies the approach: "who", "why", "how", etc. Now, in the smart grid environment, exploitation of demand response will most likely require an entirely novel approach to managing the relationships between the various actors in the ecosystem. In light of this, this thesis focuses on the question:

> What kind of demand response ecosystems can be identified concerning the emerging smart grid paradigm, and what roles and restrictions can be identified?

Accordingly, the research question is somewhat twofold by nature. Firstly, it endeavors to determine what kinds of ecosystem structures can be identified so that every actor could win and ecosystem benefit as a whole. Secondly, the question addresses the elements in the ecosystem that are most likely to change as the ecosystem matures along with DR. The literature on business ecosystems provides means of recognizing substantial participants and risks of an ecosystem. However, the literature clearly studies the past and illustrates cases with hindsight. Furthermore, the concept of the business ecosystem has been little, if at all, applied to DR studies as yet. This thesis strives for addressing the problems and outlining visual ecosystem blueprints in an unprecedented manner: in advance.

Three research objectives have been formulated to fulfill the purpose of this study and to be able respond to the challenges posed by the research question. The main ambition of this thesis is:

I To recognize *the fundamental actors* in the demand response ecosystem. This objective includes a review of the literature on business ecosystems and, additionally, looks over the steps to construct a value blueprint.

II To distinguish *the problematic nodes* hindering the adoption of DR technologies, practices, and services. This objective involves the recognition of characteristic features of the electricity markets and business models in the corresponding field.

III To provide alternative ways to *overcome possible obstacles* in order to develop a functioning business ecosystem. This objective analyzes the divergent approach to the ecosystem and especially to the end customer of DR business.

The objective I establishes the backbone of the study to address the objectives II and III. The objective II pursues the rationale behind the introductory clause of the research question that entails the need for novel insight into the field at issue. Hence, the objective III will be achieved by answering the actual research question. In order to achieve these objectives, the next section introduces the approach and method exploited in this study.

1.4 Approach and method

The novelty of the ecosystem approach to DR predicts challenges to categorize an unambiguous and suitable research approach. Given the fact that the ecosystem framework has mostly utilized to explain cases with hindsight, this thesis requires conceptual thinking at an abstract level since it looks forward. Moreover, a comprehensive review of ecosystem literature is fundamental to build an understanding of what is tried to depict and how. In addition, to be able to grasp the big picture one also has to establish a sufficient knowledge of electricity markets, including the concept of smart grid and DR. Hence, the discussion on electricity markets and ecosystem literature form the background to the study.

The mentioned purpose of the study, as well as the novelty of the approach to DR, indicates a pragmatic research philosophy, thus building on the research question. The term ‘research philosophy’ relates to the development of knowledge and its nature and, moreover, pragmatism argues that the research question indeed is the most important driver when assessing the knowledge and its nature (Saunders, Lewis, & Thornhill, 2009, pp. 107–109). Furthermore, this study employs only qualitative data.

According to Yin (1989), two different ways can be exploited to approach qualitative data: deductive and inductive. Saunders et al. argue that some of the significant differences between deduction and induction are as follows: deduction emphasizes generally an insight of “moving from theory to data” and “the necessity to select samples of sufficient size in order to generalise conclusion” whereas induction expect “a close understanding of the research context” and is “less concerned with the need to generalise” (2009, p. 127). This study lies in between deduction and induction since it has characteristics of both approaches. The ecosystem framework stems from the literature. Further, the existing literature is employed to formulate a research question and objectives. On the other hand, this study presumes a close understanding of the research context, which, in turn, seems to have few, or lack, proper real-life cases (i.e., operating businesses) from which to gather the empirical data.

Taking the preceding discussion together, this study combines deduction and induction into a multiple method study. The study aims to deepen the insight of future DR business and its issues with a ‘wide lens’ (Adner, 2012). Consequently, the thesis strives for clarifying the issues that arise when experts with different instincts try to debate the right course of action. Moreover, it endeavors to provide another, objective point of view instead of testing the theory into practice or constructing a new one.

1.5 Limitations

To begin with, this thesis focuses mostly on the economic aspect, thus scoping out the discussion on possible technical constraints impeding the emergence of smart grid and DR. As presented hereinafter, the costs *vis-à-vis* the benefits of large scale DR implementation is well studied and published (e.g., Faruqui, Hledik, et al., 2009). For this reason, this study does not assess economic, social, or environmental benefits of DR but rather assumes these benefits exist. However, the benefits are considered to such extent as it is necessary to formulate the value propositions that, in turn, are essentials in regard to the validity of the results.

Despite the fact that various programs and ways of deploying DR exist, all of them are not discussed in a great detail since little differences can be distinguished between some particular programs. The aforementioned will become apparent when the backgrounds of the study are discussed in depth. Therefore, some programs are unified, yet maintaining the validity of the study. Consequently, different DR programs are exploited to the extent to which they have a significant impact on the value blueprint formation.

This thesis concentrates on the Nordic, liberalized electricity markets, thus ignoring markets where vertically integrated utility and electricity supplier exist (e.g., the most part of the U.S.). Moreover, ancillary or system services, other than balancing services, have not been discussed in a great extent, albeit DR has a high potential to address a number of other issues as well (e.g., Ma et al., 2013). Because of the inadequacy of resources and time, the majority of ancillary services are not discussed. Additionally, the study focuses on consumers who purchase their electricity from a supplier (i.e., residential consumers as well as small and medium enterprises). This is because the large share of available demand response capacity of large-scale industry is already exploited in the electricity market by the balancing market (Aalto, Segerstam, Pietilä, & Gröhn, 2013).

1.6 Thesis structure

The thesis begins with an introductory chapter introducing the research topic and outlining the background on the subject. Further, the introduction comprises a short description of the research context, aim and objectives of the study, research approach and method, and limitations. The introduction is followed by deeper study on the background and relevant literature, from which the synthesis is drawn as well as the conclusions (see Figure 1-1).

The second chapter covers the major background to electricity markets and DR. It concerns the specific Nordic electricity market characteristics laying the foundation for what follows. Given the limitations, the Nordic electricity markets are not examined inclusively, but to build a working knowledge of it for further discussion. Chapter 2 describes the smart grid concept, too, and the major practices concerning DR. Finally, the chapter concludes with a value assessment of DR.

Next, Chapter 3 covers the major theoretical approach to the thesis. The chapter addresses the ecosystem perspective in order to conceptualize the vantage point of this study. Moreover, the chapter covers a wide range of literature on business ecosystems and introduces the main framework that is applied to several cases. The main framework, the value blueprint, is a novel approach to DR, however.

The fourth chapter describes the research method and material. Since this is a research study, the chapter presents the methodology and approach according to which the thesis is conducted. The chapter expounds the analysis of the research material, too. In other words, it discusses the origin of the material and its nature, justifying the reliability and validity of the thesis.

Now, taking the preceding discussion together, Chapter 5 provides an insight of the business ecosystems applied to DR business opportunities and issues. The insight is formed by the approach and method discussed in Chapter 4, literature review, and empirically obtained experts' perceptions. The chapter is segregated in subsections, each of which has their own focus. The subsections lay the foundation for DR ecosystems and outline the forthcoming in a general manner. Moreover, they cover a new view on ecosystem, the swimlane blueprint, as well as both AMR and HEMS cases to deploy DR.

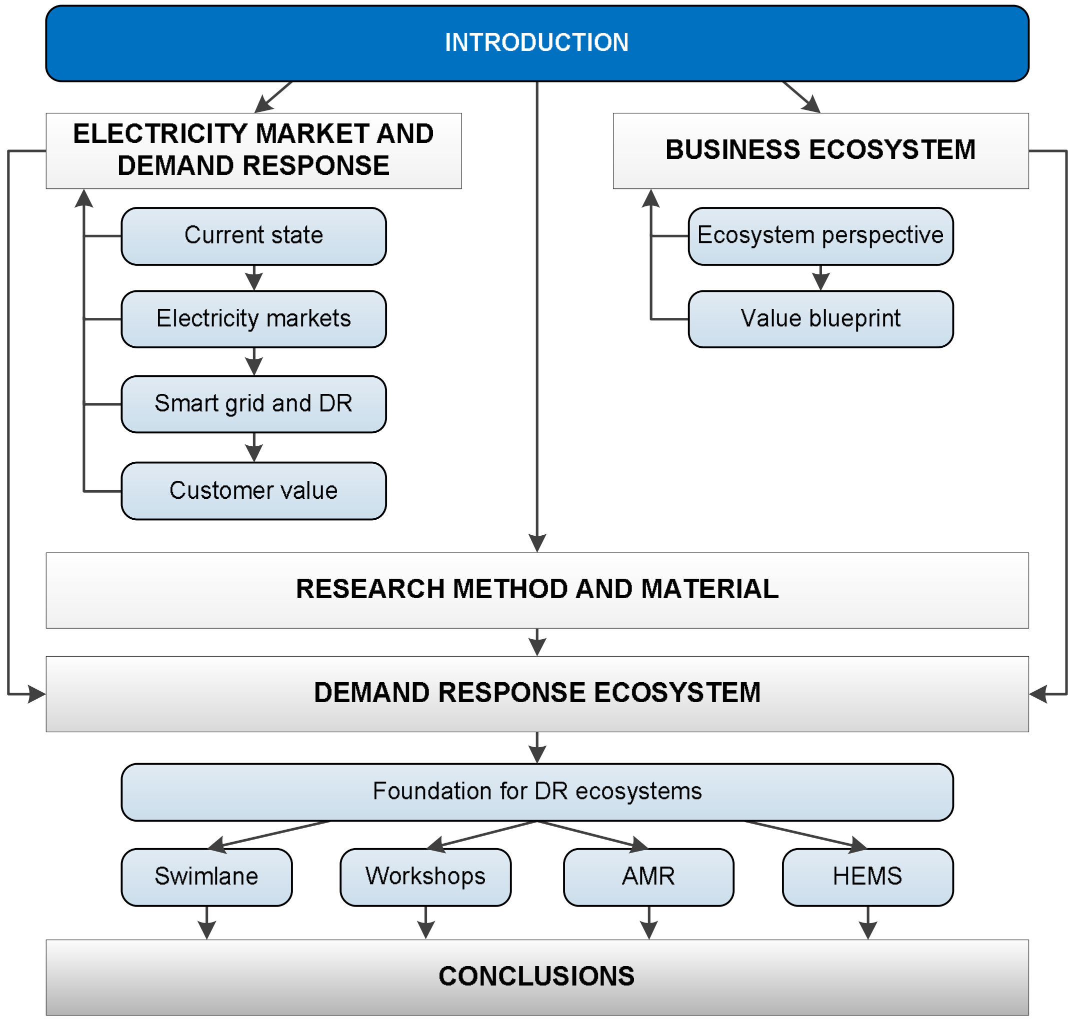


Figure 1-1: *Structure of the thesis, outlining the general path along which the thesis is conducted.*

The HEMS ecosystems include a forward-looking way to approach the DR businesses, integrating also other functionalities to the technology and applications.

Ultimately, the last chapter draws the conclusions. The conclusions recapitulate the whole study, endeavoring to present a concise round-up of the study's end results. Additionally, it entails both the theoretical contribution and managerial implications of the findings of the thesis as well as assesses the reliability and validity of the study. Moreover, the last chapter provides some suggestions for further research concerning demand response and its business outlook.

2 ELECTRICITY MARKET AND DEMAND RESPONSE

2.1 Current electricity system

2.1.1 Technical subsystem

This chapter begins step-by-step digging deeper into the electricity system and the market laying the foundation for discussion of smart grid and subsequently smart grid ecosystems. The term ‘electricity system’ is used to describe the physical electricity infrastructure that transmits electricity and also provides related services. The electricity system includes both the technical subsystem discussed in this section and the economic subsystem discussed in the following chapter. (De Vries, 2004.) The physical electricity infrastructure—i.e., the technical subsystem indicating electricity flows—comprises conceptually power generation, grid, and load (Ten Donkelaar & Scheepers, 2004).

Grid consists of a nationwide transmission grid, regional networks, and distribution networks. The transmission and distribution networks are required to interconnect the electric energy generation with the load as they often occur at great distance from each other (Karady, 2012). The reason of centralized production is, for example, environmental issues with large power plants and safety concerns. Substations and transformers are required between generation and grid, transmission grid and distribution network, and distribution and load along the way. This is for economic and safety reasons as energy losses are the lower, the higher the voltage of electricity. (Elovaara & Laiho, 2007.)

Electric energy is transmitted from producers to consumers (also referred to as final customers) that cause the load, through a complex grid network operated by TSO (transmission system operator) and DSOs (distribution system operators). Note that, in the figures, different actors of the same type are, for simplicity, aggregated into one presented actor (e.g., different DSOs are all presented as one actor DSO). To clarify, transmission grid, operated by TSO, is an extra high voltage or high voltage[1] network connected to regional and distribution networks through step-down transformers that lower the voltage of electricity. The voltage of the transmission grid is not functional for electric devices but too high; thus, the voltage has to be lowered before delivering to the

[1] Extra high-voltage is defined as a voltage level equal to or larger than 220 kV. High voltage is defined as a voltage level smaller than 220 kV but bigger than or equal to 35 kV.

distribution network (Lakervi & Holmes, 1995, p. 9). For instance, in Finland, households are typically equipped with low voltage networks delivering 230 V phase-to-ground whereas the transmission grid delivers 110–400 kV and distribution network 6–20 kV (Elovaara & Laiho, 2007).

Directive 2009/72/EC of the European Parliament and the Council concerning common rules for the internal market in electricity, 2009 OJ L 211, 13 July 2009 (hereinafter Directive 2009/72/EC), defines the transmission as "the transport of electricity…with a view to its delivery to final customers or to distributors" excluding the sale or resale of electricity to customers (p.62). Distribution is defined the same way with a distinction of electricity delivery to wholesale or final customer on high voltage, medium voltage, or low voltage grid operated by DSOs. Furthermore, the delineation between the TSO and DSOs is somewhat arbitrary (De Vries, 2004) as seen in Table 2-1 where the definitions of a few relevant parties are given.

'Square one' in the physical electricity subsystem is the power producer generating

Table 2-1: *Definitions of several relevant parties in electricity market. Adapted from EU's Directive (European Parliament and Council, 2009, pp. 62–64).*

Party	***Definition***
Producer	A natural or legal person generating electricity.
TSO	Transmission system operator is responsible for operating, ensuring 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. TSO is also responsible for the security of supply and an area to be electrically stable. The transmission of electricity is a natural monopoly.
DSO	Distribution system operator 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. Electric power quality and power reaching final customer lie with DSO. The distribution of electricity is a natural monopoly.
Ancillary service	A service necessary for the operation of a transmission or distribution system. Ancillary services are needed to keep a balance between supply and demand, stabilizing the transmission system and maintaining the power quality.
Supplier	The sale, including resale, of electricity to customers is managed by the supplier. Suplier is also referred to as retailer.
Final customer	An electricity consumer who purchases electricity for her/his/its own use from the supplier of her/his/its choice.

electricity. After generation, voltage (i.e., electrical potential difference) is raised via the step-up transformers and fed into the transmission grid (Van Werven & Scheepers, 2005). Typically, TSO transmits electricity to the distribution grid from which it is delivered to the consumers by DSOs (Van Werven & Scheepers, 2005). Alternatively, large, much electricity consuming industrial consumers that demand high voltage electric power can be attached to the grid straight from the transmission grid. More interesting than the physical route of electricity, however, are the economic transactions between the actors. As value delivery in the demand response ecosystem is concern of this thesis, the next section discusses about the economic subsystem of electricity supply.

2.1.2 Economic subsystem

As the technical subsystem is about the electricity flows, the economic subsystem is about the monetary value of the business. In the Nordic countries, liberalization of the electricity market led to distinguish between the technical and economic subsystems, and due to liberalization, TSO and DSOs are not eligible to participate in the electricity market but operate under regulation as natural monopolies. Figure 2-1 illustrates the physical path of electricity (the black line) and the financial transactions carried out between different actors to exchange electricity (the yellow line). The economic subsystem, or commodity subsystem, comprises actors that are involved in the production, trade, or consumption of electricity and their supporting activities as well (De Vries, 2004).

In the financial sense, the producers sell generated electricity in the electricity market. A producer can sell power straight to an energy retailer as well, who otherwise would purchase electricity from the electricity market. Large electricity consumers can buy electricity directly from the wholesale market (see Figure 2-1). Furthermore, retailer can have own production, too, and serve both as producer and retailer. The consumers finally purchase their electricity from the retailer (also supplier). In practice, the economic subsystem is not that simple as described, but more exact definition is not needed in here.

In his dissertation concerning the liberalization of electricity markets, Laurens de Vries (2004) argues that the technical subsystem is under control of the economic subsystem which, in turn, is constrained by the technical subsystem. Moreover, competition law and the EU directives regulate the economic subsystem and, for instance, operating licenses and emissions permits constrain the technical subsystem. The aim of the liberalization of the electricity market has been to assure the transparency of pricing to the con-

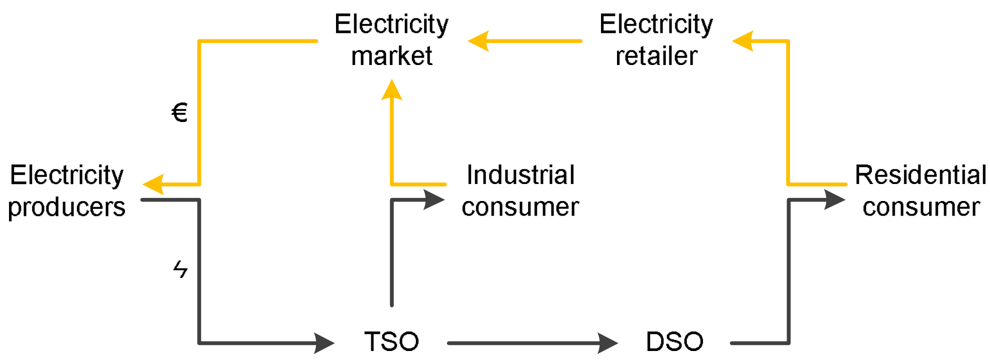


Figure 2-1: *Overview of the electricity system showing both technical and economic subsystems; the black line indicates the route of physical electricity; the yellow line shows the money flow (excluding network tariffs).*

sumers. For example, vertical integration[2] of the TSO and DSO is prohibited by law in Finland. However, the liberalization has led the parties in a situation where conflict of interests arises as regulated and deregulated players target quite different goals. That is, the suppliers' benefit would not necessarily be the DSOs benefit, too (the conflict of interest are discussed in depth later). All the market players who can entry to and exit from the market without any regulatory issues are referred to as deregulated players.

2.2 Electricity market structure

2.2.1 The Nordic electricity market

The Nordic countries (i.e., Denmark, Finland, Norway, and Sweden) have adopted free, shared electricity market with one common energy exchange and nationally independent TSOs. In addition, all the Nordic countries have liberalized their electricity markets, opening both electricity trading and production to competition; that is, parties which fulfill the certain criteria can enter the market (NordREG, 2009). According to Directive 2009/72/EC, for the consumers and suppliers the liberalization means that all consumers are able to choose freely their suppliers, and all suppliers can freely choose whether to deliver to their customers. Figure 2-2 presents a depiction of actors involved in the electricity market in Finland. The structure, with the exception of authorities, is somewhat the same in all Nordic countries.

[2] The degree to which a firm owns its upstream suppliers and its downstream buyers is referred to as vertical integration. Vertical integration means matching on upstream and downstream components of the value chain in order to provide an internal hedge.

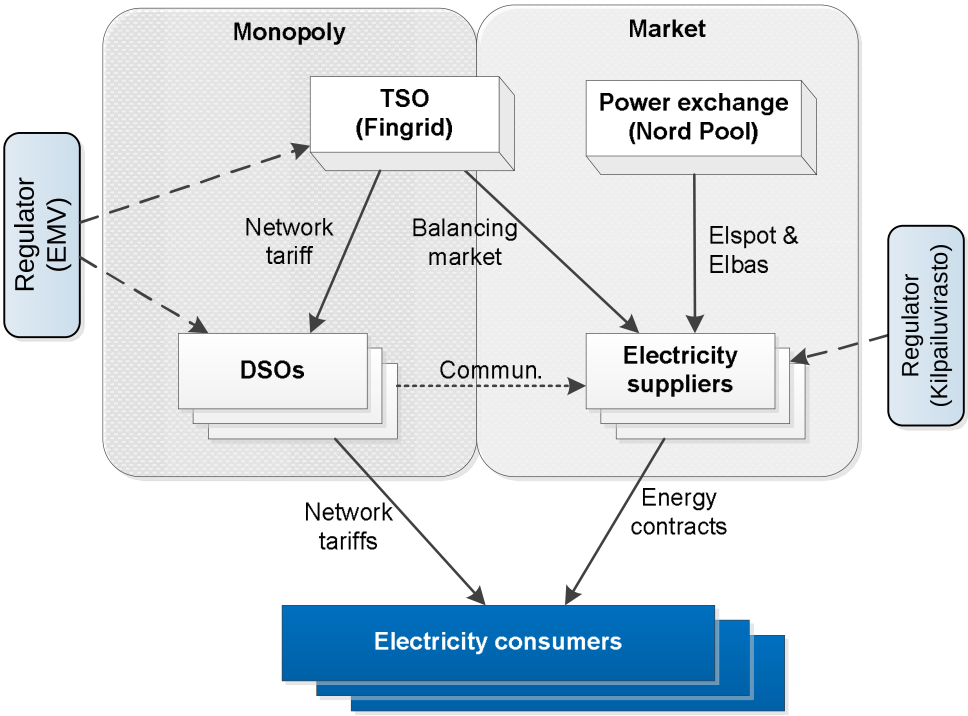


Figure 2-2: *The main actors in the Nordic electricity market. Adapted and modified from Sæle, Rosenberg, and Feilberg (2010, p. 53).*

In the Nordic electricity market, the liberalization is a fundamental factor to take into account since it has an inevitable influence on companies' business models (European Commission, 2006). As stated earlier, neither the TSOs nor DSOs are eligible to be involved in the electricity market in a traditional sense. For example, in Finland, chapter 12 of the Electricity Market Act 588/2013 (later the Act) stipulates the unbundling of operations. Section 77 of the Act prohibits a TSO or DSO operating in the electricity market from bundling any electricity system operations with other electricity trade operations (e.g., the electricity supply). The Act prohibits, too, the system operator from bundling grid operations and distribution system operations—in other words, the integration of a DSO and the TSO is outlawed. Moreover, due to liberalization the responsibility for the secure transmission and distribution operation has separated from the electricity generation business (European Commission, 2006).

As mentioned, system operations shall be unbundled with other electricity trade operations, meaning that all electricity consumers have to conclude two separate contracts. Pursuant to section 84 of the Act, the electricity system contract means a contract concluded between a DSO and consumer concerning electricity distribution through the grid; an electricity sale contract means a contract between a supplier and consumer concerning the electricity supply, as depicted in Figure 2-2. The DSOs are responsible for electricity consumption metering in many countries (Belhomme et al., 2009), and they provide the metering data to the electricity suppliers (Van Werven & Scheepers, 2005). In the Nordic countries, all the suppliers operate on the common power exchange, Nord Pool Spot AS (later Nord Pool Spot), which runs the leading electricity market in Europe (Nord Pool Spot, 2013). The suppliers trade in both day-ahead and intra-day energy markets with Nord Pool Spot (Nord Pool Spot, 2013); the monopoly position notwithstanding, the balancing market (BM) is organized by the TSO (NordREG, 2009). Moreover, the TSO overlaps the roles of being a monopoly actor and market participant, as shown in Figure 2-2.

Nord Pool Spot operates under Norwegian laws and authorities as it is a Norwegian registered company (Nord Pool Spot, 2013). Norwegian Water Resources and Energy Directorate (NVE) operates as a regulatory authority, and the Ministry of Petroleum and Energy (OED) controls the physical power exchange with neighboring countries (Ministry of Petroleum and Energy, 2013). In the Nordic countries, others than Nord Pool Spot operate under the country specific regulations and legislation (Ministry of Petroleum and Energy, 2013) such as competition laws (Sæle & Grande, 2011); for instance, the Competition Act (948/2011) in Finland. Unlike the energy suppliers, neither the TSOs nor DSOs can operate under the competition laws due to their monopoly positions—not even the TSOs their overlapping roles regardless. For instance, in Finland, the DSOs earning are regulated, and their reasonableness is supervised by the Energy Market Authority (EMV) (Energy Market Authority, 2011a). The EMV also supervises the Finnish TSO's (Fingrid Oyj), earnings that are established under a reasonable return concept (Energy Market Authority, 2011b). As the TSO is responsible for the construction of cross-border power lines and the import and export of electricity, it is also under the supervision of the Ministry of Trade and Industry for the foregoing operations (NordREG, 2009).

2.2.2 Day-ahead energy market

The day-ahead energy market, also referred to as Elspot market, is a day-ahead auction to exchange electricity in the Nordic region (Nord Pool Spot, 2013). Elspot market is one of the physical electricity markets among Elbas and the regulating power markets in the Nord Pool Spot (Ministry of Petroleum and Energy, 2013). The Nord Pool Spot includes a financial market as well, which is, however, excluded from this study. At Elspot, the electricity producers (supply bids), suppliers (demand bids), and other actors wishing to exchange electricity over the Nord Pool Spot market area send their bids for the following day (Alagna et al., 2011). Elspot includes three different types of bids: single hourly bids, block bids, and flexible hourly bids; however, the main idea of each method is giving price and volume bids separately for each hour (Nord Pool Spot, 2013).

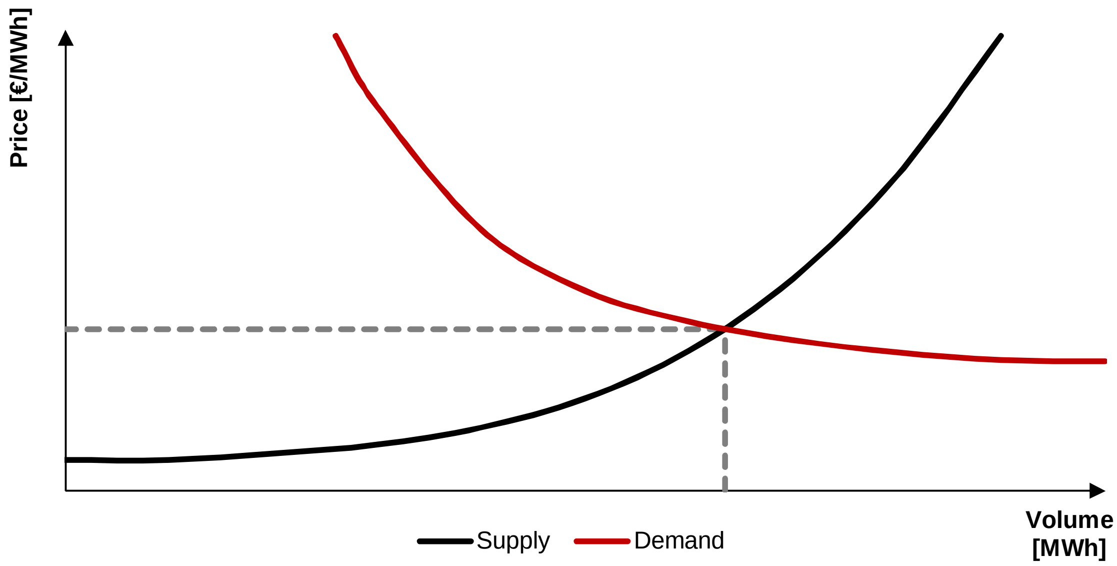


Figure 2-3: *The price formation in the day-ahead market. The system price (euros per megawatt hour) and turnover (megawatt hours) are given by the intersection of the supply and demand curves.*

Elspot, to which bids are submitted electronically, is open 365 days a year, and the auction is closed every day at 12:00 CET[3] (Nord Pool Spot, 2013). As Figure 2-3 depicts, the supply bids from several producers and the demand bids from a number of suppliers are aggregated into a supply curve and demand curve, respectively. Further, the intersection of the aggregate supply and demand curves forms a theoretical common price (i.e., system price) in the exchange area (Nord Pool Spot, 2013; Stavseth, 2013). The Elspot system price is then used as a reference price for settling financial power contracts (Flatabø, Doorman, Grande, Randen, & Wangensteen, 2003). Moreover, the system price is calculated for infinite transmission capacity in the grid resulting in the area prices which occur in a case bottlenecks, or capacity limitations, in the main grid (Stavseth, 2013). In general, the area price is determined by the same way as the system price, but with a higher price in the deficit area and lower price in the surplus area (Nord Pool Spot, 2013). The area price might also be equal to the system price. In that event, the transmission capacity between Elspot areas is not exceeded, ending in a single spot price throughout the market (Flatabø et al., 2003).

As stated earlier, the bids are made for each hour separately. That is, the price formation graph can be drawn for every hour a day, and every hour receives its own price and vol-

[3] The Central European Time (CET) is a standard time which is one hour ahead of Coordinated Universal Time (UTC), or Greenwich Mean Time—i.e., CET is UTC+01:00. CET is used to a great extent in Europe, e.g., in Denmark, Norway, and Sweden.

ume turnover, see Figure 2-3. As seen in the figure, the greater the price, the more the producers are willing to produce; however, the production capacity is limited, resulting in exponentially higher prices as demand increases. Reciprocally, the lower the price, the more the consumers are willing to buy. Moreover, one of the main theories of economics, the law of supply and demand, applies suggesting that consumers respond to the increasing prices by lowering consumption. In Chapter 2.3.4, Figure 2-6 illustrates the demand-price curve as well as the hourly spot prices that have been determined in the market by the aforementioned manner.

2.2.3 Intra-day energy market

Elbas is the intra-day energy market which supplements Elspot market and its main function are to secure the necessary balance between supply and demand (Nord Pool Spot, 2013). At Elbas, trading is continuously possible up to one hour before delivery, and it gives the participants a chance to adjust their supply or demand bids between the day-ahead market and the balancing market (Alagna et al., 2011). Although the majority of the energy is traded at Elspot, unforeseeable consequences may occur due to, for example, sudden changes in weather conditions or failure in a large nuclear power plant. This is where Elbas plays a crucial role in the markets by enabling trading close to time of delivery, thus maintaining the market balance (Nord Pool Spot, 2013).

The EU targets aim to increase the usage of renewable energy sources, meaning that more wind and solar power will enter the grid in the near future than it has so far. Unpredictability of the supply of the weather dependent energy sources results in severe need for the intra-day market since imbalances need to be offset between Elspot auctions and production volume (Nord Pool Spot, 2013). At Elbas, participants are able to conduct final adjustments to achieve a balance between supply and demand prior to delivery. Otherwise, the imbalance will occur if the consumption and generation are not at the same level at the time of delivery. Hence, Elbas offers an alternative to the balancing market for the imbalances a supplier may have after the day-ahead market (Nord Pool Spot, 2013). The balancing market, however, is required, and the national TSOs are responsible for the after delivery regulating market that automatically takes place when necessary (NordREG, 2009).

2.2.4 Balancing market

The balancing market or the regulating market is a TSO managed market place to maintain balance between the total generation and consumption of electric power in real time (Meeus, Purchala, & Belmans, 2005). In the Nordic countries, the national balancing power markets are part of the larger Nordic balancing power market (Fingrid, 2013). The bids at Elspot and Elbas are always predictions as they are made before the actual consumption. Moreover, the predictions inevitably go wrong at some point, and the

TSO has either up-regulate or down-regulate the power meaning the demand is too high compared to supply or there is more production than consumption in the grid, respectively (International Energy Agency, 2003). Fingrid (2013)—the Finnish TSO—defines the balancing power market as “a ‘tool’ required by the maintenance of the Nordic power balance.”

The TSO maintains the balance between supply and demand by the utilization of automatic frequency control and by acquiring balance power from the balancing market (NordREG, 2006). According to Fingrid (2013), players that own capacity which can be regulated “can submit bids of their available regulating capacity to this market.” Furthermore, the TSO purchases the required balancing power from the balancing market. The TSO sells balance power to the balancing responsible party (BRP) which energy consumption overshoots the production (Alagna et al., 2011). Moreover, the BRP is an entity responsible for “having equivalent injection and subtraction of electricity from the grid” (Belhomme et al., 2009, p. 125). The balance between the demand and supply can also be settled via utilization of demand response (NordREG, 2006), which, with the smart grids in general, is clearly one of the main themes of this thesis.

2.3 Smart grid and demand response

2.3.1 What is a smart grid?

Today’s traditional power grid was previously described as the one-way system in which electricity flows from the central power stations to the consumers via transmission and distribution networks. Consumer participation after signing an electricity agreement is somewhat nonexistent, they consume but do not produce energy and the load is not controllable. Since the uncontrollability, the electricity suppliers, DSOs, and TSOs suffer financial losses that can be lowered significantly through smart grid utilization (Easton, House, & Byars, 2012; Giordano, Gangale, Fulli, & Sánchez Jiménez, 2011; Valtonen, Honkapuro, & Partanen, 2011) although conflict of interests, for instance, is hindering the change (Belonogova, Kaipia, Lassila, & Partanen, 2011). In addition to the economic drivers, there are environmental and social drivers, too, to pursue a smarter grid. Table 2-2 presents some of the major differences between the traditional electricity network and the smart grid.

The foregoing differences are quite general. Additionally, Mason Willrich has noted that the smart grid is “variously defined” (2009, p. 35). In general, the grid itself is the same, but new applications around the grid are able to improve the efficiency and sustainability of the physical system and also provide new potential business cases for the players in the long term. The European Technology Platform (ETP) SmartGrids (2006) has outlined the smart grid as “an electricity network that can intelligently integrate the actions of all users connected to it—generators, consumers, and those that do both—in order to efficiently deliver sustainable, economic, and secure electricity supplies." Moreover, Erich Gunther describes the concept of the smart grid in an even more general manner:

> A. [smart grid is] an enhanced electric transmission or distribution network that extensively utilizes internet-like communications network technology, distributed computing and associated sensors and software (including equipment installed on the premises of an electric customer) to provide
>
> i. smart metering;
> ii. demand response;
> iii. distributed generation management;
> iv. electrical storage management;
> v. thermal storage management;
> vi. transmission management;
> vii. power outage and restoration detection;
> viii. power quality management;
> ix. preventive maintenance improves the reliability, security and efficiency of the distribution grid;
> x. distribution automation; or
>
> B. other facilities, equipment, or systems that operate in conjunction with such communications network, or that directly interface with the electric utility transmission or distribution network, to provide the capabilities described in clauses (i) through (x) in paragraph (A). (2007, pp. 3–4)

Table 2-2: *Differences between the traditional grid and smart grid (European Commission, 2006, pp. 15–17)***.**

Traditional grid	***Smart grid***
Large generating stations	Distributed generation and renewable energy sources
Centralized control	Flexible operation and maintenance
Old, one-way technology	Demand-side management through two-way communication
Optimized for regional power adequacy	Distributed generation connected close to consumers
Conflicting regulatory and commercial frameworks	Consistent legal frameworks enabling cross-border trading of power and grid services

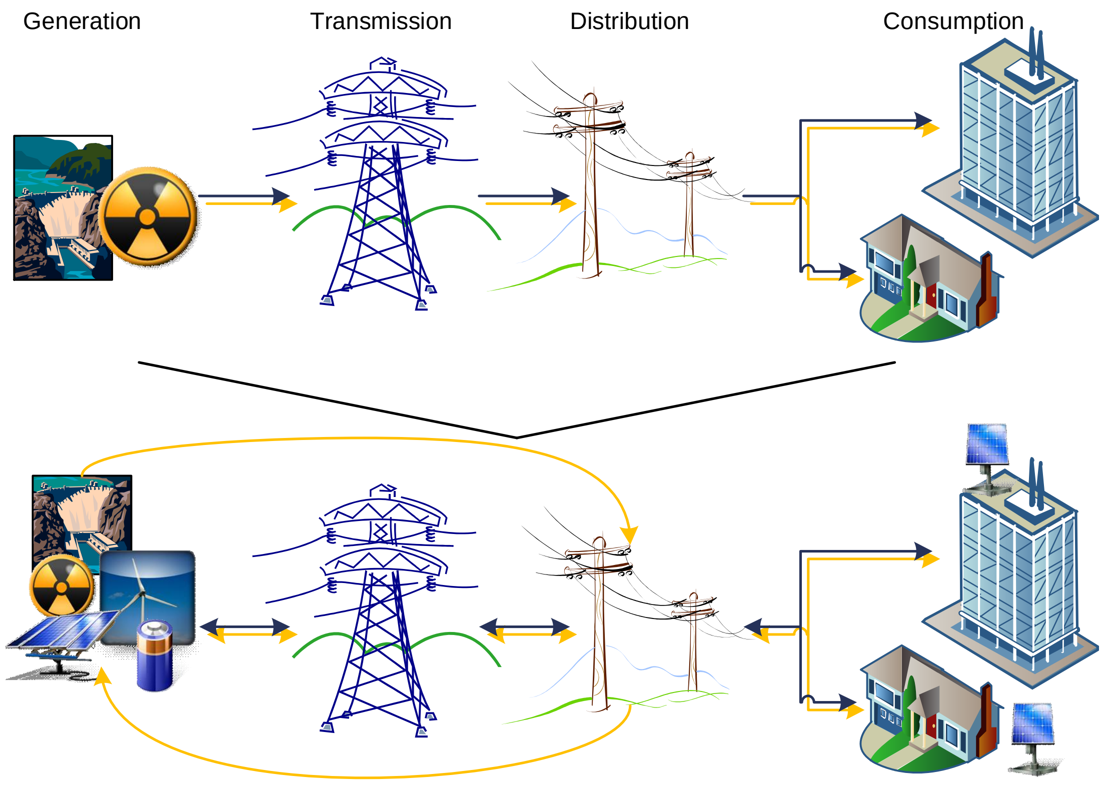


Figure 2-4: *Schematic illustrations of the traditional grid (top) and smart grid (bottom). The blue line shows the path of physical electricity; the yellow line indicates information exchange.*

A generalized visual depiction of smart grid infrastructure is shown in Figure 2-4. When applying the former definition of Gunther (2007), the figure illustrates that the smart grid could be improved. For example, DR could be utilized via smart metering in offices, houses, and industrial plants whereas wind turbines, fuels cells, micro-turbines, CHP, and photovoltaic (PV) represent distributed generation (DG). Electric power storages can be executed in a couple of ways as part of virtual power plant (i.e., aggregator) or an independent storage facility. Transmission and power quality in an interconnected grid are managed by TSO and DSOs respectively.

The smart grid is a variously defined concept; many more variations of the definition can be found in the literature. Nevertheless, it is beyond the scope of the thesis to clarify the smart grid definitional complications. The purpose of the definitional explanation is to point out that it is quite difficult to address the issues if the concept is not clear. This thesis focuses on demand response (DR) through smart metering and utilization of AMR (automatic meter reading) and HEMS (home energy management system).

2.3.2 Automatic meter reading

Compared to the conventional energy meters, the smart meters are referred to as advanced energy meters that collect the data about energy consumption and provide additional information on electricity quality to the DSOs (Depuru et al., 2011). Smart meters facilitate retrieving the data about consumers' electricity consumption and power quality easily, remotely, more often, and more cost efficiently than conventional energy meters (Valtonen et al., 2011). With an advanced smart meter, it is possible to read real-time energy consumption information and securely communicate that data onward (Depuru et al., 2011), for example, to the utility company (i.e., DSO) (see Figure 2-5). Smart meters can also execute control commands remotely and limit the electricity consumption according to the utilities requests (Vojdani, 2008). Some AMR-based meters, however, do not offer the functionality to limit the consumption remotely but more frequent consumption reading (e.g., hourly) and to switch the meter on or off remotely.

Remotely readable meters based on AMR technology allow, nonetheless, a number of benefits compared to conventional meters (Giordano & Fulli, 2011; Giordano et al., 2011). In the near future, AMR-based meters will become more common in many European countries (Valtonen et al., 2011) and, for instance, in Finland—where "the technological advancement of smart metering…is currently one of the best in the world" (Hierzinger et al., 2013, p. 39)—the new Electricity Market Act[4] requires 80% smart meter penetration by 2014 (Giordano et al., 2011). In theory, the more smart meters are installed, the more customers are expected to offer controllable load. Consequently, the DSOs and TSOs have better chances to manage peak demand (Neumann, Sioshansi, Vojdani, & Yee, 2007). So far the problem, however, has been that only the DSOs have been able to utilize the metering data easily and cost efficiently (Valtonen et al., 2011), and the situation may stay the same in the near future since, at least in some European countries, the DSOs are responsible for the smart meter rollouts (Hierzinger et al., 2013), including Finland.

The cost of the full AMR rollout has estimated to be €565–940 million in Finland (Giordano et al., 2011). Conversely, the cost of smart meter investment in the EU has estimated to be €51 billion; however, the implementation of smart meters and the adoption of dynamic tariffs could be worth of €53 billion savings in the EU (Faruqui, Harris, & Hledik, 2009). Yet studies have too concluded that all-round AMR rollout is not economically advisable in premises consuming less than 100 megawatt hours (MWh) a year (Denda et al., 2009; Energinet.dk, 2009, cited in Hierzinger et al., 2013). The latter surveys were conducted in Denmark where approximately 50% of all electricity users had remotely readable meters in 2011 however—that is, the DSOs have been installing

[4] 66/2009 Act on electricity supply reporting and metering.

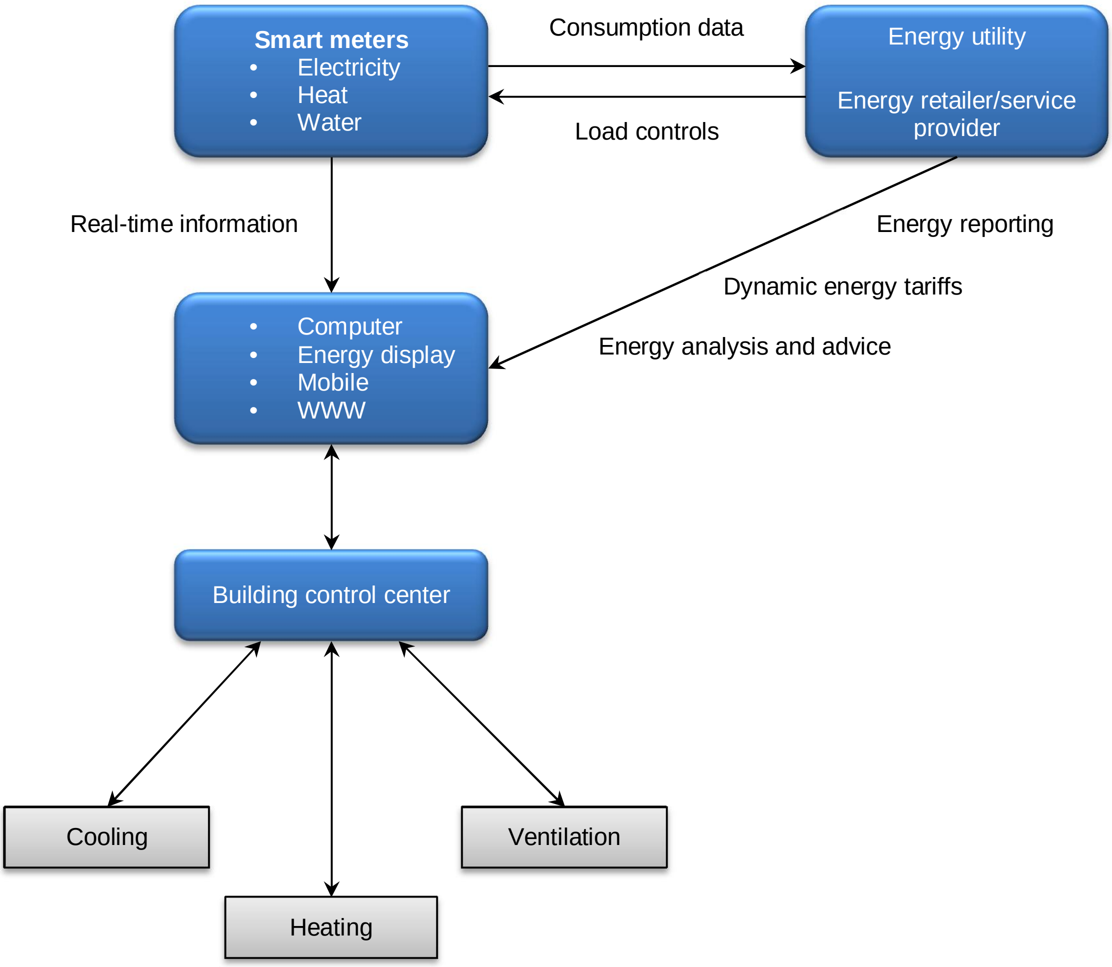


Figure 2-5: *Smart metering infrastructure, exploiting advanced meters, comprehensive building control, as well as computer-based energy control and user interface with remote maneuverability. Adapted from SmartRegions (2013).*

remotely readable meters by choice (ESMA, 2010). The conclusion to draw from the foregoing contradiction might be that the Danish DSOs are assuming the meters to be economical in the near future.

Despite the modernization of the grid and the installation of smart meters would make the grid more stable and energy consumption easier to measure within utilities, it is stated that "without these feedback tools [that enable customers to regulate their energy consumption] and additional metering services there is no benefit for the end customer" (Hierzinger et al., 2013, p. 96). According to their report on smart grid projects in Europe, Giordano et al. (2011) argue that, at least in demonstration projects, smart meters are usually combined with demand response programs. DR programs (e.g., EcoreAction, Energy Demand Research Project, and Google PowerMeter) with feedback tools that give customers economic incentives have been trialed in the Nordic countries, too, with good results (Renner et al., 2011). Compared to AMR, in the near future, more advanced smart meters or advanced metering infrastructure (AMI) integrated with ancillary services might render the status quo obsolete by providing functionalities represented in Figure 2-5.

The subsequent chapter gives an overview of energy management systems that are capable of advanced applications. They are already closer to the smart metering infrastructure (see Figure 2-5) than AMR and could provide sophisticated maneuverability and energy management.

2.3.3 Home energy management system

Thinking of the overall benefits of electricity consumption and power metering, home energy management system (HEMS) differentiate from the AMR-based solution with a number of additional functionalities it provides. As stated earlier, AMR meters are able to measure energy consumption on an hourly basis whereas HEMS is a system that is capable of real-time consumption and power metering. In physics, the term power refers to the amount of energy consumed per unit time whilst energy is the product of power and time—the integral of power over time, to be precise. The power metering enables more modern electricity pricing models such as power based tariffs and electricity contracts; consequently, HEMS technologies could enable a vast number of new pricing principles and tariff structures that mirror the reality better in the physical sense.

In addition to more accurate metering, HEMS would provide useful features to the consumers, as well. HEMS enables more efficient energy usage compared to the current situation and offers versatile controllability options over home appliances, including lighting, electric heating, washing machine, and dishwasher. For instance, one setting that HEMS includes is a home-away switch, thus allowing a resident easily set whether she is home or absent, and the system automatically switches off unnecessary consumer electronics when she is not home. HEMS could also feature other home automation (HA) functionalities such as heating and cooling adjustments as well as water consumption controls. All controls are to be handled through the user interface mounted to a wall, for example, as well as remotely via smartphone or web interface. HEMS or somewhat HEMS-alike smart home applications are studied, for instance, by Ju et al. (2011) and Mäki (2013).

HEMS enable benefitting from smart grid solutions in their full potential. For example, electric vehicle (EV) charging is easily manageable, own electricity production could be controlled and managed as well as energy storages, and specific operations could follow dynamic electricity prices and tariffs through the system. In the U.S., HEMS market is currently valued already at \$1.5 billion and forecasted to be worth over \$4 billion by 2017 (Bojanczyk, 2013). The numbers seem inspirational, albeit the U.S. markets are not similar to the Nordic markets. The adoption of HEMS solutions in Finland, for example, is impeded by the unawareness of its benefits. In Finland, where the prices of electricity are normally rather low, the consumers are not interested in what appliances consume a lot, at what time the power consumption hits its highest, etc., thus impeding the adoption of HEMS and other more modern solution (see e.g., Aalto, 2011).

In spite of the current reluctance toward load curtailment, it is undisputed fact that spikes in demand result in high generation capacity needs and eventually to high electricity prices (Bröckl, Vehviläinen, Virtanen, & Keppo, 2011). Furthermore, the form of electricity generation will also become more fluctuating with renewable energy sources, thus asserting an increasing need for consumption side flexibility. While HEMS enables an efficient control over electricity consumption, it can also be beneficiary to consumers as well, both industrial and residential. HEMS improves energy efficiency and reduces the amount of waste power that electrical appliances consume even when turned off. Moreover, when utilized together with demand response, HEMS could provide additional savings depending on the type of service. Demand response is discussed in detail in the subsequent section.

One concern around HEMS has been a high purchase price. The estimates vary between €200 and €600 for the unit and additional costs occur from installation and usage, for example. This is a major issue impeding the adoption of HEMS solutions, especially when the expected profits are probably small. Even though the HEMS business is still developing, the leading home automation companies in the U.S. charge monthly subscription fees between $20 and $60 (€15–44) from over two million total customers (Bojanczyk, 2013). However, the U.S. markets are different compared to the Nordic markets, as discussed earlier, but the market potential is increasing as we speak and while both demand and production patterns are changing when moving toward more sustainable energy environment.

HEMS solutions would benefit the whole market and its actors in conjunction with demand response, which will be explained in a moment. HEMS enable direct load control minimizing human intervention, which will probably facilitate the adoption of demand response. Furthermore, the systems combined with demand response programs could lead to dynamic pricing models for electricity as well as power based distribution tariffs, thus making both the market and power system more feasible concerning the future needs this matter. On the other hand, power-based tariff contracts and dynamic pricing would probably increase the interest in DR solution, in both the power system and electricity market vantage points.

2.3.4 Demand response

The AMR and HEMS technologies enable flexible control of supply and demand. The role and importance of flexibility of supply and demand have been recognized by electricity system designers years ago (e.g., Hobbs, Honious, & Bluestein, 1994). Management of capacity and demand are not a phenomenon concerning only an energy sector (e.g., Rohleder & Klassen, 2001); however, the term demand response is probably most often linked to the electricity sector in particular. In short, DR refers to a load shifting from critical times to moments of lower consumption. It utilizes a wide range of actions via smart meters at the customer side (Torriti, Hassan, & Leach, 2010). For the DR purposes, participating customers must be able to receive and respond to signal from a service provider. Consequently, Neumann et al. (2007) attest that smart metering must be implemented in order to take full advantage of DR. Furthermore, DR has the potential, for instance, to lower the wholesale market prices (Hirst, 2002) and to avoid construction of expensive peaking generation units that are needed only a few times per year (U.S. Department of Energy, 2006). The U.S. Depart of Energy defines DR comprehensively as

> Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized. (2006, p. 6)

B. Li, Qi, Yan, Sun, and Tang attest “demand response (DR) is one of several most important ingredients of the emerging smart grid paradigm” (2012, p. 1023). Without DR electricity demand and price fluctuate throughout the day, as seen in Figure 2-6 (the chart on the left-hand side). There have been two peak periods both in the price and consumption of electricity on March 21st, 2013. By looking at the figure, one can tell the price rose sharply between 3 and 8 o’clock in the morning while demand rose ever more sharply reaching its peak at 7 a.m. After the morning peak, both the price and demand fell gradually after the morning leveling off in the afternoon. Toward the evening, they rose dramatically again until the price reached its peak €96 per megawatt-hour (MWh) at 7 p.m. demand almost hitting the morning peak 12,000 MWh. After the peak, they fell toward the midnight. Even if the prices went up due to adverse weather conditions that increased heating power requirements and reduced the use of hydro power on that particular day (TE, 2013), the efficiency of the electric power system will be better if fluctuations in demand are small (Albadi & El-Saadany, 2008). Hence, the central idea of DR is to bring the electricity consumption forward or postpone it in order to flatten the demand curve (see Figure 2-7) or reduce the peak prices.

Typically, DR requires customer behavioral changes as its benefits are achieved by stimuli at the consumption end (U.S. Department of Energy, 2006). Interests at the con-

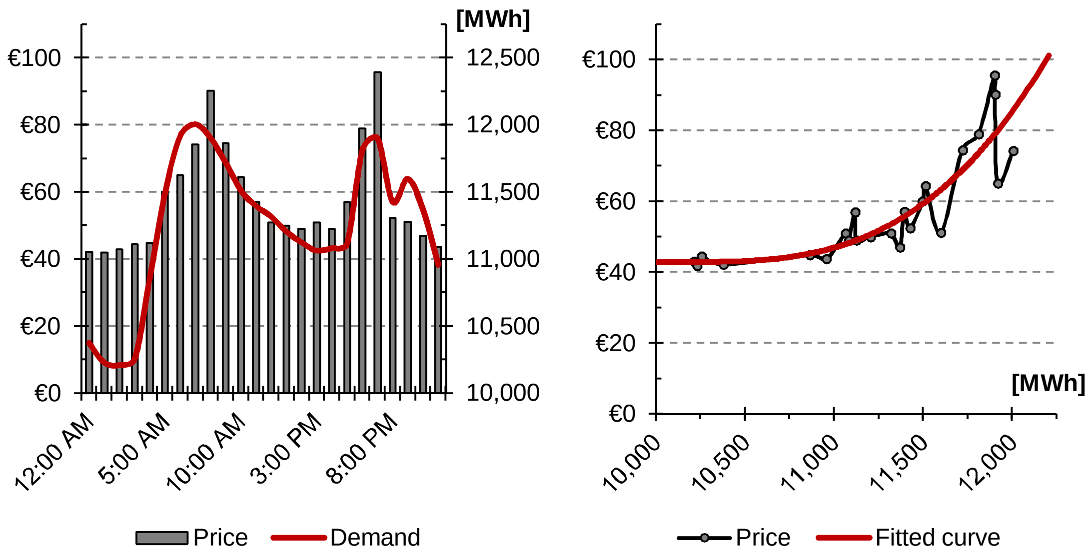


***Figure 2-6:** Example of hourly consumption measures and electricity prices (on the left) in Finland on March 21st, 2013 (data from Nord Pool Spot, 2013). The right-hand chart, basing on the same data as the latter, illustrates the positive relationship between price and electricity demanded.*

sumption end may vary; for instance, one can be interested in the reduction of electricity prices, and the other improvement in energy efficiency. However, all the actions are not direct DR, for example, energy efficiency is not DR but the utilization of DR could include applications that enhance energy efficiency. Based upon real data, Figure 2-6 presents (the right-hand chart) that electricity prices are in relation to demand. Put simply, generally the greater the demand, the higher the prices (see e.g., Kirschen, 2003). The exponential increase in the electricity price with greater demand is due to generation cost that, too, increases exponentially near maximum generation capacity (Albadi & El-Saadany, 2008). Thus, a reduction of demand could result in a decrease of generation cost, and further, lower electricity prices as well (Braithwait, Eakin, & Laurits R. Christensen Associates, 2002).

In order to reduce or shift the actual demand, DR can be exploited in various ways, including load adjustments by altering the timing of consumption, level of instantaneous demand, or total energy consumption (International Energy Agency, 2003). First, customers can influence the timing by shifting peak-hour electricity use to off-peak hours (see Figure 2-7); for example, timing the washing machine and dishwasher to operate at night would shift more load to off-peak hours. However, this will not be the case with industrial customers that might experience the diminution of productivity by rescheduling their activities (Albadi & El-Saadany, 2008). Second, they can reduce the level of instantaneous demand by reducing energy consumption during a particular time-frame when prices are high without changing their electricity usage during other periods

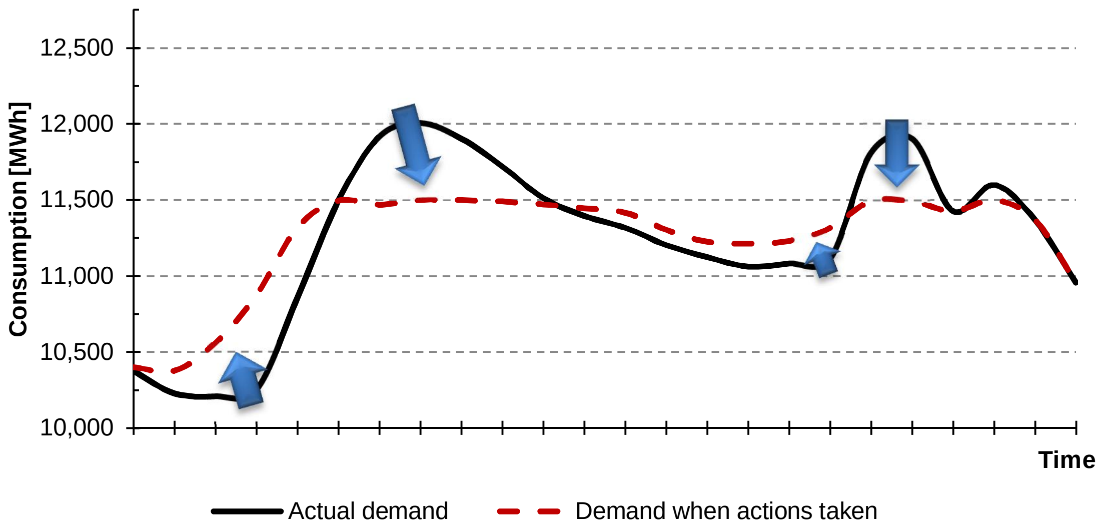


Figure 2-7: *A simplified effect of demand response on electricity demand. The demand-when-actions-taken curve illustrates peak load shaving during a period of time, having no influence on the total consumption of electricity over that period.*

(Herter, McAuliffe, & Rosenfeld, 2007). Finally, total energy consumption can be reduced by substituting demand from the DSOs for the customers' own DG (Sezgen, Goldman, & Krishnarao, 2007). Moreover, the DR actions can be exploited in numerous varying ways, as depicted in Figure 2-8.

Demand-side management is referred to as the utilities' means to reduce the electricity peak demand in order to reduce energy prices, cut emissions, improve system reliability, etc. (Malik & Bouzguenda, 2013). There are a vast number of benefits that can be achieved through implementation of DSM (e.g., Malik & Bouzguenda, 2011; Strbac, 2008); however, it is also argued that, with current wholesale prices, the necessary investments into the technical infrastructure are too high. Ultimately, the overall potential of DSM is to improve the energy efficiency and reliability from other than consumption end (Strbac, 2008), whereas in DR programs—although as being a part of DSM (see Figure 2-8)—customers are paid incentives for reducing or shifting load (Neumann et al., 2007).

Different DR programs can be categorized under the price-based programs (PBP) and incentive-based programs (IBP) (U.S. Department of Energy, 2006). Other classifications are used as well (e.g., Hirst & Kirby, 2001; Kassakian & Schmalensee, 2011) but yet the main sub-categories such as time of use program, ancillary services programs, etc. remain quite the same. According to DOE's classification, PBP include time-of-use (TOU), real-time pricing (RTP), and critical peak pricing (CPP) programs. As for IBP, they include direct load control (DLC) and interruptible/curtailable load programs as well as demand bidding, emergency DR, capacity market program, and ancillary services market program. Furthermore, DR could be incorporated into electric system planning and operations at different timescales (see Figure 2-8).

PBP are based on dynamic pricing in which the consumer prices fluctuate following the market rates (Albadi & El-Saadany, 2008). In other words, customers respond only to price signals instead of on-demand control commands from DR service provider. Borrowing definitions from the U.S. Department of Electricity (2006), in TOU the electricity is priced separately for different time periods, for instance, for a 24 hour day or simply the peak and the off-peak pricing. In RTP program, the consumer prices follow the real wholesale market prices and consumers can be notified of the price fluctuations on a day-ahead or hour-ahead basis. Moreover, RTP programs are potentially the most efficient DR programs (Borenstein, Jaske, & Rosenfeld, 2002; Goldman, Hopper, Sezgen, Moezzi, & Bharvirkar, 2004). CPP program is combinations of TOU and RTP programs. They are basically TOU programs, but the normal peak prices are replaced with much higher critical peak prices. In addition to three foregoing types, Albadi and El-Saadany (2008) present two more: extreme day pricing (EDP) and extreme day CPP (ED-CPP) which both are, however, quite similar to CPP. The next paragraph gives an overview on incentive-based DR option. Comprehensive, in-depth definitions are given in Appendix 1 for both PBP and IBP.

Incentive-based DR options can be placed in two categories: classical IBP and market based IBP (Albadi & El-Saadany, 2008). Yet again borrowing from the U.S. Department of Electricity (2006), the following definitions of several programs are provided. In Figure 2-8, DLC is positioned at the bottom of the timescale which means it is utilized roughly around the time when the actual electricity is delivered. Hence, DLC means managing a customer's load on short notice. Put differently, it is a program by which a DR responsible party remotely controls—by shutting down or cycling—residential or small customer's load. Emergency DR program and interruptible services address economic dispatch meaning the short-term determination of the optimal electricity output to meet the system load economically and reliably (*Energy Policy Act of 2005*, 2005). Emergency DR is founded upon incentive payments that are paid to customers if they reduce their load during possible reserve shortfall periods (U.S. Department of Energy, 2006).

Interruptible service and demand bidding programs are typically offered to large customers. In interruptible service, a rate discount is provided as equivalent to load reduction during system contingencies. Conversely, failure to curtail could result in penalties being assessed. As for demand bidding, it is kind of a curtailment program, too. In demand bidding (or buyback) programs customers—mainly large who consume a large amount of electricity—offer bids to restrict their loads; bids are usually based on market prices.

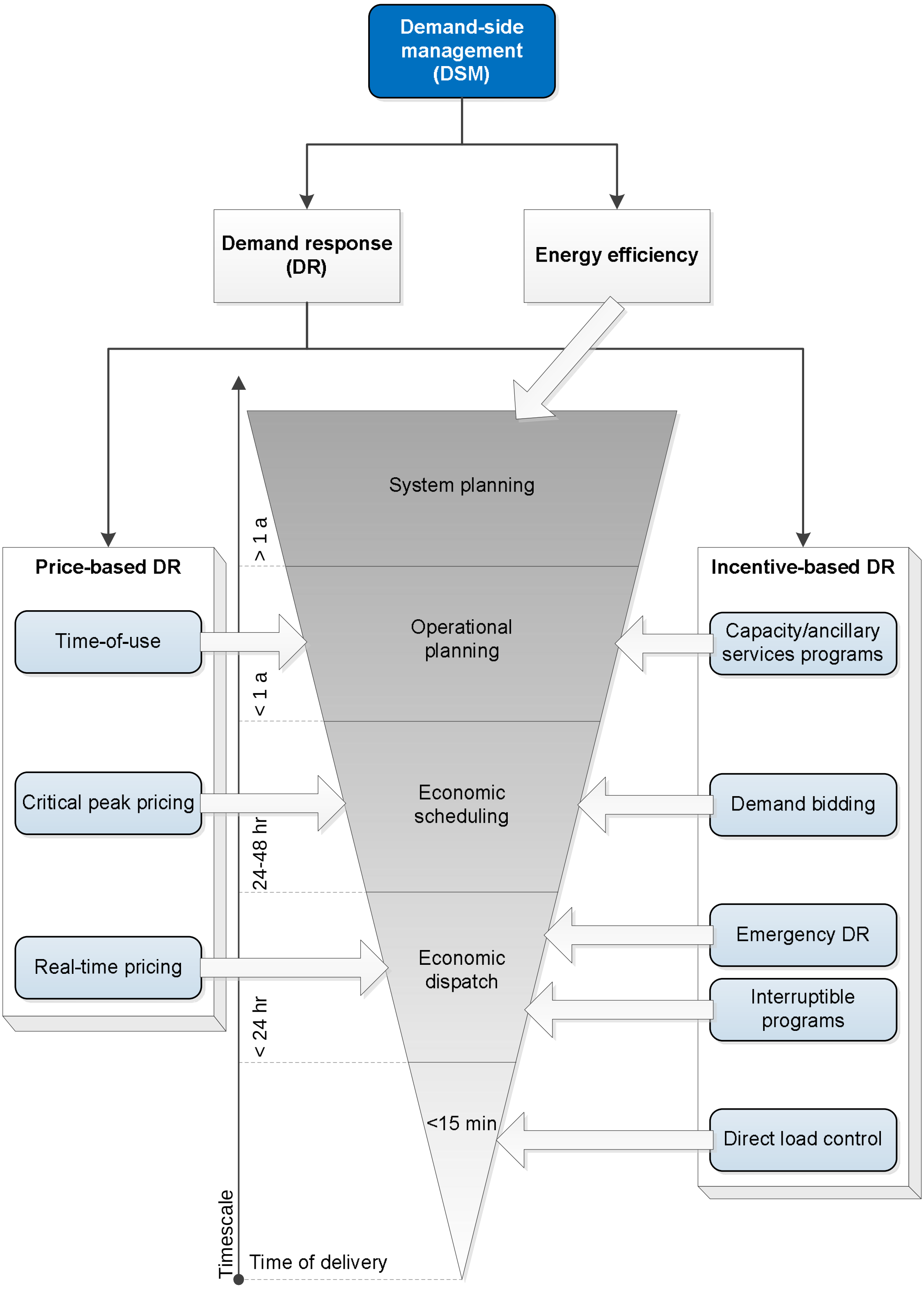


Figure 2-8: *Categories of various DR options and the role of DR in DSM. Electric system planning and operation activities are represented in the middle. System planning is often a long-term planning in which concerns over the energy efficiency are being dealt with; load management (i.e., DR) usually takes place nearer to the time of delivery. Adapted from the U.S. Department of Energy (2006, p. 15), Albadi and El-Saadany (2008, p. 1990), and NERC (2011, p. 11).*

In addition to operational planning, capacity market programs and ancillary services market programs are utilized. Both are load curtailment programs by which system capacity is enhanced. In capacity market program customers typically receive notice of load restriction requirements, and they are paid for offering load curtailments. In ancillary services market program customers bid load curtailments which then are either accepted by TSO or DSO or not; customers are paid if their bids are accepted, and if TSO or DSOs need to curtail the payments may be higher. (U.S. Department of Energy, 2006.)

On the whole, the target of DR is to enable active participation of commercial, industrial, and residential consumers to manage the balance between supply and demand, to provide benefits to power systems, to promote environmental sustainability, and to lower the cost of electricity. A vast amount of controllable load can be achieved by aggregating a number of small customers into larger units. For example, a DSO could remotely control the electric floor heating of every flat in an apartment house as a single unit to curtail load during peak hours. As for DR, it would be more lucrative if DR responsible party (i.e., TSO, DSO, or supplier) sent curtailment requests on which to respond instead of consumers adjusting their demand and making predictions on their available flexibility on their own. A provision for responding the request would be paid on a contractual or voluntary basis depending on the DR service type and, correspondingly, the mechanism could base on either price or volume signals, or both.

2.4 The value of DR

2.4.1 Assessing the value

The benefits of DR are discussed in a general manner above. From the point of view of companies which operate in the market and of business, generalized benefits work as if the starting point. Companies need more focused targets on the benefits in order to build a strategy. Moreover, companies should be able to identify their customers, and direct value propositions accordingly. In their book, *Strategy Maps: Converting Intangible Assets into Tangible Outcomes*, Kaplan and Norton (2004) provide a tool for companies' executives to assess their strategy. Kaplan and Norton state clearly that "*strategy is based on a differentiated customer value propositions*…Strategy requires a clear articulation of targeted customer segments and the value proposition required to please them" (2004, p. 10).

It must be noted that this study, however, does not strive for addressing strategic issues as such. Instead, defining the value proposition is a major single task in the forthcoming value blueprint mapping. Adner formulates the value proposition as "a promise" and, further, "a vision of the new value that your innovation efforts will create, as well as who this value will be created for" (2012, p. 84). The value, in turn, means the results customers receive with relation to the total costs they pay (Heskett, Jones, Loveman, Sasser, & Schlesinger, 1994). Neither the results nor the costs include only tangible assets, but also intangible such as value experienced by an individual person. Consequently, Heskett et al. (1997, p. 12) provide the customer value equation according to which customer value is determined as follows:

$$customer\ value = \frac{results + experience\ quality}{price + access\ costs} \quad . \qquad (1)$$

In the customer value equation, perceived experience quality and access costs depend on individual (Heskett et al., 1997, pp. 40–42), thus making it qualitative in that sense. Results and price should not be comprehended as unambiguous either, albeit they are more concrete than the latter. Although the reasoning what is a value and how it is created is not in the scope of this study, it must be realized that various customers have different expectations of products or services. For instance, in the context of this study, environmental conscious people may be willing to invest in DR without expecting return on their investment, whereas some may be pursuing merely economic benefits.

2.4.2 NABC

The acronym “NABC” stands for *n*eed, *a*pproach, *b*enefits per costs, and *c*ompetition (Carlson & Wilmot, 2006, p. 10). The NABC method is a tool to analyze and develop value propositions quickly for products, services, or projects. NABC is as if the way of rendering complex ideas and thoughts simple language. Carlson and Wilmot state that a good value proposition addresses the following four fundamentals:

> What is the market *need*? What is *your approach* to addressing this need? What are the *benefits per costs* of your approach? How do those benefits per costs compare with the *competition*? (2006, p. 10.)

Now, what is the NABC of DR? Since this thesis is normative by nature covering various aspects and potential beneficiaries of DR, the approach is hard to describe. Moreover, the approach depends on the view on end customer, to whom the DR service is eventually offered. In fact, providing an approach how to implement DR successfully would require that clarity exists toward this subject. In reality, confusion and uncertainty exist; thus, the purpose of this study is to ease the unawareness to some extent. Consequently, the benefits and especially the needs of DR are discussed herein in detail, and the approach and competition are yet to come, provided as part of the study outcomes hereinafter.

Initially, the benefits of smart grid for different market members and the environment are well-studied and published (e.g., Heinen, Elzinga, Kim, & Yuichi, 2011;

International Energy Agency, 2011; Malik & Bouzguenda, 2013; Sioshansi, 2012). In addition, the present electric power system infrastructure was not designed to meet the challenges of the twenty-first century (Depuru et al., 2011; Gellings, 2011; Hammons, 2008; International Energy Agency, 2011; SGMM, 2010; Wang & Lu, 2013). Likewise, "current trends in energy supply and use are patently unsustainable—economically, environmentally, and socially" (Tanaka, 2011, p. 1). For example, the EU has set the energy and emission targets for 2020 to address the sustainability challenges. In the EU's climate and energy policy, so-called "20-20-20" targets aim at reducing greenhouse gas emissions, increasing the use of renewable energy resources, and improving energy efficiency (European Union, 2007). Consequently, there are a plethora of issues to address, but also substantiated advantages from smart grid technologies which make tackling the issues worth trying.

DR is one way to deploy smart grid technologies and both economic and environmental advantages of DR are studied and published likewise (e.g., Albadi & El-Saadany, 2008; Faruqui, 2007; Hurley, Peterson, & Whited, 2013; Sioshansi, 2012; Torriti et al., 2010). DR is most beneficial especially on peak periods and when capacity is scarce (Neumann et al., 2007). The benefits, however, are quite different between regions with liberalized energy markets and markets where the vertical integration of the supplier and utility is allowed (Heffner, 2009). Moreover, before there is anything concrete to gain advantage from, the fundamentals have to be in place. One of these fundamentals is smart metering (Neumann et al., 2007) that would enable customers access to reduced energy prices as well as benefits from grid operations saving (Braithwait & Hansen, 2011). As stated before, this study focuses on the Nordic markets and Finland in particular. That is, firstly, the vertical integration is prohibited by authorities, and secondly, the smart meters are already, or will be, installed in a large number of household in the Nordic countries and Europe (Hierzinger et al., 2013).

Investments in DR have a potential to impact beneficially on several participant in the markets in various ways. However, either the benefits do not occur for every participant or at least they appear unevenly over the different actors (Heffner, 2009). For example, consumers might have vested interest in controlling their load, but this could vitiate the suppliers' and DSOs' plans and profits. Put simply, profit to one can be a cost to another. The issue is referred to as conflict of interests, and it is probably one matter hindering the adoption of DR applications (Belonogova et al., 2011). Therefore, it is crucial to observe the balance between benefits and costs in valuing the effects of DR on different actors. Furthermore, the conflict of interests mainly occurs when a participant is endeavoring toward the short-term (less than 48 hours) benefits such as critical peak load shedding.

In the short term, reducing the loads on critical peak periods can have significant influence on wholesale market prices benefitting all electricity consumers (Faruqui, 2007).

In regions where DR is exploited, it generally reduces the wholesale market prices, including day-ahead and intra-day markets (Heffner, 2009). In addition, the load reduction that is achieved by the actions of consumers can also improve reliability by providing a valuable resource to DSOs at times of generation, transmission, or distribution system capacity constraints (Braithwait & Hansen, 2011). Quite many DR program actually impact on the short-term consumption peaks or market price formation, as depicted earlier in Figure 2-8. Albeit some market-based programs, such as demand bidding or emergency DR, can reduce short-term peak loads resulting in avoided or reduced balancing costs, they can actually result in much bigger savings in the long term due to deferred investments in the transmission and distribution infrastructures (International Energy Agency, 2003; U.S. Department of Energy, 2006).

As for the long-term impacts, the implementation and utilization of DR will eventually lead to a lower need to invest in peaking generation, reserve margins, as well as transmission and distribution capacity inflicting a reduction in the price of electricity (Albadi & El-Saadany, 2008; Faruqui, 2007; Heffner, 2009). In addition to reduced costs, another important aspect is the environment. The perception that DR only shifts electricity usage, rather than decreases it, is profound as shifting does not have much of an effect on energy efficiency or emissions. However, King and Delurey (2005) examined this issue and went through several cases to discover that DR decreases overall energy consumption in nearly all cases, even if energy efficiency was not pursued. Furthermore, Chardon et al. (2008) ended up with the same kind of results in their more recent study concerning the broad economic and environmental potentials of DR for the EU. Conversely, Nemtzow et al. (2007) note that DR can also increase electricity usage in some circumstances, and therefore DSM projects that address both DR and energy efficiency would be more beneficial as a whole.

The EU’s 20-20-20 targets and other drivers toward more sustainable energy consumption and production will increase the penetration of renewable energy sources into the grid. As a consequence, a large amount of renewable energy causes intermittency in the grid. In some extent, DR—among the expanded European transmission grid and increased back-up capacity—is compulsory in order to manage the higher levels of intermittency (European Climate Foundation, 2010).

One may have noticed that the benefits are discussed but not the costs. The reason of which the benefit-to-cost ratio is not discussed in detail is the difficulty of the calculations. It is extremely hard to predict what would be the benefits of DR for all market players. The task can be even harder concerning a fully functioning smart grid where the benefits come from multiple sources, including DR. According to Hashmi (2011), the implementation of DR can be one of the major economic challenges in liberalized energy markets. Moreover, Hashmi states the estimation of the benefits and costs of DR or smart grid are a tough task, and potential savings are “almost impossible to count” in

Finland (2011, p. 60). The Electric Power Research Institute (EPRI) (2011, p. 1-4) estimated that the benefit-to-cost ratio of a fully functioning smart grid for the U.S. electric power sector would be somewhere in the range of 2.8–6.0. EPRI considered the projected benefits and costs over the 20-year period (2010–2030), but the market structure is different in the U.S. Hence, neither the benefits nor costs are comparable to the Nordic countries as such.

Now that the benefits and costs have been discussed, the most difficult question is: what are the market needs for DR? For instance, system operators can improve the reliability of the system through DR utilization. DR is clearly useful especially at times of generation, transmission, or distribution system capacity constraints (Braithwait & Hansen, 2011). DSOs' attraction for load control rests upon minimizing the investment costs on one hand, as well as the outage, loss, and maintenance costs on the other in the long term (Lakervi & Holmes, 1995). In actuality, DR interactions have the potential to reduce transmission investments as well as back-up generation requirements by up to thirty percent (European Climate Foundation, 2010).

Besides, large scale power blackouts could have significant adverse impacts both economically and socially (e.g., Aurora, 2005; Daniel, 2012; Hooper, 2003). Conversely, according to November (see Table 4-1, p. 59), the most important benefits that DR could provide to the TSO are short-time activation and response. Short-time activation and response concerning balancing power would mean more effective management of the grid stability when imbalances occur than with current back-up generation units.

On the other hand, electricity suppliers could improve their power balance management, leading to monetary savings by the exploitation of DR (Valtonen, Partanen, & Belonogova, 2012). Basically, the suppliers are interested in minimizing the daily electricity costs (Belonogova et al., 2011). The costs minimization includes two aspects: obtaining the minimum daily energy costs and cutting future balancing costs. First, the suppliers are able to gain more profit from the electricity they sell by minimizing their own electricity costs. Obtaining the minimum daily energy costs requires customers' load control. Second, the suppliers face major financial losses from incorrectly foreseeing the consumers' consumption patterns. When customers consume more than predicted the loser is the supplier since electricity contracts are generally flat tariffs by nature.

Whether it is about the DSOs' or suppliers' interests in question, the end consumer must be made to participate. From the end consumer point of view, criteria or motives to participate in a DR program could be financial, environmental, societal, pressure, etc. Whatever the truth, the financial vantage point seems to be one of the main priorities whether the consumer is residential, industrial, or commercial (Heiskanen, Matschoss, Kuusi, et al., 2012). Consequently, the overall price of electricity should reduce one way or the other. In fact, as Boisvert et al. (2002) attest, overall electricity price reduction is eventually expected. Additionally, enhancing the ability to utilize DR could benefit the whole markets operate more efficiently and satisfactorily (Jazayeri et al., 2005; Kirschen, 2003). Albeit the DR need and benefits are largely studied for vertically integrated utilities (e.g., in the U.S.), the need and positive impact on energy price are also substantiated in regions with liberalized wholesale markets (U.S. Department of Energy, 2006). Indeed, DR would benefit eventually the end consumers as well because of more efficient utilization of the available infrastructure (Albadi & El-Saadany, 2008).

Furthermore, investing in DR can be seen as an investment in the environment in the long run (Nemtzow et al., 2007). Additionally, the EU's 20-20-20 targets require more RES to be installed in the grid by the year 2020 (European Union, 2007). Now, this will increase the generation capacity requirements since "wind and solar PV tend to operate at part load relative to full rated capacity for much of the year" (European Climate Foundation, 2010, p. 57). That is, both wind and PV would require a total of 200 terawatt-hours (TWh) capacity toward 100 TWh demand, namely the generated energy relies heavily on wind and sun, naturally. Nevertheless, the integration of RES could be eased via DR exploitation (Hanser, Madjarov, Katzenstein, & Chang, 2011), leading to more secure future grid.

2.4.3 Value proposition

In light of the preceding discussion, who ultimately needs to adopt the DR service for

Table 2-3: *Value propositions of DR for several actors in deregulated electricity markets.*

End customer	*Value proposition*
DSO	Controllable loads for enhancing network management (faults, capacity, feeding, and arrangements). DSO can use DR for alternative for capacity building in some cases. In fault situations loads could be restored or maintained with criticality information.
Supplier (retailer)	Balance settlement correction, regulating power market, frequency control market. With more dynamic acting of production, storing, and consumption of electricity, energy retailer can correct balance errors with actively using DR service.
Consumer	Possibility to sell green energy to markets, compensation of allowing loads to be controlled, lower price of energy. Green energy: functionality needed to support and maximize this. Compensation from supplier and DSO (collected and paid by service provider). Additionally consumer could be offered low cost power for example for EV loading. Aim of this would be to improve production and consumption balance.

this kind of business to thrive? Who is the target of the value proposition? The considerable actors are the DSO, TSO, supplier, and consumer that would be able to gain from the cumulative (i.e., aggregated) impact of small savings per consumer (see Table 2-3). Moreover, the savings of these actors will mirror eventually lower electricity prices on the consumer side as well (Braithwait et al., 2002). The major distinction among the provided actors is competition as the DSOs' and TSO's profits are regulated and limited *vis-à-vis* the suppliers' that operate under competition legislation. Therefore, the suppliers' business is clearly keener in terms of competition and they have to search for strategies to gain a competitive advantage over their rivals. Reciprocally, as for the DSOs and TSOs, they do not compete against each other but their major concerns lie in power quality and development of distribution and transmission system, respectively.

Indeed, the development of distribution system may appear minor at first glance, but it is far from that. Figure 2-9 below presents the price formation of electricity of a residential consumer. In the figure, there are two types of consumers illustrated: first, column (a) illustrates a consumer connected to other than electric heating (e.g., district heating) and second, column (b) a consumer that exploits electric heating (b). On the basis of this chart, it is clear that the share of DSO is almost fivefold compared to the retailer's share, at least on the residential side. The DSO's share is partly explained by high infrastructure costs.

The price of electricity can be segregated in three categories: tax (including VAT), transmission and distribution, and energy. Although the tax system is not in the focus of this study, it has to be mentioned that value added tax (VAT) has been bound to the energy price with a fixed percentage whereas tax depends on the consumption. Hence, taxes cause approximately a third of the costs of the residential consumer's electricity (see Figure 2-9).

Furthermore, DSO's share against TSO's equivalent seems quite substantial concerning residential consumers, as seen in Figure 2-9. This is an essential point when considering how to get the consumer active in DR projects. The retailer, in turn, seems to enjoy a slight share, mirroring the tight competition that has been taken place in electricity retailer business. However, the retailer that purchases electricity from the market can control the purchase price (i.e., purchasing at cheap hours).

Taking the preceding discussion together, DSO and electricity supplier are most potential beneficiaries from DR. Of course, a 'win-win-win' situation must be attained in order to achieve prosperity and particularly the consumers should be engaged in DR (see Table 2-3). The issue concerning the consumers is that the benefits for them are hard to point out. The consumers do not feel a need for DR. Probably it is just too soon for the consumers to be interested in DR.

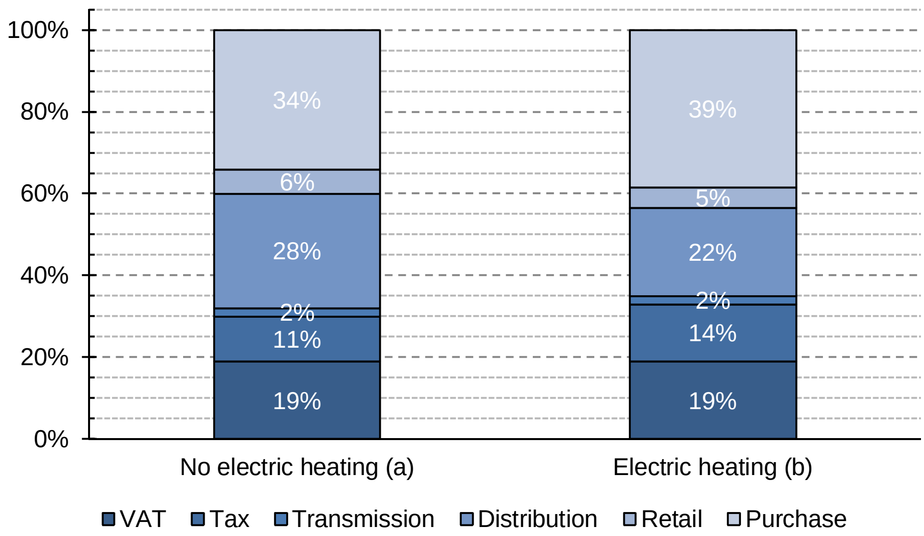


Figure 2-9: *Electricity costs distribution in the residential sector. The column on the left (a) represents a situation in which a consumer utilizes some other heating method than electric heating (€153 per MWh) and the right column (b) illustrates a case where electric heating is being exploited (€126 per MWh). Adapted from Energiamarkkinavirasto (2013).*

Consequently, the economic benefits for the suppliers are considered as direct since they are gained from the minimization of the electricity costs. Hence, the value proposition promises more accurate control over the customers' consumption. Moreover, DR would allow more accurate forecasts on the day-ahead and intra-day market, as well as reduced employment of the balancing market. Additionally, customers will receive incentive payments for complying with the supplier's load control commands or requests, and enjoy lower expenses for electricity they consume. Now, according to this vision both the supplier and consumer draw economic benefits from the DR service implementation creating a win-win situation.

Instead, the economic benefits of the regulated actors are gained generally from something that does not occur; for instance, if DSOs can avoid power losses or defer investments in the grid. Hence, the economic benefits of the regulated actors are somewhat indirect by nature, resulting in a different approach to the value proposition. Given that, the extent to which DR could bear economic value for the system operators is based on more accurate controls over frequency fluctuation and peak loads, enabling deferred investments in the transmission and distribution networks as well as manageable infrastructure for large-scale integration of RES. Ultimately these saving would mirror changes in the price of electricity, providing a win-win situation for both the consumers and system operators.

In conclusion, Chapter 2 presented the generalized structure of the current electricity system, both economic and technical. The principles of the Nordic electricity markets are also discussed. The discussion provided views on three significant market places, namely day-ahead Elspot, intra-day Elbas, as well as after-delivery balancing markets. Founding on this basic knowledge on the markets and system, the chapter afforded timely outlook on the smart grid, including relevant technologies and demand response. All this information is necessary in order to generate the value proposition of DR. In regard to DR business ecosystem, the value propositions are essentials. Moreover, every value proposition includes the vision of reduced electricity prices at the consumer end. Indeed, lower electricity prices are crucial, since the viable value proposition has to be able to provide a win-win-win business ecosystem. However, the value propositions clearly address different issues for TSO, DSO, and supplier. Consequently, conflict of interests may arise if economic and technical constraints of other participants are not addressed in exploitation of DR recourses.

The next chapter provides a comprehensive literature review on the business ecosystem concept. This and the next chapter establish a backbone for further discussion on the above mentioned conflict of interests and DR business ecosystem. Building on the business ecosystem concept, Chapter 5 endeavors to identify issues hindering the emergence of DR and overcome these issues in order to present insights how the value propositions could become reality.

3 BUSINESS ECOSYSTEM

3.1 Ecosystem perspective

3.1.1 Analogy

The word 'ecosystem' comes from the words ecology and system[5]. In the area of ecology, ecosystem is defined, for example, as "a system formed by the interaction of a community of organisms with its environment" (Costello, 1995, p. 424). That is, a biological ecosystem comprises a wide diversity of interdependent species that contribute to the ecosystem's overall wellbeing. Despite biology, or ecology, has directly little to do with the topic of this thesis, advanced analysis of this analogy is imperative to enhance one's knowledge about how ecosystems operate in the business world (Iansiti & Levien, 2004a).

Ecosystem metaphor is relatively young in the doctrine of business management, and it started to show up in the academic literature in the early 1990s. Before actual emergence in the business context, the term 'ecosystem' was coined in the area of economics. In his book, *Bionomics: Economy as Ecosystem*, Michael Rothschild (1990) argues that key natural phenomena are central at business life, too. He suggests that firms function as biological organisms and industries as species of an ecosystem—the ecosystem in which survival is a reward for efficiency and, by contrast, extinction will occur in retribution for inefficiency. In the business world, things are quite the same—companies that cannot fully exploit their scarce resources are generally bankrupted by inefficiency. Moreover, survival in an ecosystem depends on company's assets and their usage. Rothschild put it this way:

> An organization is defined by its technology and by its associations with its suppliers, competitors, and customers. From a bionomic perspective, organisms and organizations are nodes in networks of relationships. (1990, p. 213)

The corresponding analogy between nature and business is drawn also by James Moore (1996, p. 26) who argues that interacting organizations and individuals are the organisms of the business world. Iansiti and Levien (2004a) demonstrate an ecosystem observed in nature. They talk about the coastal ecosystem of the Pacific Northwest where

---

[5] Etymology: ecosystem comes from eco + system, prefix 'eco-' denoting ecology (Isaacs, Daintith, & Martin, 1991, p. 108).

sea otters help to main the healthy ecosystem by consuming vast amounts of sea urchins. In their seminal contribution, “Strategy as ecology”, Iansiti and Levien (2004a) explain that decrease in the sea otter population affects negatively on coastal fish and other organisms hindering near-shore productivity (i.e., it makes the ecosystem unhealthier). Put differently, the lower the sea otter population, the more sea urchins which, in turn, overgrazes a variety food web supporting invertebrates and plants damaging the coastal ecosystem.

Sea otters stand only for a small part of the biomass of the ecosystem. Nonetheless, the otters represent a paramount role in it and have a significant influence on the entity. In the business world, the situation is somewhat the same. That is, a keystone[6] company has a vital role in a business ecosystem concerning the ecosystem as a whole, it as if holds the other ecosystem elements in place (Iansiti & Levien, 2004b). Furthermore, due to the keystone’s behavior, some individual member of the ecosystem suffers. For example, in the sea otter case, the sea urchins get eaten by the otters lowering the urchin population which, in turn, betters the near-shore productivity. Especially noteworthy, however, is the overall health of the ecosystem that improves on some individual’s suffering. (Iansiti & Levien, 2004a.) In addition, organisms and species contribute not only to the ecosystem but the changing ecosystem contributes to the survival and success of its members as well (Iansiti & Levien, 2004b).

3.1.2 Business domain

Now, when there is understanding about how the things work in nature, the understanding can be used as a baseline while describing how they are in the business world. The term ecosystem was linked to economics in 1990, but among business and management practitioners the concept of ‘business ecosystem’ was introduced a few years later (J. F. Moore, 1993). Since its introduction, study concerning business ecosystem has increased tremendously, as shown in Figure 3-1. The data in the figure has been structured from the Web of Knowledge database using the search term ‘ecosystem*’ in the topic and limiting the search to ‘business’ and ‘management’ research domains[7]. The figure speaks the same language with Adner (2006) who claims that innovation ecosystems[8] have become a central element in the firms’ growth strategies in a wide range of industries. The rationale for this lies in the ecosystems’ capability allowing firms to create greater value together than no single firm could have created alone (Adner, 2006), or the

[6] A key member in the case of business ecosystem as well as a vital species in biological ecosystems (Iansiti & Levien, 2004a). The keystone is discussed in greater detail in Chapter 3.1.3.
[7] Web of Knowledge database on www.webofknowledge.com. Number of hits (*n* = 135).
[8] Adner talks about innovation ecosystems instead of business ecosystems; however, the constructs are used quite interchangeably in the literature although differences have been recognized.

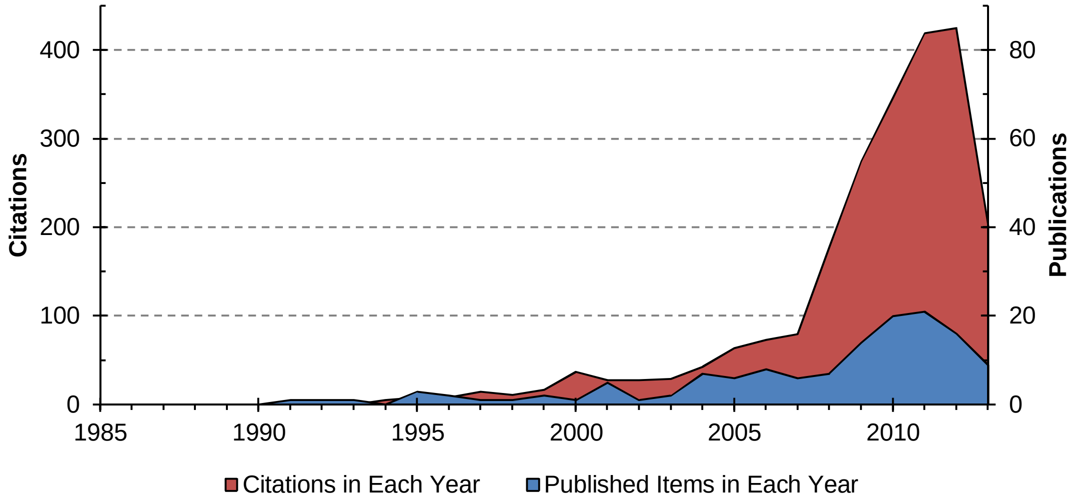


Figure 3-1: *The number of published items and citation concerning ecosystem in relation to business management research domain. Data structured on July 17, 2013 from Web of Knowledge.*

value could be even "greater than the sum of its parts" (Cusumano & Gawer, 2002, p. 58).

Consequently, what are these 'ecosystems' in business domain? In the Moore's business ecosystem, "companies co-evolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations" (1993, p. 76). The foregoing definition is quite generic, yet a unified definition is still somewhat nonexistent in the literature due to characteristics of different businesses. In spite of the lack of a unified definition, literature review reveals that the most of the scholars, however, share a common thread in their conceptualizations.

In the business world context, 'ecosystem' can be considered variously or loosely defined; nevertheless, in management research, the metaphor is often illustrated as a network of actors that are bound together through collective operations to produce a holistic entity offering value for customers and satisfying their needs (Adner, 2006; Bahrami & Evans, 1995; Ginsberg et al., 2010; Iansiti & Levien, 2004a; Lusch, 2011; J. F. Moore, 1993; Teece, 2007). In several contexts, business ecosystem is described to include actors such customers, market intermediaries, complementary product and service providers, suppliers, and the firm at issue itself (Adner, 2006; e.g., J. F. Moore, 1996; Santos & Eisenhardt, 2005). As stated earlier, characteristics vary through businesses; further, business ecosystems may also be seen constituting financing, trade associations, standard bodies, labor union, governmental institutions, universities and research institutes, and the judiciary (Adner & Kapoor, 2010; Bahrami & Evans, 1995; Iyer & Davenport, 2008; Y.-R. Li, 2009; Meyer, Gaba, & Colwell, 2005; Zacharakis, Shepherd, & Coombs, 2003).

While business ecosystem is the most commonly used concept within the structured data used in this thesis—constituting over a third of the sample[9]—there are a number of similar constructs found to describe the ecosystem in the literature. Especially during the present millennium the number of publications has increased vastly (see Figure 3-1) and different ecosystem concepts—such as industrial ecosystem (Desrochers, 2002; Sharma & Henriques, 2005; Shrivastava, 1995), innovation ecosystem (Adner & Kapoor, 2010; Adner, 2006, 2012), product ecosystem (Frels, Shervani, & Srivastava, 2003), service ecosystem (Lusch, Vargo, & Tanniru, 2010; Lusch, 2011), and technology (Adomavicius, Bockstedt, Gupta, & Kauffman, 2007; Cusumano & Gawer, 2002; Gawer & Cusumano, 2008) and technology-based ecosystem (Santos & Eisenhardt, 2005)—have been introduced (see Figure 3-2). Furthermore, one rationale behind the study around these systems is that the "benefits…are real and well publicized"[10] (Adner, 2006, pp. 99–100).

Ecosystems can be seen to have some analogies with a business model concept, too. The business model is described, for example, as "the rationale of how an organization creates, delivers, and captures value" (Osterwalder & Pigneur, 2010, p. 14), and hence the business model assesses the value logic at the firm level. An ecosystem is a cross industry network of the producers of many different types of goods and services that can be combined into different combinations (Iansiti & Levien, 2004a), and hence ecosystems transcend a single industry. For instance, Apple transcends such industries as communication industries, consumer electronics, information, and personal computer (PC) (J. F. Moore, 1993). That is, an ecosystem perspective distinguishes a network level evaluation, planning, and strategy construction although it is not a step-by-step model to build a superior ecosystem. Notwithstanding the wider lens of the ecosystem perspective in respect of the business model, it is notable that business ecosystems often have a central focus on a core firm, either a focal firm (Adner & Kapoor, 2010; Teece, 2007), a central hub or a keystone firm (Iansiti & Levien, 2004a), or a platform leader (Cusumano & Gawer, 2002).

Thomas and Autio (2012) argue that the value logic and the locus of coordination are the main differentiators between the various ecosystem models. Efficiency and flexibil-

---

[9] Sample comprises 135 articles. The three most common variants were the 'business ecosystem' ($n = 46$), 'innovation ecosystem' ($n = 29$), and 'technology ecosystem' ($n = 4$).
[10] For example, platform leadership (Cusumano & Gawer, 2002; Gawer & Cusumano, 2008; Hopkins, 2011), keystone strategies (Iansiti & Levien, 2004a, 2004b), open innovation (Chesbrough & Appleyard, 2007; Chesbrough, 2003), and value networks (Lusch, 2011; Vargo & Lusch, 2011).

Locus of coordination

Primary scope of value		Focal firm	Platform
	Efficiency/ flex-ibility	**Business ecosystem** (J. F. Moore, 1993)	(Iansiti & Levien, 2004a)
	Innovation/ externalities	**Innovation ecosystem** (Adner & Kapoor, 2010; Adner, 2006, 2012)	**Technology ecosystem** (Adomavicius et al., 2007; Cusumano & Gawer, 2002; Gawer & Cusumano, 2008)

Figure 3-2: *Varying ecosystem concepts. Adapted from Thomas and Autio (2012, p. 27).*

ity are seen as key sources of value in the business ecosystem. According to Moore's (1993, p. 76) definition, cooperation and evolving reciprocally with one another are essential in the business ecosystem, too. Iansiti and Levien (2004a) talk about the business ecosystem as well; however, they have slightly different approach. Just like in Moore's work, the locus of coordination is the firm, yet the twosome introduces value dominator called 'keystone' and use platform level coordination instead of the focal firm.

As shown in Figure 3-2, an innovation ecosystem, conversely, emphasizes innovation and externalities as the primary scope of value. Innovation ecosystems are well-known through the works of Adner (2006) and Adner and Kapoor (2010) and their study on bottleneck technologies in the semiconductor lithography ecosystem (Adner & Kapoor, 2007; Kapoor & Adner, 2007). Additionally, Adner's most recent and seminal work—used one of the backbones of this thesis later on both the theoretical and empirical stages—*The Wide Lens: A New Strategy for Innovation*, discusses the topic in great detail and propose a few unprecedented real-life examples. Nevertheless, innovation ecosystems vary substantially in complements and innovation approach from other concepts, leading to a paramount ecosystem performance as a whole. For innovation ecosystems, it is crucial that a firm identifies all the complementors[11] required—for the firm at issue as well as for each of the firm's intermediaries—to move the offer forward to the end consumer (Adner, 2006).

[11] 'Complementor' is an abbreviated version of the longer 'developer of a complementary product or service'. Brandenburger and Nalebuff (1996) introduced the role of complementor in *Co-opetition*.

Finally, the third box in Figure 3-2 contain a technology ecosystem, i.e., industrial ecosystem, that draws its benefits from complementarity and innovation as well (Gawer & Cusumano, 2008), but technology ecosystems include a population of interrelated technologies that influence the evolution and development of one another, and further, have specific technology roles depending on a context (Adomavicius et al., 2007). Moreover, unlike innovation ecosystems, the locus of coordination of technology ecosystems is the platform. In their scientific paper, "The elements of platform leadership", Cusumano and Gawer (2002) discuss the Intel's and Microsoft's ecosystems as well as Cisco's complex technology ecosystem emphasizing externalities as the primary scope of value.

With all the resemblances between business and natural ecosystems, there are also a number of distinctions between the two. To begin with, nature integrates a cyclic process. Simply put, plants grow on photosynthesis and external nutrients, herbivores feed on plants, carnivores feed on herbivores, scavengers feed on dead herbivores and carnivores, and finally decomposers feed on dead tissue and waste (i.e., plants, herbivores, carnivores, and scavengers), thus producing external nutrients to the plants. More often than not, humans, and thus businesses, work linearly. That is, the process begins with raw material acquisition, leading in general to production of goods. The production is followed by supply and distribution, in consequence of which consumers may use the goods. Unlike in nature, the used goods are seldom recycled but disposed of on the dump.

Furthermore, every element must win in a viable business ecosystem in the business world. Imagine, for example, a case where a car manufacturer sells its cars to a retailer who, in turn, resells the cars to consumers. Now, the retailer has to put purchase price premium (i.e., sales margin) on a vehicle to do viable business in the long run. The purchase price premium is essential to the retailers since they have to pay the rents, salaries, electricity, etc. Moreover, the customers cannot 'win' without the retailers. They cannot benefit from car purchases if there is no place to buy one. In other words, if one element in the ecosystem loses everybody loses. However, it is hard to see how a gazelle wins when lions feed on it, albeit every other species win. One more distinction to be mentioned is that species are seldom cannibals, whereas firms are constantly trying to edge any other companies out which operate within the same industry. The cannibals are referred to as "wannabes" by Cusumano and Gawer (2002, p. 52).

Yet another difference concerns heredity. While biological organisms pass on of qualities genetically from one generation to another, firms do not inherit the characteristics of their parent companies—at least not as surely as biological organisms do. Through heredity and natural selection, some species have been able to evolve. Obviously companies evolve, too, but generally through innovation. That is, being a spin-off does not guarantee the success of a business, even if the parent company was successful. However, a company might live forever if it manages to keep pace with innovation and environmental change, whereas all organisms eventually die.

After all, it must be noted that the whole natural (or business) ecosystem is an artificial model, a human concept about the relations among species (firms). Moreover, Adner argues "management frameworks in general, and strategy frameworks in particular, should be approached with suspicion" (2006, p. 106). However, the ecosystem concepts are useful abstractions and "to be perfect, an analogy would have to be so simplistic that it would offer little real insight" (Iansiti & Levien, 2004a, p. 72).

3.1.3 Actors and their roles

Keystone firms are potentially the most significant actors in business ecosystems. A keystone plays a crucial role as laying the foundation for other companies, striving to improve the overall health of their ecosystem. Ecosystem productivity may increase due to the keystone's activities, for example, simplifying the complex network of actors and making it easier for the firms to create connections with one another in the network. Conversely, in many cases, the whole ecosystem may collapse if the keystone is removed. (Iansiti & Levien, 2004a.) The keystone is also referred to as platform leader that direct industry-wide innovation toward a robust ecosystem contributed by separately developed pieces of technology (Cusumano & Gawer, 2002), or ecosystem leader that encourages actors to work cooperatively to continue improving the complete offer (J. F. Moore, 1993). As mentioned in the sea otter case (pp. 37–38), in spite of the keystone having a greater power in the ecosystem (J. F. Moore, 1993)—and hence, claims a disproportionate rate of value within it (Iyer & Davenport, 2008)—the keystone stands only for a small part of the 'biomass' of the ecosystem (Iansiti & Levien, 2004a).

A keystone of being a keystone is the aforementioned platform that complementors and other actors can rely on while developing their own offerings. For instance, Iyer and Davenport (2008) illustrate Google's ecosystem wherein Google plays the role of a keystone controlling the evolution of its ecosystem. In that ecosystem, Google is the hub of all germinal revenue streams—i.e., all the transactions are performed through the Google platform—enabling the firm to have complete awareness of by-product information and access to it. Just like Google, Apple, Ford, IBM, and Wal-Mart have all stood—or still stand—on podium of the leader as well (J. F. Moore, 1993). Similarly, Iansiti and Levien (2004a) illustrate the Wal-Mart's ecosystem as well and Cusumano and Gawer (2002) talk about Microsoft, for instance. Moreover, a firm cannot decide to become a keystone or ecosystem leader solely by itself, but the rest of the community (e.g., complementors and suppliers) apprentice the leadership over time (J. F. Moore, 1993).

Roles, such as keystone and complementor, are not static in the ecosystems (Iansiti & Levien, 2004a), albeit keystones, though, encourage all the other ecosystem actors to invest in cooperation and toward a common, more lucrative future (J. F. Moore, 1993). Shifting roles in an ecosystem, in process of time, may alter the 'hierarchy' (J. F. Moore, 1993) or a firm may be a keystone in one domain and, for instance, complementor in another (Iansiti & Levien, 2004a). Microsoft is one example of a firm which is simultaneously a platform leader and a complementor for the PC. Primarily, Microsoft is the platform leader due to the influence it creates over PC system architecture and other, complementary products manufacturing companies; however, at the same time, Microsoft is a complementor making ancillary software that the PC makers can utilize in their offerings (Cusumano & Gawer, 2002).

In any given ecosystem structure or 'hierarchy', the competitive advantage of the firm is reliant on the firm's ability to create value greater than its rivals' (Brandenburger & Stuart, 1996; Porter, 1985). In value aspect, an effective keystone strategy has two parts: the creation of value within the ecosystem and the sharing of value within others participants in the ecosystem (Iansiti & Levien, 2004a). Iansiti and Levien (2004a) argue that, in the first place, to create value for their ecosystem a keystone has to establish a platform, a physical or intellectual asset that affords viable solutions to other ecosystem members. For instance, Taiwan Semiconductor Manufacturing provides semiconductor manufacturing for the firms that do not have their own substrate (e.g., silicon-wafer) production, and Microsoft offers the Windows OS (operating system) platform. The Internet giant eBay is mutually a good example of a keystone company that shares the value it creates with other members in the ecosystem, and by doing so, eBay is continuously expanding its business and ecosystem (Iansiti & Levien, 2004a).

As the roles in an ecosystem are not static, wannabes (firms that want to be keystones) are frequently challenging the keystone firms and trying to dethrone the platform leader from its position (Cusumano & Gawer, 2002). An ecosystem member trying to edge other players out can also be referred to as the dominator. In nature, dominators such as weeds try to supplant other species in their ecosystem. Similarly, in the business world, dominators try to dethrone keystones and niche players in their business ecosystem. Foregoing niche players represent the majority of companies in the business world, like the majority of species in nature, with an important contribution to the prosperity and existence of their ecosystem. (Iansiti & Levien, 2004a.) Taking the role of niche players into consideration, they can be referred to as complementors, as well. For example, in the PC industry, there are numerous niche players manufacturing hardware and producing software for the platform leaders that eventually take the advantage of niche play-

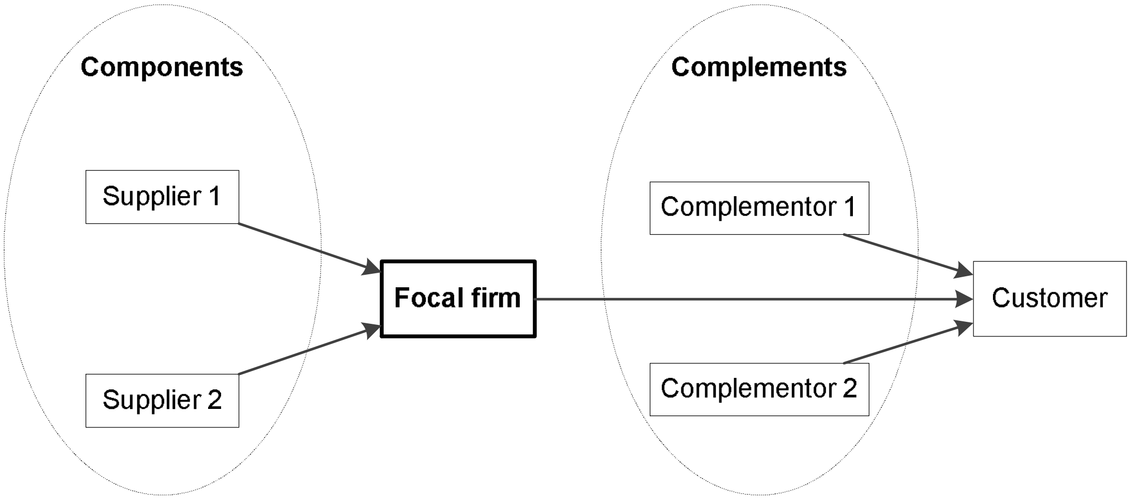


Figure 3-3: *Generic schema of an innovation ecosystem. Adapted from Adner and Kapoor (2010, p. 309).*

ers' innovations. That is, niche players function as complementors for platform leaders or focal firms[12].

Milgrom and Roberts (1990) argue that the clustering of focal firms, complementors, and niche players is no accident, but rather a strategy to exploit complementarities. The role of bargaining power, co-specialization, and relationship between business network partners in shaping companies' value capture have been explored in the strategy literature; notwithstanding these studies, the question of fundamental creation of value has hitherto tended to be disregarded (Adner & Kapoor, 2010). The question is important as the market does not operate properly if the imitation of innovations is easy and innovating firms do not accrue profits intended for them (Teece, 1986). Additionally, the presence of different roles and actors in the value chain has been distinguished, albeit the specific value chain position of an exchange party (e.g., a supplier, complementor, or buyer) relative to the focal firm has seen negligible (Adner & Kapoor, 2010). However, the need for "the innovating firm to establish a prior position in these complementary assets" has been noticed a long time ago (Teece, 1986, p. 285).

Adner and Kapoor seize upon the foregoing 'flaw', and they propose a perspective that "exploits the relative location of activities within the ecosystem to distinguish among the different roles played by various actors in the firm's environment" (2010, p. 309). In their framework, the flow of inputs and outputs determines the locations of activities in

[12] NVIDIA is one example of a niche player in the computing ecosystem, in which it designs computer graphic cards, provides customer support, and deals with marketing (Iansiti & Levien, 2004a). The good examples of platform leaders are Intel and Microsoft, discussed by Cusumano and Gawer (2002).

the ecosystem; see Figure 3-3 for a depiction. The focal firm receives inputs from the upstream suppliers whereas their outputs serve as components to the focal actor. The focal firm assembles the components into its product and delivers it forward as an output. As for the focal firm's product, it serves as an input to a customer who might also need complementors' inputs to be bundled alongside the focal firm's product to utilize the offering in the meaningful way. The central idea in the model is the location of elements relative to the focal firm; furthermore, it does not make any difference whether components or complements are produced in the same firm or not (Adner & Kapoor, 2010).

The central idea can be understood in the light of an illustrating example. Samsung is a manufacturer of TVs, tablets, smartphones, cameras, laptops, Blu-ray players, etc. that all are separate offers even though the value offering firm is common. For instance, Samsung TVs can be seen as the focal offer to end customers and Blu-ray players as complements. The focal offer and the complement are brought together by the customer regardless of whether the Blu-ray player is offered by Samsung or Sony. The study can be extended backward and forward along the activity chain, of course, but it is not meaningful or necessary in this thesis. In the next section, there is another example examined in more detail from a semiconductor lithography industry.

3.1.4 Empirical context: semiconductor lithography

Semiconductor lithography (also called photolithography) is used in manufacturing of integrated circuits (IC). Put simply, in the lithography process, a three-dimensional circuit design is imprinted on a semiconductor (e.g., silicon) substrate. Adner and Kapoor (2007, 2010), as well as Kapoor and Adner (2007), illustrate the semiconductor lithography ecosystem and how the ecosystem as a whole, rather than individual elements, determines how fast and how far the semiconductor manufacturing advances. Figure 3-4 provides a straightforward scheme of the semiconductor lithography ecosystem comprising the component suppliers (lens producers and energy source producers), focal firm (lithography tool producers), complementary products manufacturers (mask producers and resist producers), and customer (semiconductor manufacturers). The semiconductor lithography ecosystem has not changed since the birth of the industry and will probably not change in the near future either, unless "an existing element of the ecosystem reaches a breaking point" or "an alternative approach…could emerge" (Adner & Kapoor, 2007, p. S20). Despite the stability of the ecosystem structure, there have been a vast amount of varying challenges across the technology transitions (Kapoor & Adner, 2007).

By following Kapoor and Adner (2007), in the semiconductor lithography ecosystem (see Figure 3-4), the lithography tool producers serve as the focal firms, subsequently offering the lithography tools to their customers (i.e., semiconductor manufacturers). As

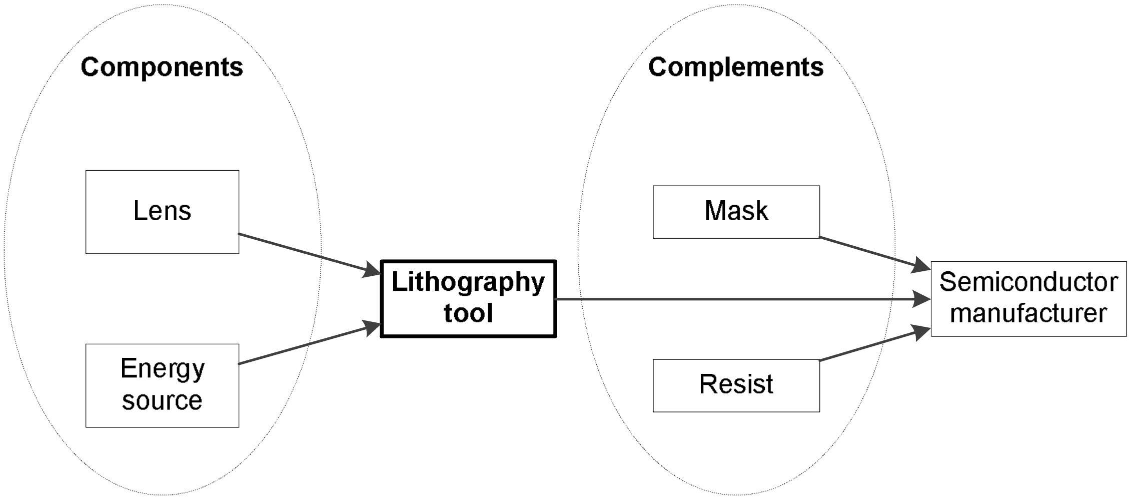


Figure 3-4: *A schema of the semiconductor lithography ecosystem. Adapted from Kapoor and Adner (2007, p. 52).*

for lens producers and energy source producers, they function as the key components suppliers that lithography tool makers need in their offers. Ultimately, in addition to lithography tools, the semiconductor manufacturers are reliant on the two key complementors—mask producers and resist producers—to completely fulfill their value proposition (Adner & Kapoor, 2010). Furthermore, in the semiconductor lithography ecosystem, the focal firm can be comprehended as a module producer for the semiconductor manufacturer utilizing the two complementors in its offering, as well. Reciprocally, the lithography tool producer can also be seen as a platform for the components suppliers in the upstream.

In the semiconductor manufacturing industry, the progress of lithography has been a major engine striving for the advance of the industry as a whole (Kapoor & Adner, 2007). In the same way as semiconductor manufacturing is reliant on the development of the lithography tools it is also reliant on its complements, and further, the lithography tool producers cannot advance their offerings without the development of components. That is, an innovation capacity of a focal firm is not solely sufficient but both downstream complementors and upstream component suppliers have to evolve along and be capable of serving an adequate level of functionality and efficiency within the desired timeframe to make the final offering development possible. Contribution of every actor is *de rigueur* for the ecosystem to evolve—and the customer experience to enhance, too—in Moore's (1993, p. 76) words, actors "coevolve capabilities around a new innovation". In the sequential section, a new, seminal insight into ecosystems is discussed and subsequently used in the empirical phase.

3.2 Value blueprint

3.2.1 A view on ecosystem

According to Iansiti and Levien (2004a), an effective keystone strategy includes two parts: value creation and sharing. Also a firm's competitive advantage is dependent on its ability to create greater value than its competitors (Brandenburger & Stuart, 1996; Porter, 1985). Adner's (2012) value blueprint offers a mapping tool how to render a firm's value proposition into action. Furthermore, Adner notes

> Drawing a value blueprint is an exercise in discipline that forces you to construct the entire picture around your project *at the beginning*. It shows you where you have a coherent strategy, where you have inconsistencies, and where you are just hand waving. (2012, p. 100)

Assessing alternative configurations and to generate shared understanding and agreement among the partners, a firm will need a tool to converge multiple elements together. Related to the value and supply chains, the value blueprint is a unique tool that differs from the latter in that it is explicit about the specific location and links of complementors that are critical for firm's or innovation's success (Adner, 2012). Essentially, the value blueprint builds on the fundamental works and perspectives of authors such as Michael Porter (1985), Brandenburger and Nalebuff (1996), Clayton Christensen (1997), and Charles Fine (1998), with a distinction of a focus on delivering the value proposition in the most effective way (Adner, 2012, p. 245).

The value blueprint explicitly maps a firm's ecosystem and its dependencies on suppliers and complementors, as depicted in Figure 3-5. The elements that are required to deliver the value proposition are laid out on the value blueprint map. Adner (2012) states that the map shows how intermediaries are linked to complementors and complementors to suppliers, how a firm is positioned in the ecosystem, and which actors are responsible for what (see Table 3-1). Each participant has to be in place in order to ecosystem come together as a whole. Furthermore, this kind of collaboration is most likely to entail co-operation-related risks.

By following Adner (2012, pp. 33–35), the risks of innovation can be assessed through three risk categories: execution risk, co-innovation risk, and adoption chain risk. In Brian Leavy's (2012) interview with Ron Adner, Adner explains that it is the execution risk that has been historically taken great care of—it has been important to develop innovations valued by customers and deliver them better than competitors. Nowadays, a plain risk assessment is not enough; the ecosystem has to be taken into account. For instance, focusing only on the execution leads firms to neglect their dependencies on other actors that increase co-innovation and adoption chain risk.

The discovery of a new innovation involves execution risk; the innovation should be valued by customers. The innovation has to entail at least required specification, and it has to be launched within the required time (Adner, 2012, p. 33). As for co-innovation risk, it takes other actors' innovations—that are requisite for the value proposition to take off—into consideration as well, meaning that the innovation will not thrive without key complements. Furthermore, Adner (see Leavy, 2012) argue that complementor co-innovation risk measures the probability of failure associated with other actors. In other words, the probability depends on how likely all other actors will be able to succeed within a required time. For instance, if a firm's collaborators will be able to deliver the offering on the 0.9 probability, then the probability that five collaborators will deliver on time is not fivefold but $0.9^5 \approx 0.59$, or approximately 59 percent. Hence, the key principle is that the co-innovation risk is not about average, but multiplication.

In addition to execution and co-innovation risk, adoption chain risk is the third risk category Adner describes. In Leavy's (2012) interview, Adner explains that adoption chain risk is about intermediaries; one or more intermediaries have to adopt the innovation before it has a chance to reach end consumers with full potential. That is, if one of the intermediaries does not benefit from the new innovation, the intermediary will not make the necessary adaptations to its own activities and the innovation will never reach the end consumers. Assessing adoption chain risk, a firm must ensure that the adoption of the new innovation will benefit every intermediary in the ecosystem.

Clearly, it is crucial to firms to critically assess both co-innovation risk and adoption

Table 3-1: *Definitions for various actors that are fundamental in the creation of a value blueprint. Adapted from Adner and Kapoor (2010), Adner (2012), and Cusumano and Gawer (2002).*

Actor	***Definition and role***
Supplier	Suppliers are actors who provide crucial input to focal firm. Focal firm needs supplier(s) in order to offer a complete product to end customer.
Focal firm	Focal firm is the most central company in the ecosystem.
Intermediary	Intermediary is actor that must adopt focal firm's innovation before it reaches end customer.
Complementor	Complementor is an essential actor in the environment, outside of focal firm's direct supply chain. End customer cannot utilize focal firm's offer to its full potential without key complementor(s).
End customer	End customer is the final target of the value proposition of focal firm. End customer's need to adopt the product for focal firm to claim success.
Wannabe	A company that endeavors to be platform leader (i.e., focal firm).

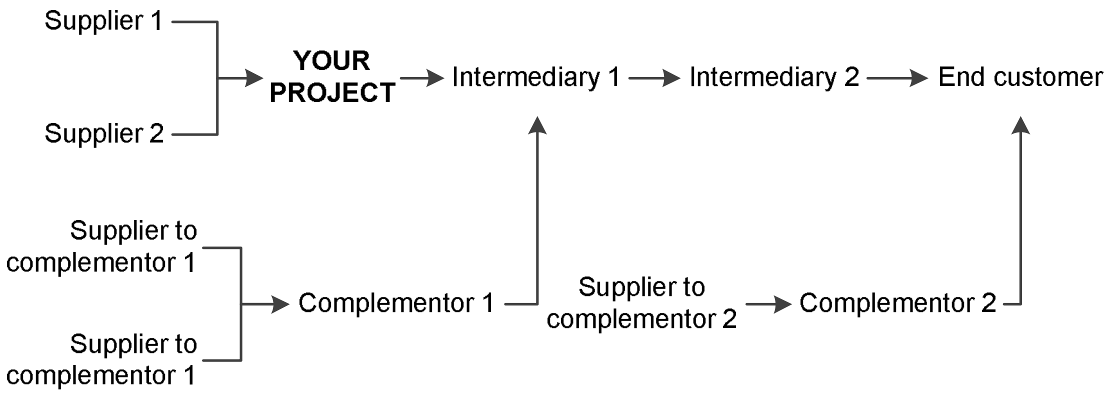


Figure 3-5: *A schematic value blueprint map illustrating the actors and their roles in the ecosystem. Adapted from Adner (2012, p. 87).*

chain risk. The critical assessment of the risks would help innovator firms identify and more precisely structure their partners, since the success of these partners is necessary for the innovator firms' success. Mapping the value blueprint through risk analysis helps firms to decide, clarify, and understand what the structure of the collaboration would possibly look like—where the partners are specifically located in the activity chain and what are their roles in delivering the overall value (Leavy, 2012). Ultimately, the value blueprint shows how activities are bundled together and what is the role of each element in the ecosystem; see visual depiction in Figure 3-5.

In order to get the participants in right places, Adner (2012, pp. 85–87) provides an eight-step guide to construct a value blueprint:

1. Identify end customer.
2. Identify your own offering.
3. Identify your suppliers.
4. Identify intermediaries.
5. Identify complementors.
6. Identify the risks in the ecosystem.
7. Identify a viable solution for every partner unable or unwilling to cooperate.
8. Update the blueprint on regular basis.

The straightforward steps to construct the value blueprint are quite simple to follow. At first (steps 1 to 5), all the actors have to be identified. Working backwards from the recognition of the end consumer, a firm has to recognize its position in the ecosystem as well as its suppliers and direct intermediaries. More difficult but necessary is to identify the actors who the firm has no immediate contact with, yet they are involved in creating the value proposition. After every participant is identified, the second part (step 6) entails assessing the participants' co-innovation and adoption chain risks. (Adner, 2012, pp. 84–87.) Furthermore, mapping the value blueprint gives a firm "a tangible form to the value proposition" and helps in refining its strategy (Leavy, 2012, p. 17). The foregoing guide to construct a value blueprint is simplified from detailed guide provided in Appendix 2.

Adner (2012, pp. 86–88) argues that not the ownership but the elements themselves are what matters. Either the elements come from the same firm or not, they have to be assessed separately when identifying the relationships among the elements and how to identify and address the risks that are inherent in collaborative ecosystems. Nonetheless, it is not necessary that a new innovation sees no obstacle in its path, but a firm must have a plan how to overcome the obstacles it sees. There can be several different scenarios and often it is as an iterative process to find the most promising path. However, making the necessary adjustments beforehand is what sorts the wheat from the chaff. That is, ignoring the steps six and seven may lead into a catastrophic end result.

In order to make the adjustments, Adner (2012) provides five levers of ecosystem reconfiguration. The ecosystem reconfiguration entails finding a new way to piece together the elements of the jigsaw. Adner (2012, pp. 177–178) argues that the five means of reforming an ecosystem are relocate, separate, combine, add, and subtract, as depicted in Figure 3-6. Taking an imaginary ecosystem to enlarge on, 'relocate' means shifting existing elements in the ecosystem to new, more productive locations, if possible. Another technique is to decouple bundled elements, meaning whether there is a way to separate some activities to eliminate a bottleneck. Obviously, 'combine' denotes the exact opposite of the latter; that is, to seek for an opportunity to bundle elements that are uncoupled such that it creates new value. Similarly, 'add' and 'subtract' are the other opposing levers, meaning including absent elements in the ecosystem to facilitate the productivity or eliminating existing elements in order to enhance the overall viability of the ecosystem, respectively.

Furthermore, while configuring or reconfiguring a business ecosystem, one can take advantage of a number of effective practices that could help in developing a vision and strategy for a platform or innovation. For example, Gawer and Cusumano (2013) list effective practices for platform leadership, including development of a vision of a product's essentialness, identification of complementors, building an easy-to-connect architecture for complementor, co-creation via mutually enhancing business models, risk sharing, incremental improvement on the core, etc. However, they note that the mechanisms behind the emergence of industry platforms are yet unclear and an important area of further research. As a result, Gawer and Cusumano conclude "the difficulty to follow the emergence of platforms may be compounded by the inherent methodological difficulty involved when attempting to follow the emergence of an unknown entity, when

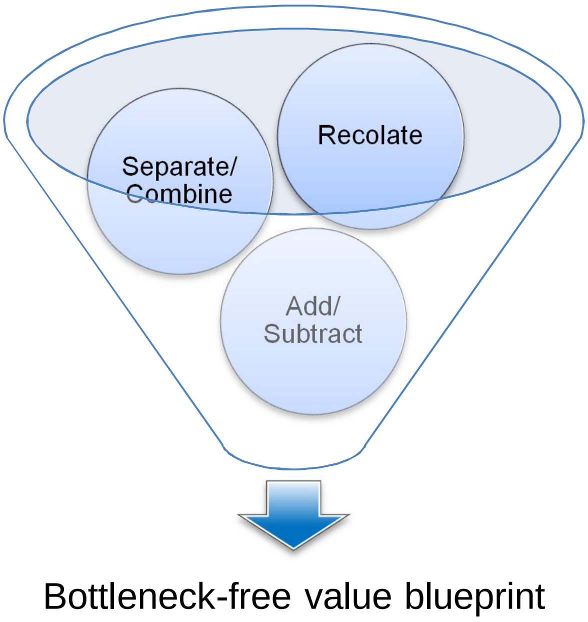


Figure 3-6: *Five means of ecosystem reconfiguration to attain a bottleneck-free value blueprint. Adapted from Adner (2012, p. 178).*

one cannot know ex ante who the actors involved in the emergence process will be" (2013, p. 13).

Indeed, it seems to be extremely troublesome to identify the crucial actors and their locations in an ecosystem. Especially, when a firm cannot know in advance who the actors involved in the emergence process will be (Gawer & Cusumano, 2013). On the other hand, although a firm manages to identify the actors, placing them right is not an easier task. For instance, Sony 'felt the pinch' as its portable electronic book reader revealed to be unsuccessful, as seen in the forthcoming section.

3.2.2 Empirical context: Sony versus Amazon

Both Sony and Amazon launched—quite similar—electronic book readers in 2006 and 2007, respectively. Both knew that there was a market for e-book readers sporting high-quality and entertaining features (Leavy, 2012). Similarities notwithstanding, Sony's PRS-500 Portable Reader misfired, but Amazon's Kindle succeeded. Adner (2012, pp. 88–99) argue that Sony's failure in developing the market for e-book readers was neither due to an inferior device nor lack of customers but not seeing a blind spot that adoption chain created. Amazon's drastically divergent approach to content and design differentiated it from Sony. The differing approaches considering value creation led Sony and Amazon to the different approaches considering the value delivery and, further, radically differing value blueprints (see Figure 3-7 and Figure 3-8). Ergo, what did the two giants make differently? In the figures, the status of an element is symbolized

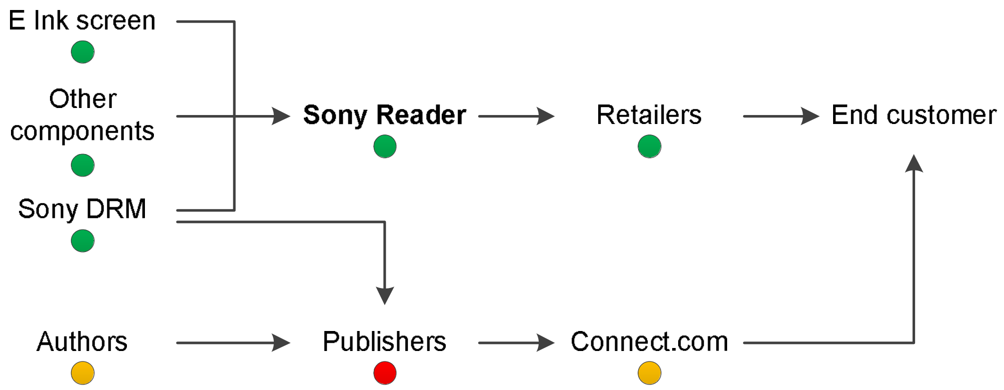


Figure 3-7: *The value blueprint of Sony's e-reader at launch in 2006. Adapted from Adner (2012, p. 94).*

by using a green-yellow-red traffic light continuum, reflecting whether the corresponding element is either all set (i.e., green), nearly but not just quite ready (i.e., yellow), or not even close of being ready (i.e., red)[13].

As depicted in the Figure 3-7, at launch time, the Reader underwent a clear, all-lights-green path across the line of the project (Sony Reader), suppliers (E Ink screen, other components, and Sony DRM), and intermediaries (retailers). Nevertheless, targeting the mainstream book readers, Sony's endeavors to manufacture a great device were not enough as the target customers needed also something to read. That is, the Reader required a complementary service delivering e-books in its ecosystem. Complementors, such as Sony's own online retail outlet Connect.com, were needed to complete and deliver the actual value proposition. However, even if the Connect.com had worked and succeeded in enticing people to use it, the blind spot lay in a critical adoption chain partner—the reserved publishers. (Adner, 2012, pp. 88–99.) Sony presumed that publishers would be enticed to participate by a superior design and eventually come along (Leavy, 2012). In truth, Sony designed its entire proposition not focusing on the publishers from which reason the publishers found themselves in a very uncomfortable position (Gusen, 2012).

On the contrary, Amazon entered the fray with the publishers very clearly in mind (Gusen, 2012). Amazon's Kindle was larger and heavier than Sony's Reader, and it had an inferior screen (Adner, 2012, p. 96). In addition, the Kindle was designed as a closed

[13] "For co-innovation risk, green means that they are ready to and in place; yellow means that they are not yet in place, but that there is a plan…and red means that they are not in place and there is no clear plan. For adoption risk, green means your partners are eager to participate…yellow means that they are neutral but open to inducement; and red means they have clear reasons to prefer status quo and prefer not to participate in the proposition as it stands." (Adner, 2012, p. 86)

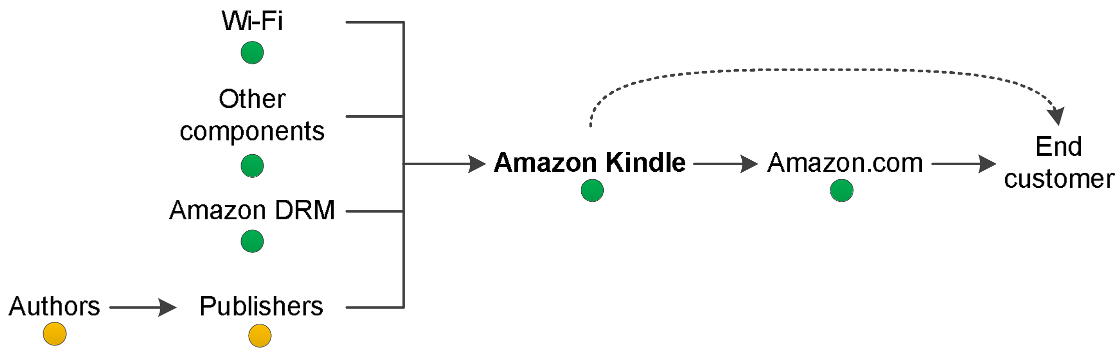


Figure 3-8: *The value blueprint of Amazon's Kindle at launch in 2007. Adapted from Adner (2012, p. 96).*

platform that did not let users to share or print books (Leavy, 2012). All the limitations were carefully considered and put in. Amazon made the Kindle inferior to the Reader on purpose and engineered a solution instead of a mere device. From the vantage point of the end customer, the Kindle offered a simple and inexpensive way to enjoy an expansive collection of titles—on Amazon.com—without the need of the PC or other devices to download books. (Adner, 2012, pp. 95–97.) As a stand-alone device, the limitations it had also offset the publishers concerns about DRM (digital rights management) and piracy issues, doing the device justice and making it more attractive to publishers (Gusen, 2012; Leavy, 2012). Amazon made the necessary adjustments beforehand and ensured that publishers were involved in and not showing the red light at launch (Leavy, 2012).

Obviously, Amazon won the bout by offering a solution instead of a mere device. Jeff Bezos, the then CEO of Amazon, described this revolutionary idea by saying that the Kindle "isn't a device, it's a service" (see Levy, 2007, p. 58). Amazon succeeded by recognizing an adoption chain risk and realized that the challenge as an innovator was not finding the win-win situation (i.e., both Amazon and end customer would win), but finding a solution in which all win, including Amazon, end customer, and adoption chain partner, namely publisher (Gusen, 2012). In spite of the compelling vision of Sony's product, Amazon simplified the value proposition for all the other actors involved, as seen in its value blueprint in the Figure 3-8. Adner argue that (2012, pp. 95–98) Amazon also had a clear vision how to turn the two yellow lights to green while Sony was without a clear plan how to turn red to green.

Worth mentioning is the fact that Amazon was responsible for approximately thirty percent of books sold in the United States; obviously, publishers had to regard with greater attention to Amazon's Kindle (Adner, 2012, pp. 95–98). After all, even one red light is enough to condemn offering to a doom because, in Adner's words, "if it's [value proposition] 'win, lose, win', you lose" (see Gusen, 2012, p. 89). For this reason, the subsequent discussion on DR business ecosystems aims at identifying the loose links, impeding the adoption of DR. Furthermore, later discussion endeavors to find a ‘solution’ instead of a mere application (referring to DR).

4 RESEARCH METHOD AND MATERIAL

4.1 Method and strategy

As it is mentioned in the introductory chapter hereinbefore, this study was conducted using qualitative technique to collect data. Qualitative research methods, as van Maanen attests, can be described “as an array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena” (1983, p. 9). In this study, qualitative research methodology was employed such that multiple DR ecosystem cases (see Appendix 3) were examined through the implementation of focus group discussions.

Qualitative technique can be utilized regardless of research philosophy, thus little limiting the approach taken. That being said, in terms of research philosophy, a perspective of realism entails a perception of reality and absolute truth (Saunders et al., 2009, p. 129). The distinctive feature of realism is a trust that an unobservable reality exists, of which theories of science can give us knowledge (Godfrey & Hill, 1995). Positivism, in turn, presumes the end products of studies to be generalizations, comparable to those in the natural sciences (Saunders et al., 2009, p. 129). The descriptive nature of this study implicates that neither the truth yet exists nor will the end result be generalizable as such, meaning that the approach of this research cannot be from either a realist or positivist perspective. Furthermore, since an ‘empathetic stance’—that I have not adopted—is a crucial element to the interpretivism philosophy (Saunders et al., 2009, p. 116), the interpretivist perspective could not be considered as approach. As a result, I have conducted an approach of pragmatism that Saunders et al. state having a “focus on practical applied research, integrating different perspectives to help interpret the data” (2009, p. 119).

Owing to the exploratory nature of this research (Robson, 2002, p. 59), it is not clear whether to exploit a deductive or inductive research approach. Hence, as discussed earlier in the introductory chapter, this research utilizes a combination of deduction and induction, employing some aspects from both. In short, as Saunders et al. (2009, p. 129) attest, the inductive approach is based on collected data from which a theory is developed, whereas the deductive one operates *vice versa* (i.e., tests a theory). Here, the ecosystem framework stems from literature and further, the existing literature is employed to formulate the research question and objectives. On the other hand, this study presumes a close understanding of the research context, which, in turn, seems to has few, or lack, proper real-life cases in liberalized markets (e.g., Finland and other Nordic countries), from which to gather the empirical data.

As the research has both deductive and inductive aspects as well as the exploratory and descriptive purpose, it was appropriate to choose a multi-method qualitative study as a research strategy (Saunders et al., 2009). That is, by using this strategy multiple qualitative data sources were possible to conjoin to strengthen the validity of the study. Furthermore, this research is cross-sectional concerning time horizon since the available time constrains the use of longitudinal study. However, longitudinal research on DR ecosystems would be interesting indeed, since the electricity markets and corresponding market-wise business models are likely about to change when new smart grid technologies emerge.

Taking the preceding discussion together, this study endeavors to increase the grasp of DR business opportunities and threats through novel insight into this field, accompanied by workshops, focus group discussions, and secondary sources. The emphasis here was put more on the ecosystem framework and how this particular framework mirrors the opportunities and threats surrounding the potentially emerging DR services in the Nordic countries and Finland. I do not take a stand on whether the framework is the most feasible one in this field or not, although van Aken attests “all good theories are practical, but some are more practical than others” (2004, p. 220). The chosen framework is to interpret and read issues from a different aspect. Moreover, as Adner states, a framework generally “presents elements and relationships that provide a grammar for the debate” (2006, p. 106). In actuality, the purpose of this study is to provide DR ecosystems that present elements and relationships that provide a basis for the further discussion.

4.2 Material

The material used to accomplish this research comprises literature review and workshops under SGEM organization. The literature provides a theoretical foundation for the electricity markets as a whole and DR in particular as well as the business ecosystem framework contributing this study. The electricity market having its own unique elements is discussed in the separate chapter from business ecosystem scheme, thus giving a practical structure for the study. Three DR workshops and several discussion sessions had a significant contribution to the research. Moreover, the last workshop provided the main input into the study, since it was organized around the DR ecosystem theme.

As mentioned, the literature is the twofold one of the electricity market and business ecosystem. The chapter of the electricity market is to clarify the industry and corresponding industry-specific functions. The chapter at hand also presents the idea of DR, including the assessment of its value. The literature on and knowledge of the Nordic electricity markets are somewhat unambiguous as such, albeit one can argue that the markets and certain functions could be rendered better. Nevertheless, the electricity market is not a framework, but an operational environment that defines certain boundary conditions (e.g., the unbundling of DSO and supplier). Customer value, in turn, is more nebulous and subject to interpretation since it depends on various variables. Consequently, the literature on DR was scrutinized widely with the intention of acquire as broad knowledge of DR as possible in order to develop possible value propositions. The literature, too, served as a secondary source of questionnaires, interviews, and case studies, affording more depth to the research at hand.

Another half of the literature review presents the business ecosystem framework. To begin with, the objective of this study is not to validate the comprehensiveness of the framework, as discussed hereinbefore. Rather, the rationale is to provide new insights into the field and increase consciousness of business perspective in the selected setting. As presented in Figure 3-1 (p. 39), the interest in business ecosystems has increased greatly during the past five years, reason of which leading academic journals have issued a number of valid articles to offer a foundation on which to build. However, in his seminal publication, *The Wide Lens: A New Strategy for Innovation*, Ron Adner (2012) presents the value blueprint concept, which act as a backbone for the whole research.

As the title of the Adner's book implies, the value blueprint mandates the consideration of the business ecosystem through a wide lens. The wide-lens examination of DR ecosystems necessitates extensive knowledge of and view on the electricity market. Hence, several experts on various disciplines were obtained to proffer advice and information (see Table 4-1). The contributors listed in the table below provided a significant input on the study as a whole; further, eleven out of sixteen (prefixed by a star) participated in the last DR workshop, thus affording roughly superior contribution to other participants. As seen in the table, the affiliations vary favorably, improving the validity of the workshops overall discussion and as if smoothing the likelihood of affiliation bias.

The workshop events comprised three separate occasions, each of which was convened via an e-mail invitation sent to people contributing to DR-related SGEM work package. The e-mail invitations contained topics for the corresponding workshop as well as the timetable for the day. The five-and-a-half hour workshops were timetabled to commence at 10 p.m. and dealt with two to four topics each. From each workshop, the participants' names were collected and the outcomes documented as well as shared to be available in the SGEM portal for later inspection and use.

As for the events, the first event incorporated topics about load and response modeling as well as price settlement by HEMS, the event took place on June 4th. The event concentrated mainly on technology perspectives concerning DR and its applications, yet providing essential background information on business vantage point as well. Likewise, the second workshop, held on September 19th, focused largely on technical aspects of DR and DSM; however, the event entailed a salient view on DR pilot programs—both the past and forthcoming. Concerning this study, the most quintessential knowledge was provided in the third workshop on October 28th. The workshop included an in-depth focus group discussion concentrating on DR business aspects, specifically business ecosystems.

I adopted a focus group discussion method as the means of collecting primary data and to carry out the workshops due to its suitable characteristics for this research. Focus group is defined by Powell et al. as “a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research” (1996, p. 499) and, according to Morgan, the topic is also “supplied by the researcher” (1997, p. 12). Moreover, the purpose of a focus group discussion is to gather information by listening (Krueger & Casey, 2000, p. 4). The focus group discussions differ from many other data collecting techniques in that it may be conducted in a non-directive and unstructured manner to aid in the development of the researcher’s understanding and analysis of an issue at hand (Gilmore & Carson, 1996). Hence, relaxed and comfortable discussions lighten the atmosphere of the focus group

Table 4-1: *List of people contributing the empirical stage of the research. Star (*) symbolizes a person that involved in the focus group discussion (i.e., the third workshop event).*

	Contributor	***Education***	***Affiliation***	***Title***
*	Alfa	Ph.D.	Research	Associate professor
*	Bravo	Ph.D.	Research	Professor
*	Charlie	M.B.A. & Ph.D. student (Tech.)	Utility (U.S.A.) / Research	Smart grid executive
*	Delta	Ph.D. student (Tech.)	Research	Research assistant
*	Echo	M.Sc. (Tech.)	EM service provider	Application specialist
*	Foxtrot	M.Sc. (Tech.)	Technology	Project engineer
*	Golf	M.Sc. (Tech.)	Research	Research scientist
*	Hotel	-	Technology	-
*	India	M.Sc. (Tech.)	DSO	Development engineer
*	Juliett	E.M.B.A.	EM service provider	Development director
*	Kilo	M.Sc. (Tech.)	Supplier	Development engineer
	Lima	Ph.D.	Technology	Managing director
	Mike	Ph.D.	Research	Senior research scientist
	November	M.Sc. (Tech.)	TSO	Manager, R&D
	Oscar	M.Sc. (Tech.)	Construction	Project engineer
	Papa	M.Sc.	Technology	Chief technology officer

discussions which may often be enjoyable for participants (Casey & Krueger, 1994), thus leading probably to comprehensive and frank conversation. Finally, the discussions are carefully and systematically analyzed afterwards, providing insights into the issue and how it is perceived by various individuals (Krueger & Casey, 2000, p. 4).

Furthermore, as Krueger and Casey clearly suggest, the focus group discussions typically have five characteristics that "relate to the ingredients of a focus group: (1) people who (2) possess certain characteristics and (3) provide qualitative data (4) in a focused discussion (5) to help understand the topic of interest" (2000, p. 10). Put differently, the focus group discussions entail the features of focused questions, no push for agreement or consensus, permissive and non-threatening environment, homogeneous participants, reasonable group size (4–12 persons), several groups, moderator guided group, and systematic and verifiable analysis (Krueger & Casey, 2010).

In this study, the focus group discussion, or workshop, on business ecosystem was built on two fundamental objectives: the recognition of bottlenecks potentially impeding the adoption of DR and the consideration of reconfiguring the roles of various actors operating in the market. The event was organized around 'free speech' environment, meaning that the occasion was little governed. At the beginning, the participants were grouped equally into two teams instructed by the event moderators (i.e., I and my colleague). That being said, the moderators, or 'facilitators' (Saunders et al., 2009, p. 347), allowed the other participants to do the creative work, thus avoiding misdirecting the discussion according to their own, as if restricted thoughts. Furthermore, the desired outcomes of the workshop were to compile a list of reasons for the bottlenecks as well as a list of proposed actions how to manage the bottlenecks.

In addition to the workshop events, the study also incorporated an unconference event in Espoo on October 25th and 26th, 2013. My contribution to the unconference was a demand response ecosystem poster drafted in cooperation with Alfa, Bravo, and Delta (see Appendix 4). A total of 36 posters were presented at the unconference on a poster market. The idea of the poster market was to gather feedback and insights from peers that could improve the research in SGEM. I was responsible for presenting our DR ecosystem poster, thus the unconference event provided some insights into this study, as well.

5 DEMAND RESPONSE ECOSYSTEMS

5.1 Swimlane blueprint

Ginsberg et al. (2010) see the ecosystem approach important when the smart grid is considered. They argue

> Our first observation, distinguishing the forest from the trees, is perhaps obvious but worth stating upfront. At least for smart grids, employing an innovation ecosystem strategy appears quite important. (2010, p. 2792)

However, the ecosystem concept in general and value blueprint in particular proved difficult to grasp during many discussions. Building upon the value blueprint concept, I developed the swimlane blueprint, an ecosystem depiction to facilitate the actual problem solving and steer the discussion in the right direction (see Figure 5-1). Swimlanes are visual illustrations used more often in business process modeling, visualizing processes and decisions grouped in lanes. The swimlane ecosystem utilizes the lanes in highlighting the central elements in the ecosystem and more explicitly presenting which elements act as complementors and intermediaries. The purpose of this presentation style is to ease the conversation around the business angle of complex systems and direct the focus on intended elements and issues.

In the swimlane blueprint, complementing actors and elements are grouped in lanes, as depicted in Figure 5-1. The roles of complementors, consumer, focal firm, intermediaries, and suppliers are as Adner and Kapoor (2010) as well as Adner (2012) define them (see Table 3-1 as a reminder, p. 49). The distinction draws from the lanes that explicitly show the complementary mechanisms and value since they are captioned. Both the lanes' captioning and the segregation of the developers of complementary products or services help one interpret the relationships between the actors. Unlike in swimming contest, the position of a lane in the swimlane blueprint does not make an argument for or against the success of that lane (in swimming contest, the top performers and winning candidates are likely to be positioned in the middle lanes). In the swimlane blueprint, focal firm and its direct value delivery is positioned in the middle, and complementary offers around the focal lane.

Relationships between elements are illustrated with solid arrows. The arrow from one element to another indicates the value delivery since the swimlane blueprint depicts value creation in an ecosystem. Considering money, it typically flows in the direction opposite to the value since value delivery means selling something to someone against

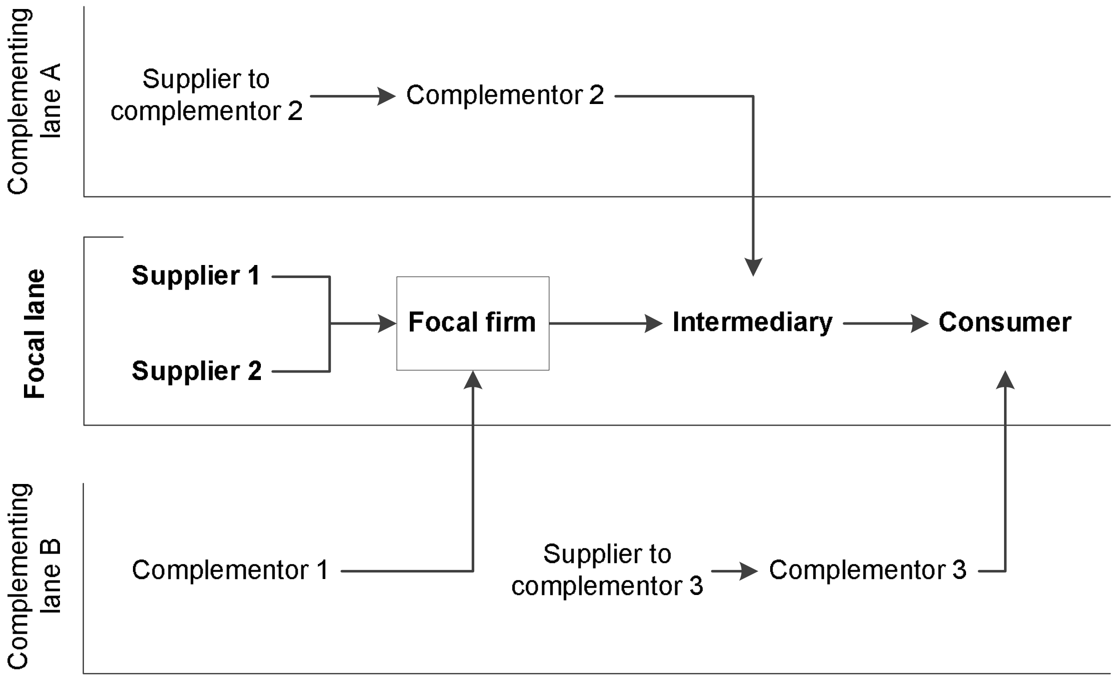


Figure 5-1: *A schematic swimlane blueprint illustrating more explicitly the roles of elements in the ecosystem than 'traditional' value blueprint map.*

money. For example, car manufacturer sells cars to retailer who resells them to consumers. On the other hand, value delivery can also mean enabling something to someone. For instance, a 3G telecommunication network support services that provide high-speed information transfer, enabling consumers to benefit from their smartphones and tablet computers. Consumers do not clearly buy 3G network but subscribe to a telecommunication service featuring 3G connectivity. As a result, they get access to a platform that is crucial for modern smartphone and tablet applications and services. Moreover, the point is that an arrow shows the value delivery but it does not necessarily reflect the route of money.

Complex business ecosystems seem to be easier to grasp when it is explicitly presented what the actual roles of various elements are in the ecosystem. The aforementioned became clear in the early stages of the research and signaled that an even more explicit depiction (compared to the value blueprint) was required to ease people to contribute to this study. The swimlane blueprint concept fulfilled its purpose quite nicely, albeit the representations used in the workshops (see Appendix 3) varies slightly from the further developed version presented here. From now on, the visual depictions of DR ecosystems rest on the swimlane blueprint with an intention to be as unambiguous as possible.

5.2 Laying the foundation for demand response ecosystems

So far, the DR ecosystem has been perceived as an ecosystem problem, in which multiple elements need to come together to enable the value proposition. A unique feature of the liberalized electricity market in the Nordic countries is a twofold nature of electricity. It is not an integrated product anymore, but the commodity and the service must be treated as segregated offers (Roggenkamp & Boisseleau, 2005). That is, the commodity electricity is bought and sold in the common market as products, whereas the service equals mainly transportation. As already mentioned, the transportation (i.e., transmission or distribution) operates under certain regulatory rules while the commodity exchange is not tied to the same rules and it is as if deregulated in this manner. However, both actors and their cooperation are needed, causing this particular market being extraordinary challenging.

Therefore, in order to understand the nature and process of ecosystem development, one has to fathom how the ecosystem is depicted in its current state. In addition to above-mentioned twofold nature of electricity, various market places and their different economic logic add more complexity to this field. According to the limitations, this thesis focuses only on physical contracts and exchange; financial contracts such as hedging and futures are not considered either. Moreover, I have adopted mainly the Adner's value blueprint concept to assess the DR ecosystem. Nonetheless, there are other tools, too, to analyze business ecosystems providing slightly differing approach (e.g., Battistella, Colucci, De Toni, & Nonino, 2013).

Elspot, Elbas, and the balancing market form the ecosystem having each, however, their own characteristics in a way how the respective market functions. In the ecosystem point of view, Elspot and Elbas markets work quite the same way[14], and they are referred to as power exchange in Figure 5-2. In the figure, the line from the DSO to the consumer (i.e., DSO referred to as complementor) is drawn due to the fact that the consumer may not enter into an agreement with the supplier without a connection to the physical electric supply. Moreover, the DSO provides also the meters to the consumers' premises, but it must be noted that both the connection and meters are 'services' that the consumer cannot choose but they are there as if of necessity implemented.

In addition to the connection to the consumer, the DSO provides meter reading data to the supplier. The supplier cannot carry on its business without the DSO (due to the necessity of the unbundling of activities) in the deregulated markets. Indeed, the DSO is *de rigueur* for the supplier as the DSO makes it possible to the supplier to move the offer forward by providing the physical infrastructure and metering (which forms the basis

[14] Market mechanisms of Elspot and Elbas as well as the balancing market are described in Chapter 2.2.

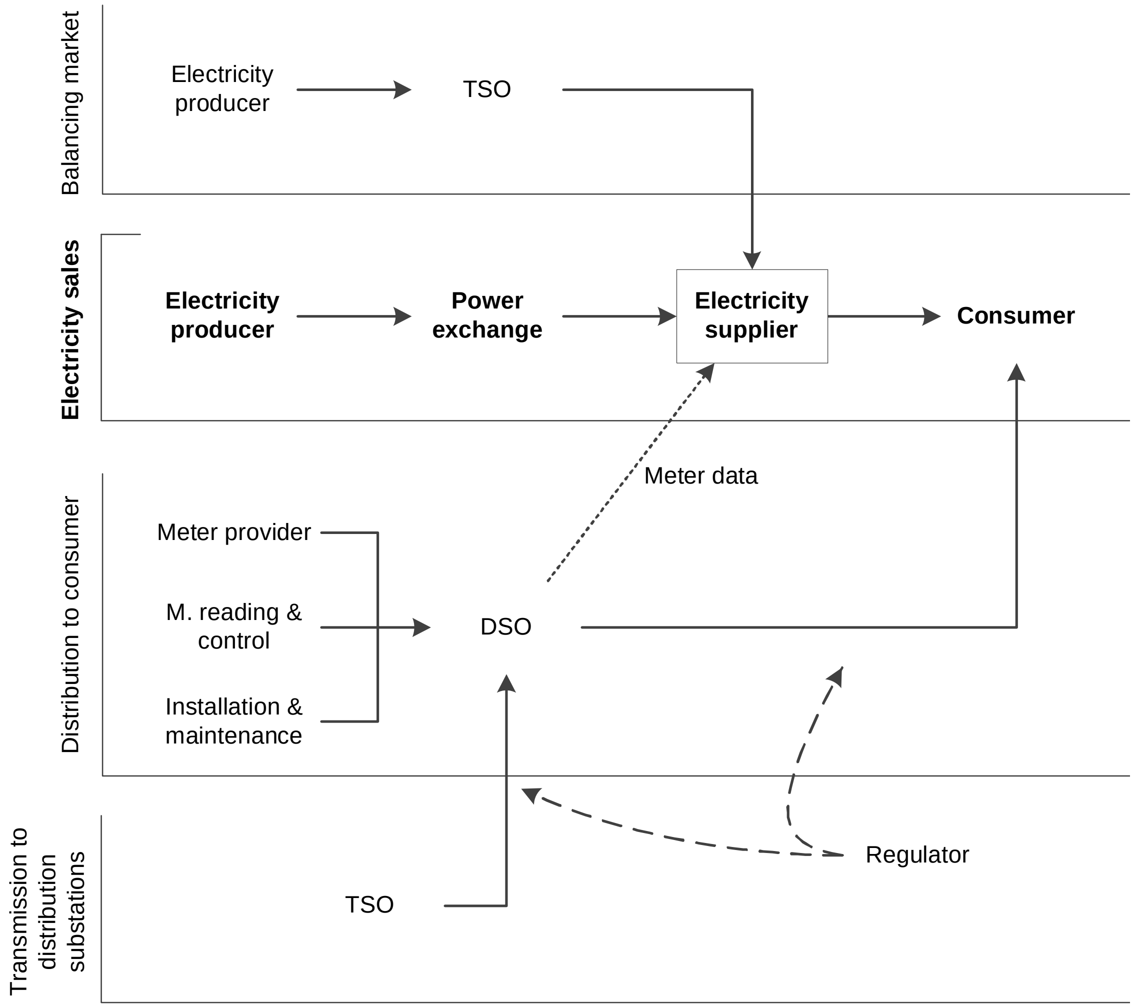


Figure 5-2: *Swimlane blueprint of Finnish electricity supply ecosystem. Electricity sales are considered the focal operation in the ecosystem. The solid lines show the path of value delivery; the short dash line indicates the DSO's obligation to provide metering data to the supplier; the long dash line expresses the regulator's supervisory role on the system operators.*

for the invoicing). However, the DSO is not seen as direct complementor to the supplier as it is to the consumer in terms of value delivery. Consequently, the relationship between the DSO and supplier is shown using the dash line. Furthermore, meter provider, meter reading and control service, and meter installation and maintenance service are the suppliers of the DSO providing the requisite inputs to manage its offer.

Moreover, as electricity cannot be stored and the foregoing demonstrates solely the prior-the-delivery markets, the balancing market is needed to take into consideration from the vantage point of on-time and after-the-delivery markets. In this regard, the TSO plays a crucial role providing the critical coordination service that balances load and generation in real time. When the supplier's forecast go wrong, it has to acquire balancing power from the TSO which, in turn, procures regulating and reserve power from the producers and interruptible loads. Furthermore, the TSO functions also in a role of complementor for the electricity supplier (see Figure 5-2) enabling the supplier's continuous operation and value proposition to the end customer (i.e., the consumer in this case). Taking the preceding discussion together, the ecosystem depiction can be expanded to illustrate the current state of the Nordic electricity market within the limits of this study.

As the role of regulatory authorities is remarkably important in this specific field, one salient regulator is also represented in the ecosystem figure. The DSOs' and TSOs' reasonable returns are regulated by authorities since they are operating as regulated monopoly actors. For example, in Finland, the EMV functions as the regulator ensuring that the transmission and distribution tariffs stay reasonable. The relation of the regulator to system operators is shown using the dash line because the regulator is unengaged in the value delivery as such; instead the regulator supervises the system operators retrospectively.

As a remark, neither the depiction above nor the ones further try to include every aspect concerning the corresponding market, but strive for providing an adequate insight into relationships and roles between the actors influencing the value proposition. Furthermore, the ecosystem design takes purposely no stand on single firms but their functions instead. Additionally, for instance, government subsidies for RES or whether the production is nuclear power, gas, water, wind, etc. are left out from the figures.

Now, concerning the emerging smart grid a number of things are changing. To begin with, the consumers (at least some of them) are becoming *prosumers* that, in addition to consuming, produce electricity, as well. Given the two-way connection of smart grid, prosumers will be able to set up their own generation (e.g., wind or solar power) on their premises and sell energy in the market if they do not want to consume it by themselves. Conversely, the foregoing is not revolutionary from the ecosystem point of view as producing consumer is treated as an electricity producer. Instead, prosumers own production—especially merged with the electricity storage—is groundbreaking relative to DR as they do not have to reduce their consumption according as the supplier's or DSO's needs, but they can substitute the demand for own production and storage and, moreover, supply surplus electricity into the grid.

Accordingly, smart meters play a vital role by communicating the prosumers' consumption and production with the suppliers and utility that, in turn, could utilize the information in controlling the balancing costs and ensuring the quality of energy, respectively. Taking this and the recent discussion together, the consumer or prosumer may not be considered as the end customer in the DR ecosystem. More likely the prosumer could be seen as an intermediary standing between the participant offering the DR service and the end customer that actually benefits the most of the offer. Alternatively, the end consumer can also be seen as a complementor enabling an intermediary or the end customer to move the offer forward or make the most of it, respectively. On the other hand, the consumer or prosumer could act as a supplier, as if an enabling actor that makes the whole service possible.

Furthermore, incentives are one problem, in seeing the prosumer as the end customer in the DR ecosystem. What the participant offering DR service has to offer to the end customer so that she could benefit from it? What is the value proposition? It is not difficult for one to draw the same conclusion as Sioshansi has done: "although many retailers offer energy services consulting to larger customers, current market arrangements mean that it is not generally in a retailer's financial interests to promote energy savings" (2012, p. 52). The consumers consuming less energy will not gain the suppliers' profits in the long term (in the short term there is a possibility that customers switch their electricity contracts to the supplier offering lower prices and, moreover, the supplier may gain in this way as compared to competitors). Moreover, little savings from shedding consumption are secondary to consumers' desire for comfort and convenience, albeit the ways in which energy efficiency may be improved are generally in the public domain (Fuller et al., 2010; Hauser & Crandall, 2011).

The first step in constructing a value blueprint is identification of the end customer and the identification of 'your own project' is not until second. Nevertheless, the focal business—i.e., the own project—in the ecosystem to be examined is perhaps already clear: the DR service. Hence, the potential value proposition should promise profit gains from cutting costs by steering the consumers' energy consumption. Through a wider lens, the value proposition should promise lower investment needs in peaking generation, reserve margins, and transmission and distribution capacity in the longer term. The potential value propositions for various actors were already discussed in Chapter 2.4.3 (pp. 33–36). Now, the next section presents the major issues that are impeding the implementation of DR and delivery of the value propositions.

5.3 Demand response ecosystems' challenges

The recognition of the most significant and fundamental issues hindering the adoption of DR in Finland was the main theme of the last DR workshop. The recognition of the issues based on five swimlane figures that were drafted in advance of the workshop (see Appendix 3). The aim was to provide a list of reasons for the identified bottlenecks in the electricity supply ecosystem. Additionally, the intention was to compile a list of actions how to overcome these issues. Consequently, the workshop provided important insights into ecosystem challenges to address and how to reconfigure the ecosystem concerning the emergence of DR.

Four major issues were identified during the study: (A) regulation, (B) function divided market, (C) consumer participation, and (D) limited functionalities, see Table 5-1. Two clearly visible hurdles to the adoption of DR drew the main attention of the experts in the workshop. First, the regulation model is unclear in Finland. The lack of unambiguous regulation and understanding of regulatory supervision raise questions about the monetary benefits of DR, such as “who would expect ROI” and “who pays the infrastructure”? Second, the function divided market for distribution and supply leads to more complex relationships between the actors. Furthermore, the divided markets lead to partial optimization among the market players as various elements aim for the different goals.

Issue A: Regulation

The regulatory issue is clearly the most important one since the regulator determines the *boundary conditions*—the focus group was unanimous in this concern. Moreover, a number of scholars and other parties support this view as well (e.g., Bryce, 2009; Hull, 2010; Hurley et al., 2013; Lehr, 2013; Simon, 2010). Hitherto, the regulator has defined, for instance, the minimum requirements for DSOs which excludes DR services (further in detail). That is, the DSOs have no incentive to invest in DR offerings in general, as they will not receive a return for their investment. Instead, because regulation allows DSOs to offload most grid investments onto their customers through network tariffs, they are further likely to tilt away from DR functionality investments.

Regulation of this kind is somewhat contradictory, since, via DR exploitation, the DSOs could defer their grid investments and ease RES integration on one hand, but the grid investments yield sound ROI on the other. Note that, in Finland, the Section 5 of the Limited Liability Companies Act (624/2006) stipulates “the purpose of an incorporated (or limited) company is to generate profit to the shareholders, unless otherwise provided in the Articles of Association”. Now, since the DSOs’ returns are regulated under the reasonable return, there is no clear reason why a DSO would invest in DR under the current circumstances.

Furthermore, the regulator has set the minimum requirements for electricity consumption metering, including the hour based metering, remote control (switch on and off), and load control relays (or a relay and a slot for another). These requirements are substantially fulfilled; however, the required meter functionality is insufficient in order to exploit a modern DR. For example, real time metering, several relays, and power load reading (instead of energy) would improve the feasibility of the meters, but nothing is likely to happen, unless the regulator otherwise provides. Moreover, in Finland, the regulation of being up-to-date is revised approximately in five-year intervals; thus, amendments are considered periodically.

In the AMR case, meter reading and control are DSOs' responsibilities. Taking the previous discussion together, a DSO cannot, however, provide DR service since the service is not treated as part of distribution business. Furthermore, the DSOs must be impartial toward electricity suppliers as well as other possible unregulated market players. That is, a DSO is obliged, for instance, to provide congruent services to all electricity suppliers without discriminating the others. Now, this kind of operation would probably jeopardize the system reliability if various actors controlled the meters in compliance with one's own interests. As a result of this contradiction, the DSOs provide additional services to no one, meaning that the full potential of the already installed meters cannot be

Table 5-1: *Major issues that are hindering the adoption demand response applications in the Finnish electricity market.*

Issue	***Specification***
(A) Regulation	• Unclear regulatory model. Should there be some or any predetermined responsibilities concerning DR utilization or infrastructure? • Contradictions between regulation, market, and DR benefits. DSO could probably benefit from DR but it might hamper suppliers' business. • DSOs' duties and responsibilities; owns the AMR meters but cannot exploit them in DR purposes. • Prosumer-to-prosumer trading. This could rationalize electricity trading since prosumers' would avoid transfer costs.
(B) Function divided market	• Conflict of interests. Suppliers strive for minimal daily electricity costs whereas DSOs for stable grid. • Lack of concrete proof of DR benefits for various market players. 'Win, win, win' business not proved. • Who pays the infrastructure to enable more modern DR? • The Finnish grid infrastructure is 'too of high-quality' to indicate concrete need for DR.
(C) Consumer participation	• How to activate consumers or prosumers? • Comfort and convenience seem more important than economic benefits, which might be low in Finland. • Poor payback time. Relatively low prices of electricity indicate low savings from DR programs in Finland.
(D) Limited functionalities	• Stand-alone DR solutions lack functionality. • Low customer value. Would an increase in a number of functionalities increase customer value?

utilized.

The other regulated market participant is TSO, of which duties include the management of the balancing market. DR operator could do decent business by aggregating loads and participating in the balancing market. However, current minimum bid to the balancing market is ten megawatts of electric power in fifteen minutes, and that is an issue. For example, let us assume that a house consumes constantly an average of two kilowatts of power. Each of these houses provides twenty percent of its load to be remotely controlled. In order to participate in the balancing market, DR service provider would need 25,000 households under its control to reach the ten megawatts limit. Consequently, addressing this issue will demand a new approach to organizing the balancing market and ancillary services. One potential way to address the issue could be distributed balancing markets with lower bid limits. The distributed balancing market depends on grid topology since the current model requires a pool of electricity generation to ensure the functionality of the ancillary services.

The novelty of DR business on liberalized electricity markets is probably the major reason for the regulatory issues. Among other issues the regulator faces, decentralized trading is one that is not addressed in the current regulatory model. For example, trading between neighbors might enhance the overall effectiveness of DR and DSM, but centralized electricity markets oblige that electricity is traded in the common market place. Furthermore, the centralized electricity markets and annually-leveled distribution pricing do not support prosumers, for instance. That is, the prosumers would acquire the maximum benefit from their own extra production in a case when they could sell to a neighbor (i.e., low distribution costs) and aggregated consumption, as well as production, would be calculated hourly (i.e., take advantage of peak hours). In conclusion, the DSOs' pricing model defines the profitability of the prosumer business. At the moment, DSO's role in general is to connect consumers to distribution grid. As of yet, the role excludes DR supporting activities.

The lack of clear regulatory guidelines probably reflects the complexity of this matter. Regardless of the complexity, some of the concerning regulatory issues are prudently being addressed, namely DR in relation to regulated operations. According to EMV's recent pronouncement "uudet palvelukonseptit ja regulaation rajapinnat (new service concepts and interfaces of the regulation)" (Dnro 592/421/2013), DR is considered neither distribution nor transmission operation, and thus the DSOs' tasks exclude demand response. In other words, DR business is deregulated meaning that a DSO could potentially arrange DR service as a spin-off since the profits would not affect the DSO's reasonable return. It must be noted, however, that the system operators shall unbundle any electricity system operations from other electricity trade operations, including DR. Now, that the field of DR is open for generally anyone, the conflict of interests, and AMR utilization in DR purposes, yet exist.

Issue B: Function divided market

In Finland and the Nordic countries, the liberalization has left in a situation where various players naturally strive for their own interests. The behavior of this kind results in partially optimized operations instead of total benefit of DR. Note that one could argue the liberalization leading to greater total benefit compared to the U.S., for example, where vertical integration of DSOs and suppliers is allowed, constituting the utilities.

The aforementioned EMV's pronouncement means that the DSOs' cannot execute DR actions unless the actions address technical grid issues that could jeopardize the security of supply. Hence, DR actions shall be a necessity from the security of supply point of view, since commercial motives are not eligible due to the requirement of equal treatment of the suppliers as well as other deregulated players. Additionally, the equal treatment of others states that the DSOs cannot provide their meter reading and control functionality to only one deregulated player (e.g., supplier or DR service provider), as when doing so it would have to provide the same service to everyone. As a result, the utilization of AMR meters in DR purposes is hard, and the DSOs are clearly willing to offer the meter reading and control to no one.

Now, the regulatory framework and divided market have hindered the discovery of a sound DR business case. For instance, as for a DSO, commercial motives to exploit DR are not an eligible driver for it, of which reason an unclear business case for the DSO exists. That being said, a corresponding DSO is obligated to compensation proceedings in situations where over a twelve-hour blackout occur within its remit in Finland. That is, the DSOs are surely interested in means whereby they could avoid the compensation costs. It is, however, a tough question what is a commercial motive and what is proactive behavior. For instance, proactive behavior could be partial load shedding (i.e., power curtailment) whereby DSOs could eschew the costs caused by disturbance in the distribution. Furthermore, the proactive operations could be scheduled in a way that the deficit of supply for an individual customer lasted no more than two hours. The question is: what sort of compensation method is the most appropriate to the Nordic or Finnish situation where few occasions appear a year?

Electricity suppliers could possibly take advantage of DR services, too. Electricity supplier as the main beneficiary highlights the conflict between DSOs' and suppliers' interests, albeit the conflict of interests is not the only issue. Here, if DSO did not benefit from the DR implementation, who would build the required infrastructure? DSOs clearly will not. How about the supplier? At least without any standards, it is complicated for a supplier to build the infrastructure since often suppliers are competing in the same geographical area. One possible solution could be an aggregator or some sort of an integrator who would build the infrastructure and sell the access to it in market terms.

To conclude, it is unclear who offers the DR or DR related service in the future. Another issue is to whom DR is offered. According to the workshop outcome, the DSOs should be considered as the main beneficiary of the DR services, albeit they cannot provide the service. The service must be provided and infrastructure built regardless. In order to achieve a working DR environment, there is a concrete need for collaboration between various industries and market players as well as authorities and political institutions (Heiskanen, Matschoss, & Saastamoinen, 2012).

Issue C: Consumer participation

Consumer participation in DR activities is fundamental, and the economic argument for participating in a DR program is based on the fact that it would reduce the consumers' electricity bill. However, no one knows beforehand how consumers of various types will accept and respond to these activities. For example, considerable uncertainty exists especially about smart pricing (Braithwait & Hansen, 2011) and, moreover, in Finland, smart pricing has been perceived rather risky than beneficial (Heiskanen, Matschoss, & Saastamoinen, 2012). DR would enter the consumers' comfort zone and demand certain actions in order to gain any benefits. Furthermore, failure in the adjustments (e.g., consumer shifts one's consumption to an even more expensive hour) would result in higher costs of electricity than without DR. The possibility of this kind of failure will not increase the excitement around DR, and for the sake of certainty and convenience people gladly pay the premium.

Hitherto, the convenience of electricity use has been unparalleled. For instance, no additional charges are offloaded onto consumers for excessive consumption or 'wrong' timing of use—generally, a second to none user experience.

The consensus among the workshop participant was that DR is more significant in terms of system reliability and market effectiveness rather than consumer benefits. Heiskanen et al. (2012) support the view, and they see cooperation with authorities as desirable. However, while DR may be more beneficial for the system, consumers must involve in the execution to some extent. Consequently, the incentive payments that participating consumers would receive must be attractive in order to reach the mass adoption of DR. Otherwise the majority of consumers will prefer the level of comfort and convenience to small savings.

Issue D: Limited functionalities

More often than not, DR refers to a load shifting from critical times to moments of lower consumption. DR in this extent, however, may not be adequate to induce the mass of consumers to participate in the programs, as discussed in Issue C. In addition to the foregoing, single service technologies seldom provide considerable results and experience quality at a low price leading to poor customer value (see Equation (1), p. 29).

Hence, the customer value is essential as long as consumers can choose whether to participate or stick with the status quo. DR service must be competitive with other offerings in order to reach the early majority (Heiskanen, Matschoss, & Saastamoinen, 2012). By offering only little functionality, it appears unlikely that DR will cross the 'chasm' (G. A. Moore, 2002) in the near future.

Demand-side management projects that address both DR and energy efficiency would be more beneficial from the system point of view (Nemtzow et al., 2007). Energy efficiency may be a potential approach to induce consumers as well since it could enable not only bigger savings at consumer end but also business opportunities for companies. However, DR itself offers no sufficient functionalities to comprehensive planning, but perhaps DR could be additional functionality. Consequently, smart grid applications, too, could be bundled with other services, such as security and maintenance (Heiskanen, Matschoss, & Saastamoinen, 2012). Bundling would enhance the results and experience quality over the price, thus increasing customer value, and moreover, increase technology adoption. DR technology adoption would, in turn, facilitate the attainment of the desired system benefits.

The limited functionalities relate specifically to the consumers since their benefits are least justified, and AMR meters that are installed are technically divergent and restricted. Instead of simple DR, more comprehensive HEMS is thus seen more potential solution concerning the consumers. Through HEMS, both DR and energy efficiency could be addressed, in addition to which HEMS could probably be easier to integrate into other services, including security and maintenance. The integration of several services would, however, demand customizability since various consumers have different expectations and requirements for the application.

5.4 Automatic meter reading

To begin with, becoming more familiar with the contents of the EMV's pronouncement (Dnro 592/421/2013) is useful. This is because the pronouncement determines certain boundary conditions considering AMR based DR services and the roles of actors in corresponding business ecosystem. Figure 5-3 presents the DR service ecosystem where DR service is just added to the electricity supply ecosystem without any other reconfiguration measures taken. The following paragraphs give a deeper insight into the pronouncement and in conjunction with the empirical results of this study they endeavor to provide reconfigured views on DR ecosystems.

At first, recapitulating the Electricity Market Act (588/2013) seems relevant. Pursuant to section 3 of the Act, electricity system operation means placing the electricity system for payment at the disposal of anyone needing transmission and other similar system services. The system operation also includes consumption metering and other measures

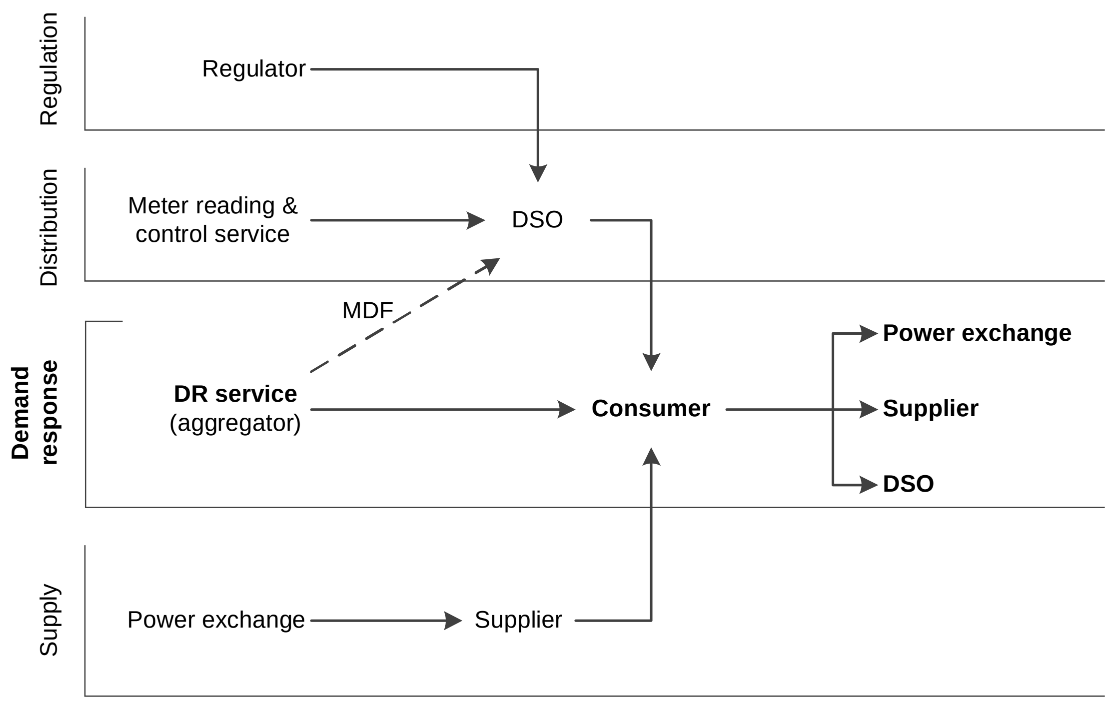


Figure 5-3: *DR service ecosystem where the service is provided either to supplier or DSO or the service provider operates on the power exchange (excludes TSO and balancing market). DR service provider acquires the consumer's load profile from the DSO for a meter data fee (MDF).*

necessary for transmission and other similar system services. The metering data cannot be disclosed to anyone, since disclosing it to other party than the customer or the corresponding electricity supplier is prohibited without the customer's permission[15].

Furthermore, metering equipment shall be able to receive and execute or pass forward demand response commands send via communication network[16]. Additionally, system operator shall provide equipment featuring hour-based metering on customer's demand[17]. The equipment shall provide such features that both utilization of DR and DSM are possible. Moreover, on consumer's particular demand, system operator shall be able to provide equipment with a standardized communication interface for real-time consumption metering functionality.

Consequently, the equipment offered by the DSOs shall feature functionality to receive and execute DR commands such that the suppliers or other market actor can provide DR

[15] Statute of the Council of State (66/2009), 6:8 §.
[16] Statute of the Council of State (66/2009), 6:5.3 §.
[17] Statute of the Council of State (66/2009), 6:5 §.

services to their customers. DR is neither the DOSs' responsibility nor electricity system operation. However, switching on and off the relay in AMR meter on consumer's premises is considered no DR, and thus it is included in electricity system operation.

The EMV's pronouncement stipulates that the system operators shall only provide the metering equipment featuring additional functionality in order to the suppliers or other market actors be able to offer DR services to their customers. Additionally, pursuant to section 22 of the Act, system operators shall contribute to the efficient and economical electricity consumption and utilization of load control options. The DSOs are eligible to offload the costs that result from the DR enabling equipment acquisition, installation, and maintenance onto their customers. However, the regulation disallows the DSOs offload the costs resulting from DR services or hour-based metering onto the customers.

That being said, the DSOs can provide the DR services as well, but in order to do so the service shall be managed as a spin-off business. Regardless of the manner the DR business is exploited, the DSOs shall indiscriminately provide the hereinbefore mentioned functionality to all service providers. However, the DSOs are obliged to offer the metering data no more often than once a day[18]. More often offered data can be subjected to charge (see Figure 5-3 where the meter data fee is depicted) unless the data reading is done by a third party via a meter featuring the standardized communication interface, albeit the meter has been installed by a DSO.

Now, the preceding discussion clarifies the challenges of DR implementation. As a result, the delineation of a functioning value blueprint is extremely challenging, albeit certain boundary conditions are about to emerge. Nevertheless, as Adner puts it, "it is rare for a significant innovation to start life with an all-green-light blueprint" (2012, p. 87). That is, every element does not have to converge flawlessly at the outset; essential is to understand the risks involved in a particular approach and find ways how to overcome these risks.

The ecosystem in Figure 5-3 illustrates how DR provider pays meter data fee (MDF) to a DSO in order to acquire customers' hourly-based load profiles. Utilizing the load profiles the aggregator is about the offer DR service either to supplier or DSO, but it also can participates in the power exchange and sell '*negawatts*' there in balancing purposes[19]. The ecosystem, however, encounters a few bottlenecks. First and foremost, the issue concerning consumer participation still exists. At least when thinking of residential consumers there seems to be inadequate incentive to execute DR commands. Second, limited functionality of the meters, too, hinders consumers' interests toward DR. Third,

[18] Statute of the Council of State (66/2009), 6:6 §.
[19] Negawatt power is theoretical power referring to amount of power (in watts) saved.

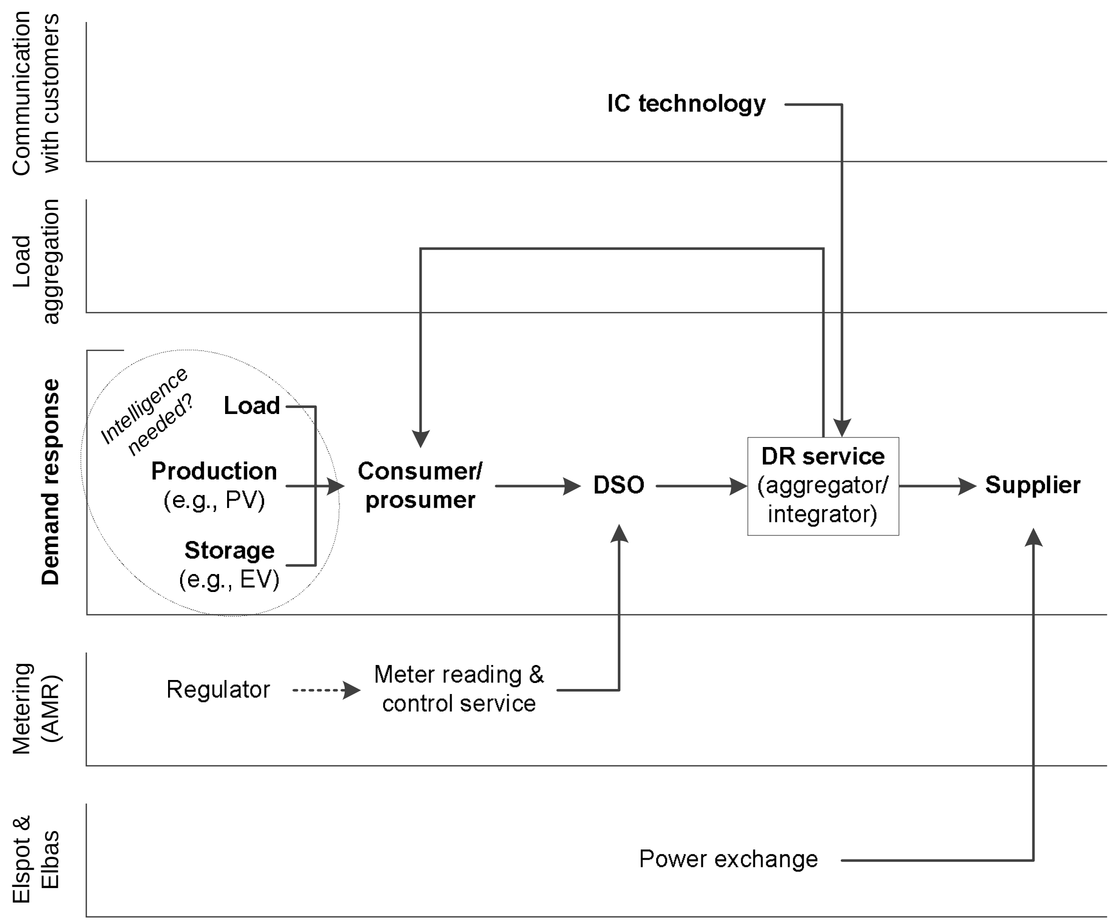


Figure 5-4: *DR service ecosystem with smart grid solutions (excludes TSO and balancing market). Essentially, supplier is treated as the end customer instead of consumer/prosumer. The dash line indicates that regulator obligates DSO to provide AMR meter reading and control service, albeit it is not directly involved in value delivery.*

regulation encourages no actor to pursue DR or its benefits as yet; the grid infrastructure is 'too high of quality', for example.

In the current regulatory environment, direct load control through AMR (i.e., switching the relays on and off) is considered electricity system operation. Hence, the third party actor is ineligible to utilize DLC by using the relays on the AMR meters. Consequently, an option is to use other incentive-based or price-based programs on the on-demand basis. However, as many times noted earlier, getting the consumers participate in DR programs is even harder without DLC. Simply put, people desire automation or at least minimal human intervention in actions. Furthermore, smart grid solutions such as higher RES integration and EVs are probable to increase interest in DR as well as other business opportunities they carry.

Another option is that the consumers, or preferably prosumers, are interested in selling their electricity savings, production, or curtailment to some market actor. Here, the prosumer is not the end customer, but a service provider or enabling actor (i.e., provides controllable load). However, large scale prosumer curtailment would probably demand a third party aggregator, of which responsibilities includes the aggregation of the load curtailments and, further, reselling the shed load. The DR service operator, or aggregator, can also be perceived as an integrator, incorporating the prosumers' load profiles, production and storage capabilities, as well as reselling the service, for instance, to a supplier (see Figure 5-4). The prosumers load profiles could be acquired from a DSO for a payment or via hour-based AMR meter installed in the prosumers premises by the DSO. The DSOs play a keystone role in AMR ecosystem regardless, since they are obliged to provide a prospect of DR service to third party companies.

However, the prosumers will need more intelligence in their premises in order to take full advantage from the smart grid solutions. The more intelligent solutions suggest smart home automation (HA) system or HEMS, which combines the electric power network with information and communication technology (ICT). Solely AMR-meter-based solutions, even more advanced ones, are not smart enough to control energy consumption or production automatically nor energy storage system.

Consequently, the AMR-based DR encounters troublesome issues with the current regulation model, high quality of the grid infrastructure, and low adoption of the smart grid solutions. However, the prosumers' or consumers' role should most probably be appreciated as the service enabler instead of the end customer in this particular ecosystem. Next section discusses potentially more forward-looking DR solutions, incorporating HEMS with other smart grid solutions.

5.5 Home energy management system

Smart home energy management systems enable a vast number of functionalities that are not limited to load shedding. HEMS could easily integrate automated DR other functionalities, and lead to electricity savings without human intervention. According to Piette et al. (2004), load response strategies may be enhanced with technologies and techniques that allow for fully automated operations. Even though considerable uncertainty still exists about how the end use customer will accept and respond to smart pricing (Braithwait & Hansen, 2011), HEMS could facilitate the adoption of DR and, further, use of its full potential.

One of the major differences between the HEMS and AMR-based execution of DR is HEMS's autonomy. That is, HEMS can be exploited independently of the meter provided by the DSO, but it can also exploit the standardized communication interface on DSO's meter (see Figure 5-5). HEMS is not only more versatile technology than AMR,

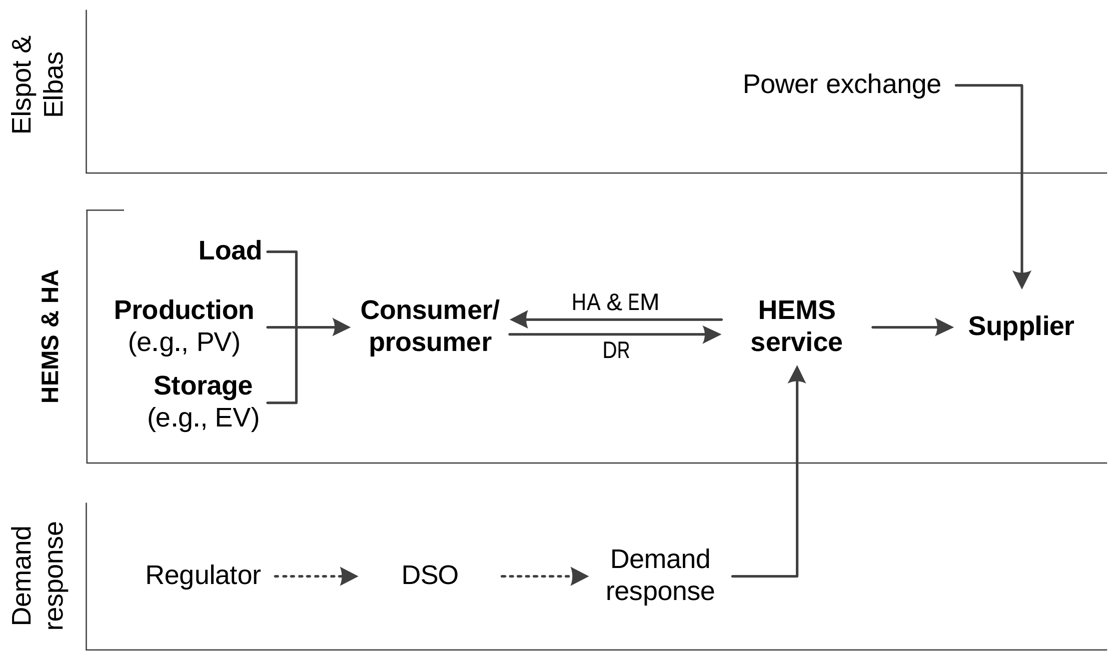


Figure 5-5: *HEMS service ecosystem with smart grid solutions (excludes ICT, capital investors, TSO, and balancing market). HEMS service provider offers home automation (HA) and energy management (EM) systems to consumers/prosumers and involves them in a DR program. The dash lines show that DSO should offer DR capable equipment, but HEMS can also be exploited independently without this equipment.*

but it is also deregulated. In essence, it must be remarked that HEMS market is currently valued at $1.5 billion in the U.S. and forecasted to be worth over $4 billion by 2017, and the market includes DR (Bojanczyk, 2013). Hence, it can be said that there is a good reason to promote HEMS emergence to a large extent in the Nordic countries, as well. Furthermore, a large scale implementation of HEMS could advance the electricity markets economically, environmentally, and socially.

However, regulatory issues in particular are difficult and cannot be addressed through technology in general. However, HEMS could be integrated in an HA system, thus offering a lot of other benefits for the consumer in conjunction with security locks of doors and other systems. In fact, integrated, full-service home management could create markets for DR along with products and services that consumers comprehend and understand more easily than actual DR. Put differently, a consumer could have an interest in the system through which she could automatically control and manage her EV charging schedule, energy storage, own production, and home surveillance; now, she decides to acquire the system. The consumer could be told that the system includes the facility to exploit DR. Indeed, the system is designed mainly for use as HA purposes, yet it enables complementary utilization in DR intentions.

The consumers could be promoted by energy efficiency and home surveillance—something more familiar than demand response. These systems work automatically or at least with minimal discomfort. One important aspect that HEMS supports is that it can be fully automated, as if plug and play, no human intervention necessary after the instalment. In order to increase comfort, the system could feature an opt-out option. That is, a consumer can override curtailment requests without a sanction. Obviously, these actions would also reduce customer incentive payments. Nevertheless, due to the opt-out option the consumers could feel having the final word on their own consumption.

Figure 5-5 presents what could a value blueprint of a HEMS service ecosystem look like. To begin with, the value blueprint builds on the same hypotheses as the value blueprint in Figure 5-4. In other words, regulator obliges DSO to offer DR functionality via its meters and the suppliers endeavor is to refrain from purchasing expensive balance electricity from the balancing market. The HEMS value blueprint elaborates an idea that the prosumers and HEMS service provider create a mutualistic or symbiotic relationship. That is, they 'work together' each benefitting from the relationship. In more detail, HEMS service provider offers the combined HEMS and HA systems (including DR) to prosumers against monthly payments. The prosumers' monthly costs could be subsidized with DR participation payments in electricity bills, in addition to savings.

Furthermore, HEMS service provider could co-operate with a supplier such that their common customers (i.e., prosumers) would have the possibility to sign an electricity contract supporting the participation in a DR program. These collaborative actions would most probably gain a competitive advantage of the supplier over its rivals, especially if the market model is changing into a more supplier centric direction, as NordREG promotes (see e.g., Åbrandt et al., 2013). On the other hand, it is desired that DR would benefit the efficiency of the electricity market as a whole, including the power system vantage point. The DSOs naturally receive the metering values through the AMR meters on an hourly basis; however, HEMS could complement the meter by providing real-time consumption information to the DSOs or even to the TSOs. The TSOs in particular would benefit from the real-time data since their frequency control requires short-time activation and response[20]. Anyway, this thesis focuses primarily on the deregulated actors in line with the NordREG's tendency toward the supplier centric model.

Alternatively, the HEMS service could also operate without the interaction with a DSO. In other words, the DSO is not a compulsory complementor to the HEMS service pro-

[20] In short of flexibility in electricity production, elasticity is sought in loads through fast disturbance reserves. The fast disturbance reserve comprises manually-activated reserves, which can be activated in 15 minutes. Source: DR workshop in Vantaa on September 19, 2013.

vider in the DR ecosystem, albeit the DSOs are still required for the purposes of the distribution of physical electricity to the consumers. That being said, the DSOs' obligation to provide the platform that enables other market actors to offer DR services may facilitate the adoption of these services. The vision of DR benefitting both the market and power system as a whole suggests that the DSOs role should be noticed, too. Hence, the DSO is taken into account in the ecosystem reflections.

Taking the preceding discussion together and developing further toward energy service aspect, energy service company (ESCo) would be the only actor that has a direct relationship with the consumers (see Figure 5-6). Now, the ESCo would be responsible for the customer interface concerning both the products and services. This would mean that the ESCo, or the supplier as for now, would be the primary customer contact in almost all electricity related issues, including the electricity contracts and DR. In addition to ESCo, the new swimlane blueprint features a substation or distribution level energy management system (EMS) which collectively aggregates the individual prosumers' loads, productions, and curtailments. As Figure 5-6 presents, EMS operates in collaboration with HEMS, thus aiming at ensuring the power system reliability while HEMS is still to provide all the possible benefits to ESCo and prosumer.

As depicted in Figure 5-6, EMS is a DSO's tool and the DSO provides the demand response platform. As for HEMS, it is an ESCo's tool to offer home automation and energy management services bundled with DR to the prosumer. Instead of the final customer, the prosumer acts as a complementor to the DSO and HEMS service provider as well as indirectly to EMS. As a result, the ESCo is considered as the final customer of demand response, albeit it offers the service to the prosumer in the last resort.

Put differently, the ESCo offers the HA service (including HEMS) to the prosumer who benefits from the service in a couple of ways. Firstly, the prosumer can take the full advantage of the smart grid solution she has such as smart EV loading schedule, own production, and smart electricity usage. Smart electricity usage would improve the energy efficiency and lower the electricity bills. Secondly, participation in a DR program would further decrease the electricity consumption and entitle the participants to incentive payments (or subsidies, as mentioned earlier). However, the main beneficiary from actual DR would be the ESCo that could exploit the load control and curtailment in several ways, as discussed in different contexts earlier.

Besides, the reliability of then distribution system could be addressed with greater care via collaborative utilization of HEMS and EMS. By having a well-designed EMS environment and DR program, the end users of electricity would have the opportunity to participate in and influence the market indirectly as well as help in improving the security of supply. Simultaneously and as a consequence, the end users of electricity would

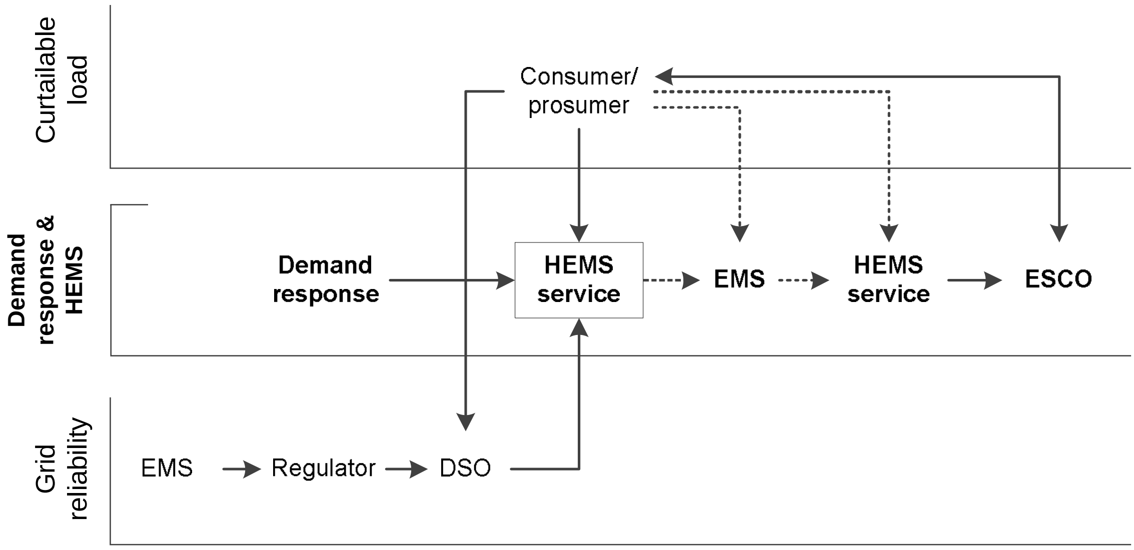


Figure 5-6: *HEMS service ecosystem after the emergence of energy service companies (ESCos) (excludes ICT, capital investors, TSO, and balancing market). In addition to ESCo, DSO now benefits from DR via energy management system (EMS) that ensures system reliability in conjunction with HEMS. In the focal lane, the dash lines illustrate HEMS-EMS collaboration, meaning that actions are not taken if they jeopardized the system reliability. The dash lines from the upper complementary lane just remark value delivery to EMS and duplicate HEMS that occur to highlight the verification of DR actions.*

assist the market to operate more effectively, meaning that the price of electricity remains constant or at decent level.

In addition, the end users would reduce their own risk of being disconnected from the supply since the DSO could operate more means of maintaining system reliability and preventative measures (Albadi & El-Saadany, 2008). This is how also DSO would benefit from DR that combines electricity system level and consumer level automation of energy consumption and production. In Finland and the Nordic countries, system reliability is no issue at the moment; however, given the undeniable fact that we are moving from a centralized energy system to a next-generation distributed energy system, the utilization of RES is most probably to increase which leads to greater fluctuation at the production end. Consequently, elasticity is also required at the consumption end.

6 CONCLUSIONS

6.1 Theoretical contribution

The aim of the study was to explore what kinds of demand response business ecosystems can be identified in the Nordic countries—emphasizing on Finland—before their actual emergence. The literature provided the justification for the need for DR, since the energy sector is at a turning point with its 20-20-20 targets etc. Moreover, the ecosystem concept has been argued to afford a useful toolkit to assess the coherence of strategy and its inconsistencies (Adner, 2012, pp. 99–100). I adopted and further developed the Adner's (2012) value blueprint concept to picture the ecosystems in an effort to offer simplistic visual depictions what the DR ecosystem could look like and what are the different pieces. The value blueprint is an example of visual illustration how the value of a product or service is delivered to the end customers.

As for the value proposition concept, it has not been exploited to depict emerging businesses, or indeed of demand response. Hence, the thesis expands the value blueprint concept to the phenomenon where it has not previously been applied, aiming at offering visual views on demand response value creation. In other words, previous research has not examined how demand response changes the structure of electricity supply ecosystem, and what would be the new roles of different elements in the emerging DR ecosystem. This study demonstrates the importance of the assessment of the roles, relationships, and places of elements in business ecosystems—obviously in DR ecosystems in particular. Although the importance of the ecosystem concept has been recognized in the smart grid environment (e.g., Ginsberg et al., 2010), the interpretation of these ecosystem discussions has been complicated by the fact that the visualizations of the ecosystems are not simple, and they do not manage to explain issues hindering the DR adoption. In the Nordic countries, DR is still in its infancy, and I endeavor bringing light in the discussion how the consumers and other elements could be treated in DR ecosystems.

As for this thesis, it identifies that electricity consumers must not be considered as the end customer of DR service ecosystems. That it, the value proposition of DR is not of most benefit to the consumers, and thus the consumers cannot be considered as the final target of the value proposition. The identification of the role of consumers not necessarily being the end customer strengthens the views of Adner (2012) and Cusumano (see Hopkins, 2011) who state that the ecosystem of a new product or service should be assessed at the beginning, and prior to launch of the product or service.

Moreover, one of the major theoretical contributions of this study is the swimlane blueprint. The swimlane blueprint concept, developed from the value blueprint, bring new, comprehensible method to assess business ecosystems. Previously the swimlane representation has been widely used in business process modeling but it seems to be helpful and valuable also considering business ecosystems. The swimlane blueprint explicitly maps ecosystem's various elements and presents complementary actors in an unambiguous way grouped in lanes. After its discovery, the swimlane blueprint proved to be useful when discussing the ecosystems of complex businesses.

6.2 Managerial implications

The value blueprint addresses the firm's strategy and assesses its coherence and inconsistencies (Adner, 2012, p. 100). I report some major issues that impede the adoption of DR services in the Nordic countries, especially in Finland. Now, regarding managerial implications of this study, the thesis represents some views on how managers could avoid potential pitfalls. Moreover, I attest the thesis shedding light on the importance of ecosystem observation at the beginning of the project. As it seems, at least for DR, employing the business ecosystem strategy appears quite important. Herein presented DR value blueprint depictions offer a 'springboard' to steer the discussion on a right direction. The depictions present some issues that arise when the final target of a value proposition is chosen incorrectly. Furthermore, they highlight that the places of elements in an ecosystem truly matters, and that the careful assessment of an ecosystem structure may help firms and managers overcome inconsistencies and avoid risks they face.

Consequently, in the context of DR, the thesis implies that even if a firm's product or service is good and useful, the offer will not thrive unless the ecosystem thrives as a whole. Thus, companies should address DR services with extreme caution until they manage to figure out how the ecosystem problem is unraveled. As yet, solving the puzzle may be tricky since government participation and support are seen desirable to or even mandatory for smart grid initiatives to take off (Bryce, 2009; Hull, 2010; Hurley et al., 2013; PwC & NVCA, 2008; Simon, 2010). Indeed, the aforementioned government's, or regulator's, role only confirms the necessity of ecosystem level approach concerning demand response services.

Lastly, the role of wannabes seems vital. Wannabes could speed up the business because it might be hard for a single firm to promote and develop its product or service alone. Competition not only makes companies vulnerable to underachieve compared to their rivals, but it also promotes the success of an innovation in its early stages. I base the statement upon the fact that union is strength in marketing and promotion of business since it increases the coverage of the offering. Additionally, when there is competition, there is also more high of quality products and services than monopoly firms could offer because industries must evolve or adapt when facing new challenges or environmental pressure if they are to avoid extinction (Fine, 1998).

6.3 Assessment and limitations of the study

The thesis provides insights how to assess demand response at an ecosystem level and what hindering issues can be identified through the usage of the value blueprint concept. Also, the topicality of the research is undisputable since the need for DR increases as the share of intermittent generation increases, and importance of ecosystem level approach has been seen essential in this field. In actuality, it seems that the outcomes of this study indeed expose substantial and sensible facts concerning DR in the Nordic countries. Taking the nature of this study into consideration, the results are not meant to be generalized, but rather represent a subjective view on the topic at hand. However, the views and results are developed on experts' opinions and secondary data sources; thus they are non-exclusively individual opinions of mine. This does not eliminate the fact that they are views, describing the qualitative and narrative nature of this thesis. Hence, some reliability and validity related limitations concerning the used research method must be assessed to clarify the usefulness of the results. As Olkkonen (1993, p. 38) defines the terms reliability and validity, they are constructs describing how probable it is that replicated measuring procedure yields the same research results and how well the used method mirrors the reality, respectively.

Furthermore, Carmines and Woods (2005) provide guidelines to assess the validity through construct, content, and criterion-related validity as well as reliability. However, it has been argued that while the terms validity and reliability are essential in the assessment of quantitative studies, they are not necessarily suitable in qualitative research. For instance, Stenbacka attests "the concept of reliability is even misleading in qualitative research" (2001, p. 552). She continues by stating that if it is used "the consequence is rather that the study is no good" (2001, p. 552). Furthermore, some researchers have argued that the term validity is not useful in qualitative research, and they have preferred other terms (e.g., Lincoln & Guba, 1985; Seale, 1999; Stenbacka, 2001). Consequently, instead of reliability and validity, the terms credibility, confirmability, dependability, and transferability are seen more suitable criteria for quality in qualitative research (Lincoln & Guba, 1985). The quality of this thesis is subsequently assessed with these four terms.

As for *credibility*, the idea of the thesis is to provide views on demand response business ecosystems in the Nordic countries. Since the aim of the study was to describe the issues hindering the adoption of DR and present what kind of business ecosystems can be identified as yet, the used research approach seems appropriate. I must remark that the thesis is not to discuss how the ecosystem would emerge, but to provide a view on the matter. Credibility of the results could be improved through proper demand response pilot programs that gave realistic data about consumer behavior and monetary benefits of DR. That is, quantitative data could improve the results and, as a result, could have a credibility enhancing effect on this topic.

As I mentioned earlier, the results are not generalizable as such and, consequently, *transferability* of the thesis suffers in some extent. However, as it is also mentioned, it is the narrative nature upon which this thesis rests, thus aiming at intriguing discussion around the outlook for demand response. The results implicate that much has to change in order to DR initiatives to take off, indicating that the electricity market environment is probably different from now in the future. For example, the responsibilities of some actors might change in process of time, and the responsibilities might involve liabilities that are nonexistent or somewhat vague as yet. This is, nevertheless, obvious since the future is unpredictable to a certain extent.

The overall generalizability seems to lack feasibility. That being said, the main findings (i.e., consumers role and DR end customer) entail some generalizability in the given context when certain assumptions are taken into consideration. The main assumptions comprise the notion that the prices of electricity stay relatively low, the quality of the transmission and distribution networks are not to weaken in the short term, the explosion of renewable energy sources is not in sight, and the DSOs cannot include DR in their balance. Realizing these assumptions—that actually illustrate the present situation—the thesis has some transferability; for example, the consumers, or prosumers, must be made active element in DR ecosystems. The ecosystem and value blueprint concepts are transferable as well, albeit researchers may end up with different final results concerning the ecosystems.

As in quantitative research, the term reliability refers to the repeatability of the study. Instead of reliability, Lincoln and Guba use the term "dependability" (1985, p. 300) to describe repeatability in qualitative research. *Dependability* in a qualitative research can easily be questioned since obtaining exactly the same results by repeating or replicating the observation procedure seems a distant idea. That is because the empirical material is based on subjective views which may be altered between the previous and subsequent material collection, even if the participants were the same. Also, the essence value blueprint modeling in this thesis is highly based on the participants' current subjective views. Thus, although the material collection was repeated or replicated exactly the same way as in here, the end results would hardly be exactly the same. This is, however, tolerable since the characteristics of qualitative research entail the notion that if the procedure (i.e., measure or observation) is replicated "we are measuring two different things" (Trochim, 2006).

The material collection method I adopted has been documented after all, thus enabling the repeatability or replicability. Additionally, the aforementioned issues concerning the dependability have been regarded with a thorough literature review, including inquiry into former research concerning the topic. Since the literature provides no satisfactory knowledge on DR ecosystem as yet, other material collection not only strengthens but is indeed essential for this study. However, I argue that the participants engaged in this research project have the top knowledge on demand response in Finland; thus, they represent a trustworthy source of information with regard to needs of this thesis. If DR and smart grid applications in general draw more attention in the near future, dependability of this kind of study will most probably increase along with a growing awareness of the topic as well as high-quality literature and research.

The last of the four assessment constructs is *confirmability*. As the results rest upon subjective views, they can only be confirmed or corroborated, or disproved, with other subjective views. The majority of the findings presented in Chapter 5 are achieved via collaboration with experienced researchers and professional, as discussed earlier. However, some of the final results and value blueprints are the products of my own subjective view in the last resort, and those results were not confirmed during the research process. There is no doubt but that the research process itself may lack some noteworthy vantage points, thus leaving unanswered some aspects one may view as important. After all, one shall note that the aim of this study was not to explain all the alternative value blueprints, but provide some preliminary insight into those. When giving these preliminary insights, the thesis leaves a lot of room for contradictory observations and views; I hope this sparks off a debate on demand response ecosystems.

6.4 Future research and closing notes

To the best of my belief this is the first research document covering demand response business ecosystems and value blueprints—at least to be publicly available. This clearly implies a need for further research on this topic and gives researchers all the more reason for studying demand response business constraints and opportunities. I claim that an ecosystem level approach is essential in order to gain understanding how DR would change the electricity sales ecosystem. Furthermore, ecosystem dynamics as well as competitive dynamics are sure to change as the ecosystem matures along with the DR services. The change in the dynamics stems from the idea that the value logic is about to change in days to come. The value logic will change with prosumers that not only purchase but also sell and store electricity, let alone intermittent energy sources that call for demand-side management and demand response. That is, differing sources of value will lead to differing ecosystem dynamics, thus making research of this thesis kind significant.

Furthermore, to improve the quality of DR ecosystem studies, I suggest that large-scale pilot programs must be implemented to acquire real user experiences in the Nordic countries, on which to base earning principles and risk assessments. Until now, the main principle has been that the electricity curtailments consumers execute result in lower electricity bills (e.g., Frilander, 2013). However, in Finland, the price of electricity is already below the average in Euro area and quite low; for example, in Germany, the price of electricity for households was roughly €0.29 per kWh during the first semester of 2013, while Finnish consumers paid only around €0.16 per kWh (Eurostat, 2013). Low electricity prices in Finland undisputedly implicate low saving potential, as well. Large-scale DR pilots, including incentive plans, would most probably shed light on the guesswork about the true potential of DR in Finland. The empirical data acquired through the pilots would expose new, well-founded views on the discussion as well as monetary benefits and, thus, DR ecosystems and value blueprints visualization.

As mentioned, unclear regulation concerning DR impedes its emergence. Consequently, regulation models should also be thoroughly studied. Studies on regulation models could include discussion on tariff structure possibilities (cf. feed-in tariffs) in the context of DR. Demand response tariffs could facilitate the emergence of DR services and subsidize initial capital needs.

Last but not least, I must highlight the need for more holistic research on market opportunity and competitive dynamics of DR service providers in particular. This should include the issue concerning DR service providers independency. In other words, studies on independent DR service providers role should be carried out, since it is not clear whether DR services should be offered by an independent actor or should, for example, a supplier include DR in its offer. As the Adner's value blueprint is specific about the elements and their location, not their ownership, the aforementioned reasoning should not directly affect the visualization of the ecosystems. However, it is sure to have an effect on competitive dynamics facing firms in electricity markets. Hence, the emergence of DR is most likely to have somewhat of a disruptive influence in the market. Furthermore, as wannabes could fuel the competition, similarly disruptiveness could bring about new challenges or environmental pressure to firms to manage.

In the U.S., demand response along with other energy management applications is already a lucrative business. I believe it is just a matter of time before the business thrives in the Nordic and other countries, as well. Ecosystem approach could help in solving the puzzle, spurring the emergence of demand response. What is the solution to the puzzle? That is the question. Getting the answer demands more research and more researchers to sink their teeth into the topic—credit where credit is due.

REFERENCES

Aalto, J. (2011). *Development opportunities for smart metering* (M.Sc Thesis). Tampere University of Technology, Tampere.

Aalto, J., Segerstam, J., Pietilä, P. A., & Gröhn, M. (2013). Demand response event flow in a distributed market environment. SGEM D4.5.2.1. Helsinki: CLEEN.

Åbrandt, G. E., Ellinggard, K. M., Salo, M., Pedersen, J. H., Söderlund, P., & Norstedt, D. (2013). Nordic harmonisation of universal service supply obligations. Oslo: Nordic Energy Regulators (NordREG).

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review*, *84*(4), 98–107.

Adner, R. (2012). *The Wide Lens: A New Strategy for Innovation*. New York, NY: Portfolio/Penguin.

Adner, R., & Kapoor, R. (2007, November). Managing transitions in the semiconductor lithography ecosystem. *Solid State Technology*, *50*(11), S20. San Francisco, CA.

Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generation. *Strategic Management Journal*, *31*(3), 306–333.

Adomavicius, G., Bockstedt, J. C., Gupta, A., & Kauffman, R. J. (2007). Technology roles and paths of influence in an ecosystem model of technology evolution. *Information Technology and Management*, *8*(2), 185–202.

Van Aken, J. E. (2004). Management research based on the paradigm of the design sciences: The quest for field-tested and grounded technological rules. *Journal of Management Studies*, *41*(2), 219–246.

Alagna, V., Cauret, L., Entem, M., Evens, C., Fritz, W., Hashmi, M., Mutale, J., et al. (2011). Description of market mechanisms which enable active demand participation in the power system. ADDRESS project D5.1. ADDRESS.

Albadi, M. H., & El-Saadany, E. F. (2008). A summary of demand response in electricity markets. *Electric Power Systems Research*, *78*(11), 1989–1996.

Aurora, L. (2005, August 19). Massive blackout hits Java, Bali. *The Jakarta Post*. Retrieved October 9, 2013, from www.thejakartapost.com

Bahrami, H., & Evans, S. (1995). Flexible re-cycling and high-technology entrepreneurship. *California Management Review*, *37*(3), 62–89.

Battistella, C., Colucci, K., De Toni, A. F., & Nonino, F. (2013). Methodology of business ecosystems network analysis: A case study in Telecom Italia Future Centre. *Technological Forecasting and Social Change*, *80*(6), 1194–1210.

Belhomme, R., Sebastian, M., Diop, A., Entem, M., Bouffard, F., Valtorta, G., De Simone, A., et al. (2009). Technical and commercial conceptual architectures. ADDRESS project D1.1. ADDRESS.

Belonogova, N., Kaipia, T., Lassila, J., & Partanen, J. (2011). Demand response: conflict between distribution system operator and retailer. *21st International Conference on Electricity Distribution*. Frankfurt, Germany: CIRED.

Boisvert, R. N., Cappers, P. A., & Neenan, B. (2002). The benefits of customer participation in wholesale electrcitity markets. *The Electricity Journal*, *15*(3), 41–51.

Bojanczyk, K. (2013). *Home Energy Management Systems: Vendors, Technologies and Opportunities, 2013–2017*. GTM Research, Greentech Media, Inc.

Borenstein, S., Jaske, M., & Rosenfeld, A. (2002). *Dynamic Pricing, Advanced Metering, and Demand Response in Electricity Markets*. Berkeley, CA: Energy Foundation.

Braithwait, S. D., Eakin, K., & Laurits R. Christensen Associates. (2002). The Role of Demand Response in Electric Power Market Design. Washington, DC: Edison Electric Institute.

Braithwait, S. D., & Hansen, D. G. (2011). How large commercial and industrial customers respond to dynamic pricing—the California experience. In F. P. Sioshansi (Ed.), *Smart Grid: Integrating Renewable, Distributed & Efficient Energy* (pp. 289–316). Waltham, MA: Academic Press.

Brandenburger, A. M., & Nalebuff, B. J. (1996). *Co-opetition*. New York, NY: Currency Doubleday.

Brandenburger, A. M., & Stuart, H. W. (1996). Value-based business strategy. *Journal of Economics & Management Strategy, 5*(1), 5–24.

Bröckl, M., Vehviläinen, I., Virtanen, E., & Keppo, J. (2011). *Examining and proposing measures to activate demand flexibility on the Nordic wholesale electricity market*. Helsinki: Gaia Consulting Oy.

Bryce, R. (2009, March 5). Let's get real about renewable energy. *Wall Street Journal*. New York, NY.

Carlson, C. R., & Wilmot, W. W. (2006). *Innovation: The Five Disciplines for Creating What Customers Want*. New York, NY: Crown Business.

Carmines, E. C., & Woods, J. A. (2005). Validity assessment. In K. Kempf-Leonard (Ed.), *Encyclopedia of Social Measurement, Volume 3* (pp. 933–937). San Diego, CA: Academic Press.

Casey, M. A., & Krueger, R. A. (1994). Focus group interviewing. In H. J. H. MacFie & D. M. H. Thomson (Eds.), *Measurement of Food Preferences* (pp. 77–96). London: Chapman & Hall.

Chardon, A., Almén, O., Lewis, P. E., Stromback, J., & Château, B. (2008). Demand response: A decisive breakthrough for Europe. Retrieved October 9, 2013, from http://www.capgemini.com/resources

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA: Harvard Business School Press.

Chesbrough, H. W., & Appleyard, M. M. (2007). Open innovation and strategy. *California Management Review, 50*(1), 57–77.

Christensen, C. M. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston, MA: Harvard Business School Press.

Costello, R. B. (Ed.). (1995). *Random House Webster's College Dictionary*. New York, NY: Random House.

Cowan, K. R. (2013). A new roadmapping technique for smart grid. *Creativity and Innovation Management, 22*(1), 67–83.

Cusumano, M. A., & Gawer, A. (2002). The elements of platform leadership. *MIT Sloan Management Review, 43*(3), 51–59.

Daniel, F. J. (2012, July 31). Power cut hits millions, among world's worst outages. *Reuters*. Retrieved October 9, 2013, from http://in.reuters.com

Denda, R., Carmelo, R., Romero, G., Tarruell, F., Mauri, G., Pajot, A., Alberdi, G., et al. (2009). *D1.2 Report on regulatory requirements*. Brussels.

Depuru, S. S. S. R., Wang, L., & Devabhaktuni, V. (2011). Smart meters for power grid: Challenges, issues, advantages and status. *Renewable and Sustainable Energy Reviews*, *15*(6), 2736–2742.

Desrochers, P. (2002). Industrial ecology and the rediscovery of inter-firm recycling linkages: Historical evidence and policy implications. *Industrial and Corporate Change*, *11*(5), 1031–1057.

Ten Donkelaar, M., & Scheepers, M. J. J. (2004). A socio-economic analysis of technical solutions and practices for the integration of distributed generation. ECN-C–04-011. Amsterdam: DISPOWER.

Easton, B., House, K., & Byars, J. (2012). *Smart Grid: A race worth winning?* London: SmartGrid GB & Ernst & Young.

Electric Power Research Institute. (2011). *Estimating the Costs and Benefits of the Smart Grid: A Preliminary Estimate of the Investment Requirements and the Resultant Benefits of a Fully Functioning Smart Grid. Report # 1022519*. Palo Alto, CA: EPRI.

Elovaara, J., & Laiho, Y. (2007). *Sähkölaitostekniikan perusteet* (6th ed.). Helsinki: Otatieto.

Energiamarkkinavirasto. (2013). Sähkön hintatilastot (Price of electricity). May 1, 2013. *Tilastot ja lomakkeet (Statistics and reports)*. Retrieved November 15, 2013, from www.energiamarkkinavirasto.fi

Energinet.dk. (2009). *Analyse af grænsesænkning for fjernaflæsning og timeafregning (Analyses of reduced threshold for remote meter reading and hourly settlement)*. Fredericia.

Energy Market Authority. (2011a). *Regulation methods for the assessment of reasonableness in pricing of electricity distribution network operations and high-voltage distribution network operations in the third regulatory period starting on 1 January 2012 and ending on 31 December 2015*. Helsinki.

Energy Market Authority. (2011b). *Regulation methods for the assessment of reasonableness in pricing of electricity transmission network operations in the third regulatory period starting on 1 January 2012 and ending on 31 December 2015*. Helsinki.

Energy Policy Act of 2005. (2005). (pp. 594–1143). United States of America: www.gpo.gov.

Environmental Protection Agency. (2012). *ENERGY STAR® and Other Climate Protection Partnerships: 2011 Annual Report*. Washington, DC.

ESMA. (2010). *2009 Annual Report on the Progress in Smart Metering*. European Smart Metering Alliance.

European Climate Foundation. (2010). Roadmap 2050: A practical guide to a prosperous, low-carbon Europe. *Roadmap 2050 Volume 1*. Retrieved September 27, 2013, from http://www.roadmap2050.eu/

European Commission. (2006). *European Technology Platform SmartGrids: Vision and Strategy for Europe's Electricity Networks of the Future*. (M. Sánchez & A. Quelhas, Eds.). Brussels.

European Parliament and Council. (2009). *Directive 2009/72/EC* (pp. 55–93). Europen Union: OJ L 211, 8/14/2009.

European Union. (2007). The EU climate and energy package. Retrieved July 4, 2013, from http://ec.europa.eu/clima/policies/package/index_en.htm

Eurostat. (2013, November 20). Electricity and natural gas price statistics. *Statistics Explained*. Retrieved January 16, 2014, from http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Electricity_and_natural_gas_price_statistics

Faruqui, A. (2007). Demand response: Breaking out the bubble. *Public Utilities Fortnightly*, (March), 46–51. Vienna, VA.

Faruqui, A., Harris, D., & Hledik, R. (2009). Unlocking the €53 billion savings from smart meters in the EU: How increasing the adoption of dynamic tariffs could make or break the EU's smart grid investment. The Brattle Group.

Faruqui, A., Hledik, R., George, S. S., Bode, J., Mangasarian, P., Rohmund, I., Wikler, G., et al. (2009). *A National Assessment of Demand Response Potential. FERC report*. Federal Energy Regulatory Commission.

Fine, C. H. (1998). *Clockspeed: Winning Industry in the Age of Temporary Advantage*. New York, NY: Perseus Books.

Fingrid. (2013). Definitions. Retrieved September 20, 2013, from http://www.fingrid.fi/en/customers/Balance services/Definitions/Pages/default.aspx

Flatabø, N., Doorman, G., Grande, O. S., Randen, H., & Wangensteen, I. (2003). Experience with the Nord Pool design and implementation. *IEEE Transactions on Power Systems*, *18*(2), 541–547.

Frels, J. K., Shervani, T., & Srivastava, R. K. (2003). The integrated networks model: Explaining resource allocations in network markets. *Journal of Marketing*, *67*(1), 29–45.

Frilander, J. (2013, August 22). Kotitaloudet halutaan säännöstelemään sähkön käyttöä – vastineeksi luvataan pienempiä sähkölaskuja (Households are desired to control their electricity loads for lower bills). *YLE*. Retrieved January 4, 2014, from http://yle.fi/uutiset/kotitaloudet_halutaan_saannostelemaan_sahkon_kayttoa__vastineeksi_luvataan_pienempia_sahkolaskuja/6779596

Fuller, M. C., Kunkel, C., Zimring, M., Hoffman, I., Lindgren Soroye, K., & Goldman, C. (2010). *Driving Demand for Home Energy Improvements*. Berkeley, CA.

Gawer, A., & Cusumano, M. A. (2008). How companies become platform leaders. *MIT Sloan Management Review*, *49*(2), 28–35.

Gawer, A., & Cusumano, M. A. (2013). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management*, *31*(3), 1–17. Early view. DOI: 10.1111/jpim.12105.

Gellings, C. W. (2011). Foreword. In F. P. Sioshansi (Ed.), *Smart Grid: Integrating Renewable, Distributed & Efficient Energy* (p. vii). Waltham, MA: Academic Press.

Gilmore, A., & Carson, D. (1996). "Integrative" qualitative methods in a services context. *Marketing Intelligence & Planning*, *14*(6), 21–26.

Ginsberg, A., Horwitch, M., Mahapatra, S., & Singh, C. (2010). Ecosystem strategies for complex technological innovation: The case of smart grid development. In D. F. Kocaoglu, T. R. Anderson, T. U. Daim, A. Jetter, & C. M. Weber (Eds.), *Technology Management for Global Economic Growth, Proceedings of PICMET '10* (pp. 2787–2794). Phuket, Thailand: IEEE.

Giordano, V., & Fulli, G. (2011). A business case for Smart Grid technologies: A systemic perspective. *Energy Policy*, *40*, 252–259.

Giordano, V., Gangale, F., Fulli, G., & Sánchez Jiménez, M. (2011). *Smart Grid projects in Europe: Lessons learned and current developments*. Luxembourg.

Godfrey, P. C., & Hill, C. W. L. (1995). The problem of unobservables in strategic management research. *Strategic Management Journal*, *16*(7), 519–533.

Goldman, C., Hopper, N., Sezgen, O., Moezzi, M., & Bharvirkar, R. (2004). *Does Real-Time Pricing Deliver Demand Response? A Case Study of Niagara Mohawk's Large Customer RTP Tariff*. Berkeley, CA.

Gunther, E. W. (2007). Smart metering. Pierre, SD.

Gusen, C. (2012). Questions for: Ron Adner. *Rotman Magazine*, (September), 88–90. Toronto.

Hammons, T. J. (2008). Integrating renewable energy sources into European grids. *International Journal of Electrical Power & Energy Systems*, *30*(8), 462–475.

Hanser, P., Madjarov, K., Katzenstein, W., & Chang, J. (2011). Riding the wave: using demand response for integrating intermittent resources. In F. P. Sioshansi (Ed.), *Smart Grid: Integrating Renewable, Distributed & Efficient Energy* (pp. 235–256). Waltham, MA: Academic Press.

Hashmi, M. (2011). Survey of smart grids concepts worldwide. Espoo.

Hauser, S. G., & Crandall, K. (2011). Smart grid is a lot more than just "technology." In F. P. Sioshansi (Ed.), *Smart Grid: Integrating Renewable, Distributed & Efficient Energy* (pp. 3–28). Waltham, MA: Academic Press.

Heffner, G. (2009). Demand Response Valuation Frameworks Paper. Berkeley, CA.

Heinen, S., Elzinga, D., Kim, S.-K., & Yuichi, I. (2011). Impact of Smart Grid Technologies on Peak Load to 2050.

Heiskanen, E., Matschoss, K., Kuusi, H., Kranzl, L., Lapillone, B., Sebi, C., Mairet, N., et al. (2012). Literature review of key stakeholders, users and investors. Entranze project D2.4. Entranze.

Heiskanen, E., Matschoss, K., & Saastamoinen, M. (2012). *Asiakkaan näkökulma älykkään sähköverkon lisäarvoon (Added value of the smart grid from the customer's perspective)*. Helsinki: Kuluttajatutkimuskeskus.

Herter, K., McAuliffe, P., & Rosenfeld, A. (2007). An exploratory analysis of California residential customer response to critical peak pricing of electricity. *Energy*, *32*(1), 25–34.

Heskett, J. L., Jones, T. O., Loveman, G. W., Sasser, W. E., & Schlesinger, L. A. (1994). Putting the service-profit chain to work. *Harvard Business Review*, *72*(2), 164–174.

Heskett, J. L., Sasser, W. E., & Schlesinger, L. A. (1997). *Service Profit Chain: How Leading Companies Link Profit and Growth to Loyalty, Satisfaction, and Value*. New York, NY: The Free Press.

Hierzinger, R., Albu, M., Van Elbung, H. van, Scott, A. J., Łazicki, A., Penttinen, L., Puente, F., et al. (2013). *European Smart Metering Landscape. Report 2012 – update May 2013*. (P. Traupmann, Ed.). Vienna: Österreichische Energieagentur – Austrian Energy Agency.

Hirst, E. (2002). The financial and physical insurance benefits of price-responsive demand. *The Electricity Journal*, *15*(4), 66–73.

Hirst, E., & Kirby, B. (2001). *Retail-Load Participation in Competitive Wholesale Electricity Markets*. Washington, DC.

Hobbs, B. F., Honious, J. C., & Bluestein, J. (1994). Estimating the flexibility of utility resource plans: An application to natural gas cofiring for SO2 control. *IEEE Transactions on Power Systems*, *9*(1), 167–173.

Hooper, J. (2003, September 30). Italy's blackout raises questions. *The Guardian*. Retrieved October 9, 2013, from www.theguardian.com

Hopkins, M. S. (2011). Interview with Michael Cusumano. How to innovate when platforms won't stop moving. *MIT Sloan Management Review*, *52*(4), 55–60.

Hull, D. (2010, March 31). Record number of cleantech deals in the first quarter of 2010. *Silicon Valley News*. San Jose, CA.

Hurley, D., Peterson, P., & Whited, M. (2013). *Demand Response as a Power System Resource*. Brussels: By Synapse Energy Economics, Inc. for Regulatory Assistance Project.

Iansiti, M., & Levien, R. (2004a). Strategy as ecology. *Harvard Business Review*, *82*(3), 68–78.

Iansiti, M., & Levien, R. (2004b). *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability*. Boston, MA: Harvard Business School Publishing.

International Energy Agency. (2003). *The Power to Choose—Demand Response in Liberalized Electricity Markets*. Paris: OECD/IEA.

International Energy Agency. (2011). *Technology Roadmap. Smart Grids*. Paris: OECD/IEA.

International Energy Agency. (2012). *World Energy Outlook 2012*. (R. Priddle, Ed.). Paris: OECD/IEA.

Isaacs, A., Daintith, J., & Martin, E. (Eds.). (1991). *The Oxford Dictionary for Scientific Writers and Editors*. Oxford: Clarendon.

Iyer, B., & Davenport, T. H. (2008). Reverse engineering Google's innovation machine. *Harvard Business Review*, *86*(4), 58–68.

Jazayeri, P., Schellenberg, A., Rosehart, W. D., Doudna, J., Widergren, S., Lawrence, D., Mickey, J., et al. (2005). A survey of load control programs for price and system stability. *IEEE Transactions on Power Systems*, *20*(3), 1504–1509.

Ju, S. H., Lim, Y. H., Choi, M. S., Baek, J., & Lee, S. (2011). An efficient home energy management system based on Automatic Meter Reading. *International Symposium on Power Line Communications and Its Applications (ISPLC)* (pp. 479–484). Udine: IEEE.

Kaplan, R. S., & Norton, D. P. (2004). *Strategy Maps: Converting Intangible Assets into Tangible Outcomes*. Boston, MA: Harvard Business School Publishing.

Kapoor, R., & Adner, R. (2007). Technology interdependence and the evolution of semiconductor lithography. *Solid State Technology*, *50*(11), 51–54. San Francisco, CA.

Karady, G. G. (2012). Concept of Energy Transmission and Distribution. In L. L. Grigsby (Ed.), *Electric Power Generation, Transmission, and Distribution* (3rd ed.). Boca Raton, FL: CRC Press.

Kassakian, J. G., & Schmalensee, R. (2011). *The Future of the Electric Grid*. Cambridge, MA.

King, C., & Delurey, D. (2005, March). Energy efficiency and demand response: Twins, siblings or cousins? *Public Utilities Fortnightly*, (March), 54–61. Vienna, VA.

Kirschen, D. S. (2003). Demand-side view of electricity markets. *IEEE Transactions on Power Systems*, *18*(2), 520–527.

Krueger, R. A., & Casey, M. A. (2000). *Focus Groups: A Practical Guide for Applied Research* (3rd ed.). London: SAGE Publications.

Krueger, R. A., & Casey, M. A. (2010). Focus group interviewing. In J. S. Wholey, H. P. Hatry, & K. E. Newcomer (Eds.), *Handbook of Practical Program Evaluation* (3rd ed., pp. 378–403). San Francisco, CA: John Wiley & Sons.

Lakervi, E., & Holmes, E. J. (1995). *Electricity Distribution Network Design*. (A. T. Johns & J. R. Platts, Eds.) (2nd ed.). London: Peter Peregrinus Ltd.

Leavy, B. (2012). Ron Adner: Managing the interdependencies and risks of an innovation ecosystem. *Strategy & Leadership*, *40*(6), 14–21.

Lehr, R. L. (2013). New utility business models: Utility and regulatory models for the modern era. *The Electricity Journal*, *26*(8), 35–53.

Levy, S. (2007, November). The future of reading. *Newsweek*, *150*(22), 57–64. New York, NY.

Li, B., Qi, B., Yan, H., Sun, Y., & Tang, L. (2012). New communication infrastructure for demand-side management by utilizing multi-mode consumer electronics devices. *China International Conference on Electricity Distribution (CICED 2012)* (Vol. 2, pp. 1023–1026). Shanghai, China: IEEE.

Li, Y.-R. (2009). The technological roadmap of Cisco’s business ecosystem. *Technovation*, *29*(5), 379–386.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. Beverly Hills, CA: SAGE Publications.

Lusch, R. F. (2011). Reframing supply chain management: A service-dominant logic perspective. *Journal of Supply Chain Management*, *47*(1), 14–18.

Lusch, R. F., Vargo, S. L., & Tanniru, M. (2010). Service, value networks and learning. *Journal of the Academy of Marketing Science*, *38*(1), 19–31.

Ma, O., Alkadi, N., Cappers, P., Denholm, P., Dudley, J., Goli, S., Hummon, M., et al. (2013). Demand response for ancillary services. *IEEE Transactions on Smart Grid*, *4*(4), 1988–1995.

Van Maanen, J. (1983). *Qualitative Methodology* (2nd ed.). London: SAGE Publications.

Mäki, J. (2013). *Asuinkerrostalon energiankulutuksen hallinta älykkään asukasportaalin avulla (Managing energy consumption in residential building with smart home portal)* (M.Sc Thesis). Tampere University of Technology, Tampere.

Malik, A. S., & Bouzguenda, M. (2011). Smart grid capacity and energy saving potential – A case study of Oman. *Innovative Smart Grid Technologies, IEEE PES Conference on ISGT Middle East ’11*. Jeddah, Saudi Arabia: IEEE.

Malik, A. S., & Bouzguenda, M. (2013). Effects of smart grid technologies on capacity and energy savings – A case study of Oman. *Energy*, *54*, 365–371.

Meeus, L., Purchala, K., & Belmans, R. (2005). Development of the internal electricity market in Europe. *The Electricity Journal*, *18*(6), 25–35.

Meyer, A. D., Gaba, V., & Colwell, K. A. (2005). Organizing far from equilibrium: Nonlinear change in organizational fields. *Organization Science*, *16*(5), 456–473.

Milgrom, P., & Roberts, J. (1990). The economics of modern manufacturing: Technology, strategy, and organization. *American Economic Review*, *80*(3), 511–528.

Ministry of Petroleum and Energy. (2013). Facts 2013: Energy and Water Resources in Norway. (I. Østensen, Ed.). Oslo: The Ministry of Petroleum and Energy.

Moore, G. A. (2002). *Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers* (Rev. ed.). New York, NY: HarperCollins.

Moore, J. F. (1993). Predators and prey: A new ecology of competition. *Harvard Business Review*, (May-June), 75–86.

Moore, J. F. (1996). *The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems*. New York, NY: Harper Business.

Morgan, D. L. (1997). *Focus Group as Qualitative Research* (2nd ed.). London: SAGE Publications.

Nemtzow, D., Delurey, D., & King, C. (2007, March). Demand response: The green effect. *Public Utilities Fortnightly*, *March*(March), 40–45. Vienna, VA.

NERC. (2011). *Demand Response Availability Data System (DADS): Phase I & II Final Report* (p. 93). Princeton, NJ.

Neumann, S., Sioshansi, F. P., Vojdani, A., & Yee, G. (2007). Demand response: The missing link. *Public Utilities Fortnightly*, (March), 52–57. Vienna, VA.

Nord Pool Spot. (2013). Power market in Europe. Day-ahead and intraday power markets. Retrieved September 12, 2013, from www.nordpoolspot.com

NordREG. (2006). *A Common Definition of the System Operators' Core Activities (Report 4/2006)*. Eskilstuna: Nordic Energy Regulators (NordREG).

NordREG. (2009). *Market Design: Common Nordic End-user Market (Report 3/2009)*. Oslo: Nordic Energy Regulators (NordREG).

Olkkonen, T. (1993). *Johdatus teollisuustalouden tutkimustyöhön (Introduction to Industrial Management Research)*. Espoo: Teknillinen korkeakoulu (Helsinki University of Technology).

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation*. Hoboken, NJ: John Wiley & Sons.

Piette, M. A., Sezgen, O., Watson, D. S., Motegi, N., Shockman, C., & Ten Hope, L. (2004). *Development and Evaluation of Fully Automated Demand Response In Large Facilities*. Berkeley, CA: California Energy Commission, The Public Interest Energy Research (PIER) Program.

Porter, M. E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York, NY: Free Press.

Powell, R. A., & Single, H. M. (1996). Focus groups. *International Journal for Quality in Health Care*, *8*(5), 499–504.

PwC, & NVCA. (2008). *Cleantech comes of age: Findings from the MoneyTree^{TM} Report*. PricewaterhouseCoopers and National Venture Capital Association.

Renner, S., Albu, M., Van Elburg, H., Heinemann, C., Łazicki, A., Penttinen, L., Puente, F., et al. (2011). *European Smart Metering Landscape Report*. (F. Unterpertinger, Ed.). Vienna: Österreichische Energieagentur – Austrian Energy Agency.

Robson, C. (2002). *Real World Research: A Resource for Social Scientists and Practitioner-Researchers* (2nd ed.). Oxford: Blackwell Publishing.

Roggenkamp, M. M., & Boisseleau, F. (2005). The Liberalisation of the EU Electricity Market and The Role of Power Exchanges. In M. M. Roggenkamp & F. Boisseleau (Eds.), *The Regulation of Power Exchange in Europe* (pp. 1–29). Antwerp: Intersentia.

Rohleder, T. R., & Klassen, K. J. (2001). Combining Operations and Marketing to Manage Capacity and Demand in Services. *The Service Industries Journal*, *21*(2), 1–30.

Rothschild, M. L. (1990). *Bionomics: Economy as Ecosystem*. New York, NY: Henry Holt and Company.

Sæle, H., & Grande, O. S. (2011). Demand response from household customers: Experiences from a pilot study in Norway. *IEEE Transactions on Smart Grid*, *2*(1), 102–109.

Sæle, H., Rosenberg, E., & Feilberg, N. (2010). *State-of-the-art. Projects for estimating the electricity end-use demand. TR A6999*. Trondheim: SINTEF Energy Research.

Santos, F. M., & Eisenhardt, K. M. (2005). Organizational boundaries and theories of organization. *Organization Science*, *16*(5), 491–508.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students* (5th ed.). Harlow: Prentice Hall.

Seale, C. (1999). Quality in qualitative research. *Qualitative Inquiry*, *5*(4), 465–478.

Sezgen, O., Goldman, C. A., & Krishnarao, P. (2007). Option value of electricity demand response. *Energy*, *32*(2), 108–119.

SGMM. (2010). *Smart Grid Maturity Model: Model Definition*. Pittsburgh, PA: Software Engineering Institute.

Sharma, S., & Henriques, I. (2005). Stakeholder influences on sustainability practices in the Canadian forest products industry. *Strategic Management Journal*, *26*(2), 159–180.

Shrivastava, P. (1995). Ecocentric management for a risk society. *Academy of Management Review*, *20*(1), 118–137.

Simon, S. (2010, February 13). Even Boulder finds it isn’t easy going green. *Wall Street Journal*. New York, NY.

Sioshansi, F. P. (Ed.). (2012). *Smart Grid: Integrating Renewable, Distributed & Efficient Energy*. Waltham, MA: Academic Press.

SmartGrids. (2006). The SmartGrids European Technology Platform. Retrieved August 30, 2013, from http://www.smartgrids.eu/ETPSmartGrids

SmartRegions. (2013). Smart metering - The key to better energy management. Retrieved August 29, 2013, from http://www.smartregions.net/default.asp?SivuID=28925

Stavseth, E. C. (2013, June 11). THE NORDIC/`BALTIC POWER MARKET. Oslo.

Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. *Management Decision*, *39*(7), 551–555.

Strbac, G. (2008). Demand side management: Benefits and challenges. *Energy Policy*, *36*(12), 4419–4426.

Tanaka, N. (2011). *Technology Roadmap. Smart Grids*. Paris: International Energy Agency.

TE. (2013, March 21). Ja taas pomppasi... sähkön hinta on vuoden huipussaan ja ennusteet lupaavat pahaa (The price of the electricity is at its top of the year and the prognoses promise a bad one). *Talouselämä*. Retrieved August 30, 2013, from http://www.talouselama.fi/uutiset/ja+taas+pomppasi+sahkon+hinta+on+vuoden+huipussaan+ja+ennusteet+lupaavat+pahaa/a2176046

Teece, D. J. (1986). Profiting from technological innovation: Implication for integration, collaboration, licencing and public policy. *Research Policy*, *15*(6), 285–305.

Teece, D. J. (2007). Explicating dynamics capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350.

Thomas, L. D. W., & Autio, E. (2012). Modeling the ecosystem: A meta-synthesis of ecosystem and related literatures. *The DRUID Society Conference on Innovation and Competitiveness - Dynamics of organizations, industries, systems and regions*. Copenhagen: Copenhagen Business School.

Torriti, J., Hassan, M. G., & Leach, M. (2010). Demand response experience in Europe: Policies, programmes and implementation. *Energy*, *35*(4), 1575–1583.

Trochim, W. M. K. (2006). Qualitative validity. *Research Methods Knowledge Base*. Retrieved January 3, 2014, from http://www.socialresearchmethods.net/kb/qualval.php

U.S. Department of Energy. (2006). *Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them. A Report to the United*

States Congress Pursuant to Section 1252 of the Energy Policy Act of 2005. Washington, DC.

Valtonen, P., Honkapuro, S., & Partanen, J. (2011). Impacts of smart grids on electricity retail business. *21st International Conference on Electricity Distribution (CIRED)*. Frankfurt, Germany.

Valtonen, P., Partanen, J., & Belonogova, N. (2012). The role and business potential of customer load control in an electricity retailer's short-term profit optimization. *10th Nordic Conference on Electricity Distribution System Management and Development (NORDAC)*. Espoo, Finland.

Vargo, S. L., & Lusch, R. F. (2011). It's all B2B…and beyond: Toward a systems perspective of the market. *Industrial Marketing Management*, *40*(2), 181–187.

Vojdani, A. (2008). Smart integration. *IEEE Power and Energy Magazine*, *6*(6), 71–79.

De Vries, L. J. (2004). *Securing the public interest in electricity generation markets: The myths of the invisible hand and the copper plate* (Doctoral dissertation). Delft University of Technology, Delft.

Wang, W., & Lu, Z. (2013). Cyber security in the Smart Grid: Survey and challenges. *Computer Networks*, *57*(5), 1344–1371.

Van Werven, M. J. N., & Scheepers, M. J. J. (2005). The changing role of distribution system operators in liberalised and decentralising electricity markets. ECN-C–05-048. Amsterdam: DISPOWER.

Willrich, M. (2009). Electricity Transmission Policy for America: Enabling a Smart Grid, End-to-End. MIT-IPC-09-002. Cambridge, MA: MIT Industrial Performance Center.

Yin, R. K. (1989). *Case Study Research: Design and Methods*. New York, NY: SAGE Publications.

Yin, R. K. (2009). *Case Study Research: Design and Methods* (4th ed.). Thousand Oaks, CA: SAGE Publications.

Zacharakis, A. L., Shepherd, D. A., & Coombs, J. E. (2003). The development of venture-capital-backed internet companies. *Journal of Business Venturing*, *18*(2), 217–231.

Demand response options

Policymakers have several tariff and program options for eliciting demand response. The most commonly implemented options are described below.

Table A1-1: *Price-based demand response options. Adapted from the U.S. Deparment of Energy (2006, p. 9).*

Tariff options ("price-based" demand response)
Time-of-use (TOU) TOU is 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. TOU rates often vary by time of day (e.g., peak vs. off- peak period), and by season and are typically pre-determined for a period of several months or years. Time-of-use rates are in widespread use for large commercial and industrial (C/I) customers and require meters that register cumulative usage during the different time blocks.
Real-time pricing (RTP) RTP is a rate in which the price for electricity typically fluctuates hourly reflecting changes in the wholesale price of electricity. RTP prices are typically known to customers on a day-ahead or hour-ahead basis.
Critical peak pricing (CPP) CPP rates include a pre-specified high rate for usage designated by the utility to be a critical peak period. CPP events may be triggered by system contingencies or high prices faced by the utility in procuring power in the wholesale market, depending on the program design. CPP rates may be super-imposed on either a TOU or time-invariant rate and are called on relatively short notice for a limited number of days and/or hours per year. CPP customers typically receive a price discount during non-CPP periods. CPP rates are not yet common, but have been tested in pilots for large and small customers in several states (e.g., Florida, California, and North and South Carolina).

Table A1-2: *Incentive-based demand response options. Adapted from the U.S. Deparment of Energy (2006, p. 9).*

Program options ("incentive-based" demand response)

Direct load control (DLC)

DLC is a program in which the utility or system operator remotely shuts down or cycles a customer's electrical equipment (e.g. air conditioner, water heater) on short notice to address system or local reliability contingencies. Customers often receive a participation payment, usually in the form of an electricity bill credit. A few programs provide customers with the option to override or opt-out of the control action. However, these actions almost always reduce customer incentive payments. Direct load control programs are primarily offered to residential and small commercial customers.

Interruptible/curtailable (I/C) service

I/C programs integrated with the customer tariff that provide a rate discount or bill credit for agreeing to reduce load, typically to a pre-specified firm service level (FSL), during system contingencies. Customers that do not reduce load typically pay penalties in the form of very high electricity prices that come into effect during contingency events or may be removed from the program. Interruptible programs have traditionally been offered only to the largest industrial (or commercial) customers.

Demand bidding/buyback programs

These are programs that (1) encourage large customers to bid into a wholesale electricity market and offer to provide load reductions at a price at which they are willing to be curtailed, or (2) encourage customers to identify how much load they would be willing to curtail at a utility-posted price. Customers whose load reduction offers are accepted must either reduce load as contracted (or face a penalty).

Emergency DR programs

Programs that provide incentive payments to customers for measured load reductions during reliability-triggered events; emergency demand response programs may or may not levy penalties when enrolled customers do not respond.

Capacity market programs

These programs are typically offered to customers that can commit to providing pre-specified load reductions when system contingencies arise. Customers typically receive day-of notice of events. Incentives usually consist of up-front reservation payments, determined by capacity market prices, and additional energy payments for reductions during events (in some programs). Capacity programs typically entail significant penalties for customers that do not respond when called.

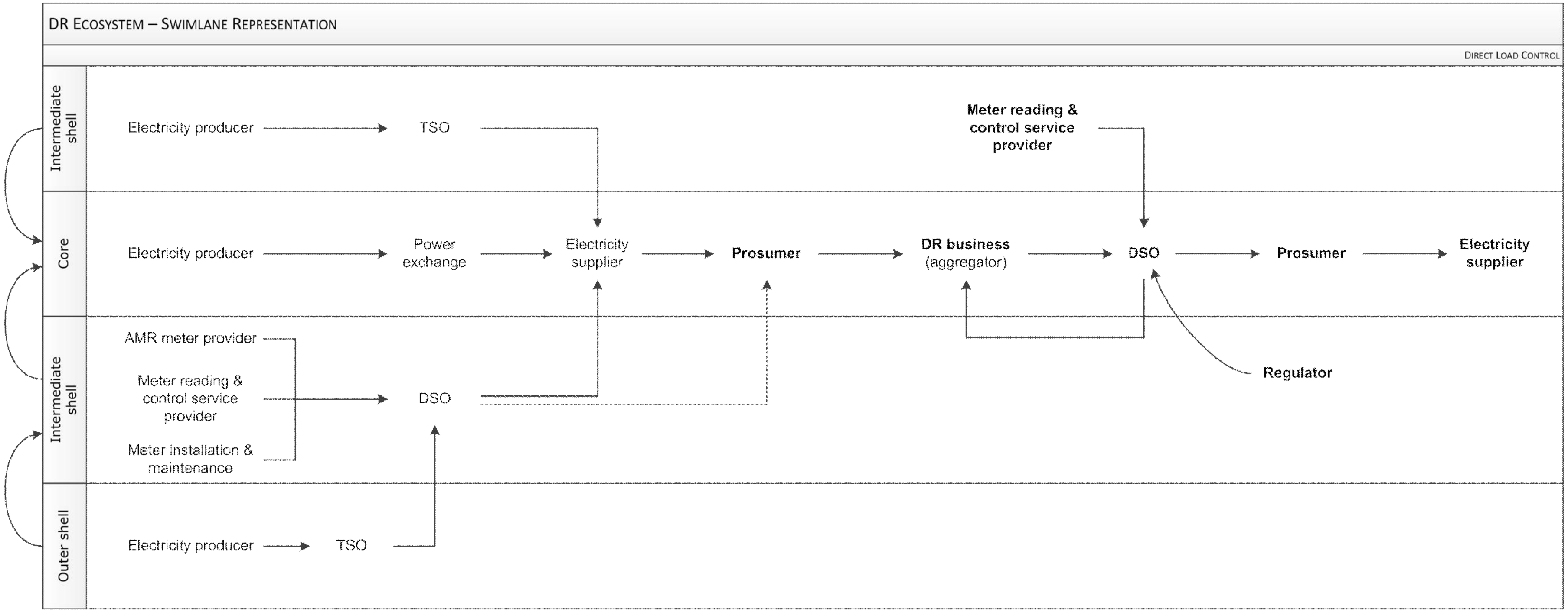
Ancillary services market programs

These programs allow customers to bid load curtailments in ISO/RTO markets as operating reserves. If their bids are accepted, they are paid the market price for committing to be on standby. If their load curtailments are needed, they are called by the ISO/RTO, and may be paid the spot market energy price.

The steps to construct a value blueprint (Adner, 2012, pp. 85–87)

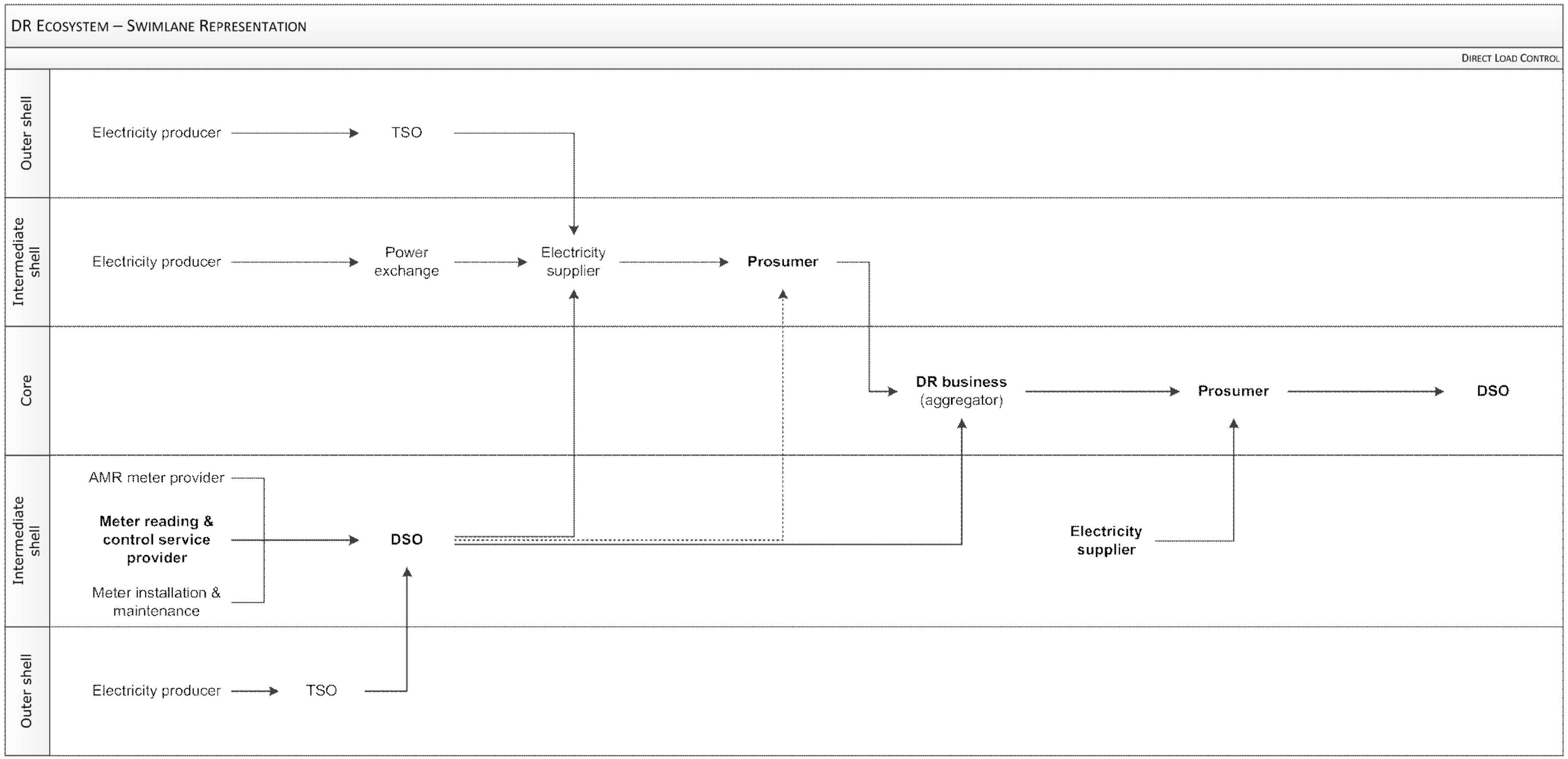
1. Identify your end customer. Ask: *Who is the final target of the value proposition? Who ultimately needs to adopt our innovation for us to claim success?*
2. Identify your own project. Ask: *What is it that we need to deliver?*
3. Identify your suppliers. Ask: *What input will we need to build our offer?*
4. Identify your intermediaries. Ask: *Who stand between us and the end customer? Who touches our innovation after us, and to whom do they pass it on the way to the end customer?*
5. Identify your complementors. For each intermediary ask: *Does anything else need to happen before this intermediary can adopt the offer and move it forward to the end customer?*
6. Identify the risks in the ecosystem. For every element on the map ask:
    a. *What is the level of co-innovation risk this element presents—how able are they to undertake the required activity?*
    b. *What is the level of adoption risk this element presents—how willing are they to undertake the required activity?*

    It is often most productive to characterize the status of each element of your innovation effort along a green-yellow-red traffic light continuum. For co-innovation risk, green means that they are ready to and in place; yellow means that they are not yet in place, but that there is a plan—they must be late, but they'll get there; and red means that they are not in place and there is no clear plan. For adoption risk, green means your partners are eager to participate and see clear surplus from their involvement; yellow means that they are neutral but open to inducement; and red means they have clear reasons to prefer status quo and prefer not to participate in the proposition as it stands. In assessing the risk implied by new links, it is important to consider the incentives of each linked party to choose to interact in this new way.
7. For every partner whose status is not green, work to understand the cause of the problem and identify a viable solution.
8. Update the blueprint on a regular basis. Your value blueprint is a live document, and as conditions change over time, it will need to be modified accordingly.

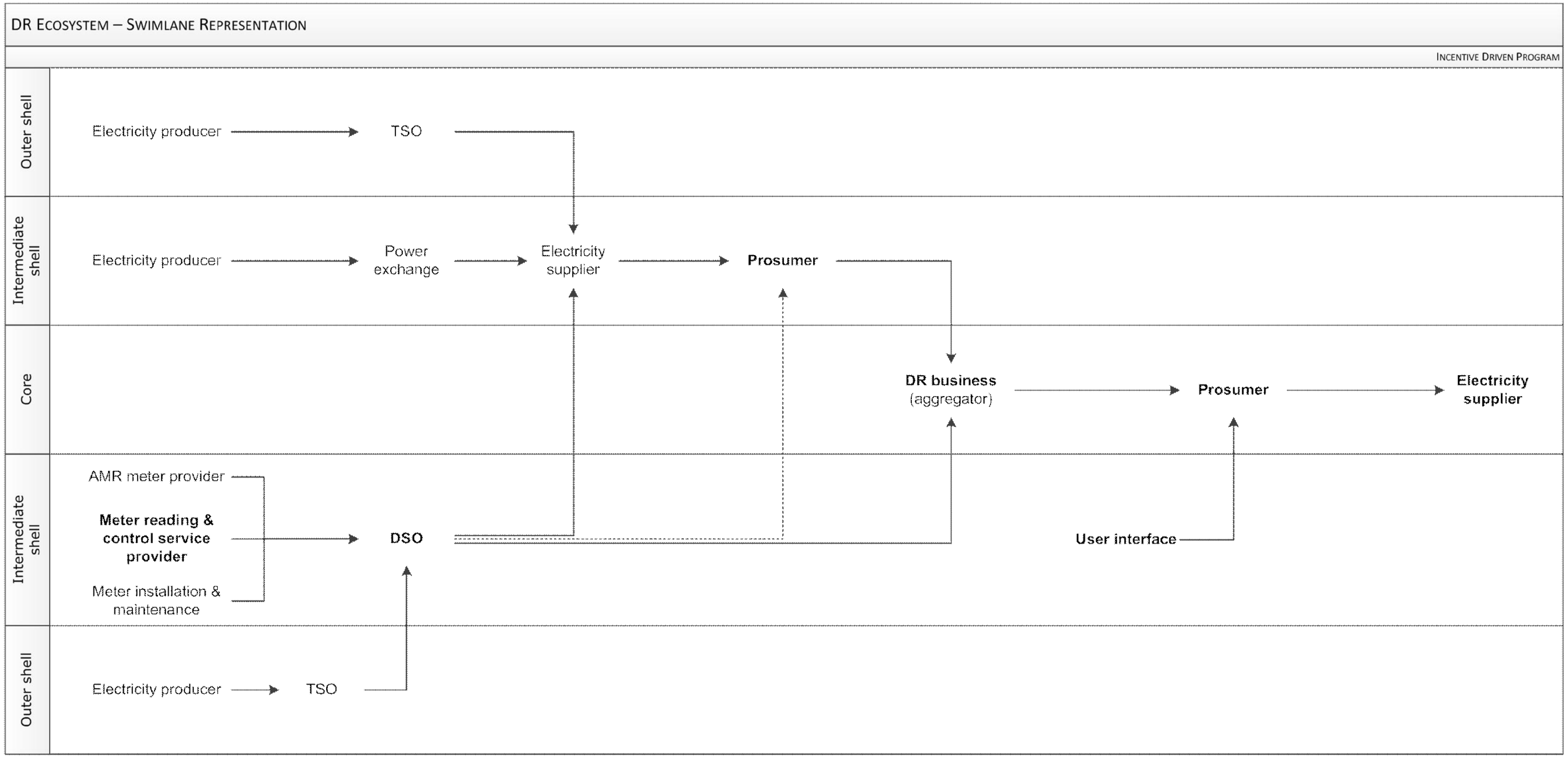


- For DSOs, no incentives to invest in DR because the profits would be zero. Instead, investments in distribution infrastructure can be charged from consumers.
- Regulator determines minimum requirements to DSO. Accordingly, AMR is required but its properties are inadequate.
- DSOs' must enable electricity distribution on their corresponding areas. Could do more but won't because don't have to.
- Minimum bids to balancing market are 10 MW in 15 minutes, i.e., aggregator would need lots of customer to be able to participate in balancing market. → In the future, distributed balancing market with lower bids (e.g., 1 MW or even 100 kW)?
- Regulatory rules do not address how to deal with consumer-consumer trades. Net demand is calculated once a year which is not fully supporting own production.

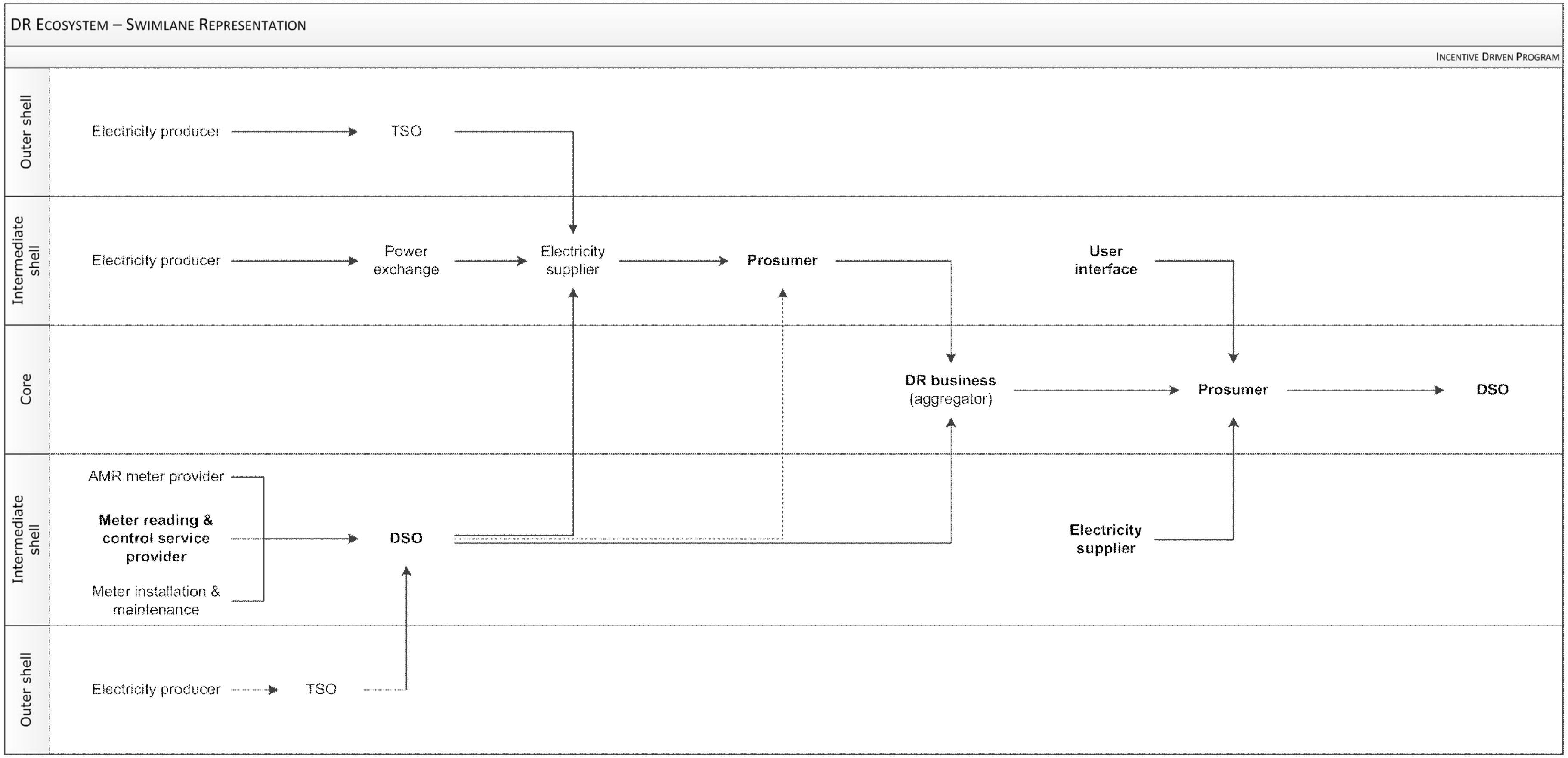
- AMR load control systems are complex and distributed and provide different interfaces. They are not open. → Problem to DR business aggregator.
- Regulatory changes occur in a five-year intervals (last one two years ago).
- Regulation should provide ROI to DSO to develop AMR load control system.



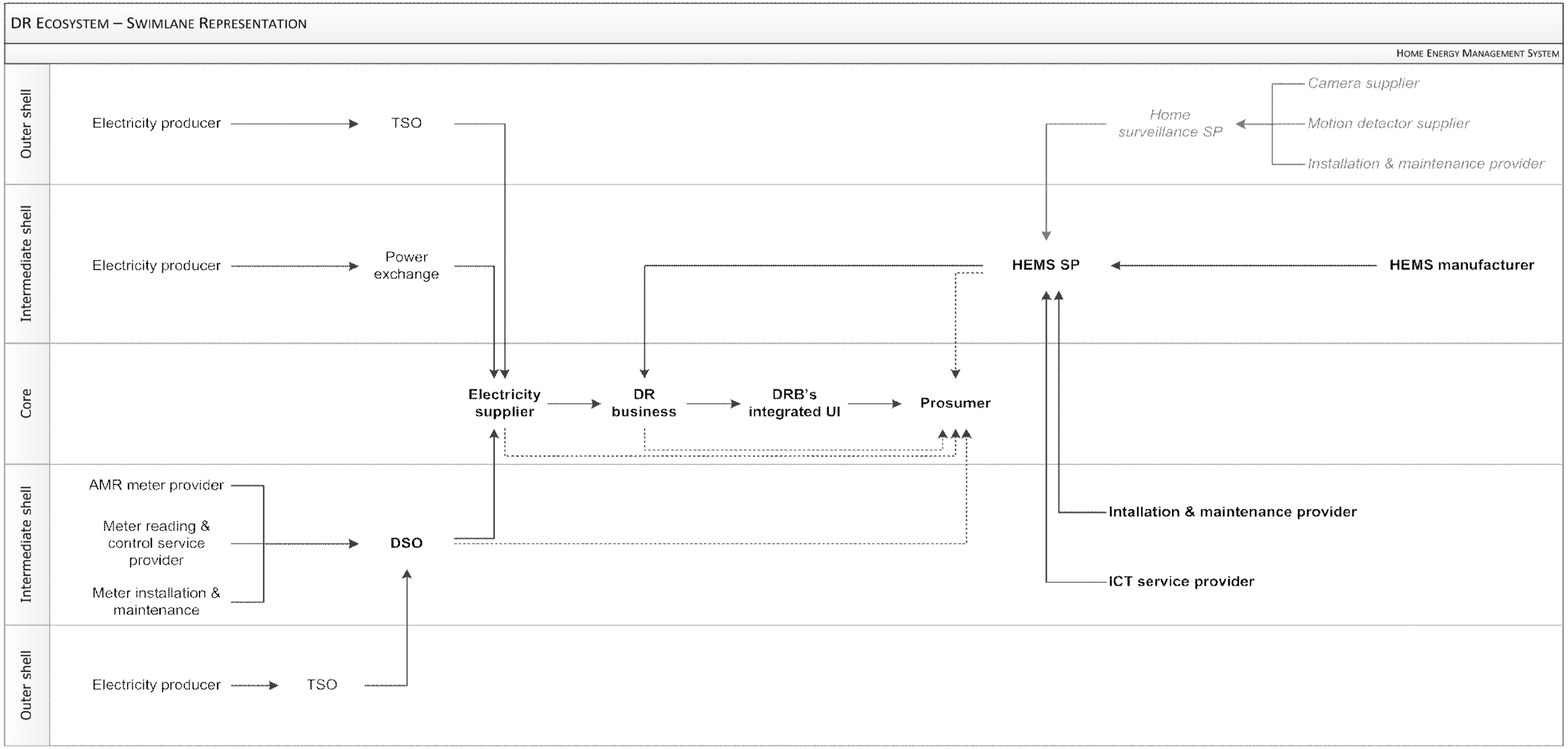
- Savings for DSO through restricting consumer access to grid.
- In a case of grid failure, is there a possibility to maintain some tolerable conditions concerning distribution (e.g., lights on) in order to avoid compensation costs.
- No lack of capacity in Finland → no true need for DR.
- DR is not part of 'reasonable return' → golden opportunity to do business (unbundled from distribution)? Neutrality toward suppliers?



- Who will build the infrastructure?
- Monetary incentive to get consumer involved.
- Aggregator’s market position should be large enough to take advantage.
- But small enough to avoid of being market player.



- For DSO, cost without profit.
- For aggregator, where to bargain? In the future, distributed balancing market with lower bids (e.g., 1 MW or even 100 kW)?
- Consumer incentives?
- The Finnish grid is ‘too good’ for this, no ‘win-win-win’ potential



- Service portfolio doesn't exist.
- Separate technologies are too expensive compared to customer value. Bundling could solve this problem providing more customer value with little increase in costs
- Flexibility of service?
- Energy efficiency could profit better than DR → Mix up?

The poster the author presented in the SGEM unconference

sgem
Smart Grids and Energy Markets

TAMPERE UNIVERSITY OF TECHNOLOGY

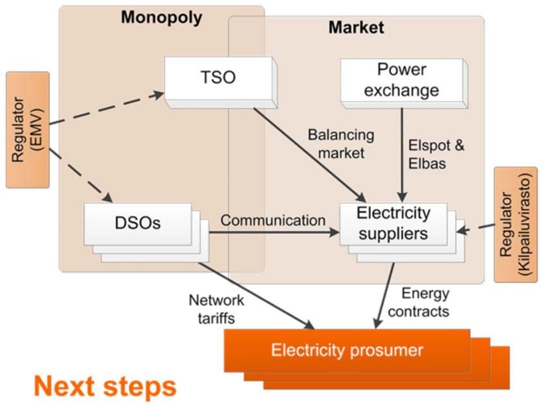
Ecosystems for Demand Response

Objectives

We examine the DR business ecosystem in the smart grid environment focusing on the liberalized Nordic electricity markets. The aim is to afford a blueprint of an ecosystem to identify the problematic nodes and provide alternatives how to overcome possible obstacles in order to develop a functioning ***demand response ecosystem*** for this field.

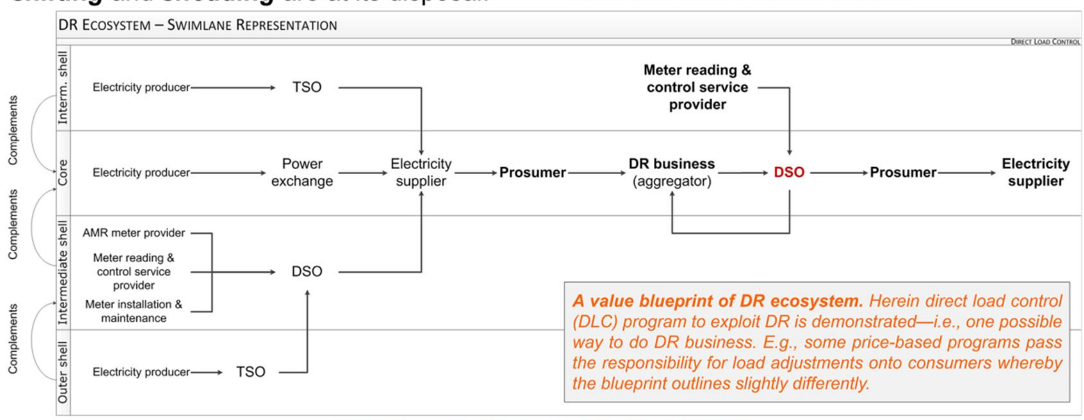
Main achievements

Based on earlier work on SGEM, we have considered that ***a consumer may not be treated as the end customer*** in this ecosystem. Thus, the value proposition of DR should be developed by considering a DSO, TSO, retailer, or even yet non-existing aggregator as the end customer in this business ecosystem. Substantial economic, environmental, and social advantages are possible through DR utilization in these cases. For instance, an electricity supplier can cut its future balancing costs if ***load shifting*** and ***shedding*** are at its disposal.



Next steps

We are going to study the business ecosystems of several different DR programs and strive for identifying the key obstacles hindering the development of thriving DR businesses. We see crucial the identification of the key elements and their explicit locations in the ecosystem as well as detecting the ways to overcome the key obstacles to bring about the DR businesses to boom. This work will be supported with business model examinations.



SGEM unconference 24.-25.10.2013