

Smarter Metering

An analysis of the requirements and bottlenecks of meter-data service delivery.

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Pim Veldhoven
p.veldhoven@gmail.com
Student number: 1102427

Graduation committee:
Dhr. W.A.G.A. Bouwman (Chairperson, TU Delft)
Dhr. T.W. Fens (TU Delft)
Mw. Z. Lukzo (TU Delft)
Dhr. C. Berkhof (Capgemini Nederland B.V.)

Faculty of Technology, Policy and Management
Section Information and Communication Technology
Delft University of Technology

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Executive Summary

The mandatory introduction of smart energy meters in Dutch households is expected to have a significant impact on the Dutch energy sector. Smart energy meters enable bidirectional communication between the customer energy meter and the utility and thereby significantly change existing administrative and operational processes in the sector. One of the objectives of the Ministry of Economic Affairs for the mandatory introduction is that smart meters enable new information and communication applications based on meter data. The current initiatives in the sector are solely aimed at improving these administrative and operational processes, although a smart meter role out also enables the delivery of innovative value added customer services. The innovative character of these applications lies primarily in the fact that the availability of meter data enables parties from outside the utility sector to deliver such services possibly bundled with their existing propositions. Innovative information and communication applications can therefore lead to transsectorial innovation in the sector.

In this research we have focussed on the delivery of value added services to electricity customers. Although the concept of service delivery is very broad, the possibilities for service delivery using a smart meter are generally determined by the current technical and institutional characteristics of the Dutch utility sector. Because, the existing technical functions and institutional arrangements solely focus on existing parties and operational processes, we expect that these functions limit the possibilities for innovative service delivery. Therefore, the research question of this thesis has been formulated as follows: *‘What are the requirements for innovative meter data service delivery to electricity customers and how can these requirements be satisfied in the current technical and institutional design of the sector?’*

The methodology for answering this question constitutes of literature research, secondary analysis of cases and interviews with experts at Capgemini and representatives from parties active in the utility sector. The deliverables and conclusions of this research can be divided in two parts, due to the use of different perspectives during the research project. Part One is of explorative nature and has an economic perspective as we determined the requirements for delivering commercial value added services. Part Two discusses the governance perspective of satisfying these service requirements by discussing the technical and institutional bottlenecks for service delivery in the Dutch sector.

In Part One of our research we developed a conceptual model specifying the variables which are important for smart meter service delivery. Based on this model and interviews with utility representatives from Eneco, Essent, E-on Benelux and Oxxio, we distinguished several types of smart meter services, namely: *usage information services, financial incentive services, cross-sector and automation services and internal applications.*

Depending on the type and characteristics of the service, different requirements for service delivery need to be satisfied. Based on our research, we distinguished two types of requirements, *functional requirements* and *boundary conditions for service delivery*. The functional requirements we distinguished are: *effective usage feedback, suitable customer incentives and a suitable display device*. Although the functional requirements are an explicit design choice for a service provider, the boundary conditions should be guaranteed by the current technical and institutional design of the sector. We distinguished the following boundary conditions: *compliance with distributed generation, a healthy customer relationship, a suitable penetration rate, meter functionality, physical meter access and meter data management.*

Consequently, we discussed in Part Two how these boundary conditions for service delivery could be satisfied in the technical and institutional design of the sector. We concluded that the technical and institutional designs are primarily designed for optimizing the processes in the sector. As a result, we identified significant bottlenecks for service delivery due to the choices made regarding the functionality and characteristics of the physical meter ports, data management and the responsibilities of the parties in the sector.

As a result of these bottlenecks service delivery suffers from switch barriers, customer lock-in, capital requirements and strategic resource advantages which limit innovative customer service delivery and increase complexity in the sector. The disadvantages of supplying value added services in the current institutional environment can be attributed to:

- No alignment between individual costs and benefits. The regional grid operator has different incentives with respect to sharing meter data compared to a third-party service providers, stemming from a difference in both the regime (regulated versus commercial) and a difference in objectives (minimum functionality due to versus maximum functionality).
- An undesirable separation between regulated and commercial activities. Since the regulatory framework prohibits the regional grid operator to enable commercial activities over its proprietary infrastructure, this leads to a situation where third-party service providers require an additional infrastructure for leveraging the full functionality of the smart meter.
- Decentral architecture inefficiencies. The Dutch energy policy mandates that each regional grid operator should maintain a central access server where it stores and aggregates meter data. However, as for more advanced meter data applications information from multiple access servers is required, the number of relations between these parties makes the current situation unnecessarily complex.

Taking into account the bottlenecks discussed above, we recommend an explicit review of the future role of the regional grid operator in both maintaining the distribution grid and being responsible for data collection. Furthermore, we propose to increase the functionality of the two external ports of the smart meter in a sense that these ports both enable bidirectional connections and high-frequency, i.e. (near) real time meter data. This way, the bottlenecks for service delivery are significantly reduced.

Next to this, an explicit division of functions is the first step towards a central data register, which could further simplify the institutional designs and solve the inefficiencies associated with the current decentral architecture. Such a central access server should be based on an open architecture, e.g. web services, and an appropriate data standard, such as ebXML.

For delivering commercial smart meter services, we recommend further research with respect to the customer perspective on smart meter services and the usage of smart meters by regional grid operators to enable a smart or intelligent grid. To reduce the bottlenecks with respect to service delivery caused by the Dutch energy policy, we furthermore recommend further study on the data requirements of a central data register and the implications of distributed generation services with respect to the meter and institutional design requirements.

Acknowledgements

Scanning the recent newspaper headlines, many articles can be directly or indirectly related to energy issues. Global warming, new nuclear energy policy, increasing energy prices, unbundling of existing energy activities, unreliable administrative process and the role out of smart meters are just some examples. The process of liberalization, increased competition and continuing globalization contributed an increasingly complex and dynamic environment. With the mandatory introduction of the smart meter, an additional communications infrastructure towards the customer becomes available, increasing the possibilities for service delivery. The fact that such developments and uncertainties pose both treats and opportunities to new and existing parties, intrigued me from the beginning. Therefore when I was asked to explore the possibilities for smart meters to increase customer service delivery, I had found my master thesis subject.

This study concerns a master thesis project and completes the Systems Engineering, Policy Analysis and Management Master of the faculty of Technology, Policy and Management of Delft University of Technology. The study was commissioned by Capgemini Nederland. Besides this thesis report, the deliverables for the master thesis project also includes a scientific paper. This paper is included in this report after the appendixes.

Carrying out this thesis proved a valuable experience, both from an empirical and scientific perspective. Many people have contributed to this study, who I would like to thank for their contributions. In particular, I would like to thank the members of my graduation committee: Harry Bouwman, Theo Fens, Zofia Lukzo and Cor Berkhof. First of all, I would like to thank my first supervisor and chair person Harry Bouwman, for his critical comments about the importance of a sound scientific methodology and his efforts for taking my scientific paper to a higher level. Furthermore, I would like to thank my second supervisor Theo Fens, for maintaining the topicality of my research in a fast-changing environment and his supervision to maintain a healthy balance between the required technology, policy and governance aspects. Third, I would like to thank my third supervisor, Zofia Lukzo for her enthusiastic feedback and advice regardless of her late acceding to the committee. Fourth, I would like to thank my external supervisor Cor Berkhof for the freedom I had to work independently, for his enthusiasm with regard to my project, and for always making time for me despite his busy agenda.

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List of abbreviations

AMI	Advanced Metering Infrastructure
AMR	Automatic Meter Reading
APX	Amsterdam Power Exchange
AT	Agency Theory
CAS	Central Access Server
CBL	Cross Border Leases
CHP	Combined Heat and Power Plant
CTS	Cost To Serve
DG	Distributed Generation
EAN	European Article Number
ECH	Energy Clearing House
EPR	European Pressurized Reactor
ETC	Emissions Trading Scheme
EU	European Union
GIS	Geographical Information Systems
GPS	Global Positioning System
IAF	Integrated Architecture Framework
IE	Institutional Economics
MAC	Meter Asset Company
MAM	Meter Asset Management
MC	Meter Company
MDC	Meter Data Company
MDM	Meter Data Management
NAP	National Allocation Plan
NCE	Neoclassical Economics
NGN	Next Generation Network
NIE	New Institutional Economics
NRT	Near Real Time
OIE	Original Institutional Economics
PLC	Power Line Communications
PRP	Program Responsible Party
PRT	Property Rights Theory
RBV	Resource Based View
RF	Radio Frequency
RGO	Regional Grid Operator
RT	Real Time
SEA	Smart Energy Alliance

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TCE	Transaction Cost Economics
TOGAF	The Open Group Architecture Framework
TOU	Time Of Use
TSO	Transmission System Operator
TSP	Third-party Service Provider
UCTE	Union for the coordination of electricity transmission
VAS	Value Added Services

1 Introduction

1.1. Background

1.1.1 Introduction

A quick glance at recent newspaper articles on energy and energy management provide an overview of the dynamics that currently characterize the sector. These developments vary from severe energy crisis as a result of rolling blackouts as seen in California in 2000 and 2001, to the entry of new players on local energy markets as a result of further liberalization and privatization of national energy delivery.

On the international level, increased environmental awareness has led to ratification of the Kyoto Protocol of which the ambition is to reduce the continuous rise in carbon emissions, improve energy efficiency and increase the use of renewable energy sources. On the other hand we have seen that an increase in extreme weather conditions such as in Spain and the US pinpointed the existing vulnerability of the distribution grid to large variations in energy demand.

In general, the margin between utilities energy capacity and the actual demand has decreased significantly in recent years, due to increased energy consumption and hampered investments in new energy generation facilities, increasing the vulnerability to external events and extending the need to manage peak loads efficiently (Ribbers & Olde Rikkert, 2006).

On the EU level, market restructuring as a result of both mergers and acquisitions and regulatory mandates, change the energy landscape. The strive towards a global EU energy market and a level playing field for new entrants and former state-owned utilities influences the day to day functioning of the utility, for example by means of retail price regulation. While retail prices are bound by regulation, an increase in wholesale prices tightens the margin for the utility and thereby asks for an evaluation of their current strategies.

In the Netherlands, utilities are even faced with a more stringent regulator, as the Dutch government considers carrying through the mandate that obliges the utilities to realize a complete legal and financial separation between activities associated with the transportation and the delivery of electricity. This process is called the unbundling of the physical and service functions (Ministry of Economic Affairs, 1999).

As the Dutch utilities are considered to leverage a relatively high degree of vertical integration, this situation, and the associated benefits, is bound to change dramatically in the next years. As electricity delivery generally is characterized by a negative sales margin and cross-subsidies are prevented by the unbundling act, energy suppliers are looking for new ways to increase their competitive position and to acquire a viable position in the liberalised EU energy market (Fens, 2005). Another primary driver for these dynamics is the EC mandate for the instalment of smart energy meters starting 2008 (Directie Toezicht Energie, 2005; Ministry of Economic Affairs, 1999).

Within this demanding environment, several innovative technologies are emerging, which could be used to cope with the challenges posed by current developments. Examples are tools for worker mobility using the Global Positioning System (GPS), Geographical Information Systems (GIS), wireless services, real-time and adaptive forecasting and the use of smart energy meters.

Thus, the Dutch energy sector can be characterized by a high level of dynamics due to market, regulatory and technical uncertainties, with respect to the future roles and responsibilities of the parties involved.

Especially the mandatory introduction of the smart meter is considered to have a significant impact on the sector and utility business models of new and existing players in the utility market. An important question is how to fit these meters in the current and future corporate strategy, while optimally leveraging the changed market circumstances. From a governance perspective, the introduction of the meter has significant implications for the current technical and institutional designs.

1.1.2 Smart energy meters

Smart energy meters provide promising solutions at the customer site, because they enable automatic, bi-directional communication between the customer and the utility. Compared to traditional energy meters which only display the amount of energy (i.e. electricity and/or gas) which is consumed, smart energy meters can directly communicate usage data back to the utility. Therefore smart energy meters are the enabler for Automatic Meter Reading (AMR), which is the key to both reducing cost associated with manual meter reading, reliability and quality of power supplies (Ribbers & Olde Rikkert, 2006).

This does not only make manual meter reading unnecessary, but also opens up new ways of paying for energy and several advanced functions where automated communication between utility and customer is central. Hence, smart metering can be seen as the main information gathering device for the operations of the utility and other parties in the energy value chain.

Furthermore, smart energy meters are an important prerequisite for enabling Distributed Generation (DG) of energy in order to measure and administer the energy delivered back to the network. An example of DG is the use of Combined Heat and Power Plants (CHPs). Using CHPs, electricity and heat are produced at the customer site and the carbon emissions are reduced, yielding significant environmental benefits (Entchev et al., 2004).

The real challenge for organizations lies in how to adopt this technology into current systems in order to gain a competitive advantage. According to Harrison (1999) utility companies have three strategies at their disposal in order to achieve customer retention and acquisition: (1) increase operational efficiency in order to reduce prices, (2) deliver unique, value added services (VAS) to their customers and (3) become smarter in branding and affinity marketing. Especially the first two strategies provide opportunities for leveraging smart energy equipment.

Obtaining operational excellence can be one strategy for the utility enabled by smart meters. Operational excellence in this case is defined as minimized cost associated with administration, operations, leakage, illegal tapping of electricity or other types of energy fraud on one hand, and on the other hand as optimally managing network load, i.e. reducing the cost-to-serve (CTS).

High costs are associated with network management, due to the fact that storage of energy poses significant problems. Therefore energy suppliers have entered into long term contracts with energy producers to guarantee a continuous supply. However, when the local demand exceeds the current available supply, the energy utility needs to buy-in extra capacity on the spot market, on which the prices are significantly higher than agreed in the long term contracts. If this spot purchasing can be prevented by managing the network load more efficiently, significant savings are within reach.

An incentive structure, such as a flexible billing scheme, can change customer behaviour at peak times; so that less energy is consumed and the total energy demand does not surpass the current supply.

A reduction of cost associated with leakage or energy fraud can be reduced because smart energy meters increase transparency in energy delivery, as it allows real-time delivery of information about the amount of energy used. Furthermore, cost associated with administration and disconnection can be minimized due to the ability to remotely read and connect/disconnect the meter. Furthermore, insight into day-to-day usage and behaviour of consumers increases the accurateness of demand forecasts.

Furthermore, remote energy management provides a necessary step towards a more intelligent energy network, as these products require the entire transmission and distribution networks to be upgraded to a fully intelligent grid where information is exchanged near real-time. Therefore smart meters are the cornerstone of the intelligent grid (Sumic, Ray, & Spiers, 2005). On the other hand, smart energy meters enable innovative value added services offerings to the customers of the energy utilities, i.e. consumers and enterprises.

Intelligent energy equipment can be used for a number of new services both at the customer and at the utility side. Examples of such services include pricing and tariff management, home automation services, load control and demand management, forecasting of energy usage and pre-paid metering management (Capgemini, 2006). A promising example of such value added technology are home automation services and ubiquitous computing (Houseman, 2005). Intelligence embedded in domestic equipment e.g. the washing machine or heating in case of a CHP can be used to optimize energy usage in terms of minimizing the customers' energy bill. What type of value added services can be offered depends to a large extent on the level of pervasiveness of intelligent in-house technology.

Furthermore, value chain integration and transsectorial innovation becomes possible, because utilities can deliver innovative services which were previously outside their domain, such as home automation services.

Although the function of service delivery currently primarily lies with the electricity supplier, in the future it is expected that third-parties entrants will also leverage the possibilities smart meters bring as (near) real time availability of meter data enables parties to deliver truly innovative products of which the benefits can be attributed to both the customer and the environment (Wood & Newborough, 2003). The advantage for such a third-party service provider is that it could possibly leverage an existing customer relation, such as telecommunications providers, banks etc. The possible treat of such new entrants is widely recognized among existing energy suppliers.

Hence we can say that smart energy meters provide a new platform for electricity and service delivery to the customers.

1.2. Problem statement

Despite the possible savings and possibilities for VAS delivery, utility companies in the Netherlands are currently mainly concerned with satisfying regulatory requirements, since the government has issued that every new installed or replaced energy meter in 2008 needs to be a smart energy meter (Directie Toezicht Energie, 2005). Yet, for existing utilities the emphasis lies

on the implementation, instead of on strategies to recover these costs and increase their competitive position. This gives possibilities for third-party service providers.

Although smart energy meters in potential provide several opportunities for creating a feasible business case, predicting the impact on internal operations, cost savings and demand of end users for VAS remains extremely difficult (McBurney, Parsons, & Green, 2002). Furthermore, the revenues of such services are highly dependent on the future direction of the future developments.

The difficulty in predicting demand for possible VAS is emphasized by Mc Burney et al. (2002) and De Marez and Verleye (2003) who state that in the current ICT environment, traditional adoption and diffusion patterns with respect to technical innovations cannot be taken for granted anymore, making it extremely difficult to predict the demand for new applications, such as smart meter services. Hence, uncertainty about future developments on a global, EU and national scale in combination with uncertainty about cost savings and revenues from possible VAS and high investment costs restrains large scale smart meter initiatives in The Netherlands (McNicolas, 1997).

However, other countries such as the U.S., Canada and Italy already have experience with the roll out of smart energy meters, and possibly valuable lessons can be learned here.

A requirement to successfully leverage smart meter technology for service delivery from the perspective of a service provider is a sound value proposition towards the customer. The challenge for a viable value proposition is that business and technology aspects should be aligned (Gordijn, 2002). Gordijn (2002) emphasizes the importance of a multi-viewpoint exploration of the solution space, to determine the relevant requirements with respect to e.g. business, technology and organizations. How these requirements are aligned will determine the success of the value proposition and thereby the viability of the associated business model.

Hence, smart meters provide different opportunities for different parties to increase their competitive position by increasing operational efficiency or delivering VAS to the customer. However, as existing electricity suppliers are mainly concerned with designing the new administrative processes according to the latest agreements, the amount of services delivered based on meter data is scarce. As a result, the problem statement of this thesis focuses on the knowledge gap in terms of with the requirements for delivering future VAS enabled by a smart meter roll out.

1.3. Research objective and research questions

The objective of this research is to determine the service requirements of delivering VAS to customers enabled by smart energy meters and to determine if these service requirements can be satisfied by the available technology and the institutional environment. Furthermore, this research addresses the question how the functional and technical choices can be aligned with the current institutional design in an environment characterized by increasing uncertainties stemming from changing roles and regulation.

Put together, the main research question of this research project can be defined as follows:

What are the requirements for innovative meter data service delivery to electricity customers and how can these requirements be satisfied in the current technical and institutional design of the sector?

The main research question and the research project are structured in two parts. Part One discusses the service requirements for value added services from a service delivery, i.e. business perspective. Part Two discusses the technical and institutional design issues that can be derived from the service requirements, and hence has a governance perspective.

In this research the primary focus will be on delivering service to the customer. Service delivery is defined as a broad concept and includes both services that contribute to operational efficiency of the supplier, as well as information and automation services delivered by third parties. Hence, a service provider can both be the existing the electricity provider or a new entrant, such as a third-party service provider.

Currently, additional services are delivered by the energy supplier, i.e. electricity and little information feedback. However, as it is expected that third parties will enter the market for more advanced service delivery, i.e. information and automation services. Hence, the perspective of this thesis is twofold. On one hand, we focus on the electricity supplier for delivering services in order to reduce their operational cost or increase customer service, and on the other hand we discuss the possibilities for a new third-party service provider (TSP) on the service market.

The choice for this delineation is clear, namely the distributive activities and price setting are bound to be placed into the regulatory domain, therefore competition is limited and the number of incentives for the grid operators for commercial meter data applications is reduced.

Although energy meters can be applied for multiple commodities, such as electricity, water and gas, this thesis will focus solely on electricity. Privacy and security aspects will determine to a large extent the applications of meter data, however, this is not the focus of our research.

Yet, we can distinguish two types of services. The first category is information services which only present information to the customer, e.g. energy and savings advance, usage monitoring etc. These services can consequently be divided in information represented centrally at the meter or locally using a remote display or via the internet. The second category are automation services, where equipment is operated or controlled based on meter data information, e.g. micro combined heat and power plant (micro CHP) management, distributed generation, home automation etc. The innovative character of the value added services primarily lies in the latter type of applications.

Although these types of services are still broad categories, they have one aspect in common, namely changing customer behaviour in terms of their usage pattern and usage behaviour. Hence, this thesis focuses solely on the retail market for consumers.

To answer the research question as stated above, many knowledge gaps that have been identified in previous sections need to be filled in. These knowledge gaps are discussed in the research issue, which identifies all necessary information that is required to fulfil the research objective (Verschuren & Doorewaard, 2005). Verschuren en Doorewaard (2005) suggest the use of a research framework as a schematic representation of the research objective which includes the approximate steps that need to be taken in order to realize the research objective.

Furthermore, the research framework enables the various viewpoints, i.e. business, technology and organization, to be explicitly related and thereby provides the first step towards a successful alignment and business case.

On the other hand, an important aspect of a research framework is that it helps in establishing a theoretical background. Furthermore, it serves as a means of communication between all parties involved in the research project and facilitates the delineation of the problem context. The research framework for answering the question stated above is shown in Figure 1 below. Each horizontal arrow indicates a step that has to be taken to be able to answer the research question and hence is discussed in a separate chapter. What steps are required and which knowledge gaps need to be filled to arrive at founded recommendations will be discussed in the next sections.

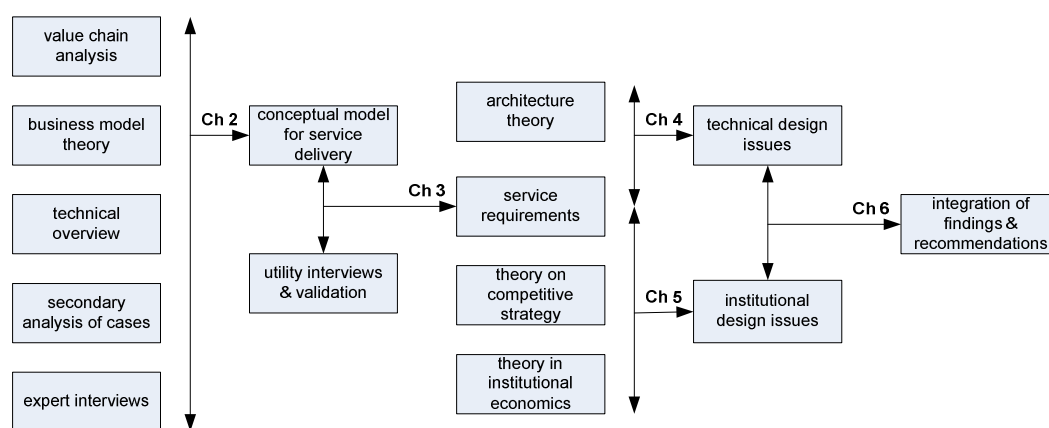


Figure 1 Research Framework

In order to answer the main research question as stated above several practical and scientific deliverables need to be formulated. The practical deliverables are relevant for the commissioning party, namely Capgemini. The scientific deliverables on the other hand should satisfy certain scientific requirements.

Issues formulated in the research framework can be perceived from different viewpoints, such as an empirical viewpoint which looks at the problem domain from a market, service provider or technology perspective, or as a scientific viewpoint by applying different scientific theories to the problem domain. In this research we will do both.

To some degree, however, these perspectives overlap and their interdependence influences the final market outcomes. Furthermore, challenges faced by parties in the utility sector are not unique for the sector, as; (1) uncertainty about customer demand for new products and services characterizes many new introductions, (2) a lack of insight into future demand is often the main cause for the failure of such an introduction, (3) often the network aspects of cooperating organizations are ignored in service design and (4) although the translation from service to technical, and institutional requirements seems straightforward, the interdependency of these designs requires coherency and alignment between both critical technological aspects and critical institutions aspects (Finger & Künneke, 2006; Künneke, 2006).

The scientific value of this research stems from the emphasis on alignment between service, technology and institutions. After these aspects have been analyzed using a specific framework, created by the design of a conceptual model in case of *service*, literature on architecture theory in

case of *technology* and a literature overview on corporate strategy in case of *institutions*, we will elaborate on the technical and institutional design issues, i.e. bottlenecks for service delivery.

Although the models, frameworks and theories facilitate the analysis of the relevant aspects, the deliverables are primarily of practical nature. We have presented the deliverables and the relation between these deliverables in the research process in Figure 2 below.

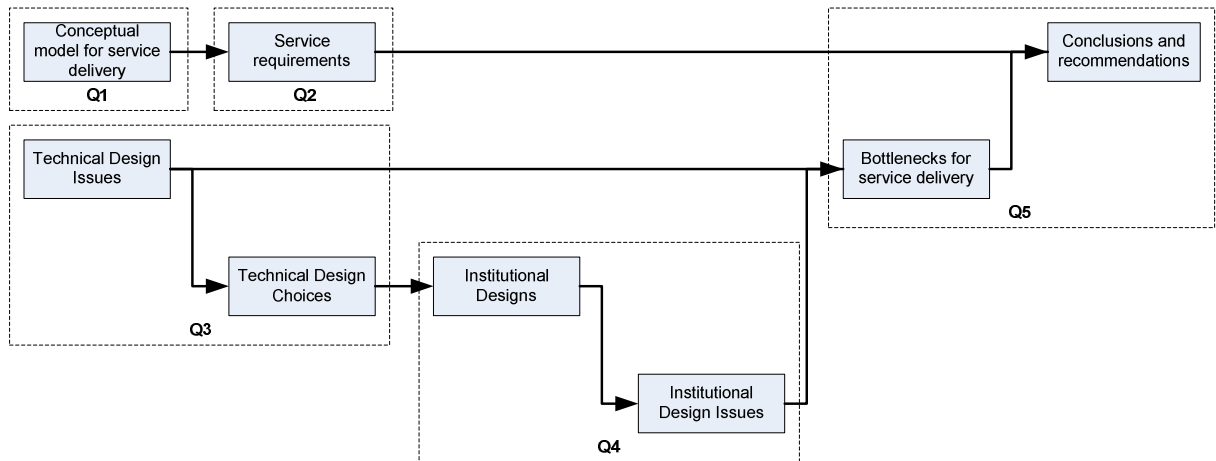


Figure 2 Deliverables per research question

The process of answering the main research question as depicted in the research framework of Figure 1 comprises several steps. For this reason, each step has been translated into a sub-question, specifying the existing knowledge gaps and required research issues that have to be solved at each level. The following sub-questions are defined as follows:

1. *What are the key variables with respect to delivering value added services based on smart energy meters and how are these variables related?*
2. *What are the service requirements of smart energy meter products and services,*
3. *What are the technical design issues with respect to service delivery?*
4. *What are the institutional design issues with respect to service delivery?*
5. *What are the bottlenecks associated with service delivery in the current technical and institutional design and what can be recommended to reduce these bottlenecks.*

How these sub-questions relate to each other and to the research framework is shown in Figure 1. Where the research framework of Figure 1 primarily shows the methodology used for answering the research questions, in Figure 2 we have presented the deliverables associated with each sub-question and how they relate. Below the starting point, research method and expected deliverables for each sub-question are further elaborated upon.

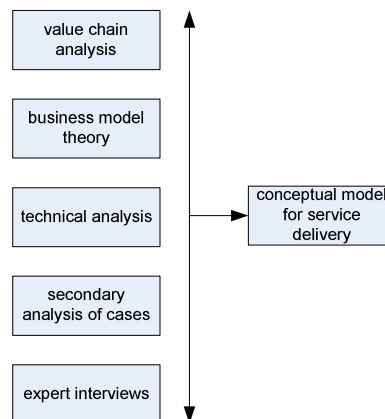
1.4. Research methods and report structure

Different research methods are suitable for different types of research questions. Verschuren en Doorewaard (2005) discuss several methods for conducting scientific sound research. Often, the suited method depends on the available data or the goal of the research. Because the research project has a large exploratory component, triangulation of methods is used (Verschuren & Doorewaard, 2005). This means that three types of methods will be used throughout the research

that will form the basis for answering the research questions. These methods are literature study, desk research and interviews. Below, for each sub-question the methodology will be shortly discussed.

Sub-question 1: What are the key variables with respect to delivering value added services based on smart energy meters and how are these variables related?

The first step in answering the research question is defining and examining the solution and design space. For exploring the problem context, and design and solution space different methods are available (Verschuren & Doorewaard, 2005). Since the core the research will be primarily of explorative nature, explorative methods, such as interviews, and are most suited the early design stadiums of the project. Because these explorative methods require a theoretical foundation, literature study and desk research will be used to determine the key variables for a viable introduction of smart meter products and services. First, the dynamics in the utility sector in delivery electricity to the customer and will be analyzed by examining the trends in the different components in the energy value chain (Porter, 1980).



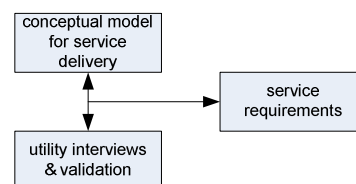
Chapter 2

Second, we zoom in on the business model of a individual service provider, for which we use the STOF business model framework, as it is a suitable tool for identifying both internal and external forces which influence a business model in designing new products or services (Faber et al., 2003). Therefore the STOF model will be used to provide an overview of the main aspects of a service providers' business model and the external business drivers which facilitate or inhibit change, such as technical developments and regulatory changes.

Third, smart metering will be discussed from a technical perspective. Fourth, existing pilots of a smart meter roll out will be analyzed in order to extract valuable lessons and experiences. These aspects, together with a first round of interviews with professionals at Capgemini will lead to a conceptual model which gives an overview of important variables and relations between these variables that should be taken into account when delivering VAS based on smart meter data.

Sub-question 2: What are the service requirements of smart energy meter products and services?

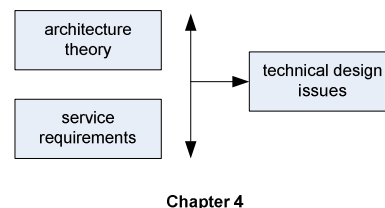
The next step in the research project is to translate the conceptual model to service requirements of smart meter products and services. The conceptual model will be the starting point for a second round of interviews held with energy suppliers, i.e. Essent, Eneco, E-on and Oxxio, of which the purpose will be twofold, namely: empirically testing both the variables and relations derived in chapter 2 and specifying what products and services can be derived from these variables and interviews. All interviews with utility representatives will be transcribed and analyzed using the ATLAS.ti (www.atlasti.com) scientific software programme for visual qualitative data analysis. This will result in a revision of the conceptual model, which will be the basis for the design of service requirements that enable the delivery of VAS. Furthermore, the external interviews provide a second empirical validation of the findings so far.



Chapter 3

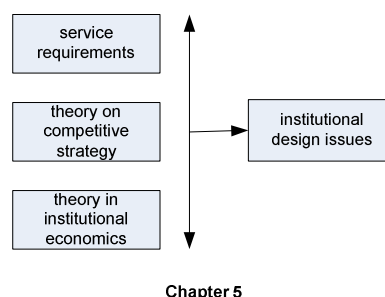
Sub-question 3: What are the technical design issues with respect to service delivery?

The service requirements will be the starting point for discussing the technical design issues and constraints. Because this chapter focuses on the technical design issues, the designs will be looked at from an architecture point of view. Hence, we will first discuss the current technical framework with which we will analyze the technical architecture of the meter and its implications regarding service delivery. When discussing the technical system our focal point will be the output of the system, instead of internal system quality. The deliverables of this chapter will be several technical design issues with respect to the technical architecture for satisfying the service requirements. This technical perspective on smart meter VAS will be discussed in chapter 4.



Sub-question 4: What are the institutional design issues with respect to service delivery?

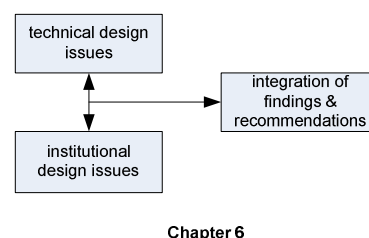
How the institutional embedment of organizations in the utility sector should look like has been a fierce point of discussion in recent years, mainly because institutional choices create a significant amount of path dependency. In order to determine what the institutional design issues for service delivery are, we will develop several institutional designs based on the technical design choices presented in chapter 4. From this perspective, it is interesting to look at the way that the proposed service requirements and can be embedded in the current institutional context.



Therefore, a theoretical framework will be designed consisting of theory on competitive strategy and institutional economics. By comparing several theories on competitive strategy, i.e. competitive advantage (Porter, 1980, 1985), the resource based view (Barney, 1991) and resource dependencies (Pfeffer & Salancik, 1978) important aspects of each theory will be discussed. Finally, these aspects will be used to discuss what the institutional requirements are for delivering VAS by evaluating the service requirements and designs. This institutional perspective on smart meter VAS will be discussed in chapter 5.

Sub-question 5: What are the bottlenecks associated with service delivery in the current technical and institutional design and what can be recommended to reduce these bottlenecks?

In chapter 6, the findings from previous questions are combined. An analysis of the technical and institutional design issues and has lead to an overview of opportunities and limitations for delivering VAS. Combined with the service requirements of these services, the end product of this research will be an advice, which bottlenecks need to be solved to enable a viable business model in terms of service delivery to customers and how these requirements fit within the current technical and institutional environment.



Together the deliverables of the sub-research questions enable us to answer the main research question by means of aggregation the service, technical and organizational requirements and to

present our recommendations with respect to increasing alignment between these issues and solve the bottlenecks in the current technical and institutional design.

In the next chapter, we will start with an extensive domain analysis where we will elaborate on relevant developments in the energy sector from different perspectives and analyze existing smart meter cases in order to identify key variables and relation between the variables that determine the viability smart meter business case.

2 Domain analysis and model building

2.1 Introduction

The purpose of this chapter is to identify key variables that influence the viability of smart meter products and services. A prerequisite for this analysis is a thorough understanding of the key players in the energy sector and their roles and interdependencies. Hence, we will start with a detailed study of the characteristics and trends in the energy value chain (Porter, 1980) in order to provide an overview from a market perspective (section 2.2).

Next, the perspective of a service provider's business model is taken (section 2.3). The business model approach focuses on the product or service to be delivered and hence discusses the internal and external forces that influence its success. This approach uses the STOF business model framework (Faber et al., 2003), which we have discussed in appendix 4.

Consequently a technical perspective is taken which focuses on the architecture of the smart metering system that is required for delivering a product or service (section 2.4).

Next, existing pilots of smart meter roll out will be analyzed in order to extract valuable lessons and experiences (section 2.5).

Finally, this chapter ends with a synthesis of findings and a categorization of the key variables that are expected to be of primary interest for designing a viable smart meter business case for a service provider. Consequently these key variables will be related in a first conceptual model (section 2.6), which is the starting point for the second round of interviews with utility representatives from Essent, Eneco, E-on and Oxxio and the design of service requirements.

2.2 Smart metering from a market perspective

In the energy value chain several activities can be distinguished before the electricity is supplied to the customer. The Dutch energy sector is currently characterized by a high level of integration, because many large players provide the entire range of services, except for transmission services, which is state-owned and controlled by the Transmission System Operator (TSO). The energy chain is a mix of regulated and free domain as shown in Figure 3.

The specific components and trends relevant for the introduction of smart meters that elaborate on the focus area of this research (see Figure 3) will be discussed below. For a complete and more detailed overview of the roles, players and trends in the Dutch energy value chain we refer to Appendix 1.

Although uncertainty exists with respect to the future governmental mandates e.g. unbundling of the distribution and supply parts, the market model for retail users and the position of the metering market, the expected direction is shown in Figure 3. The part in the value chain which we currently label the Meter Company (MC) is bound to disappear. Instead, its functions are being distributed among the regional grid operators (RGO) and the suppliers. More specifically, Meter Asset Management (MAM) will become the responsibility of the RGO and Meter Data Management (MDM) will be part of the suppliers' service package. What this yields for the supplier and customer will be elaborated upon below.

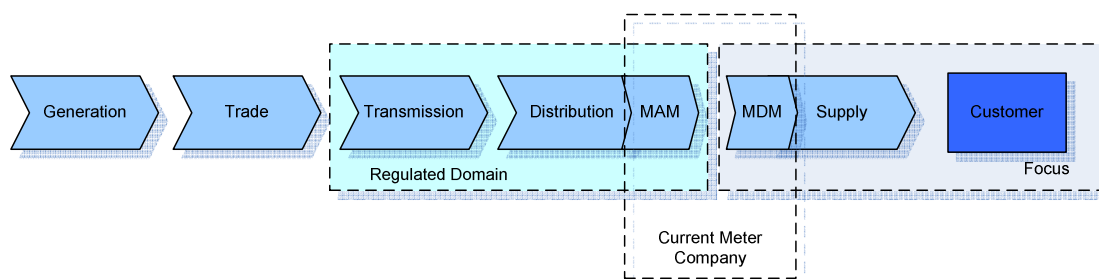


Figure 3 the proposed electricity value chain

The supply market in the Netherlands is fully deregulated and currently many new entrants are starting to deliver energy to both business and consumers. Currently, suppliers mainly limit themselves to delivery of energy instead of other services. However, an increasingly competitive environment demands a more customer oriented focus. Nevertheless, currently suppliers are mainly struggling with the results of a deregulated market, i.e. managing supplier switches and correct billing, and applying the new market models for retail users and capacity tariffs.

Effects and trends in the value chain also have their influence on the daily operations of the energy supplier. An increasingly lower capacity margin between production and supply leads to an increase in pressure on retail prices and drives up prices on the spot market. Hence, demand and supply management also becomes an important issue for the energy supplier. Especially since forecasting deviations lead to fines from the TSO as a result of settlement. Next, the proposed unbundling of the distribution and service network increase the need for information exchange between these parties. On the other hand, pilots with respect to decentralized energy generation (DG) and micro combined heat and power plants (micro-CHP) require both balancing and administration of energy and financial streams at the customer site. All these developments have one important requirement, namely they require (near) real time insight in the amount of energy usage (and production) at the customer site. Smart energy meters are the medium to provide such information.

The process of energy delivery is a cumbersome process, with many interdependencies between the parties involved. Although the traditional energy value chain suggests otherwise, except for the physical energy delivered to the customer, it is everything but a linear process. The interdependencies are primarily a result of the usage and financial information streams between the parties. As opposed to the physical stream, these streams go from customer to generation instead of the other way around (see Figure 3).

On a high level of aggregation, the interactions between the parties can be described in terms of economic value exchange as described by Gordijn (2002). However, due to regulatory obligations, some interactions are unidirectional, and no direct value exchange takes place. Furthermore, because the interactions in the process of energy delivery are generally uniform, we chose to describe this process in Figure 4 by means of the electricity, information and monetary streams with respect to electricity delivery, meter data and commercial applications of meter data.

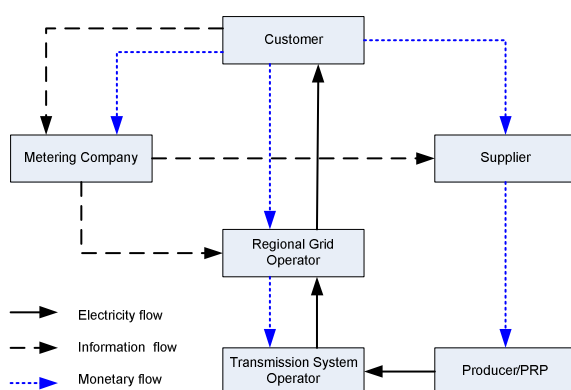


Figure 4 Flows in the current market situation

In the figure above, some simplifications have been applied. The electricity flows from producer, i.e. the program responsible party (PRP), via the transmission system operator (TSO) and the RGO towards the customer. For administrative and billing purposes, the MC manually gathers meter data and consequently sends this data to the supplier and RGO. The customer furthermore individually pays for the services of the metering company (MC), the RGO and supplier, which consequently pay their part to the TSO and the producer/PRP. Currently, the MC is both owner of the meter asset and responsible for gathering and administrating meter data. Yet, the MC communicates usage data towards the supplier for billing purposes and to the RGO for settlement, balancing etc.

In Figure 5 the new market situation is presented, as it is expected to exist from 2007 (Ministry of Economic Affairs, 2007b). Where the MC previously had both the role of meter asset management (MAM) and meter data management (MDM), in the new situation, MAM will be the responsibility of the RGO. MDM on the other hand will be the responsibility of the meter data company (MDC) which can be both an autonomous party equally to the current MC or an internal division of the supplier. Both designs are shown in Figure 5 below.

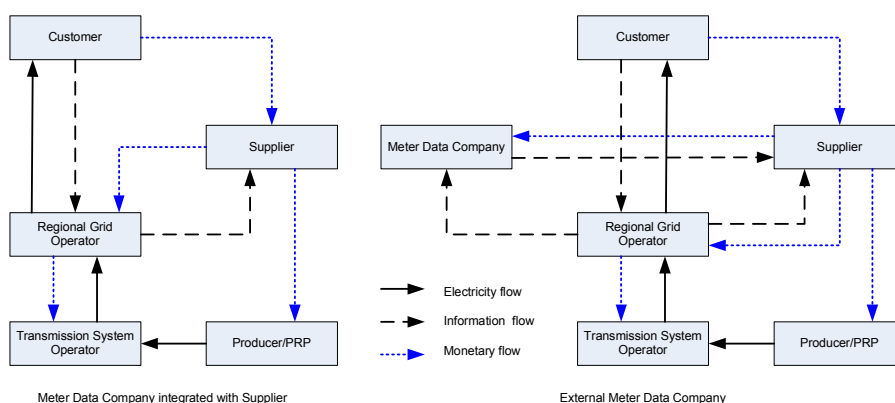


Figure 5 Flows in the new market situation

Besides the change in metering responsibilities, the flows in the new market situation also take into account the new market model for the Dutch retail market, i.e. the supplier model (Ministry of Economic Affairs, 2007b). According to this model, the customer only has a billing relation with the supplier, which aggregates all other costs in one energy bill.

Although the metering responsibilities are divided among the MDC and the RGO, the MDC cannot access this information autonomously, and is thus still dependent on the RGO. The same holds for the situation where the MDC is integrated with the supplier

Leveraging smart meter technology starts with gathering, storage and communication of information. To be precise, the impact of introducing the smart meter works contrary to the value chain as information flows from customer in opposite direction to generation. Furthermore, the introduction of smart meters asks for a change in both business model and attitude towards the customer.

Parallels can be seen with the telecom market, where deregulation and increased competition caused the sector to become increasingly customer centric. In order to create a competitive advantage initiatives are visible with respect to delivery of VAS, client segmentation, demand management and new pricing schemes.

Smart meters are required for enabling of both delivering such services and striving for a reduction in the Cost to Serve (CTS). Furthermore, the goals of a typical energy service provider should provide a valuable starting point for identifying the important factors on which the outcomes of the business model will be evaluated. These drivers are visualized on a high level of abstraction in Figure 6 and in more detail in Appendix 2. In the next sections, the relations between these factors will be identified and further elaborated upon.

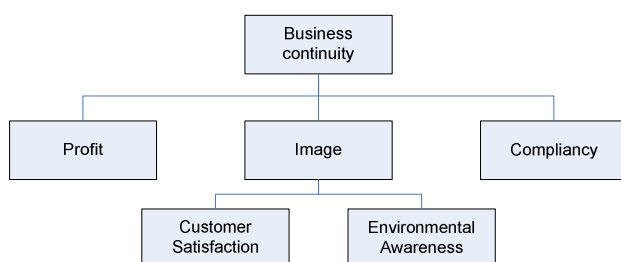


Figure 6 Drivers for supplier strategy

Although business continuity is determined by different factors as shown in Figure 6, in the end this means how the incoming revenues surpass the cost associated with operations, branding etc and determine the profit of the organization. Hence, factors such as image also determine profit, but in an indirect way. For compliance holds that it is a condition for business continuity and therefore not an explicit choice for the supplier as this taken as given. However, the other factors can be influenced by a supplier's strategy.

The customer is the final chain in electricity delivery, however the customer to a large extent responsible for the workings of previous parts. In the Dutch energy market three types of customers are distinguished at times of liberalization of the energy market, namely wholesale markets, semi-wholesale markets and retail markets, depending on the delivered capacity.

Differences is customer energy usage during the day and during the year, i.e. seasonal effects such as heating and use of air conditioning equipment, are for a large part responsible for the peaks in energy usage which the other parties in the energy value chain should deal with. This is called balancing. The behavior of customers with respect to energy is dependent on several factors, such as the composition of the family household, age, work-sleep pattern, technology

uptake etc. The choice for an energy supplier – as with many other commodities – , however, is based on less divergent criteria. In Figure 7 a high-level overview is given of the drivers for customer behavior. These factors are derived from a analysis of customer objectives (Bots, 2001) shown in appendix 3.

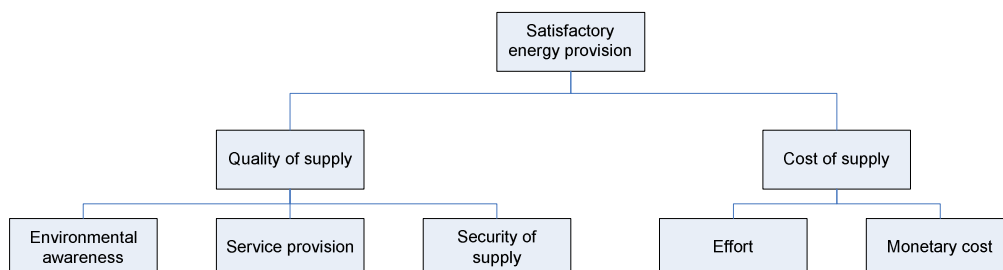


Figure 7 Drivers for customer behavior

As shown in both Figure 6 and Figure 7 the goals of the supplier and customer are to a large degree related, as *customer satisfaction* determines one of the key drivers for *business continuity*, namely *image*. As we have studied the goals of both parties in more detail, relations can also be drawn on a more detailed level as shown in Figure 8 below. Besides compliancy requirements, no external forces influencing a service provider's business model are taken into account. This will be the focus of section 2.3.

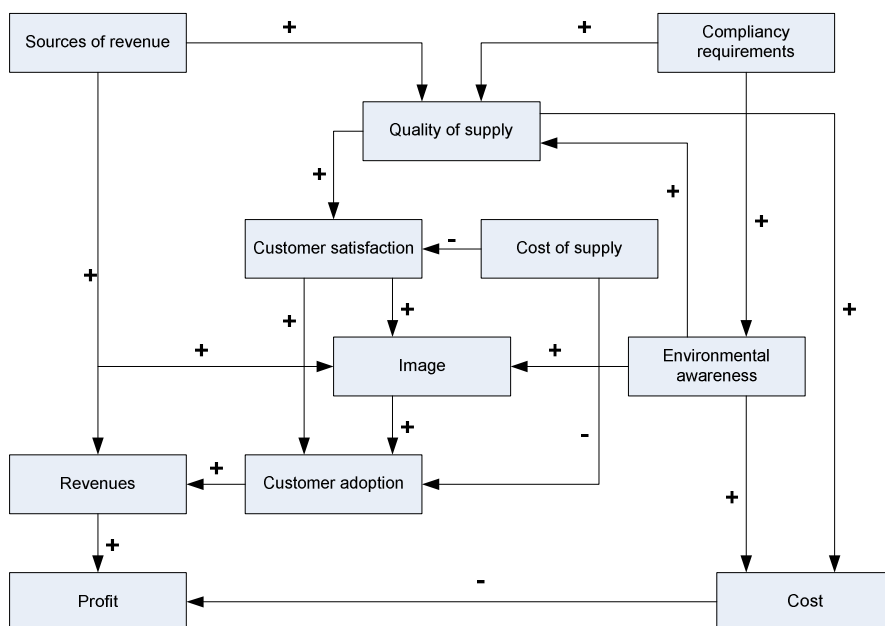


Figure 8 causal relations between supplier and customers goals

Because most of the relations shown in Figure 8 are presumed to be evident, we will shortly elaborate on the less evident ones. First, compliancy requirements mandated by the government will influence mainly the quality of supply e.g. security of supply and the environmental friendliness of energy production, sourcing etc. As these sources and production methods are more expensive than traditional ones and a higher security margin requires a higher than normal production level, this increases the cost for a supplier indirectly.

Second, image plays a crucial role in both retaining existing customers and obtaining new ones. Therefore, customer satisfaction both directly and indirectly determines customer adoption. Third, one of the factors based on which customers evaluate the quality of supply is the range of services a supplier can deliver. These sources of additional revenue for the supplier both influence the image of the supplier on the market, e.g. innovative newcomer or rigid incumbent, and on the other hand contribute directly to the revenues received from customers buying these services.

An increase in customer centric service delivery increased the attention for the main drivers of a customer for choosing an energy supplier (see Figure 7). Important drivers that can be distinguished from a customer perspective are an increase in environmental and price (cost of supply) awareness. The latter is visible in both consumer buying behavior, e.g. low energy light bulbs, low energy displays and devices that display energy etc, and scientific research on the positive effect that visualization of energy usage has on customer behavior (Wood & Newborough, 2003, 2007).

However, despite increased customer price awareness, switching rates between energy suppliers remains considerably low, compared to surrounding countries with comparable market characteristics and governmental policy, namely around 3%, compared to 20% in Australia and in the UK.

Smart meters are considered an important enabler for increasing consumer awareness by the EU government and are one of the main reasons for issuing the 2003/54/EG and 2003/55/EG mandates regarding unbundling and the smart meter implementation.

Where in this section the focus primarily lay with the market and the interaction between the parties in the value chain, especially the customer and the supplier, the next section will discuss environmental drivers that influence an energy service provider business model.

2.3 Smart metering from an service provider perspective

In the previous section, developments in the energy sector have been analyzed from the perspective of the energy value chain. This analysis has delivered valuable insight into industry wide trends and opportunities for smart meters. However, for the existing and new service providers, these opportunities translate differently to their individual business models. Review of the literature shows many definitions and taxonomies of business models, although in general a distinction can be made between abstract models that classify each business, and conceptual models which can be used to describe specific business in more detail (Osterwalder, Pigneur, & Tucci, 2005; Papazoglou & Ribbers, 2006). The widely used definition of Timmers (1998) discusses the aspects important in this chapter and can therefore serve a partial delineation for the scope of this chapter:

“A business model is an architecture for the product, service and information flows, including a description of the various business actors and their roles; and a description of the potential benefits for the various business actors; and the descriptions of sources of revenues.”

However, a corporate business model should be distinguished from a corporate strategy, as a business model does not indicate how the company's objectives should be realized. This is these aspects concern corporate strategy, which specifies how a business model can be applied to

differentiate a company from its competitors (Elliot, 2002). However, literature is not consistent in usage of both terms and often both terms are used interchangeably.

Nevertheless, a widely used distinction is that the business model shows how the internal pieces of a corporation fit together in delivering products or services, the strategy has a broader view and focuses on market forces and competition (Margretta, 2002). Hence, the business model is described as the implementation of the corporate strategy into organizational structures and systems. However, both corporate business model and corporate strategy are influenced by external factors which have a different impact on they key aspects of both approaches.

Although we discuss the value chain developments, service provider business model and technology separately, in practice these factors have many interdependencies. To structure and analyze these interdependencies, Faber et. Al.(2003) suggest the use of the STOF business model framework (see Figure 9). In appendix 4 we have discussed this framework and elaborated on how insight into the different the different domains contribute to the deliverables discussed in chapter 1.

As both the STOF business model domains and the external drivers and developments have been elaborated upon in appendix 4, we will present here our main findings that were derived from these analysis, namely the derivation of the key variables that influence the introduction of smart meter services, i.e. the building blocks of the first version of the conceptual model presented in section 2.6.

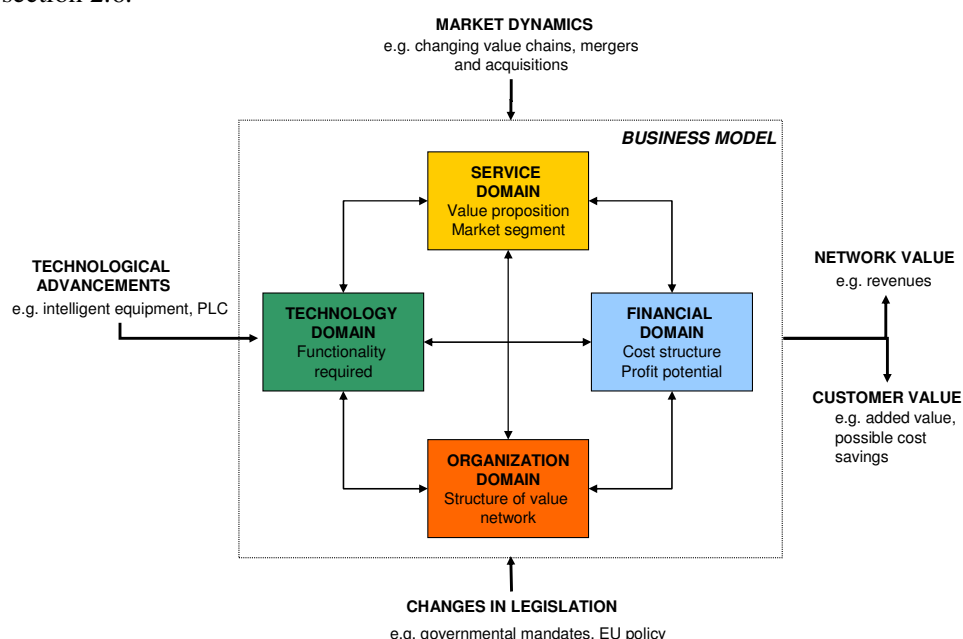


Figure 9 STOF business model framework

2.3.1 Market dynamics

The dynamics in the energy market are one of the main sources of uncertainty for service providers (see Appendix 4.2.). The main drivers that determine the market dynamics are (1) globalization, (2) mergers and acquisitions, (3) market restructuring and (4) increased environmental awareness of both business and consumers. These market dynamics have two requirements in common, namely: they require an increasing exchange of information and a higher level of standardization.

Information exchange requirements stem from the fact that globalization increases the need for alignment between production and supply on both a retail and wholesale level. Furthermore, energy trade requires detailed information about actual energy usage per party. Environmental friendly behavior requires that consumers become aware of the way they consume energy. Timely information about actual usage is required for giving customers the right incentives. Standardization, with respect to both technology and information is furthermore required to enable different parties to leverage aggregated information about energy usage and manage the monetary and energy streams.

A wholesale trading market is required for bulk energy trading and for handling day-to-day fluctuations in demand. Especially on a European scale these developments increase the need for energy data management between all parties involved. This is currently one of the issues that hinder efficient billing and switching between Dutch suppliers, thus these requirements are becoming even more important in a liberalized North-West European market.

On the other hand separation between formerly integrated back-offices, an increasing interest in distributed and combined heat and power generation and different tariff and billing structures increase the need for information exchange with respect energy usage and prediction of electricity streams.

Because usage information is gathered by the metering company, metering plays a key role in enabling future transformations. Therefore, an open metering information infrastructure is essential for efficient billing and easy switching of energy supplier. Although many attempts have been undertaken to arrive at a central meter registry, regulatory uncertainty have inhibited progress. Hence it is considered that a transparent metering infrastructure is a prerequisite for innovation in the sector.

However, access to information is considered troublesome as parties are reserved to publish information in an unregulated central information registry that is open to every party involved as long as metering is in the unregulated domain. This however, could change in the near future as a result of the NTA 8130 project initiatives by NEN in which the requirements and technical implementation of smart metering systems are being designed (NEN, 2006). These requirements will be further discussed in section 2.4.

2.3.2 Changes in legislation

Regulatory uncertainty plays an important role on both the EU and national level. Previous choices with respect to liberalization and privatization still determine the energy market as we know it today. Furthermore, consequences of path dependent decisions are clearly visible in the case of expected Cross Borderline Lease (CBL) claims with respect to the network assets when full unbundling and privatization should be mandated. Disparities with respect to national and EU policy, furthermore places Dutch parties in a disadvantages position compared to the “national champions” of surrounding European countries, which inhibits equal competition on an EU level (Energieraad, 2004).

A prominent example of the effect of regulation on the smart metering business model of the supplier is the national implementation of EU guideline 2006/32/EG with respect to the requirements for metering systems in the Dutch retail market. Currently, the NEN is constructing the NTA 8130 document which is charged with translating this guideline to the Dutch situation and formulate service requirements for the smart meter. In section 2.4, the NTA 8130 model is discussed in more detail.

Smart metering focuses primarily on the national setting, because on an EU level, no coherent metering regulations have been proposed, only abstract guidelines. However, disparities between international policies co-determine the effects of national policy on the final market outcomes and consolidation, as the current policy gap already is disadvantageous for Dutch utilities.

Regulatory requirements with respect to smart meter products and services focus primarily on the technical aspects, i.e. third party access and the other objectives that have been discussed in the appendix. Hence here it suffices to state that it is important that smart meter initiatives fit the regulatory framework. The technical and institutional details will be discussed in the next chapters.

2.3.3 Technological advancements

The key characteristic of smart metering is that it enables bi-directional communication between the customer and RGO. The physical infrastructure required to remotely read this meters, often called the Advance Metering Infrastructure (AMI), determines to a large extent the investment and operational cost.

With respect to the physical infrastructure, several developments increase the number of possibilities, such as: Next Generation Networks (NGN) like KPNs All-IP, wireless radio technologies and Power Line Communications (PLC).

Furthermore, smart meter are a necessity for administrating DG and micro-CHP plants. Last but not least, smart energy technology enables new intelligent solutions to enter the customer home, such as ubiquitous computing and domotics, such as home automation services. More specifically, the following home automation service categories can be distinguished: safety and security, comfort and control and flexibility and savings (see appendix 4 table 1). Applications that focus specifically on energy delivery are shown in Figure 10 below.

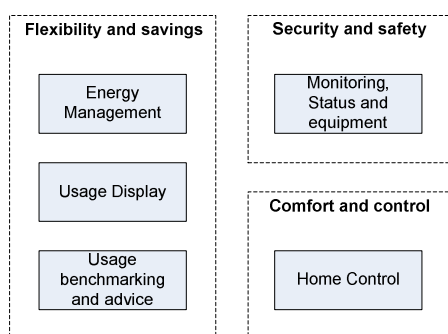


Figure 10 Smart meter home automation applications

Technological developments are often on of the primary source of both uncertainty and dynamics in a sector where technology plays a crucial role. In the case of the introduction of smart meters, this uncertainty yields both threats and opportunities for the energy supplier and third-party service providers with respect to service bundling, convergence of infrastructures, home automation products and distributed energy management. However, these developments themselves have certain requirements for a business model, such as availability and exchange of

information, standardization of protocols etc. Yet, these requirements are not unique for the smart meter application.

In the next section, an overview of business model requirements are given, taking into account the drivers discussed above.

2.3.4 Conclusions

Below in Figure 11 the environmental drivers discussed in the previous sections are summarized. The STOF requirements for delivering smart meter VAS that follow from these drivers are focused on: customer incentives, interoperability, information exchange, standardization and compatibility. In order to optimally leverage meter data with respect to the market, technology and legislative drivers, these requirements with respect to meter data need to be taken into account. Below the conclusions with respect to the key variables and relations are elaborated upon.

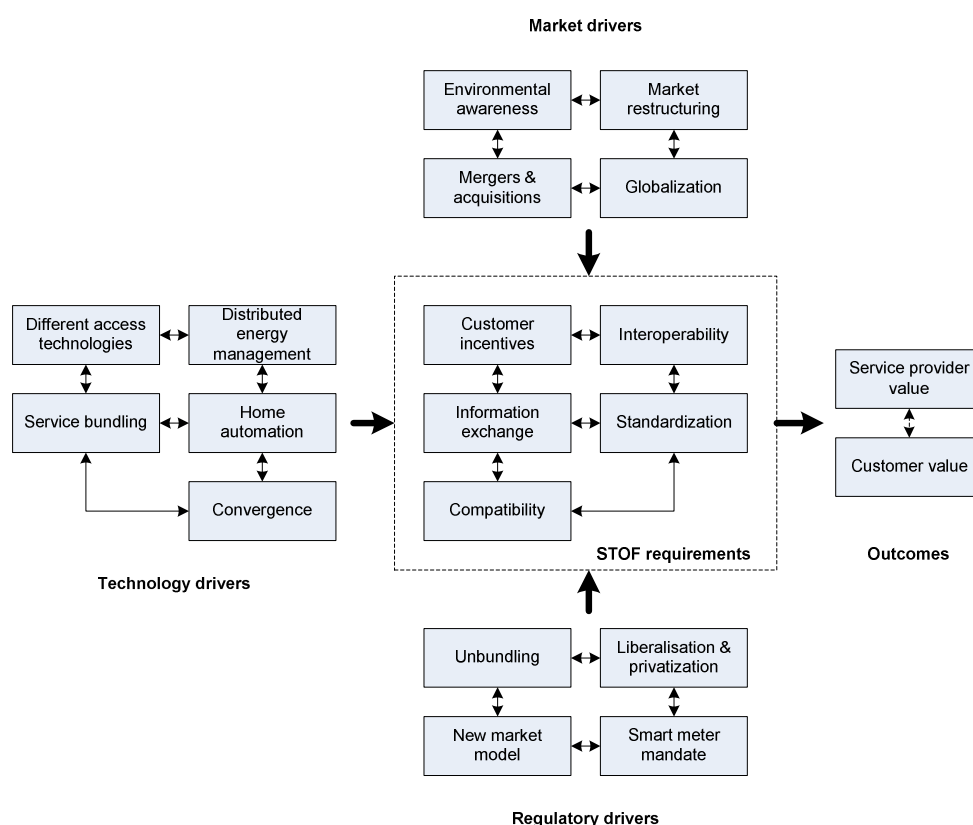


Figure 11 drivers and requirements of a service provider business model

Smart meter equipment enables gathering and storage of information about (near) real-time energy usage. This information is not only required for billing and settlement for every party in the value chain, this enables energy trading and emission rights trading as the link between energy production and consumption now can be made explicit. Hence, smart metering technology is the enabler for information transparency and exchange with respect to market restructuring both on a national and EU level. Information transparency and exchange is furthermore one of the

main objectives behind the Dutch regulatory policy, the new market model and the mandate to install the smart meters on a nationwide scale.

The second possibility focuses on one the next step once the information is gathered, namely using this information in an intelligent and efficient and effective way. Triggers for data use can be found in the market, such as an increased environmental awareness, and technology, such as service bundling, home automation services and distributed energy management. What these meter data applications have in common, is that they do not only require a physical access infrastructure and ideally, the multiple access infrastructures to choose from. Hence, these infrastructures, together with the in-house equipment and back-offices of different parties should leverage a high degree of compatibility (with in-house equipment), standardization (of interfaces and messages e.g. output) and interoperability (of equipment and infrastructure).

Although the advantages discussed were primarily ascribed to the customer, detailed insight into customer behavior and energy usage can also be advantageous for the service provider and energy supplier in terms of billing effectiveness, i.e. remote connect and disconnect and less problems with defaulters. Furthermore, detailed usage data can be used for balancing demand and supply and decrease operational cost associated with reconciliation fines administrative due to timely delivery of usage information, instead of only once per 3 years. However, instruments are required to leverage these possible advantages, and therefore a suitable incentive structure is required. Currently, prepay pricing and code red curtailment programs are becoming visible in the Dutch market.

The requirements for meter data enabled VAS discussed in this section primarily focus on the technical infrastructure and architecture required to deliver such services. Because technology plays a crucial role in determining the possibilities and challenges for smart meters, the next section will zoom in on the proposed technical architecture of the smart meter. Hence, where this section discussed the technical requirement from a top-down, sector perspective, the next section will start with a bottom-up view on the technology, and how architecture choices influence the possibilities for delivering VAS.

2.4 Smart metering from a technical perspective

In previous sections, two different perspectives have been discussed, namely from a market, i.e. value chain perspective and a top-down perspective on a service providers business model. In this section, a technical bottom-up approach is taken to identify the important variables and requirements from a technical perspective. The technical discussion will turn towards the energy meter when we discuss the functional communications architecture and its relevance for delivering VAS.

Under the supervision of NEN the 8130 working group has issued a standard with respect to determining the minimum set of functions for metering of electricity, gas, water and thermal energy for domestic customers. The goal of this standard is to determine what the characteristics should be of a metering system and what the requirements for such system need to be in order to enable advanced meter products and services, which can be divided in critical internal operations and supporting future product and services (NEN, 2006). Central in this report is the distinction between the institutional and the functional model, describing the interactions between the parties involved, i.e. the network operator, the meter data company (MDC), the energy supplier, third party service providers (TSP) and the customer.

The institutional and functional approaches are aggregated in the reference model issued by the Ministry of Economic Affairs (EZ) which is shown in Figure 12 below. The arrows indicate the information exchange between the smart meter, the central access server (CAS), third parties and meter data responsible parties.

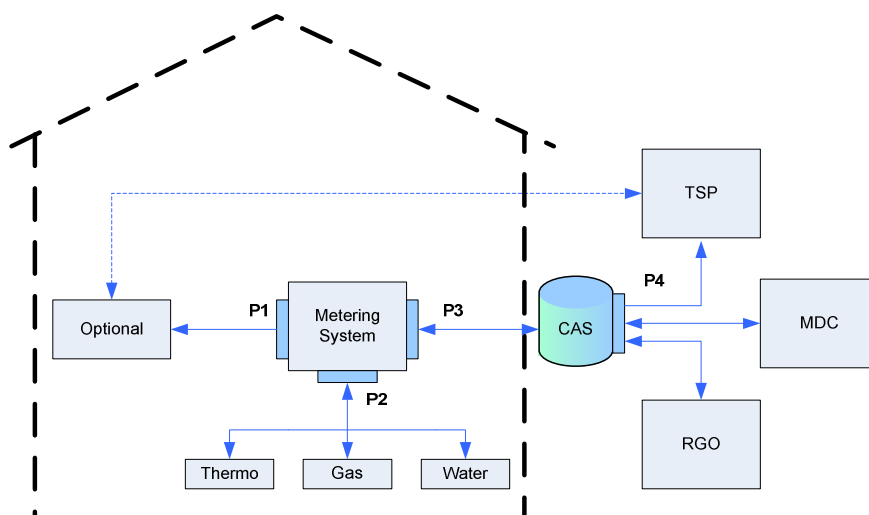


Figure 12 EZ Reference model for smart meter communications

In Figure 13 a part of the functional NEN 8130 model is displayed in which the different communication interfaces, i.e. ports are shown (NEN, 2006). The entire functional model consists of the different media, i.e. electricity, gas, thermo energy and water, but for sake of clarity in Figure 13 only the electricity part has been displayed, since all relevant communication ports are visible. The arrows indicate the direction of information and data communication. Communication ports P1, P2 and P3 are used for information exchange directly with the meter, and port P4 indirectly via a CAS:

- P1: local communications port for information display and exchange at customer premises
- P2: local communications port between metering functions and intelligence, i.e. hardware and software
- P3: external communications port for external connections, i.e. by the RGO
- P4: central access server port for external connection, e.g. third party access

Although the P1 port is still considered optional in the early EZ reference model (see Figure 12), in the later NTA version the importance of this port is already recognized. In Figure 13 the latest NTA functional model is shown where the functionality of the ports is displayed in relation to third party service providers and the meter data responsible party. The possible applications of the different ports are shortly discussed below.

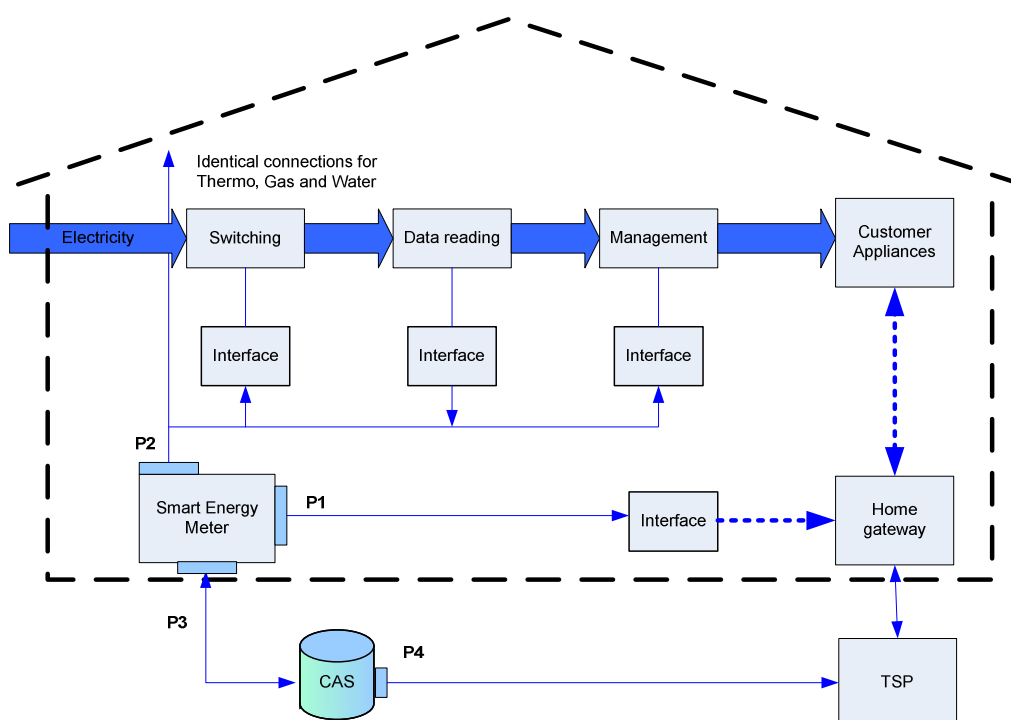


Figure 13 NTA 8130 functional model for electricity

In the functional model for the functional architecture of the meter, four different communications ports have been described (NEN, 2006). Three of these ports enable direct communication with the meter (P1, P2 and P3) and one port (P4) enables third party to access the information stored in a Central Access Server (CAS) operated by the RGO. Because each port fulfills a different function, the characteristics of these ports differ.

Port P1 is unidirectional in nature and is meant to be used primarily for displaying information about energy usage and tariffs at the customer site. Port P2 facilitates the internal communication between the different meters for electricity, gas, thermo and water with the other communication modules. The purpose of P3 is to allow the RGO bidirectional access the metering hardware and software, by which is can control and operate the meter. The RGO is legally obliged to make certain data available to third parties. For this purpose the RGO is obliged to maintain a central CAS where it stores and aggregates meter. Via port P4 suppliers, MDCs and service providers and other parties may access the data stored in the CAS, and they may perform certain operations on the meter software.

Thus, with respect to delivering innovative services based on meter data, service providers have two design possibilities for obtaining this data, namely via port P1 and P4. Using this architecture, the sector expects to enable both a level playing field for service delivery and third party access to meter data. How the service provider technically accesses the meter data is formulated as the technical design choice.

Conclusions

The intensity and length of the discussion with respect to the service requirements of the NTA implies the significance of such an initiative. Although the success of meter data VAS primarily depend on customer adoption, an important requisite is that the available technology facilitates

such service delivery. However, each product or services have its own technical requirements. To be able to deliver a wide range of VAS without large additional investments suppliers would opt for a high degree of functionality for every meter. The RGOs on the other hand bear the cost of such an implementation and hence would limit the functionality to the required minimum to meet the legal requirements.

During the process of analyzing the developments in the energy sector with respect to the technical requirement of metering hardware and infrastructure, several levels of functionality could be distinguished for delivering both customer and internal services. Each level has its own requirements with respect to e.g. the metering interval, customer involvement and commitment and level of automation, as the next generation of services builds on the previous one. The model shown in Figure 14 visualizes the expected development from both a customer and an internal perspective.

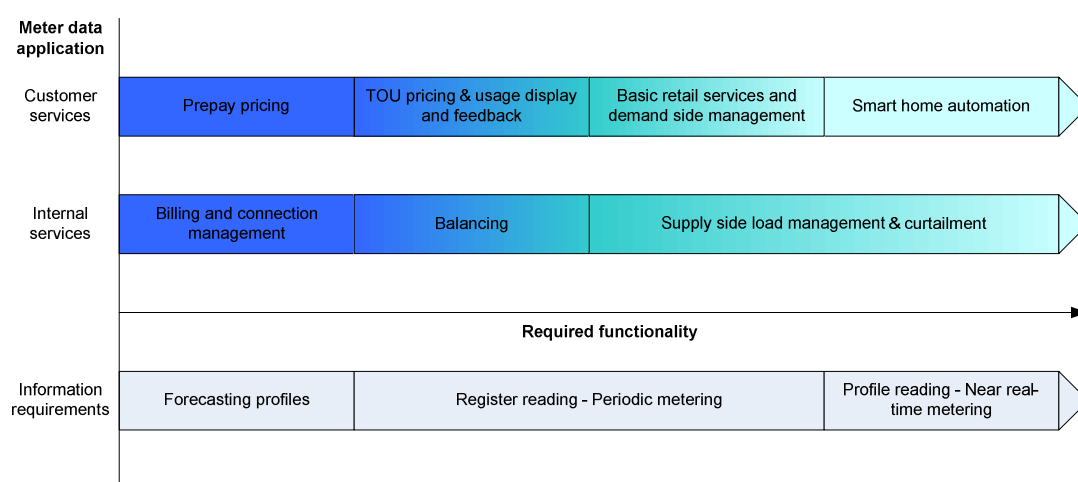


Figure 14 Smart metering development model

For this figure also holds that the availability of usage information is the starting point for enabling customer and internal services at various levels of functionality. Yet, the development timeframe of Figure 14 goes one step further, as here we distinguish three types of information exchange schemes for communication information between the customer and other parties, namely: (1) Forecasting profiles, where decisions are made based on existing customer profiles. The correctness of these profiles is verified occasionally, e.g. once a year during manual meter reads. (2) Register reading or periodic metering, where meter data is requested at fixed time intervals, i.e. once a day or once a week or at times when the data is explicitly requested, i.e. using a pull model. And (3) Profile reading or near real-time metering, where meter data is exchanged at short time intervals, such as every 15 minutes, and at request.

The important conclusion that can be drawn from this picture is that development phases need to be anticipated when considering a grid update or extension and that dispersion of usage and network information is the basis of higher level network and customer services. This means that the architecture of both the infrastructure and the back office need to be modular with clear interfaces between relevant components in such a way that future upgrades can be easily incorporated, i.e. that the network is future proof. The same holds for the data, as it should be standardized and easily accessible.

In the discussion about the smart meter service requirements of the NTA, several variables, drivers and requirements discussed in section 2.2 and 2.3 reappear when discussing the possibilities for delivering VAS. Although the requirements for each port are one step closer towards a full architecture, in practice both the Technical (T) and Organizational (O) components of the STOF business model framework still require further elaboration. With respect to the technical choices of a service provider, e.g. physical infrastructure, architecture, interfaces, protocols, data formats and the organizational choices and institutional designs, interdependencies etc, several institutional and functional models are possible.

In the next section, we will look at several smart meter roll outs outside the Netherlands, in order to determine what choices have been made with respect to both technical and organizational aspects and how these choices have influenced the possibilities for delivering VAS.

2.5 Secondary analysis of cases

In order to cope with the dynamics and drivers described in section 2.2, several utilities have started pilots for preparing the large scale roll-out of smart energy meters. Apart from small initiatives where a couple of houses are equipped with intelligent equipment for remote monitoring and experimenting with different architectures and equipment, currently (Q2 2007) world-wide about 6 large scale roll-outs are underway.

Although these projects are still in a too early stadium to extract valuable lessons with respect to the required functionality and the information and resource requirements, insights have been obtained with respect to the consequences of technological and institutional design issues. The cases discussed here each have a specific characteristic that makes them interesting in the light of this research project, namely a centralized message hub, equal to a national CAS discussed in the NTA for interval meter in the NEMMCO case, extensive load control and demand management in the Florida Power & Light case, meshed network communication in the HydroOne case and a complete platform for delivering VAS in the ENEL case.

2.5.1 Cases

From the small amount of large-scale Advanced Metering Infrastructure (AMI) initiatives, for some hold that many similarities exist between the Dutch energy market and the pilot energy market. Examples of such pilots are visible in Australia with NEMMCO and in Canada with HydroOne. Hence, the choices with respect to technology and the institutional design may have been steered by regulative policy instead of the free market mechanism. However, we will not discuss the rationale behind these choices here.

NEMMCO

In Australia, at the time of installing smart meters regulation caused opening of the wholesale and retail markets. The size of the customer base with respect to installed meters, 10 million in Australia and 6 million in The Netherlands, are better comparable than previous smart meter introductions. Furthermore, the divided structure of the Australian utility market matches that of the market in the Netherlands. Yet, both markets have similar characteristics with respect to scale and complexity. However, one important difference is that before the introduction of smart meters, the metering part of the Australian energy value chain was fully liberalized and unbundled from other value chain activities. Therefore, competition was already visible also on the consumer retail market. Furthermore, switching was considerably high compared to Europe, namely around 25%.

Currently, the first batch of 0.3 million smart meters has been installed, with a result of millions of data transactions between meter and utility. It is expected that after a full roll out of around 2 million meters the number of data transactions will increase towards 96 million. This poses not only stringent requirements on network capacity, but also on regulatory aspects such as responsibilities with respect to gathering metering data, accessing data and data storage. With respect to the network architecture, NEMMCO required settlement processes to be centralized at a central message hub for interval metering.

In the Netherlands this is currently a point of discussion if third parties should be allowed to access data directly, or by means of a centralized database. Furthermore, the NEMMCO project is issued by the regulator, instead of by commercial parties. This makes comparing the requirements for an AMI, and especially a central message hub or national CAS, difficult.

Florida Power & Light

Florida Power & Light Company is the pioneer with respect to load control and AMI as they are running load management programs for over fifteen years. Their AMI module is geared towards reducing overall energy consumption and managing utility peak demands and enabled TOU rates, real-time pricing, demand response and an incentive program for load control.

In practice this means that customers can sign up for a program that defines certain “convenience loads” that can be shut off remotely to reduce peak-demand. Using incentive payments to sign up for such a program, two or three appliances, such as central air conditioning/heating, water heaters and pool pumps can be shut off in cycled for periods of 15 minutes to multiple hours. Wide adoption of such savings program has lead to the ability to shed 2000-3000 MW per 60 seconds, which has avoided the construction of approximately 10 new generation power plants.

HydroOne

In the Canadian example, HydroOne installed 2 million smart meters primarily with the goal of enabling TOU pricing and increasing operational efficiency. Anticipation of future developments with respect to smart meter services is limited, although consumers are able to view their energy usage online. A specific characteristic of this project is that communication between the individual smart meter and the grid company uses mesh network with RF technology. At a central station data from the mesh network stations is bundled and send to the grid company using a GPRS connection. For this project also holds that no quantitative data is available about achieved savings e.g.

ENEL

Forerunner in the EU is a project governed by ENEL in Italy. The ENEL distribution company started the roll out of their Telegestore system which should replace all current meters in the low voltage grid in order to remotely read and manage the customers of electric energy. The innovative character of this project lies on one hand on the scope (approximately 30 million customers should be serviced using the new system) and the extent with which future developments are incorporated in the design as the Telegestore system. The Telegestore system includes the following functional subsystems:

- A remote meter reading system, to automate usage information gathering
- A customer management system, to optimally handle customer data and tariff management, connection and disconnection etc.
- A potential value added services delivery system, to enable future services, such as domotics.

During the pilot Enel has experimented with different infrastructures and means of communication, such as PLC technology using the low voltage distribution grid and the public telecommunication networks (GSM). One of the experiences from these trials was that PLC technology was technically suited to communicate with the meter, however, the use of the GSM network proved more cost efficient for communication in the medium and/high voltage networks. Furthermore, the extent to which the technology was integrated into the network enables ENEL to remotely monitor the low voltage network in terms of quality of service and the energy balance. Overall, the Telegestore system supported the following key features (Bhattacharya, 2005):

1. Active and reactive energy measurement
2. AMR functions
3. Time of use, time of the year contract management functions
4. Remote connect/disconnect for load control
5. Fraud detection/anti-tampering functions
6. Customer information
7. Prepayment (without card) enabling
8. Demand power management
9. Low voltage grid energy management
10. Individual customer service quality level monitoring
11. Potential development of value added services for energy market

Using the Telegestore system ENEL achieved significant savings in their operational processes and field work already of 33 million in 2004 over a total investment of 2.1 billion. Savings are expected to reach 500 million when the project is completed, hence having a pay back time of less than 5 years (Borghese & Cotti, 2005). Besides the financial advantages, ENEL achieved significant secular advantages, such as early compliancy with governmental regulations, prestige, environmental savings and new services matching real-time customer needs, all contributing to a significant first mover advantage.

2.5.2 Lessons and experiences

One of the critical design issues is the choice of an infrastructure technology for communicating with the intelligent energy meter. As several technologies are available, e.g. PLC, RF technology and GSM/GPRS, different utilities such as Enel and HydroOne have chosen different architectures based on local characteristics. Based on the intended functionality, a PLC or GSM/GPRS technology was chosen. Nevertheless, in practice, the requirements for possible future services only played a minor role, as emphasis lies on financial aspects such as cost of field work, installation and maintenance cost and modem prices. Taken these aspects into account, PLC technology is expected to be best suited for urban areas and RF or GSM/GPRS for sub-urban and rural areas.

In practice, the advantages of PLC technology lie in the low installation and set-up cost. However, PLC for use of advanced value added services has significant drawbacks, as real-time communication proves difficult and network conditions can deteriorate service delivery. GSM/GPRS technology, on the other hand, is a reliable and well tested technology which enables bi-directional real-time communications. Nevertheless, the set-up cost (SIM cards, modems etc.) are significantly larger than PLCs', hence this technology is more suited in areas with less density. As an intermediate solution meshed network radio (RF) technology can be an attractive option, as individual installation cost are below GSM technology.

Furthermore, when choosing a technology or infrastructure for implementing an AMI, two other important lessons can be identified. The first lesson is that the proposed changes in the architecture for enabling AMR should take into account the existing legacy architecture. Since Greenfield situations are not very common, existing technology should be used as a basis for a smart meter upgrade. As back office operations are based on this architecture and large changes would further disrupt normal operational procedures. The second lesson is that giving the AMI project the appropriate scope and resources. Approaching the AMI project as solely a remote metering system is a far too narrow perspective. As a result, no business model based on this scope will be viable. It is therefore required that the scope of the project is broadened for enabling data gathering and sharing in order to provide leverage for optimizing internal operations or delivery smart value added services in the future.

The AMR benefits generally sought have been focused on distribution operations, asset management and customer service. While energy efficiencies via demand response and load management are also viable AMR benefits, it was too early to quantify these benefits at the utilities forming these case studies (Bhattacharya, 2005). At this time (Q1 2007) only two examples are known where utilities execute load management programs. Florida Power & Light Company decreased the need for extra production capacity by managing existing load more efficiently. Enel on the other hand accomplished to move 1% of consumption of peak hours to off-peak hours using their innovative pricing scheme, which enabled a reduction in capacity need of about 3000 MW, i.e. the temporary switching of extra capacity plants (Borghese & Cotti, 2005). However, it should be noted that the benefits achieved with AMI pilots benefit the whole integrated supply chain. Hence, the question remains if from the perspective of the sole energy supplier, these benefits counterbalance the required investments.

From the studies described above one important conclusion can be drawn. Except for Enel, current pilots are primarily focused at basic metering functions such as automatic metering and remote connect/disconnect. Furthermore, several initiatives are being undertaken with respect to extending the use of the smart energy meter using prepay and TOU payment systems. Nevertheless, experiences with and anticipation of future value added services, such as home automation and domotica is limited. However, as the case of Florida Power & Light showed, the customer will adopt his behavior if a suitable incentive is given, in this case a lower energy bill.

2.6 Building the conceptual model

Analyzing the utility sector from different perspectives and using different approaches (bottom-up versus top-down) and have led to several important insights into the relations among parties in the value chain, trends and developments that influence a service providers business model and the technical specifications of a smart energy meter. Furthermore, a study on smart meter pilot projects showed that, although only limited quantitative data is available, demand management enabled significant operational savings when presenting the right incentive to the customer.

On the other hand, experiences with value added services, such as home automation, are limited. In this section, these insights will be aggregated in a conceptual model, in which the key variables will be related and consequently elaborated upon with respect to their relevance in delivering smart meter VAS based on meter data.

The purpose of the conceptual model is to structure the variables that underlie a successful implementation of smart meter VAS. Consequently, both the variables and the relations between these variables will be the subject of interviews held with utility professionals. The purpose of

these questions is twofold, namely: validate the relations between the factors and on the other hand identify how these relations can be specified into explicit customer services the utilities expect in the near future.

We will develop the conceptual model step by step, in order to guide the reader along our process of reasoning and design.

2.6.1. Step 1

The first step in building a conceptual is to define the scope of the model on a high level of aggregation. A starting point for this thesis is the mandatory instalment of smart meters, resulting in a new way of measuring and using meter data. The availability of meter data enables a wide variety of meter data applications. From the perspective of the individual service provider, these applications are a necessity for designing a viable business case, as the expected operational savings do not level the required investments. Furthermore, the market drivers discussed in section 2.3 create the need for a supplier to distinguish oneself from their competition, and optimally leverage the technological possibilities while taking into account the regulatory requirements.

What these perspectives have in common, is that the customer is central in terms of purchase of the service, or changing their usage behaviour. Meter data can be used to deliver VAS to the individual customer, tailored to their specific needs. In this case, the involvement of the customer is straightforward. In the other case, meter data can be used to optimally manage internal processes, such as administrative issues, switching, balancing, forecasting, load management etc.

The goal of the latter three is to influence the way customers use energy and spread their use to reduce peaks. Hence, cooperation should be a result of a suitable incentive, as shown in both literature (Wood & Newborough, 2003, 2007), in the Florida Power & Light case and during a prepay pilot of Eneco in the Netherlands. Thus, the business case for meter data applications relies on one hand on customer value, in terms of VAS, and on the other hand on supplier or sector value, in terms of operational excellence (see Figure 8). These insights have been translated to the relations and variables shown in Figure 15.

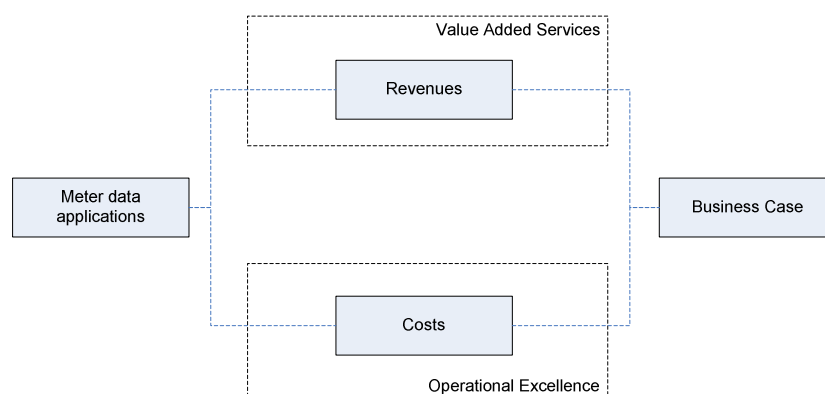


Figure 15 Conceptual model - step 1

2.6.2. Step 2

The next step of building the conceptual model underlines the delineation and focus of this research. Although it is difficult to assign direct revenues associated with energy delivery to the smart meter roll out, additional revenues are expected by the use of meter data in delivering additional services. The trend that can be identified is that these services are developed centered around the customer. As operational excellence is one way of achieving a competitive advantage, delivering unique value added services to customers is another, and thus not less important.

However, determining what products and services customers' desire and what the adoption potential of such services will be remains difficult (De Marez & Verley, 2003; McBurney, Parsons, & Green, 2002). Nevertheless the interest of customers for lowering their energy usage is clearly apparent, both from a financial or environmental perspective, as long as the incentive structure matches their needs.

Primarily, future services will focus on fulfilling customer desires best in terms of flexibility and savings, security and safety and comfort and control (see Figure 10). In order to let the users make informed choices about their consumption, information about actual usage, financial information about possible energy savings and the way and place where information is displayed is of critical importance (Wood & Newborough, 2003). Wood and Newborough (2003) have conducted several case studies in order to determine the requirements for such an information display unit. They concluded that feedback with respect to decreasing energy use is most effective if provided directly following the action which consumes energy and if it relates to individual parts of the control system, i.e. domestic equipment (Wood & Newborough, 2003).

Operational efficiency on the other hand can be reached by reducing operational cost, as discussed in step 1. Because we have seen that incentives for energy savings can be highly effective, the supplier has a conflicting interest, namely enabling energy savings on one hand, and energy sales on the other.

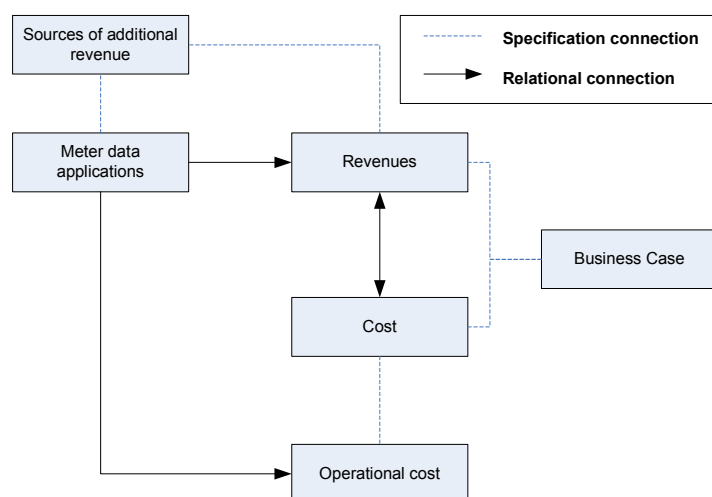


Figure 16 Conceptual model - step 2

2.6.3. Step 3

The third step in building the conceptual model is making explicit what sources of additional revenue based on meter data can be designed, and what services can be expected. The availability

of real time usage data equips the supplier with detailed insight into individual energy flows to its customers. This enables the supplier to increase its forecasting and profiling ability. This furthermore enables the supplier to optimally manage the tension between supply and demand.

A second utilization of usage data for operational purposes is to display usage data, in terms of KWh or monetary values at the customer site, in order to increase customer awareness, with the result to influence customer behavior which this is meant with *demand side management*. These applications currently in practice as discussed in the section 2.5 and are characterized as internally oriented applications (see Figure 17).

Finally, usage data can be used to monitor the network status, e.g. low voltage links, load management and incident reports. However, it is expected that this information will not necessarily lead to a decrease in energy fraud as the location of the fraudulent behavior will transfer from beyond the energy meter, i.e. at the customer site, to before the energy meter, i.e. to the local distribution grid, where monitoring is less precise and cannot be remotely traced back to an individual user. Besides the fact that this increases the risks due to the higher voltage level, this also changes the need for other types of fraud management, namely from an individual level to a more neighborhood level. Comparing the input on the neighborhood level with usage data of the individuals in that area hence are a tool for detecting possible fraudulent activities. Energy fraud beyond the individual energy meter on the other hand, is detected using meter software and communicated electronically to the distributor.

Furthermore, smart meters provide possibilities for delivering additional VAS based on bi-directional communications. The extent of these services could vary from basic retail services, such as security monitoring, to demand side management of energy, where smart equipment automatically starts and stops based on the current energy price (see figure 7 and Appendix 5 for an overview of smart home applications).

Intelligence equipment will be primarily used to monitor the network components (low voltage grids) for gathering information about network status and energy usage, intelligence with respect to customer centric services lies primarily at the customer site, i.e. at domestic equipment. As a result, a platform needs to be created where domestic equipment manufacturers and utilities cooperate to set common standards.

On the other hand, home automation services cannot be delivered only by the supplier, as Internet Service Providers (ISPs), telecommunication companies and content providers increasingly strive for leadership of future customers' digital home (P. Jackson, 2004). As these parties have much more experience with branding and customer loyalty programs, they are a potential threat to the supplier. Because these parties often already have a presence in the customer home, service bundling initiatives can be both an opportunity and a threat to the energy supplier.

Service bundling is further enabled by the technology drivers discussed in figure 8, e.g. convergence, different access technologies and distributed energy management packages. Currently, these services are to some degree delivered by the energy supplier, such as Essent, delivering heating, security and care services. However, these services are mostly delivered by a third party supplier, therefore possibilities for bundling these services with energy remains one of the possibilities to create additional value for the customer, by means of a single point of service, a single bill etc.

The overview of smart meter applications derived from literature, interviews with Capgemini professionals and case studies is presented in Appendix 5. However, as the goal of the conceptual

model is to test if these applications can be expected in practice, the two conceptual types of services, i.e. meter data applications and service bundling, are added to the conceptual model (Figure 17). Furthermore, the relations between customer oriented services and internally oriented services with potential revenues and operational cost are drawn.

However, there also exists a relation between customer oriented and internally oriented applications, as a specific service can be used for both purposes, i.e. give incentives to customers by means of a remote display (customer oriented application) to reduce energy usage at peak times for the supplier (internally oriented application).

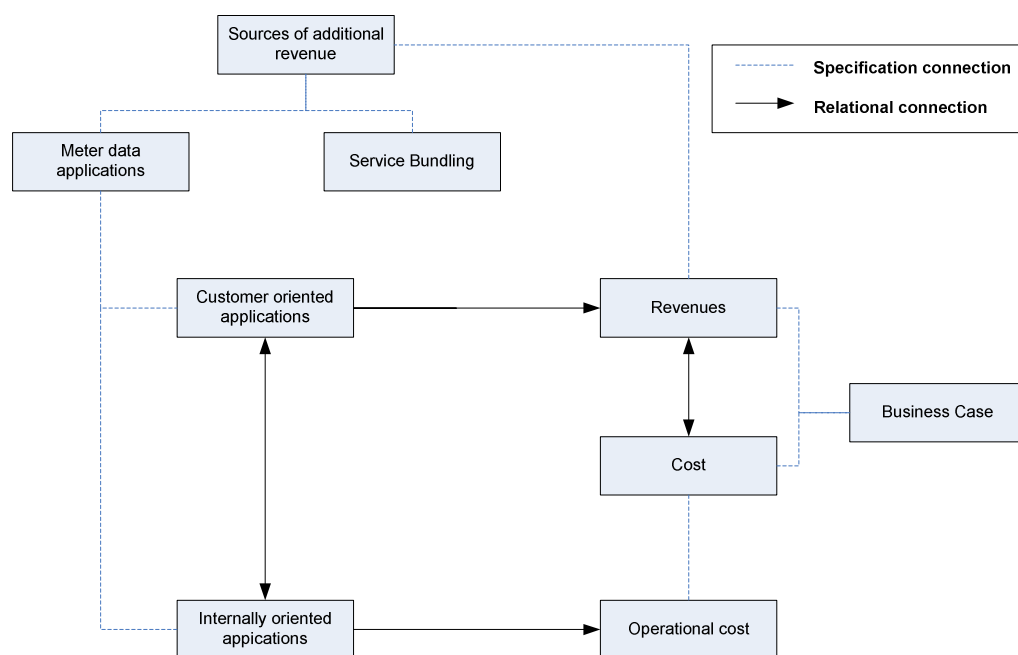


Figure 17 Conceptual model - step 3

2.6.4. Step 4

Although the availability of meter data provides many possibilities for delivering VAS to the customer, the actual customer adoption will depend on how customers evaluate these services. In section 2.2 and Appendix 3 the drivers for customer behaviour have been discussed and related to supplier goals as shown in figure 5. On a conceptual level, two important drivers for customer adoption can be distinguished, namely cost of supply and quality of supply.

Cost of supply encompasses the performance indicators from a customer perspective with respect to all financial aspects related to service delivery and effort. Recent experiences such as the prepaid pricing scheme of Eneco showed that variable tariffs such as TOU pricing schemes and possibilities for energy savings determine the perception customers have of the cost of supply.

Quality of supply on the other hand encompasses the performance indicators customers have with respect to the quality and the range of services delivered by the supplier. Quality of supply encompasses multiple aspects, such as security of supply, service quality and the range of services delivered. Yet, a distinction can be made between the quality of the product or service that is delivered and the range of products and services that is delivered. Hence, service bundling directly influences the quality of supply. Since, quality of supply is often associated with higher

reliability, overhead and service, a strong relation exists with the cost of such services. Furthermore, customer adoption determines the advantage of scale and scope and thus potential operational revenues.

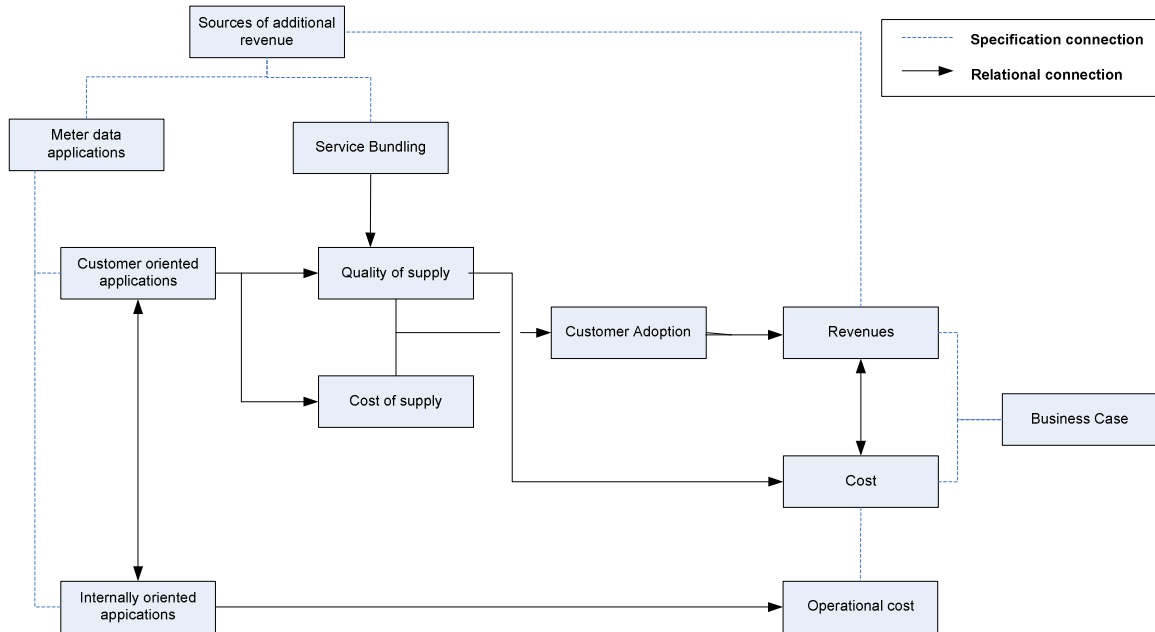


Figure 18 Conceptual model - step 4

2.6.5. Step 5

Although customers will evaluate a service offering based on their own needs and the perception of quality and cost, several general drivers for customer behaviour can be distinguished. In section 2.3 an overview is given from these drivers related to customer incentives. The recognition that the customer has a choice between suppliers, and that they will evaluate these suppliers on more than just price and security of demand, asks for an approach that takes competition into account.

Furthermore, price changes as a result of competition will determine how existing and new customers evaluate the cost of supply for certain products and services. Globalization and market restructuring increase the level of competition. Another global trend is an increase in environmental awareness with both customer and suppliers. Environmental awareness hence recurs in both supplier and customer objective analysis (section 2.2). Environmental awareness will influence the image of a product, service or supplier, but image is also determined by the perceived quality and cost of supply. Hence image plays a crucial role in determining customer adoption (see figure 5). These three factors are added to the conceptual model.

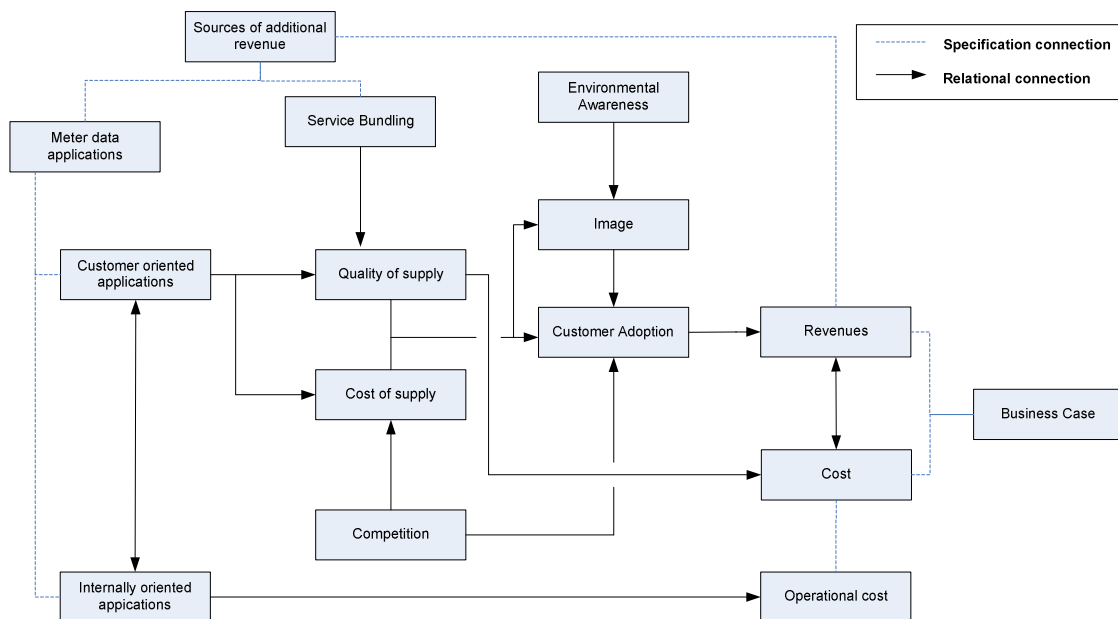


Figure 19 Conceptual model first version

In Figure 19 the first version of the conceptual model is shown, after all the notions from previous sections have been applied. Hence, it provides an overview of the key variables and their relations with respect to delivering value added services based on smart meter technology (research sub-question 1). In the next section we will discuss how the conceptual model will be applied and how external interviews with utility professionals will contribute to the design of service requirements for smart meter VAS (research sub-question 2).

2.6.6. Next steps

Although the conceptual model structures the problem space and way of working, the question remains how the different variables influence each other and in the end determine the requirements for service delivery and how these service requirements translate to technical and institutional design issues. Therefore, we will empirically validate the model using interviews with representatives from Eneco, Essent, E-on and Oxxio

The interviews will be used to falsify the stated relations and determine what products and service can be expected. This distinction is derived from the type of relations between the factors, i.e. a specification connection and a relational connection (see Figure 20). The factors shown in the conceptual model provide the starting points for the interviews with energy suppliers in order to verify these relations.

Two types of questions can be distinguished based on these relations, namely: (1) relational questions, indicated in black and (2) specification questions, indicated in dotted blue. The relational questions primarily answer the how-questions and why-questions as the goal is to validate the causal relations between the factors determining a viable business model. The specification questions try to answer the what-questions, as they try to make an inventory of the possible value added services which can be delivered using smart meters such that these can be compared with the smart meter services discussed in appendix 5.

Due to the specific focus of this research, the interview questions primarily focus on what services to deliver to the customer, in order to really add value for that customer and to reduce operational cost. Hence, trivial macro economic relations are discarded, and only relations that are of relevance within our domain of analysis are translated to specification interview questions and relational interview questions. The numbers besides the arrows and connections shown in Figure 20 relate to the relevant interview questions presented in appendix 8.

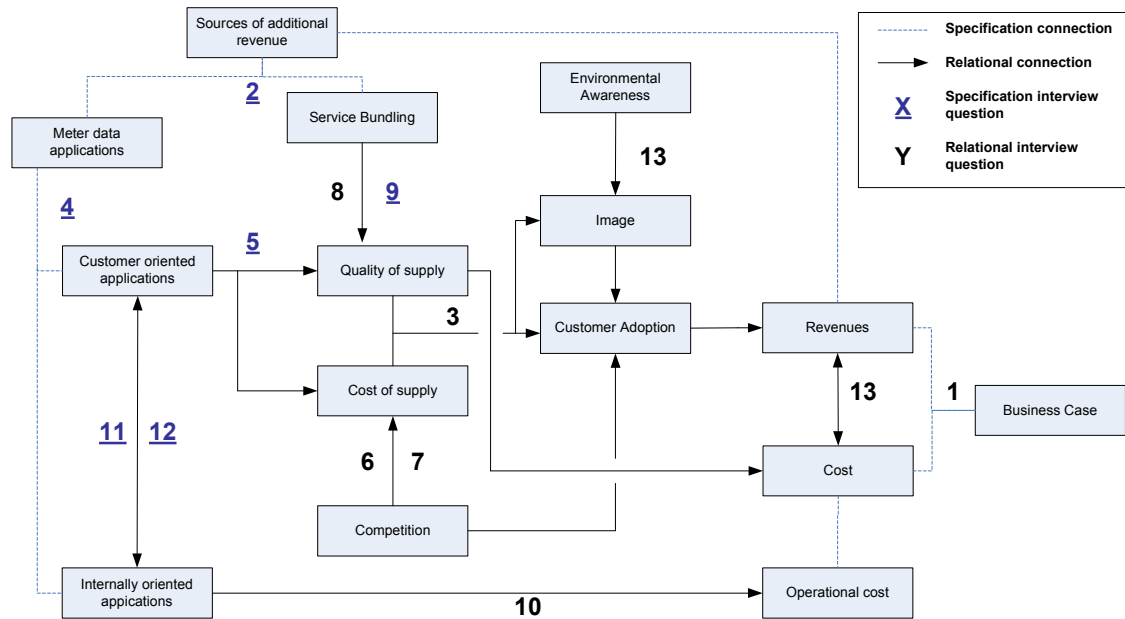


Figure 20 Conceptual model

Smarter Metering

3 Model redesign and requirements analysis

3.1 Introduction

The goal of this chapter is to empirically verify the conceptual model designed in chapter 2 and to translate this model to service requirements for smart meter products and services (research sub-question 2). The conceptual model of chapter two which is based on desk research, a secondary analysis of cases and interviews with Capgemini professionals, functions as the starting point for interviews held with external utility representatives.

The objective of the interviews is on one hand to test the relations among the stated variables in building a viable business case and on the other hand on specifying how the variables can be translated to concrete smart meter products and services. Therefore the deliverables of this section will be a revision of the initial conceptual model which can consequently be used to determine the service requirement for such smart meter VAS. Hence, the structure of this section looks as follows:

First, in section 3.2 we will elaborate on the different types of design that are relevant for designing a conceptual model with respect to smart meter VAS. Next, we will position our design method and discuss the important aspects. Second, the first conceptual model will be the starting point for determining relevant interview questions. What aspects and what type of questions will be asked will be discussed in section 3.3. Third, in section 3.4 the design method will be elaborated upon. As the research method depends on many factors, such as the available source data, data gathering techniques etc, it is important to discuss the choice for a specific design approach, namely qualitative data analysis. Fourth, in section 3.5 the results from the interviews will be analyzed and the initial conceptual model will be updated and specified based on these findings. Fifth, in section 3.6 the updated conceptual model will be interpreted and the service requirements for delivering smart meter VAS will be discussed, thereby answering sub-research question 2.

3.2 The Design process

The problem of designing a viable utility business model based on the introduction of smart meters can be approached from several perspectives as discussed in chapter two. This does not only hold for analyzing the environment, but also holds for design. Therefore here we discuss the different types of design and how they are positioned. Next, we discuss the research and design approach, before starting with the actual design of the conceptual model.

Although technology plays a key role in determining the range of services that can be delivering using smart meters; however, in complex technological systems such as the energy and telecommunication networks, the challenge lies only partly in technology. Besides the design of the technological component, these systems require an institutional structure that coordinates the positions, relations and behaviour of parties that own, operate or are dependent on such a system (Koppenjan & Groenewegen, forthcoming).

A smart meter architecture or grid is characterized by a large number of interdependencies, for example with respect to (1) the number of private and public parties involved, (2) external, market, technological and legislative forces, (3) sharing of usage and billing information and (4) access to the physical infrastructure. Hence, designing a smart metering system does not only

have a technological or substantive dimension, but it also pre-supposes coordination of behaviour of parties necessary to make the system function (Goodin, 1996; Nelson, 2001).

However, an institutional design is not separate from a technical design as a choice of the first influences the design space for the latter, and vice-versa. Although path dependence cannot be prevented, it should be stated that the process of designing in practice is often an iterative process. In order to rightly position the institutional design, Koppenjan and Groenewegen (forthcoming) have visualized the relation between three types of design; the technological, institutional and process design (Figure 21).

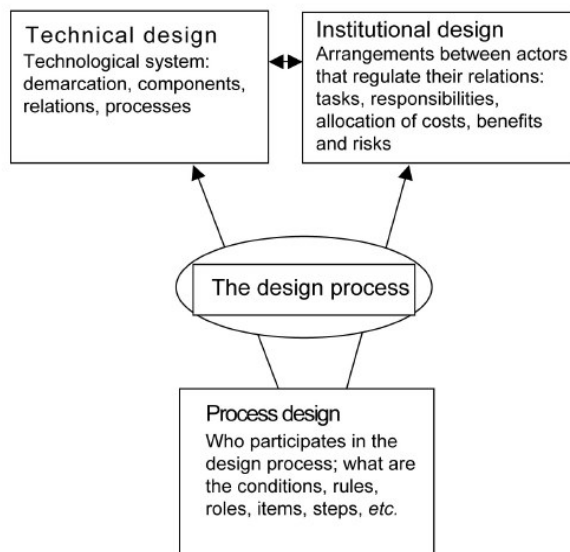


Figure 21 positioning technical, institutional and process design

When looking back at the framework used in chapter 2, namely the STOF business model framework, the technical and institutional design correspond with the technical (T) and organizational (O) domains of the framework. Together with the service domain (S) these domains are the focus of this research, as respectively the service, technical and institutional aspects are discussed.

What Figure 21 however adds to this enumeration is the fact that in order to translate the service requirements (question 2) to the technical (question 3) and institutional (question 4) requirements, a process design is required to guide and safeguard the process. Hence, the process design elaborates on the *process* of arriving at a technical and institutional design, by giving attention to who should be involved in the design process, how this involvement must take place, what rules of the game are relevant, what subjects are to be considered, what core values need to be satisfied etc. A process design consists of the whole of agreements and provisions aimed at the organization of the design process (de Bruin, ten Heuvelhof, & in 't Veld, 2002). Aligning institutional and technical requirements should be an iterative process, just as the arrows of Figure 21 above suggest. As in this thesis the emphasis lies on the determination of service requirements, the process design falls outside the project scope and is thus suggested as a subject for further research when these requirements need to be implemented.

3.3 Research and design approach

In the previous section the three core deliverables of the design process have been discussed. In order to arrive at these designs, the design process needs to be structured. In literature several design approaches can be distinguished, such as heuristic design and iterative design leading to well known design models such as the waterfall and spiral model of design.

Although many general frameworks for design exist, many similarities exist with respect to the design process (Macmillan, Steel, Austin, Kirby, & Spence, 2001). That is, they start with a stage defining the problem and consequently proceed through the conceptualization stage, basic engineering stage and detailed design phase. The problem definition stage and the conceptual design stage are generally considered to be the most important stages with respect to the impact of design decisions on the final outcomes (Herder & Stikkelman, 2004).

Several types of approaches to a design process can be distinguished, however, the aspect that they have in common is that they require some sort of data input. Because the data we derive from the interviews are of qualitative nature, a method should be chosen that fits this type of data, such as analytic induction or grounded theory (Bryman & Bell, 2003). Grounded theory has become by far the most widely used framework for analyzing qualitative data and can be characterised as 'theory that was derived from data, systematically gathered and analyzed through the research process'. In this method, data collection, analysis, and eventual theory building stand in close relationship to one another (Glaser & Strauss, 1976).

By coding the qualitative data, relation between concepts on different levels of aggregation can be build and hence theory can be developed based on these relations. However, a grounded theory approach requires an unstructured and unbiased problem field without any explicit intrinsic role for the interviewer. As here we first constructed a theoretical conceptual model and thus created a preliminary structure ourselves, these requirements cannot be met. Therefore the research method used in this research can be best described as qualitative data analysis.

Qualitative data analysis

Several approaches are available to gather and analyze data, such as meta-analysis to analyze existing literature, content analysis on hypothesis and propositions and network analysis to analyze the data extracted from literature (Bouwman, Fijnvandraat, & van de Wijngaert, 2006).

However, gathering data is just the first step as sound methodological approach also includes an empirical validation, verification and falsification. During this research project, several types of validation have been performed. First, the design of key variables has been face validated by Capgemini professionals. To validate and construct the conceptual model regarding smart meter services and their requirements, we use a qualitative research methodology of in-dept interviews with energy supplier professionals and concept mapping.

It is important that the interviews are both structured and open to ensure that the interviewee can express as much knowledge and ideas about possible future smart meter strategies as possible. This implies that although the same questions are presented to each interviewee, the open character of the interview lies in the fact that the questions are open ended. All interviews are to be taped, transcribed and reviewed by the interviewees. Consequently, all interviews will be coded and analyzed using version 5.0 of the ATLAS.ti (www.atlasti.com) scientific software programme for visual qualitative data analysis.

This package enables the segmenting of a text into passages which can be indexed and related using meta-data codes. As a result, the software makes it possible to visually connect selected passages based on the assigned meta-data, into diagrams which graphically outline the complex relations. This way, insight into the underlying constructs of the stated variables and their relations is acquired, which can be used to revise the conceptual model and provide a starting point for the design of functional designs. The type of qualitative data analysis performed using ATLAS.ti uses concept maps to express these variables and relations.

Concept maps

Concept maps are a graphical two-dimensional way to display relations between concepts using directed arcs enclosing brief relationships (Canas et al., 2005). Hence, a concept (or causal) map is useful for visualizing and understanding complex, ill-structured problems and multi-dimensional issues that can have multiple consequences or multiple explanations.

The term concept is defined in a general term, in order to determine the appropriate level of detail and aggregation dependent on the research goal. The same holds for the type of relation which associates the various concepts or variables. In previous research, concept mapping was primarily used for visualizing information resources. Currently, however, the possibility for using concept maps to integrate and display both information and knowledge are of increasing value (Canas et al., 2005).

After connecting the concepts to each other, the input data (often text) can be translated to a graphical lay-out for constructing networks of concepts and theories based on those relationships, so called “concept maps”. Hence, concept mapping is a technique for visualizing the relations between abstract concepts. Due to its level of abstractness, concept mapping can be applied to a variety of fields and subjects.

Furthermore, Axelrod (1976) has proposed cognitive maps as a means of representing the conceptual structures underlying decision making. In later studies by Eden, Jones and Sims (1979) this has been empirically verified. Furthermore, Fijnvandraat and Bouwman (forthcoming) have shown that it is a suitable technique for validating conceptual models with respect to their empirical validity.

Although open ended interview questions are a frequently used technique to gather new information about an experience or topic and explore, explain or confirm existing ideas, the drawbacks of such an approach are that open ended interviews are often time-consuming, and that interviewer or analyst bias pose threats to the reliability and validity of the results using existing analysis techniques (K. M. Jackson & Trochim, 2002).

Concept mapping can be seen as an alternative method to existing text analysis, .e.g. close reading techniques, that overcome the drawbacks associated with these techniques, and is especially suited for questions of explorative nature, such as the question central in this thesis, as concept mapping combines the strengths and weaknesses of both word-based and code-based methodologies (K. M. Jackson & Trochim, 2002). Furthermore, the validity level of the concept mapping approach profits from the fact that it combines statistical analysis with human judgement in order to detect and remedy unusual outcomes. Hence, it combines the best of representative and interpretive techniques, for which it will be used to determine the conceptual relations between the key variables discussed in chapter 2.

Qualitative coding

In order to verify the causal relations between factors determining a viable business model and the specification relations regarding specific meter data applications interviews have been held with utility representatives. Consequently, these interviews have been coded and analyzed using the qualitative data analysis approach as discussed above. Because we distinguished two types of relations, the method for verifying these relations differs.

The first type of connection is based on a causal link, between the variables that contribute to a smart meter business case. These relations are of conceptual nature and try to simulate the factors that suppliers consist important for creating a positive smart meter business case. Hence the connections between the nodes focus on how they are related (in increasing relational strength):

- Association (is associated with)
- Contribution (contributes to) or Contradiction (contradicts)
- Cause (is a cause of)
- Requirement (is a requirement for)

Of these relations, *association* is of bi-directional nature, *contribution/contradiction* and *requirement* are of uni-directional nature and *cause* is of transitive nature. The nature of these relations will be indicated using the arrows connecting the variables.

Although the four types of relations suffice to indicate the strength of the relation between two concepts, no indication can be given of what the probability is of such a relation. Therefore the supplement “*could be*” can be added as shown below. The second type of connection, tries to identify what different types of services can be identified. Hence, these relations test the summation shown in Appendix 5. To enable an aggregation of components, two types of relations are specified:

- Type [is a]
- Part [is a part of]

The same as with the relation connections with respect to expressing probability applies here.

Table 1 relational and specification connections

X could be associated with Y	X could be a type of Y
X is associated with Y	X is a type of Y
X could contribute to Y / X could contradict Y	X could be a part of Y
X contributes to Y / X contradicts Y	X is a part of Y
X could be the cause of Y	
X is a cause of Y	
X could be a requirement for Y	
X is a requirement for Y	

In the next section, the interview results will be analyzed and the conceptual model will be validated and revised based on these findings. Because the conceptual model has two dimensions, namely a relational dimension and a specification dimension, the deliverables of this chapter are also twofold. After analyzing the specification and causal connections and key variables and relations, conclusions will be drawn with respect to the expected future services and the service requirements of smart meter services (research sub-question 2).

3.4 Revising the conceptual model

The information gathered during the interviews with utility representatives has been analyzed and coded using the concept mapping methodology discussed in section 3.4. Per interview, this

resulted in a non transparent “blurb” caused by a high number of variables and relations between these variables. In this section, we will review the design steps taken in section 2.6 and try to maintain a consistent level of aggregation.

3.4.1 Step 1

The first step in designing the conceptual model discusses the high level relation between future meter data applications and the business model of a supplier. In Figure 22 the primary factors influencing a viable business case can be distinguished. We explicitly choose to exclude relations of the type “association”, due to the limited explanatory value. Based on these information, we can identify four high level categories of variables that influence a viable business case, namely three specification connections: additional revenue from customer services, additional revenue from management and maintenance of the meter, operational savings (including savings associated with increased accessibility) and one relational connections: customer switching behavior (determined by customer adoption and retention).

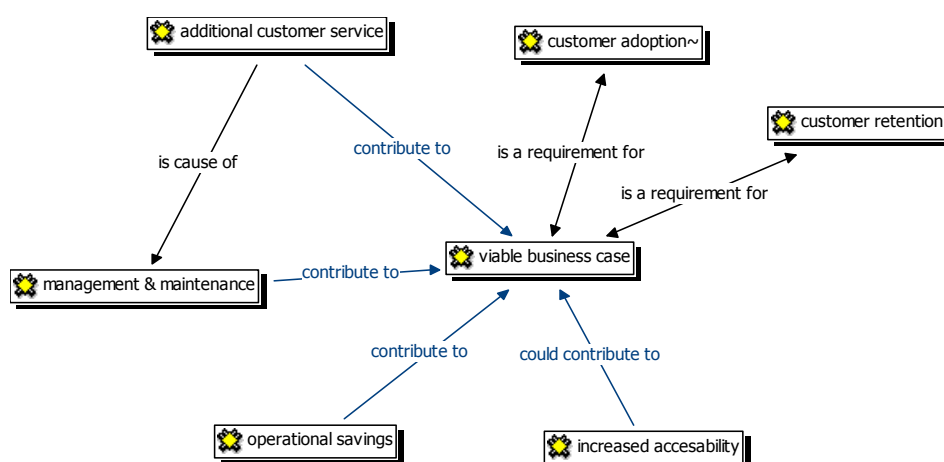


Figure 22 Variables influencing a viable business case

On the other hand, the interviewees have discussed several explicit meter data applications as shown in Figure 23. Furthermore, the relation between meter data applications and a viable business case (by means of additional customer services) is given. Meter data applications with respect to operational savings are not mentioned explicitly, however, load balancing and billing can be assigned to this category. Because management and maintenance will be related to a specific service or product installed at the customer site, we group these additional sources of revenue under customer oriented applications.

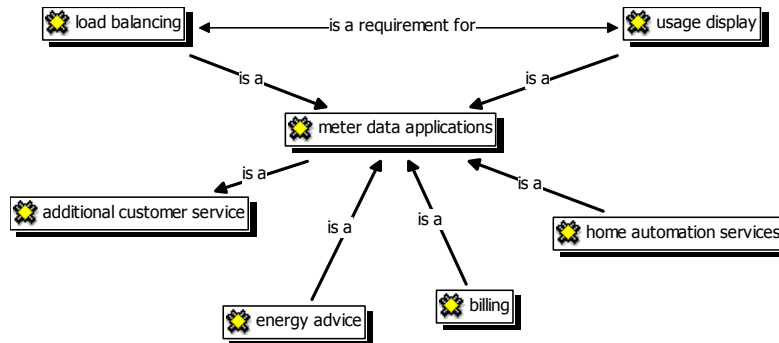


Figure 23 Meter data applications

From the verification of step 1, we can conclude that on a high level, the initial variables are acknowledged during the external interviews. However, the construct of customer adoption should be extended to both customer adoption and retention, as shown in Figure 22.

3.4.2 Step 2

During step 2 we have discussed meter data applications as source of additional revenue for the supplier. In Figure 24 the variables influencing additional revenues can be distinguished. On one hand, specific services are discussed, such as communications and telecommunication products and service bundling with other parties such as home electronics retailers. Furthermore, the relation between additional revenues and load balancing and customer adoption has been confirmed.

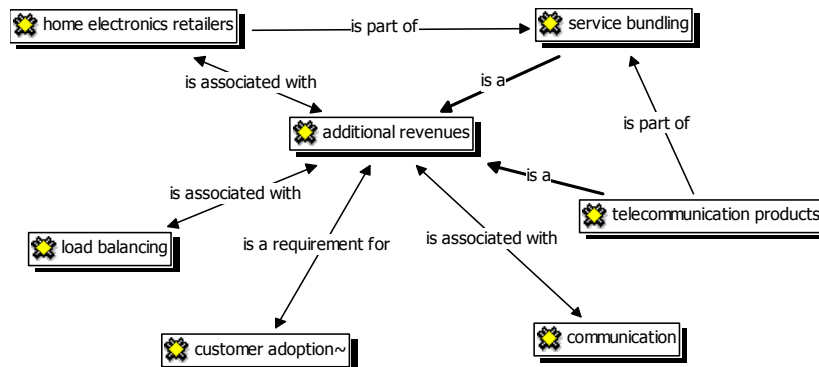


Figure 24 Sources of additional revenues

As shown in Figure 24, the sources for additional revenue can be related to a variety of services, which can focus on internal operations, customer added value or both. In Figure 25 the applications associated with operational savings have been presented. The interviewees expect that operational savings can be reached through load balancing, forecasting, resolved administrative issues, a reduction of energy network losses, billing and fraud prevention, however especially the latter three are to a large degree unclear (as indicated by the “association” relation). Furthermore, two important requirements can be distinguished, namely accessibility of meter data and a large scale meter roll out.

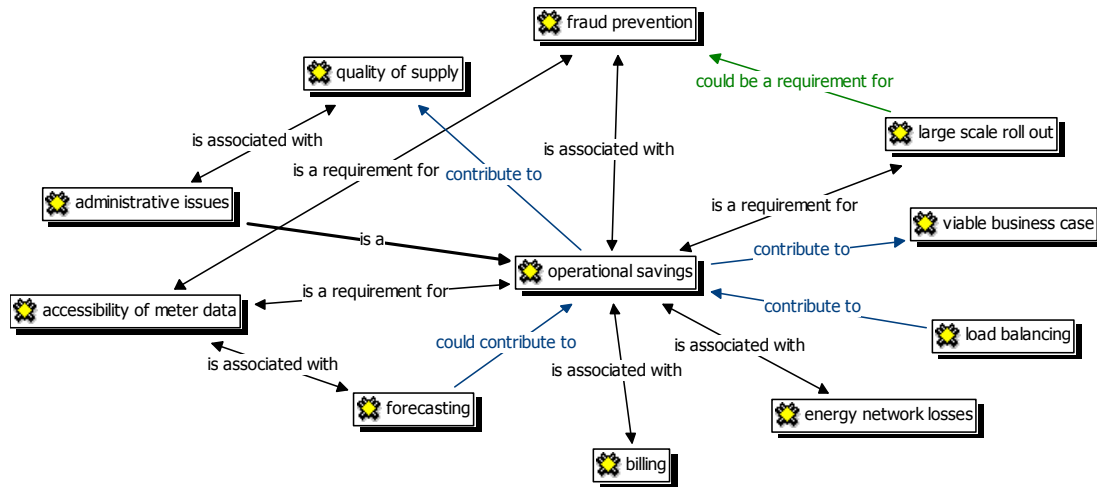


Figure 25 Operational savings

The relational connections of step 2 are in agreement with the results derived from the interviews. Besides a number of ways to reach operational savings, Figure 25 also shows two important requirements to do so, namely a large scale smart meter roll out, i.e. a large degree of coverage and accessibility of meter data. The first suggests that the potential of the smart meter can only be leveraged when a specific degree of coverage can be reached, and thus the savings in the early years are small. Because both the speed of roll out and the accessibility of the meter is a result of the governmental policy, these can be grouped in the factor *technical and regulatory boundary conditions*, which should be added to the conceptual model.

3.4.3 Step 3

In step 3 of the design of the conceptual model, the possible meter data applications have been further specified in *customer oriented applications* and *internally oriented applications*. Because the causal relation between these applications and additional revenues already has been validated, here we will focus primarily on the specification relations, i.e. what customer and internally oriented applications can be enabled by meter data applications? For sake of clarity the ability of the software package ATLAS.ti has been used to group the variables into customer oriented and internally oriented application families as shown in Figure 26 and 27. However, the distinction between customer oriented applications and internally oriented applications for instance in billing, load balancing and remote management is rather thin, as the actual application will determine which party profits most.

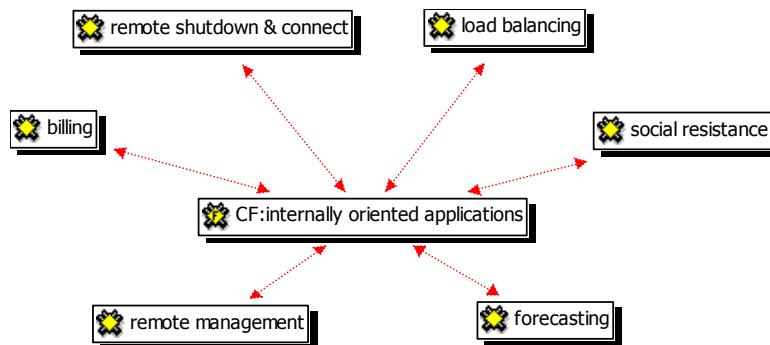


Figure 26 internally oriented applications

The internally oriented applications as shown in Figure 26 are in line with the line of argument presented in step 2. From a customer perspective, two types of applications can be distinguished, namely applications which do not interfere with customer usage patterns and behaviour, such as load balancing, forecasting and billing, and applications that require the customer to change their usage patterns for instance by giving a specific incentive, such as remote shutdown & connect and remote management. Because the latter type of applications fundamentally changes the relation between the supplier and the customer, social resistance is expected with respect to a large scale, top down introduction of such programs.

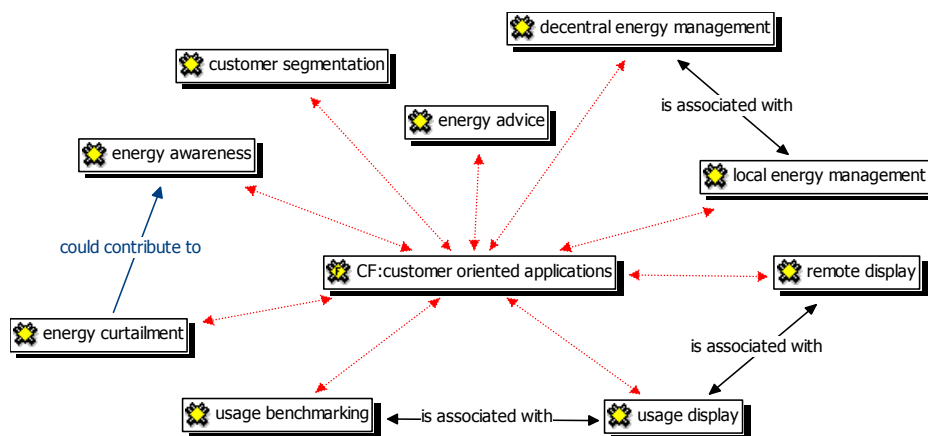


Figure 27 Customer oriented applications

The applications shown in Figure 27 give an overview of how the utility representatives expect that the smart meter will be used with respect to delivering of VAS to the customer. The remote display plays a crucial role in the delivery of specific services. Furthermore, a new category of services can be distinguished, absent in the overview of appendix 5, namely applications associated with local or distributed energy management. Furthermore, an overlap with internally oriented applications can be seen, such as energy curtailment applications, because these types of applications can be advantageous for both consumer and supplier of the service. Below, an overview is given of the possibilities associated with service bundling, since the interviewees expect that this is one of the greatest threats for their commercial position.

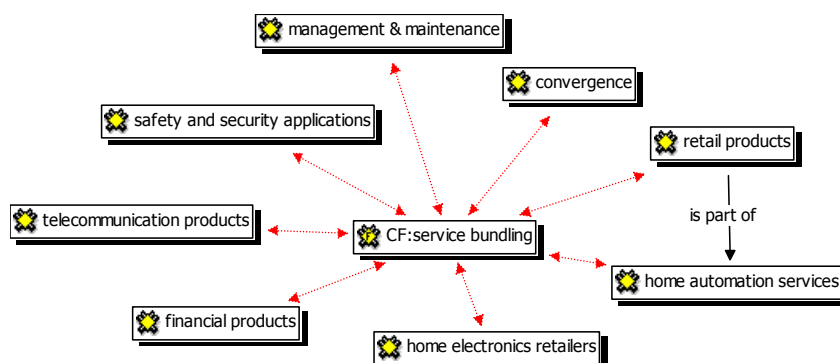


Figure 28 Service bundling applications

In Figure 28 an overview is given of the service bundling possibilities the various parties identified. To a large extent, these services are in agreement with the smart meter key attention area's discussed in appendix 5. However, the involved parties expect that primarily parties with an existing and intensive customer relation, e.g. telecommunication providers and financial service providers will leverage the service bundling possibilities. Furthermore, a service that wasn't identified previously is the fact that retailer have the opportunity to provide customer specific promotions based on their usage pattern or customer segment, e.g. by means of the internet of the remote display.

3.4.4 Step 4

The starting point for step 4 was the analysis of customer objectives performed in section 2.2. The two identified variables that influenced the adoption of the VAS delivered to the customer were quality and cost of supply. During the interviews these variables were distinguished based on their focus area, i.e. financial and non-financial. In Figure 29 an overview has been given of the variables related of contributing to quality of supply. These relations are relatively straightforward and hence in agreement with conceptual model.

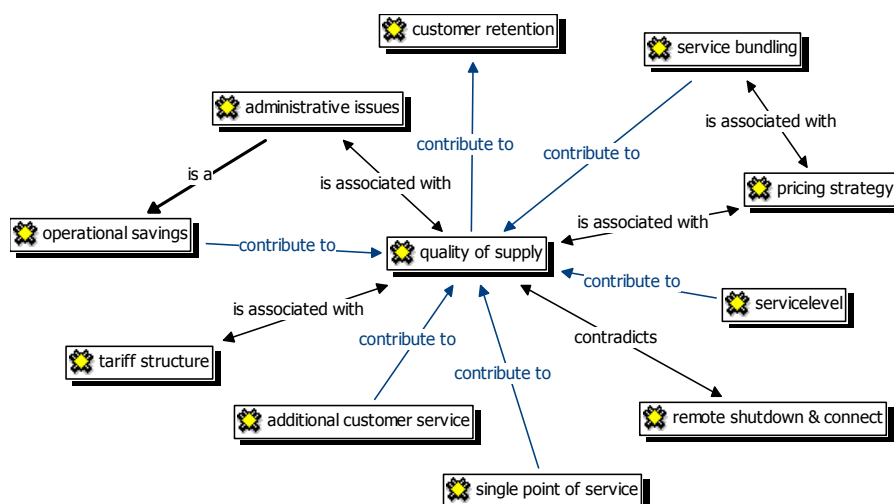


Figure 29 Quality of supply

The financial characteristics based on which suppliers expect customers to evaluate the product or service, can be divided in factors influencing the change in price, dynamic, i.e. TOU pricing, monetary savings associated with a decreased energy usage and a different pricing, e.g. billing strategy. The advantages perceived by service bundling, such as a single point of service directly determine the quality of supply. This is in agreement with the original relations in the conceptual model, however, the conceptual model lacks a variable that shows the influence of the strategy of the service provider, with respect to what type of services to deliver, e.g. pricing strategy, price levels etc. Although the service provider strategy is limited by the technical and regulatory boundary conditions as discussed above, the service provider has sufficient degrees of freedom in developing and delivering customer oriented and internally oriented applications. This holds for both electricity suppliers and TSP.

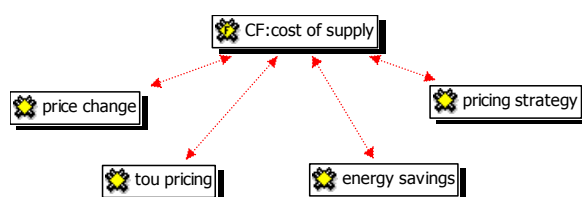


Figure 30 Cost of supply

3.4.5 Step 5

During step 5, the environmental factors were added to the conceptual model, namely competition, environmental awareness and image. Below in Figure 31 these factors have been related to other first order variables, such as customer retention. Although image contributes to a competitive position, the variable customer retention is absent in the first version of the conceptual model but will be added in the revised version. Furthermore, the relation between image and competitive position will be added.

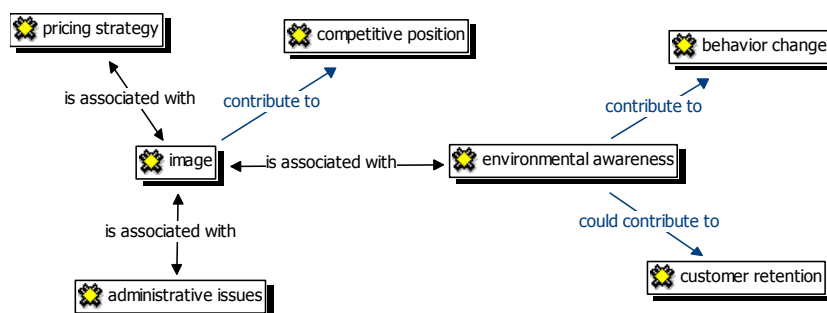


Figure 31 Environmental factors

3.4.6 Validation

Above the relations of the first conceptual model have been tested with respect to their empirical validity. Furthermore, the specification relations have been elaborated upon in more detail in Figure 26, 27 and 28. However, although the stated relations are verified, we should also check the completeness of the model with respect to the problem domain, problem delineation and the chosen level of aggregation. The procedure for checking for completeness will be as follows. First, we will determine what variables have appeared most often during the analysis of the interviews and what variables have the highest number of relations with other variables, i.e. the highest degree. In case of completeness, the variables should already be apparent in the

conceptual model. If this is not the case, the variable will be analyzed and if necessary translated to the correct level of aggregation.

When looking at the most appearing variables, the top 5 is as follows:

- Service bundling [13]
- Additional customer service [13]
- Operational savings [10]
- Behaviour change [10]
- Quality of supply [10]

The top 5 variables based on the number of relations are:

- Behaviour change [19]
- Additional customer service [16]
- Quality of supply [15]
- Usage display [14]
- Price change [12]

Based on these frequently occurring variables, we can conclude that the initial model does not sufficiently take into account customer behaviour in terms of *behaviour change* and the explicit strategy of a supplier, i.e. service provider. Price change is an example of such a strategy. We will look further into these variables and the variable *usage display* in order to determine how these variables can be added to the conceptual model.

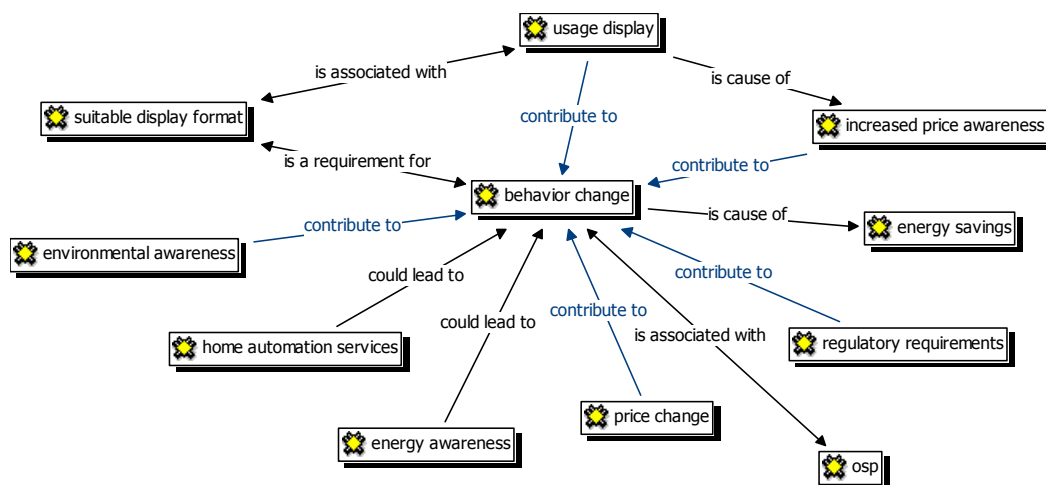


Figure 32 Behavior change

Behavior change is regarded as a result of a specific action or incentive. The services shown in Figure 32 can be categorized primarily as *customer oriented applications*. Furthermore, behavior change and customer behavior in general is determined by the customer objectives, discussed in section 2.2. Therefore behavior change is determined by both quality and cost of supply. Hence, customer behavior should be incorporated in the conceptual model.

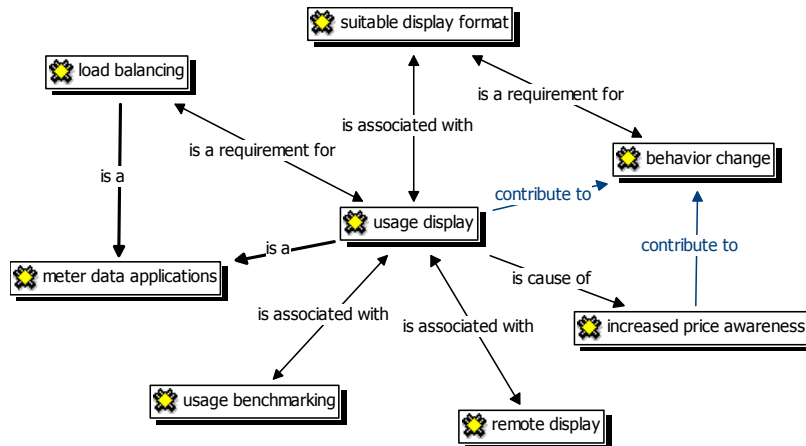


Figure 33 Usage display

Although usage display can be categorized under the variable *customer oriented applications*, its significance in terms of relations justifies a closer look and further validation. As shown in Figure 33 usage display is both a requirement and enabler for more intelligent VAS.

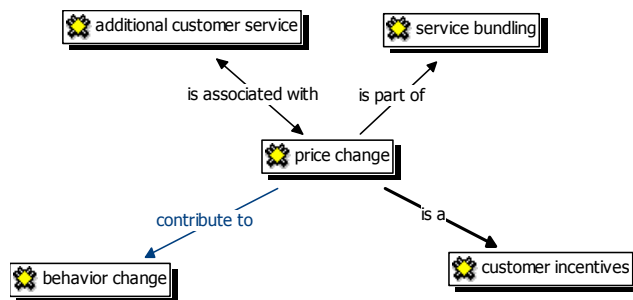


Figure 34 Price change

Price change is mentioned often in relation to the four variables shown in Figure 34. One important conclusion from the interviews is that price will be the main incentive for the customer for changing their usage behaviour. As a result, additional customer services should focus primarily on price and emphasize the monetary advantages of such services. In the next section, we will translate our findings to an updated version of the conceptual model, which will consequently be used to identify service requirements for smart meter VAS.

3.5 Key variables, relations & applications

The empirical validation of the first conceptual model has led to the conclusions that some variables and relations were absent. These variables include: *technical and regulatory boundary conditions*, *supplier strategy*, *customer behavior*, *competitive position* and *customer retention*. On the other hand, *environmental awareness* has been excluded, because it is a property of *quality of supply* (for the customer) or *image* (for the supplier). The added relations focus on these variables. The final conceptual model is shown in Figure 35.

Smarter Metering

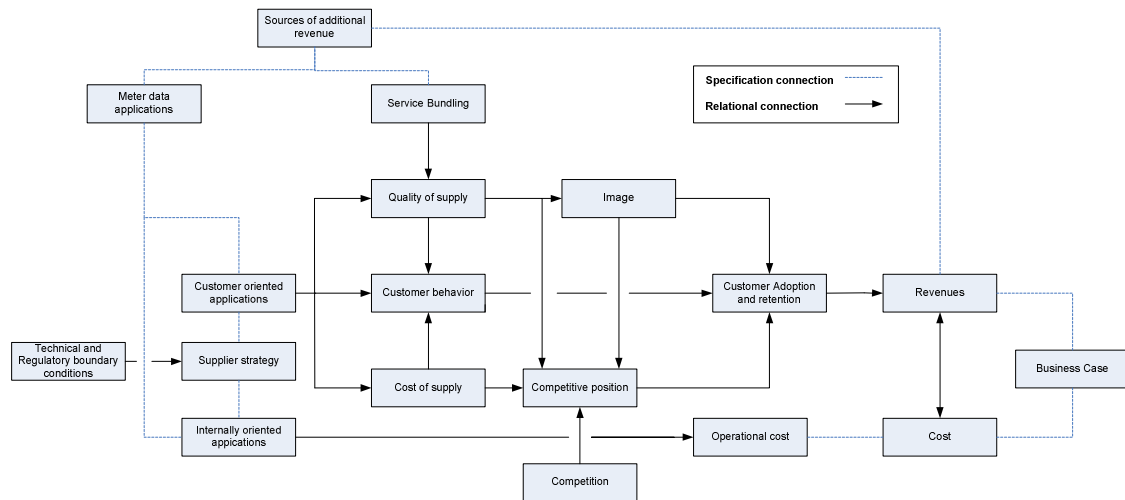


Figure 35 Final conceptual model

The final conceptual model shown in Figure 35 is to a large extent in agreement with the preliminary conceptual model derived from literature, case studies and internal interviews. However, the added value of the final model lies in its empirical validation and the variables and relations that have been emphasized or added. This is in line with the explorative nature of this research and hence these variables and relations are most interesting when determining service requirements. Before translating these notions to service requirements in order to provide an answer to research sub-question 2, we will discuss the insights attained through the external interviews with respect to the final conceptual model shown above. The importance of the following variables was emphasized:

Boundary conditions and supplier strategy

Due to the large range of possible appliances of meter data, the supplier of such services has different strategies available to leverage these possibilities and create added value for their customers. Nevertheless, the interviewees have recognized several boundary conditions for instance with respect to fraud reduction, access to meter data, the required physical infrastructure and image of the sector.

An important conclusion was that the current market model does not optimally use the existing infrastructure and investments, as the RGO does not have a commercial incentive to use this infrastructure for delivering or enabling additional VAS. Furthermore, specific applications, such as fraud management and increasing administrative processes require a full smart meter roll out whereas a full smart meter roll out is unattractive from a cost perspective, since suppliers prefer delivering VAS to specific target groups. However, since a full roll out is mandated by the government, this is a given boundary condition which both suppliers and RGO need to take into account. As these variables discuss both the degrees of freedom and the available courses of action for a supplier, they should be added to the conceptual model.

Customer behaviour

To what extent meter applications have their desired effect, e.g. enabling operational savings, or increasing customer adoption and thereby the competitive advantage of the supplier depends in the end on if customer buys or uses the services delivered to them. Central is this assumption is that customers need appropriate incentives to change their usage behaviour in favour of the

operational functions of the utility or to reduce their own energy bill. What incentive will be most effective; will depend on the type of user or user group and the way it is presented.

However, utility representatives agree that the most important incentive will be of monetary nature. As detailed insight into individual usage patterns enables detailed customer segmentation programs, smart meters can be leveraged to provide specific incentives for individual users, tailored to their needs. A conclusion that is supported by each interviewee is that customer adoption of VAS and behaviour change will be determined by the way the service and information is presented, e.g. by a remote display device, the internet etc. Because the success of a VAS will depend on customer behaviour not only with respect to adoption of a specific VAS, but also with respect to switching etc, this variable should be incorporated in the model.

Competitive position

In the first version of the conceptual model, *customer adoption* was directly related with *competition* and *cost* and *quality of supply*. However, what we primarily want to measure is switching from supplier or adoption of new services of potential customers. When we look at an individual customer, the determinants for choosing for a specific supplier will initially be based on the objectives of the customer. Second, when the customer is already buying the services, past experiences play a large role in how they evaluate the cost and quality of supply. At the same time, they will evaluate this against competing offers from other suppliers. The results of these evaluations will be fed with objectives, previous experiences, image etc. and thereby determines the competitive position of one supplier compared with the other. Hence, the influence of competition on customer adoption and retention is of indirect nature and the variable *competitive position* should be added to the model.

Customer adoption and retention

Customer adoption of VAS was already included in the first version, however, the amount of additional revenues is determined by total number of customers and hence, not only customer adoption, but also customer retention (or switching) has to be taken into account. There are three factors that determine customer adoption and retention, namely *image*, *competitive position* and *customer behaviour*. Furthermore, the total customer base can be divided into existing customers and potential customers. Existing customers will evaluate the current cost and quality of supply compared to offerings from competitors. On the other hand do negative experiences and the image of the sector influence their switching behaviour. For potential customers the latter is also true, however they are more likely to evaluate the cost of supply than the quality of supply, because the latter is more difficult to compare and customers are generally more price oriented. Hence, *customer adoption* should be extended to include also *customer retention*.

Sources of additional revenue

In Appendix 5 a preliminary overview has been given of meter data applications and opportunities. From literature, the following meter data key attention areas have been defined: *customer oriented applications*, *internally oriented applications* and *service bundling*. During the interviews many of these applications were acknowledged, however applications based on automated functions, such as home control, energy management and other types of home automation services are not expected in the upcoming years, due to the lack of a technical and standardization platform. With respect to service bundling, the bundling component does not lie primarily in the combination of existing products, such as security, heating etc, but primary in the functional bundling, i.e. bundling of billing functions, communications functions, front office functions and administrative functions. On the other hand, a combination of customer oriented services and service bundling can be enabled by an increase in distributed generation facilities, where TSP can manage energy streams on a local or regional scale.

Meter data applications

The following meter data applications we often mentioned during the interviews:

Usage information services

- Online presentation of usage data
- Online benchmarking of usage data
- Online energy advice aimed at reducing energy usage

Financial incentive services

- Dynamic TOU pricing schemes
- Alternative payment and settlement programs
- Energy advice via a remote display driven by different tariff blocks
- Energy curtailment programs

Cross-sector and automation services

- Display of third party promotions or sales packages via a remote display
- Energy delivery by TSPs with a existing customer relation
- Local energy management programs enabled by DG and micro-CHP
- Regional energy management initiatives enabled by an aggregation of enabled by DG and micro-CHP
- Home automation products in newly build houses
- A home gateway for security and care applications, e.g. external monitoring

Internal applications

- Fraud detection and prevention
- Increasing forecasting accuracy
- Automation of administrative process
- Customer incentive programs for supplier and network load management
- Change in profiling system

The added variables and meter data applications together with conclusions previously drawn when designing the first version of the conceptual model lead to a number of service requirements for optimally using meter data and delivering VAS to the customers. These requirements hold for meter data value added service in general, and are hence not bound to the role of electricity supplier or TSP.

3.6 Service requirements

In this section, the insights acquired during the process of designing and validating the conceptual model will be combined to determine the service requirements for VAS en meter data applications. The use of a conceptual model proved a valuable tool for determining the strength of relations between variables leading to a viable business model and on the other hand for acquiring an overview of the current bottlenecks with respect to commercial service delivery.

The service requirements can be divided in functional requirements and boundary conditions for service delivery. The functional requirements discuss the characteristics of the service that will contribute to the customers buying the service and thereby enabling value delivery or operational excellence as a result of a change in customer behavior.

Boundary conditions are determined by the current technical and institutional arrangements in the sector. We will discuss both types below.

In previous sections the main objectives of customer services have been elaborated, namely changing customer behavior in terms of energy usage in order to increase the value delivered to the customer or to enable operational savings for the utility. Furthermore, we discussed service bundling as a possibility for increasing customer value. The functional requirements primarily focus on the primer aspect, as bundling of services does not require a change in customer behavior.

The following customer requirements with respect to customer service delivery have been identified; *effective usage feedback*, *suitable customer incentives* and *a suitable display device*.

- **Effective usage feedback**
In order to create customer awareness with respect to their energy use independent of the type of objective, e.g. load balancing or monetary savings, the customer should be confronted with his behavior in an appropriate way. An interview and literature analysis showed two requirements with respect to types of customer feedback can be distinguished: near real-time feedback with respect to the time period and feedback specified to the equipment. Furthermore, a higher level of awareness should be assigned to this data, in a way that the data is transformed to meaningful information, e.g. different levels of aggregation, energy advice or usage benchmarking.
- **Suitable customer incentives**
Although customer awareness is a requirement for changing customer behavior, to really facilitate a behavior change a suitable incentive is required. Although customer are increasingly becoming environmental aware, the growth in number of users of green electricity decreases. On the other hand, the price elasticity of the consumer with respect to their switching behavior is highly dependent on the user group. Therefore a small financial incentive for one group, would not suffice in for double income couples, which may be more motivated by environmental friendly products. As a result, detailed customer segmentation is required to provide a suitable and effective incentive for each target group.
- **A suitable display device**
Besides what information is presented and how information is presented, the means with which this information is presented will determine the amount of change in customer behavior. In order to let customers make founded choices with respect to at which time they want to switch on energy intensive applications, the incentive should be easily visible and interpretable for the customer, hence a remote display would be suggested. On the other hand, to increase energy awareness afterwards, aggregated user and peer group information or energy advice should be presented via the internet, to create sufficient understanding.

During the interviews with external utility representatives, several boundaries or preconditions for service delivery were emphasized. These preconditions could consequently be categorized in technical and non-technical. The non-technical requirements mentioned often were related to the expected future role of the customer in energy generation and the current image of the sector. These non-technical requirements are *compliance with distributed generation*, *a healthy customer relationship*, and *a suitable penetration rate*.

- **Compliance with distributed generation**
One type of services that are expected in the near future is services focused on distributed generation of energy. Although these products are complicated from a customer perspective, the challenge for service providers lies in marketing, for instance a micro-CHP as an alternative for the current CH equipment. Local energy management is just a first step towards distributed generation services. Initiatives with respect to regional energy management, consisting of multiple micro-CHP, solar power cells etc., in a neighborhood are expected. Especially for these type of services holds that the customer should have explicit, financial advantages without being confronted with the burdensome process of installment, maintenance of operating the equipment. Although it is a strong trend in the sector, discussing these issues falls outside the scope of this research.
- **Healthy customer relationship**
Where the previous service requirement with respect to smart meter applications focuses mainly on one type of application, a prerequisite for all meter data applications or service bundling initiatives will be a good image towards the (potential) customer. Especially since many interviewees indicated that the current image of the sector limits the number of customer that switch from supplier, because of a lack of confidence in the administrative settlement. The same may hold for delivering additional VAS or service bundles to the customer. However, this requirement is more of an image requirement, then a service requirement.
- **Suitable penetration rate**
A tension exists between certain meter data applications in terms of the required penetration rate, effectiveness of the service and the cost associated with the roll out. For certain applications, such as fraud detection, benchmarking and regional energy management a large scale roll out is required in order to pinpoint the exact location of the fraud, give a representative overview of the peer group or have sufficient flexibility in allocating energy sources. Such a large scale implementation however, requires a significant investments and time-span before it's complete. With respect to commercial VAS, suppliers only want to focus on a specific user group, namely where operational savings go hand in hand with additional value delivery to the user. Such an investment will be much smaller and easier to accomplish. Because such a design has direct effect, a viable business case may become reality. Hence, depending on the type of VAS, a certain penetration rate is required, yet this is in contradiction with the governmental mandate.

The technical preconditions primarily discussed the prerequisites for delivering meter data services, namely meter data itself. We distinguish three types of technical boundary conditions, i.e. *meter functionality*, *physical meter access* and *meter data management*.

- **Meter functionality**
In the NTA8130 the service requirements of the meter have been discussed in terms of physical interfaces, protocols and information objects. Although this code provides what basic data at what interval should be made available through each port, this basic data is often insufficient for TSPs, which may require historical data, 15 minute data or sample data. For billing purposes, the supplier for instance, requires validated data from P4. A service requirement for the meter will thus be that at both ports, i.e. P1 and P3 the same types of data can be requested. Furthermore, a supplier may require a bidirectional connection with the customer, both in terms of information and electricity in case of distributed generation.

- Physical meter access

According to the new market model different types of meter data should be available by means of the P1 port of the meter or via the CAS (P4) operated by the RGO. However, although the P4 port enables the MDC, suppliers and TSP access to meter data, the latest NTA doesn't specify what detailed claims can be made upon these data. Through the P1 port, only unidirectional communication is possible. Thus for bidirectional communication an additional communication infrastructure is needed. Nevertheless, for delivering additional services, the TSP may require correct, detailed and timely meter data of all connected customers. Currently, this institutional service requirement is not yet sufficiently safeguarded. To enable advanced service delivery, also suppliers and TSP require bidirectional access to the meter, preferably independent of the RGO.

- Meter data management

One of the main arguments for the smart meter implementation is to enable innovation in the sector, by means of innovative meter data applications. Therefore, meter data should not only be available for third-parties, besides, the format of the information should also suit the needs of these parties. To enable the online customer oriented applications, such as benchmarking, a service provider should be allowed and able to aggregate information from peer group members, with respect to both actual and historical data. Therefore different report categories are required to manage these types of information. Because in the current situation many parties, i.e. the RGOs are responsible for acquiring information manually, such a distributed approach makes administration and aggregation of data significantly more difficult. Therefore for meter data applications that focus on increasing the efficiency of internal processes, a central database with aggregated information is required.

The conceptual model with respect to key variables and relations has been the focus of both chapter 2 and chapter 3. In chapter 2 we designed the first conceptual model based on desk research, secondary analysis of cases and internal interviews with Capgemini professionals. Consequently, this model has been verified using a design approach consisting of qualitative data analysis applied to interviews with utility representatives from Eneco, Essent, E-on and Oxxio. This has lead to a review of the stated variables and relations and an inventory of expected meter data applications brought up by the interviewees. Consequently, the conceptual model and these applications served as input for the construction of several service requirements which should be satisfied in order to enable VAS delivery by means of the smart meter architecture.

The service requirements could be divided into functional requirements and preconditions for successful service delivery. The functional requirements aimed at the customer applications, while the preconditions or boundary conditions were primary of technical nature.

In order to elaborate more extensively on these service requirements, in the next section we will look more closely at the technical aspects for service delivery in order to identify the technical design issues with respect to satisfying these requirements.

Smarter Metering

4 Technical design analysis

4.1 Introduction

In the previous chapter, the conceptual model has been empirically verified of which the foundation was laid in chapter 2, where we discussed key variables for value added service delivery using smart meters. The service requirements should be satisfied by future smart meter products and services. In this chapter we will try to answer research sub-question 3: “What are the technical design issues with respect to service delivery?” The approach will be as follows:

First, in section 4.2, we will discuss the technical framework, which we will use to elaborate on the different technological aspects of meter data service delivery. Although the translation from service to technical, and later to organizational requirements, seems straightforward, the interdependency of these designs requires coherency and alignment between both critical technological aspects and critical institutions aspects (Finger & Künneke, 2006; Künneke, 2006).

In section 4.2.1 we will discuss this need for coherency and how it influences the way technology should be approached. Next in section 4.2.2 we will discuss the Integrated Architecture Framework (IAF) (Mulholland & Macaulay, 2005), which will be used to discuss the relevant technical aspects and tensions that exist for satisfying the stated service requirements.

In section 4.3 we will elaborate on the technical design issues and design choices. Depending on the type of functionality, different technical requirements in terms of information, information systems and technical infrastructure are expected to be of more or less importance. We will summarize these issues in terms of technical design choices, before we analyze these design choices from an institutional perspective in chapter 5.

4.2 Theoretical framework

4.2.1 Positioning of technological and organizational perspectives

It is argued by different writers (Finger & Künneke, 2006; Künneke, 2006) that a sustainable sectorial organization depends on the alignment between technical functions and institutional arrangements. In light of the ongoing liberalization process, the question arises how the new market design, characterised by unbundling and the new market model fits the existing technical functions, because certain technical functions need to be supported by the institutional arrangements in order to safeguard a satisfactory functioning of the energy infrastructure. For a further analysis of the coherence and alignment between technical and institutional functions we refer to Finger and Künneke (2006) and Künneke (2006).

However, what we do want to discuss is how to manage these coherence requirements when designing a technical system suitable for delivering smart meter products and services. Two high level approaches can be distinguished, namely a bottom-up technology approach, where the technology is the starting point for designing a system, and an institutional approach, where the market structure is designed top-down. However, missing aspect in both approaches is the fact that it is the customer that experiences the final outcome in terms of products, services, price levels, transparency, vendor choice etc, not technology nor the institutions. Hence, several studies emphasize the central role of the customer during the design process. Therefore, the customer

should not be the point of attention in discussing the service requirements, but also in designing technology and organizational requirements.

Consequently, the customer requirements should be translated to the data model, processes, architecture and the organizational structure. This approach does not only ensures that the institutional functions are aligned with the technical, i.e. data model, process and architecture functions, but also that both are coherent with customer demand.

Reflecting on the approach taken so far, the conceptual model of chapter 3 describes the service requirements of the customer in general according to the utility. In the next section the technical aspects that can be derived from the service requirements will be discussed using the Integrated Architecture Framework (IAF).

4.2.2 Integrated Architecture Framework (IAF)

An architecture is commonly used to align a organizations strategy with the current or future structure and behaviour of the organizations processes, information systems, information types, technology infrastructure etc. This high level architecture approach is called enterprise architecture and is often associated with an architecture methodology to translate the current situation “as-is” to the desired future “to-be” situation. Formally the ANSI/IEEE Std 1471-2000 defines architecture as “the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution.”

For describing the various components of the architecture an architecture framework can be used to visualize the relations between these components and to specify them in further detail. These frameworks structure all relevant aspects within the organization including business, applications, technology and data. Such a framework provides a rigorous taxonomy and ontology that clearly identifies what processes a business performs and detailed information about how those processes are executed. The end product is a set of artifacts that describe in varying degrees of detail exactly what and how a business operates and what resources are required. Consequently, decision makers can use these descriptions to physically change the relevant components in a way they are aligned with overall company strategy.

A widely used example of an enterprise architecture framework is The Open Group Architecture Framework (TOGAF). TOGAF provides a comprehensive approach to the design, planning, implementation, and governance of enterprise information architecture. The architecture is typically modeled at four domains; Business, Application, Data and Technology. These domains are in harmony with the four aspect areas of the Integrated Architecture Framework show in Figure 36 (Mulholland & Macaulay, 2005). The IAF furthermore providers four levels of abstraction in order to allow a consistent level of definition and understanding of the specific area under study:

- The contextual level, which describes both the environmental drivers and developments that influence the organization, and the strategy of the organization itself. Furthermore, it specifies the solutions and design space. Hence, it answers the question why the “as-is” structure should be changed and what the “to-be” situation should look like.
- The conceptual level, decomposes the organizational goals into service requirements in terms of the four aspect areas; business, information, information systems and technology infrastructure

- The logical level, describes how the service requirements can be translated to respective process, information, information system and technology infrastructure requirements in an implementation independent manner. It discusses the structure of these aspects and the role of the various parties in relation to these aspects is.
- The physical level is concerned with translating the logical level requirements to an implementation specific level in terms of hardware, software, standards, modules, packages etc.

Besides the four aspect areas discussed above that cover the core aspects of an overall architecture, the IAF also recognizes the disciplines of security and governance. Although these aspects are not less important, they fall outside the scope of this research.

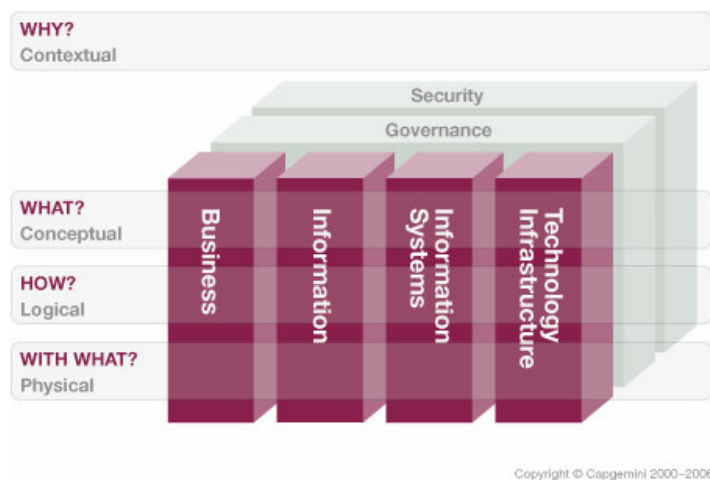


Figure 36 the Integrated Architecture framework

Reflecting on the research goal of this thesis the deliverables reside in the contextual, conceptual and logical levels of the IAF. In chapter 1 and 2 the solution and design space have been elaborated and the rationale for the introduction of smart meters and this research have been discussed. Hence, the contextual layer is sufficiently elaborated upon. The conceptual level on the other hand is explicitly delineated to meter data applications. The service requirements have been analyzed and verified using the conceptual model of chapter 3. However, without taking in mind four aspect areas due to the explorative nature of the various interviews. The translation between functional and technical requirements will nevertheless explicitly use this classification to discuss the relevant technical design issues in section 4.3 to enable the required smart meter functionality.

4.3 Technical design issues

Below we will discuss the technical design issues of a meter data services in terms of business, information, information systems and technology infrastructure design issues.

4.3.1 Business

The business domain focuses on the conceptual layer mainly on the processes required to deliver specific smart meter products and services to the customer. On the logical layer, the orchestration

between the processes and the relation with the different actors is discussed. Hence, it discusses the requirements with respect to the relations between both actors and processes. The services discussed in this research however, are not physical products or services (such as energy delivery) but merely information and automation services. As a result, the input and output of the processes are both information based on which further action can be executed. Therefore the conclusions with respect to the business layer of technology discuss mainly the interaction between information, actors and required resources. These interactions have been discussed extensively in section 2.2, Figure 3, 4 and 5 hence will not be further elaborated upon here.

4.3.2 Information

Where the business layer focuses on the processes relevant for delivering smart meter products and services, the information layer discusses the information required to enable those processes. Depending on the type of services, information requirements differ. The requirements that have been identified in the previous sections are:

- **Timeliness of information**
Depending on the type of service, (near) real-time information is required to enable a change in customer behaviour. For instance, usage display has the greatest effect if the presentation of energy usage is directly linked with customer behaviour. On the other hand, home control such as security can only be valuable if the customer directly receives a notification of some system state changes. However, for other purposes, such as usage benchmarking and monitoring of equipment a time delay of e.g. 15 minutes is acceptable.
- **Information history**
Depending on the meter data application information is required about the present usage or about historic usage, possibly combined with historic usage of equal households for benchmarking. Although third parties have access to delayed meter data, it is currently unclear how this information portal is being constructed. If the RGO only provides access to delayed meter data, third parties should themselves keep a database with historical data. On the other hand, if the RGO provides a database with historic data, only access to this database suffices to create or compare historic overviews.
- **Information detail**
Specific meter data applications require different types of information. For current billing for instance, the supplier only required usage data about a certain time period. However, for instance with respect to prepay and TOU pricing, more detailed information is required, for instance with respect to the available credit, the exact time stamp of usage, the tariff agreement with the customer etc. Especially when looking at more advanced services such as home automation, signalling and status information also needs to be available for the supplier of the service.
- **Availability of information**
For specific commercial services, such as benchmarking and network functions, e.g. balancing, fraud reduction and decreasing administrative cost, both commercial parties and the RGO require information from more than one household. However, giving these parties access to information about clients that are served by other parties raises the question if third parties should be allowed to access this information and, consequently, how access to customer sensitive information needs to be governed. To maintain the privacy with respect to customer sensitive data, customer must give their consent before third party may use their data, e.g. for benchmarking purposes.

- **Correctness of information**

Because usage information can be used for specific purposes, varying from low criticality, e.g. savings advice to high criticality, e.g. billing and balancing, the correctness of information, especially for these latter cases needs to be guaranteed.

Furthermore, service providers have two ways of obtaining meter data, namely indirect via the CAS maintained by the RGO and directly via the P1 port of the meter. However, there are significant differences with respect to what data is available via the CAS or the P1 port. Via port P1, the following information is available at a 10 second interval (NEN, 2006): (1) current meter reading with respect to supplied electricity at the normal or high tariff rate, (2) current meter reading with respect to the provided electricity at the normal or high tariff rate, (3), current load, (4) tariff indicator (normal or high), (5) curtailment value and (6) Switch indicator electricity (on or off). Furthermore, the following information can be provided via P1; (a) an announcement with respect to a depletion of prepaid credit, (b) reason for switch off and (c) an arbitrary message of 1024 characters.

The difference in data read from the CAS compared to the data read from P1 lies in the fact that basic data is send automatically every 24 hours to the CAS (1,2,3,4) and that additional information can be requested making use of the P3 port. Besides the information shown above, this includes: day readings (for 1-4), interval electricity readings, current switch time, logging data with respect to switching (on or off) and monitoring data. Another difference between the P1 and CAS is that P1 is unidirectional and the CTS (via P3) is bidirectional. The CAS can hence be used to send information to the meter in order to set the curtailment value, switch time, prepaid announcements (a), reason to switch off (b) and other arbitrary messages (c).

4.3.3 Information Systems

Regardless of the choice for one specific communication medium is the fact that an architecture is required to enable the various technical components to communicate with each other and to send data from point A to point B. However, the choice for a communication medium will determine to some extent what the technology infrastructure architecture will look like.

A GPRS connection for instances supports a 1-tier architecture, because it can bridge the distance between consumer and distributor by means of one wireless medium. PLC on the other hand is only available in the low voltage grid, and hence required a 2-tier architecture at minimum. In a 2-tier architecture, data is gathered at a concentrator and then transferred by means of another medium, wired or wireless, to the distributor. In a 3-tier architecture, data is consequently gathered in a centralized database, which the distributors have access to.

In the latter option, some sort of middleware is required to enable communication between the various distributors and the centralized database. Especially when they use different hardware, software and data models, this requirement is a prerequisite for centralized information management. Because many distributors, suppliers, hardware vendors, services leverage different legacy systems, a Service Oriented Architecture (SOA) is a logical choice. Because a SOA enables a layered structure, the risks associated with vendor and technology lock-in and complexity are reduced and central management of the entire infrastructure becomes possible. Another requirement for a middleware solution is the use of open standards, such as industry-standard interfaces, e.g. web services or ebXML. This way, new metering technologies and services are easy to implement and a steadily transition towards a more intelligent grid and value added services becomes possible.

4.3.4 Technology Infrastructure

The technology infrastructure should at least enable the different parties to communicate with each other using their own information systems, hardware, software etc. In order to identify what requirements those relations have, we will use a simplified version of the proposed market model to illustrate the different types of infrastructure and what parties make use of that infrastructure.

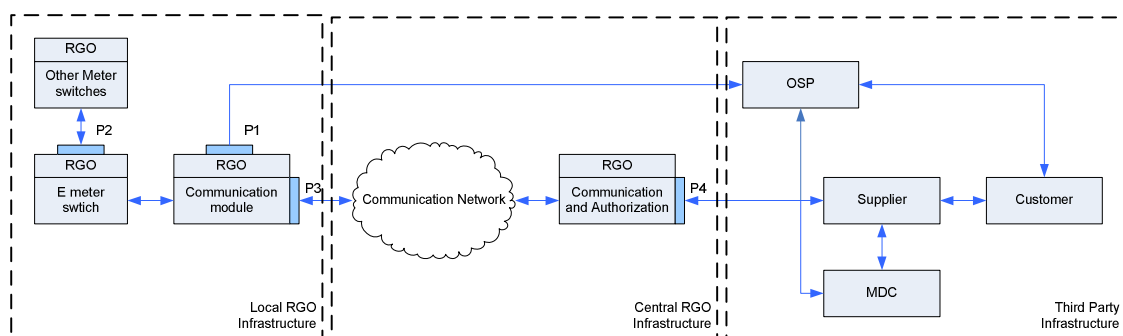


Figure 37 Overview of technology infrastructures

In Figure 37 three types of technology infrastructure can be distinguished, namely: the local meter infrastructure owned and operated by the RGO, the central communications infrastructure also owned and operated by the RGO and the third party infrastructures to communicate with the RGO (B'con, 2007; Stratix Consulting, 2007). Below we will discuss the technical requirements and possible alternatives for each one in more detail.

Local RGO infrastructure

The local RGO infrastructure is in fact the entire metering equipment asset situated at the customer site. Because here the focus lies on the electricity meter (E meter), the purpose of current standardization efforts is to design the meter in such a way that it can also handle switching, data reading and management and multiple sources of energy. However, to enable for instance gas and thermo meters to be coupled with the E meter, port P2 should be able to communicate with these modules in a standardized way.

With respect to the communication module of the meter, it is recommended in a review of the current standardization efforts, that there should exist a clear, physical separation between the metering and communication equipment (Stratix Consulting, 2007). As the technical lifespan of meter equipment is about three to four times as large as the lifespan of communication equipment, a tightly integrated meter would lead to an unnecessarily replacement of metering equipment.

Technically speaking, this requires another port to be defined which enables communication between the E meter switch and the communications module which controls and operates port P1 and P3. This line of argument has been visualized and shown in Figure 38. In this layout a clear separation of concerns becomes possible, because the communication module takes care of both internal communications and external communications in a transparent and operator independent way. The functional and technical requirements of a smart meter should hence solely focus on the interfaces with: (1) the metering equipment by means of P2', (2) consumer displays or equipment by means of P1 and (3) the RGO or other third parties via P3.

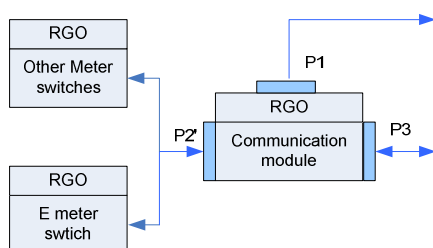


Figure 38 modular meter architecture

Besides independency of metering and communication equipment this topology has the following advantages. First, both port P1 and Port P3 are independent of the E meter. Second, it facilitates continuous innovation, because the communication module can be easily replaced as long as it satisfies the minimum port requirements. Because innovations are expected primarily in the telecommunications domain, the proposed topology furthermore makes the design more future proof, because the choice of a particular infrastructure is left to the organizations themselves. However, the P1 and P3 ports should be designed in such a way, that it can be easily adapted for usage in different wired or wireless infrastructures. The responsibility for the communications module should hence lie with a single, independent party which can leave instalment of the metering equipment to the meter manufacturers. Although we are primarily interested in access to the meter, instead of the internal workings of the meter, we will leave these notions for further research.

Central RGO infrastructure

In Figure 37 above, the central RGO infrastructure functions merely as an aggregator of data from the individual meters and portal for accessing this aggregated information per RGO. In the proposed market model, aggregation, authentication and communication of information is located at the RGO, which means each RGO has its own central infrastructure. With respect to the physical infrastructure that connects the utilities back office systems to the smart meter, different choices are available. The choice for a wired or wireless solution depends to a large extent on the demographic layout of the area under study, but other factors, such as availability of equipment, required performance, independency and cost are also important drivers. In the Netherlands, Eneco and Continuum (Nuons distributive activities) have chosen two different approaches for their smart metering platform. Although Eneco's meter has PLC capability, Eneco favoured GPRS because of the following reasons (Bevelander, 2007):

- The fact that GPRS coverage exists in the whole EU provides direct coverage of 100%.
- GPRS supports a scattered roll-out, e.g. for customer segmentation.
- The GSM encryption layer ensures a high level of security
- GPRS can be easily outsourced as the cost for communication and performance measures are well known.

The choice for outsourcing GPRS network management however increases dependence on telecommunication providers. This is one of the reasons that Continuum chose for using PLC instead of GPRS (Campfens, 2007). Other reasons are:

- A PLC implementation costs less than GPRS
- When using GPRS the utility is dependent on a third party telecom operator, and the availability of GPRS licences beyond 2013. When using PLC the distributor can perform

management, control and supervision themselves, because they own the existing physical infrastructure.

- PLC in potential has 100% coverage with respect to the target group, i.e. electricity users, because these users have access to the electricity grid.
- PLC supports a broader functionality with respect to energy management; e.g. grid management, energy curtailment and network analysis.
- PLC doesn't cause additional radiation at the customer site, which is still a point of discussion.
- PLC performance suffices for the desired functionality.

In the current situation, it doesn't matter how the RGO accesses the meter and aggregates the data, as long as it provides access to this data within the agreed time period to third parties, such as the supplier and TSPs. When using PLC there is an explicit reason why the RGO should provide this function since it owns the infrastructure, however, when leveraging a different infrastructure, no such reason exists. Therefore one could question if this function should be placed within the regulated domain or not.

Third party infrastructure

With respect to the third party infrastructure only one aspect is important in the scope of this research. What meter data have parties access to, what is the quality and actuality of this information and how should access to this data be arranged?? Because information is stored at a central point, at least for the individual RGO, third parties can communicate using the internet backbone using secure VPN connections or leased lines.

4.4 Conclusions

In this chapter we have discussed the technical perspective on value added service delivery. An analysis of the service requirements in the previous chapter identified several technical boundary conditions with respect to service delivery.

On the other hand, the integrated architecture framework has provided an overview of the technical design issues with respect to the delivery of smart meter VAS in general. Below, we will present the technical design issues with respect to the technical boundary conditions, i.e. *meter functionality*, *physical meter access* and *meter data management*.

Meter functionality

Although the minimal functional requirements of the meter have been extensively discussed during the preparation of the NEN NTA 8130 standardization document, the functionality that currently applies does not explicitly take into account service delivery.

The design choices made with respect to the different ports and the characteristics of these ports should therefore be reconsidered. Although not directly relevant for service delivery, we agree with the advice to create a modular architecture, decoupling the metering and communications components.

First, the specification of the two external communication ports of the meter, i.e. the P1 and P3 port does already imply a certain functional division of tasks, since the RGO is the only party that may access P3. Although this functional division fits the existing market model, for a level playing field for service delivery this situation is not preferred, due to the fact that the

characteristics of the ports differ and a party may claim the advanced functionality of P1 in terms of high frequency data.

Second, both ports have different characteristics with respect to the possible directions of communication, since port P3 is bidirectional and P1 unidirectional. This implies that for sending steering messages to the meter, a service provider needs to access the CAS via P4. Nevertheless, it is currently unclear what functionality the RGO supports via P4.

Thus we can conclude that the differences in characteristics and functionalities per meter port in combination with the exclusive right of the RGO to control bi-directional, validated data via the CAS is undesirable, as it hinders a level playing field and places a significant amount of power with the RGO.

Physical meter access

Not surprisingly, the physical possibilities for accessing the meter are strongly related with the meter functionality. As described above, the RGO may access the P3 port of the meter directly, using their proprietary infrastructure. How third parties access P1 is left to the parties themselves. Nevertheless, this also implies that to leverage the possibilities of the meter via the CAS, service providers are also dependent on the RGO.

Furthermore, for access to high frequency data via P1, a provider has to roll out their own infrastructure. Nevertheless it also needs access to the P3 port of the meter for delivering applications that require bidirectional communications with the meter.

Service providers and RGOs have different technologies available to communicate with the meter. The communication medium chosen will determine both the functionality and capacity of the network. The choice for which communications infrastructure to use for communicating with the meter is relevant for both the RGO and TSP when accessing the meter via P1. For communicating with the P3 port of the meter, the RGO can use a PLC, Ethernet or wireless connection, such as GSM, GPRS or UMTS. Depending on the frequency of data transmission, one wireless technology is more suited than the other, dependent on the question if a continuous connection is required. Since it is not expected that the RGO will leverage these possibilities for commercial services, it is expected that they will opt for a low-cost solution, namely PLC.

However, from a broader perspective, a GPRS infrastructure would enable a wider range of functionality independent of the RGO. This is why for instance Eneco's smart meter platform is being developed based on GPRS, to provide an overall smart meter solution which can fulfill both low cost objectives of the RGO and commercial objectives of supplier or TSPs. Thus, this solution is independent of both the RGO and the supplier. When looking solely from the perspective of a TSP, it will choose a communication solution that matches best their objectives. Hence it may choose to leverage an existing infrastructure by partnering with telecommunications companies or other internet service providers, or they may install their own wireless solution.

Meshed network technology as implemented by HydroOne (see section 2.5) could be a viable alternative for wired infrastructures in less density areas or where they do not have an existing communications infrastructure. Although we here only discussed point-to-point architecture, a meshed network architecture could significantly decrease the cost associated with the roll out of a proprietary communications network.

Besides, from the perspective of service delivery and complexity of the institutional design a central location where all meter data is stored is to be preferred. Especially for services where a

significant penetration rate, i.e. aggregation of data, is required such as for fraud prevention, forecasting and benchmarking this would have significant advantages.

Meter data management

The starting point for delivering value added services to the customer is the availability of meter data. What types of meter data can be extracted from the meter is primary determined by the metering functionality. Furthermore, how this data may be accessed is determined by the physical meter access infrastructure.

However, how the data is consequently stored and made available to third-parties such as service providers is equally important. Currently, the RGO should collect data via P3 and make this data available via the CAS; hence the sector has chosen for a 3-tier information architecture.

This would prove an efficient solution on a regional scale, with one RGO, because the different suppliers can access the information at a central location. However on a national scale, several RGOs maintain a separate CAS, and an individual supplier or service provider operating in different regional areas should access multiple CASs. Nevertheless, compared with a situation where a TSP has a physical (or wireless) connection with each customer, the number of connections would be as large as the number of customers, instead of as large as the number of RGOs connecting these customers to the distribution grid.

Standardization of these messages is required to enable parties to adopt their architecture in a way that these messages can be handled consistently and without many additional organizational dependent software interfaces. The sector is currently discussing the use of ebXML for this purpose, as it this solution leverages the advantages of an XML message structure and compliancy with web-service technology.

Integration of findings

Here, the relations between the technological and institutional design are clearly visible. Because PLC uses the physical cables owned and operated by the RGO, TSPs have significant disadvantages when this communications infrastructure is chosen for data transport. On the other hand, with a GPRS infrastructure both RGO and TSP are dependent on a third party operating the wireless network. From this perspective, telecommunications providers have low entry barriers for entering the value added services market.

In this chapter we have looked at the boundary conditions for smart meter product and service delivery from a technical perspective in terms of. Thereby we identified several technical design issues and elaborated on how these design issues influence the design choices for delivering VAS to the customer. Thereby we answered research sub-question 3.

In the next chapter, we will take an institutional perspective when we discuss how the institutional arrangements contribute to or hinder service delivery.

5 Institutional design analysis

5.1 Introduction

This chapter takes an organizational perspective on smart meter products and services discussed in previous chapters. The organizational perspective will be discussed based on an institutional framework. We will develop this institutional framework using different economic approaches that discuss the relation between a firm and its environment. Consequently, we will apply this framework on three different institutional designs for service delivery, in order to determine the bottlenecks for service delivery.

How an institution is defined depends on the economic perspective taken (Goodin, 1996). Generally speaking, institutions coordinate transactions between parties. This is done by means of different governance mechanisms and rules of the game defining actor behavior. Transactions can be of various natures, however, in light of the research question we will define a transaction in terms of electricity, monetary and information streams between the actors. Hence, an institutional design discusses the relations between the parties in terms of these flows. Opposed to the theory of Gordijn (2002), these flows do not necessarily imply a direct value exchange between two parties, as monetary flows can also be discounted through the value chain and certain obligations are assigned to party due to regulatory mandates.

In literature, many theories are available to position a firm in its competitive environment and to discuss the effects that available resources and actions of competitors have on the courses of action available to that firm and how this influences the transactions between multiple firms. In general a distinction can be made between theories that focus on the industry and theories that focus on the firm.

The arguments presented in these theories can be positioned in several ways, which often have significant overlap; nevertheless, different paradigms can generate important and different insights. That is, because there is typically no one best way of positioning a theoretical point of view, and what choice is made with respect to positioning necessarily involves emphasizing certain aspects at the expense of others (Barney, 2001). This implies that studying one institutional paradigm for determining the resource and capability requirements with respect to smart meter value added services would be limited by empirical validity and effectiveness.

For this reason, we have combined the notions of various economic theories into one institutional framework, of which we expected to be of most value for determining how the institutional designs for service delivery fit within the current institutional and economical embedment. This institutional framework will be used to determine the fit between the institutional designs for service delivery and the current institutional environment. Hence, the structure of this chapter will be as follows:

In section 5.2 we will introduce the institutional framework that is the core of this chapter. The creation of this framework will be fed by means of two approaches, (1) an overview of competitive strategy theory to position a service provider of smart meter VAS relative to its environment and (2) aspects of institutional economic theory to determine how the relations and dependencies between the service provider and other third parties should be governed. The relation between these paradigms will be discussed in section 5.2.1. The theories themselves are elaborated upon in more detail in Appendix 6 and 7.

In section 5.3 we will analyze the current institutional setting and identify different ways of service delivery within the current embedment. Consequently, these different designs will be analyzed using the institutional framework in section 5.4 in order to identify the main institutional bottlenecks for service delivery. Section 5.5 will present the conclusions of these designs in terms of how the institutional designs fit the current institutional embedment, i.e. the proposed retail market model, and what are the institutional bottlenecks that need to be overcome.

5.2 Theoretical framework

5.2.1 Positioning of economic theories

Many theories are available for explaining why economic activity is organized the way it is (Barney, 1991; Coase, 1937; Porter, 1980; Williamson, 1998). Although each theory has its own starting points and assumptions, they also have one thing in common, namely that they try to explain the concept of coordination inside or between firms under different environmental circumstances. In general, two different views on corporate strategy can be distinguished, namely one that looks at the internal drivers of a firm's success, i.e. the capability-based view of the firm, and another that looks at the external drivers and how a firm behaves on the market (Madhok, 2002).

The latter view is based on popular theories of the firm by e.g. Coase (1937), Williamson (1975; Williamson, 1988) and Porter (1980; Porter, 1985), which generally can be classified as neoclassical economic (NCE) theory where the invisible hand of the market is responsible for the outcomes of a corporate strategy. However, a lack of perfect information and market dynamics leading to non-equilibriums has increased the need for an approach that was able to focus on the arrangements between actors and the cost of these arrangements. Theory on Transaction Cost Economics (TCE) was a response to this need to study why certain arrangements existed (Williamson, 1988, 1998).

Koppenjan and Groenewegen (forthcoming) have positioned both Transaction Cost Economics (TCE) and the theories of the firm in the four layer model of economics of institutions (Figure 39). What's different in this model in comparison with the TCE approach is that the layer of actors and their strategies is added and that the relations between the various layers are explicitly visualized. Although the original TCE model is criticized due to its lack of incorporating dynamics and changes in the layers (Groenewegen, 2005) it gives a clear overview of the relevant aspects. Several other attempts have been undertaken to relate economic theory to theories of the firm (see e.g. Seo and Creed (2002)), however, the model below distinguishes itself by its clarity and instinctive nature. Below the relevance of each layer for determining the relevant aspects of the organizational perspective are discussed and the relation with corporate strategy theory will be elaborated upon.

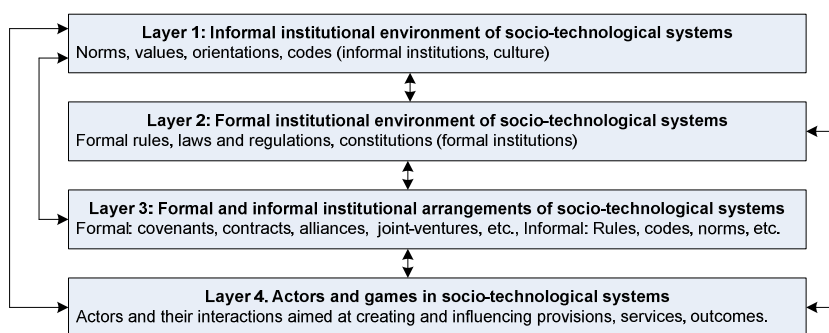


Figure 39 Economics of institutions

Layer 1 is about the culture, values, norms and attitudes that characterize the organization and the organizations environment. Because changes in level 1 take many years to become manifest, the trend analysis of chapter two gives a first indication of what changes in norms and attitudes, e.g. an increased level of environmental awareness, we can expect in the upcoming years.

Layer 2 is about the legal framework in which the organization or organizations reside, such as corporate laws competition and merger and acquisition roles. These influences were also discussed in chapter two as regulatory business model drivers. The proposed market model, the NTA 8130 standardization requirements and the mandate to unbundle the distribution and supply activities are two examples of changes in the formal institutional environment.

Layer 3 is about the formal institutional arrangements, e.g. the means by which the interactions between the parties are coordinated. These institutional arrangements are often called “governance structures” and are designed to coordinate specific transactions among multiple actors with the lowest possible transaction cost. TCE can be used to study what the governance structure is best suited for a specific transaction between two actors. The type of transaction will determine the type of dependence or degree of freedom for the individual party, such as the TSP. Hence, the advantages and disadvantages of the institutional designs can be studied in more detail.

Layer 4 is about the interactions of actors in the context of a complex technological system or setting, such as the energy network. The energy value chain, as discussed in chapter 2, can be seen as such a system where the conduct of individual agents is being determined. The emphasis in this layer lies mainly at the specific characteristics of the organization, i.e. resources, capabilities etc, and how these characteristics influence the output of the organization and the input for other organizations up the chain.

Hence, in this layer the foundation of Neo Classical Economics (NCE) is found where the individual firm, its organization and strategy are the subject of study. Teece, Pisano and Shuen (1997) distinguish three different paradigms with respect to firms striving for competitiveness, namely the competitive forces approach by Porter (1980; 1985), popular in the 1980s, the resource based perspective elaborated upon by Barney’s Resource Based View (1991) and theory on resource dependencies (Pfeffer & Salancik, 1978) and the dynamic capabilities approach. The first two approaches, also known as *strategizing* and *economizing* (Teece, Pisano, & Shuen, 1997) will be discussed.

The arrows in Figure 39 indicate how changes in this layer influence both upper and lower layers. In the next section we will discuss the institutional framework for studying the different institutional designs.

5.2.2 Institutional framework

The theories discussed above each explain the existence and economic behavior of firms and organizations, although each theory has its strengths and weaknesses with respect to certain firm or environmental characteristics. It is therefore useless to classify these approaches based on their practical value, because the strength of these theories lies in combining different insights.

Hence, a truly strategic theory of the firm should address not just the decision with respect to the competence model or governance strategy, but also take into account how a firm's resources and capabilities can best be developed and deployed for striving towards a competitive advantage. Madhuc (2002) calls this concept triangular alignment of firm strategy, which emphasizes the importance of (1) firm strategy, (2) resource particulars and (3) governance structures in determining firm boundaries. Thus, he focuses on layer 3 and layer 4 of the model shown in Figure 39.

We have extended the concept of triangular alignment combining several economic theories. From the perspective of firm strategy, we analyzed Porter's (Porter, 1980, 1985) theory on competitive advantage (see Appendix 6.1). Second, we discussed Barney's Resource Based View (Barney, 1991) and theory on resource dependencies (Pfeffer & Salancik, 1978) to elaborate on the resource particulars of smart meter products and services (see Appendix 6.2 and 6.3). Third, Transaction Cost Economic (TCE) theory has been analyzed to discuss the importance of governance structures (see appendix 7). The important concepts in light of the research questions have been summarized in the institutional framework specified in Figure 40.

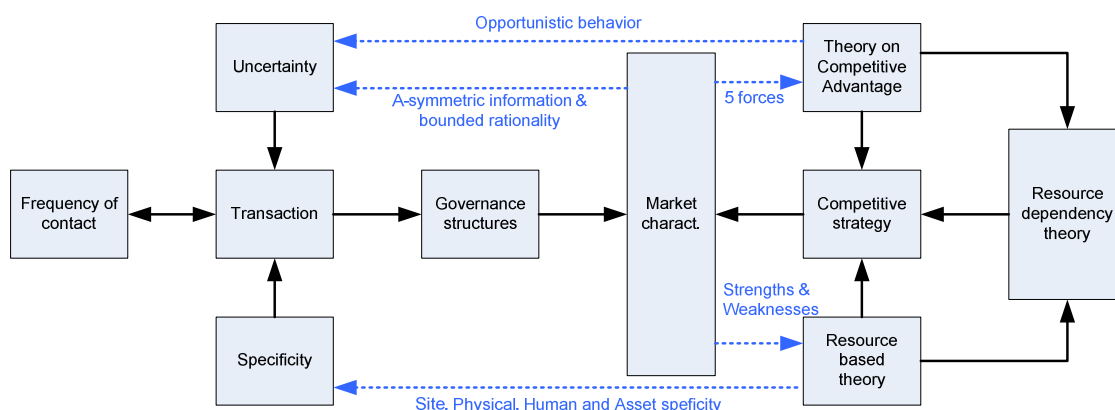


Figure 40 Institutional framework

The institutional framework of Figure 40 shows the institutional delineation for determining the fit between the requirements for service delivery and the current institutional environment. On a high level, level 3 (on the right) and level 4 (on the left) of Williamson's 4 layer model can be distinguished as discussed in section 5.2.1. Both levels are related to the market characteristics, such as legislation (level 2). Furthermore, it positions the economic contributions to the field of strategic management in relation to each other as it emphasizes the fact that the resource dependency framework is based on notions from both theory on competitive advantage and resource based theory.

On the other hand, it relates the core aspects of TCE in determining what type of transactions suits a specific type of uncertainty, specificity and frequency of contact best. The relations between the approaches can be classified in two types, namely (1) consequences of (changed)

market characteristics on the strategies of individual firms and (2) consequences of the changes in market characteristics and firms strategies on the transactions between firms.

As opposed to uncertainty and specificity, frequency of contact is directly related to the type of transaction, because frequency of contact depends primarily on the dynamic of the environment (uncertainty, specificity and market characteristics) and type of product/service. The relation with the preferred type of transaction is bi-directional. The relation between these two high level approaches is drawn by means of the outcomes of both processes, i.e. the market characteristics. These characteristics are constantly influenced in changes in individual strategies and governance structures that are based on the type of transaction.

How changed market characteristics translate to changes in the individual firms' strategy depends on the perspective taken. From the external perspective discussed in appendix 6.1 the effects can be analyzed using the Porter's five forces competitive advantage framework. On the other hand, when the approach discussed in appendix 6.2, the resource based view, is practiced, the environmental model of competitive advantage can be used to determine the influence on the required resources and capabilities in terms of strengths and weaknesses compared to its competitors. The resource dependency framework, however, is fed indirectly by both approaches and thereby does not have a specific value besides the aspects discusses in those theories.

As said, the dynamics and characteristics of the market are the level where the interactions and outcomes of the institutional levels are determined. The aspects by which the scientific theories exert their influence are derived in appendix 7. These characteristics are shown in blue in Figure 40. The key characteristics of a specific transaction are influenced both directly and indirectly by changing market characteristics. The direct influences stem from changes in complexity, because market changes increase dynamics, and from a-symmetric information and bounded rationality of the actors involved. The latter aspects are inherent to most imperfect markets and human behavior.

The indirect relations are based on the assumptions that changes in competitive forces will increase opportunistic behavior as long as information a-symmetries exist. How this is determined by the market characteristics can be analyzed using Porter's five forces theory, as this theory focuses on the role different parties' play in the market and the threats these roles can yield for the service provider. Furthermore, specificity of a transaction is determined by the resources and capabilities a firm possesses and how the firm can leverage these assets. Where Porter discusses the market characteristics in terms of the parties involved, resource based theory elaborates on the market characteristics. These characteristics are discussed in terms of available resources which determine individual parties' strengths and weaknesses in terms of availability and access to tangible, intangible and financial resources. By combining these approaches, both opportunistic behavior and the different types of specificity can be explained.

Figure 40 shows how we have drawn the relations between the different perspectives on corporate strategy and TCE. Although both the scope and specificity of those relations may be arguable, we think this framework provides an overview of the complexity of the institutional design and the scope of our research.

Because we want to assess the institutional barriers with respect to service delivery in the future energy market, until now two external aspects have been central in determining the main bottlenecks for a viable business model. These aspects are described in Figure 40 as *market characteristics* and *uncertainty*. Uncertainty may also be defined as risks associated with service delivery and is determined both by the relations with other parties (as shown in Figure 40) and

with other fundamental questions, such as regulatory developments, market demand and technological developments discussed in chapter 2. These latter questions may furthermore be used to describe the market for value added energy services in terms of a firm's competitive position and their strategy compared to possible competitors.

By discussing both the characteristics of the current market and the uncertainties and risks associated with the future development, we take both the existing and future bottlenecks for service deliver into account.

In the previous sections we have discussed the technical design issues with respect to service delivery. These issues can be translated to design choices a service provider faces when considering service delivery. Two of these design issues will be the starting point for assessing the fit between the institutional and technical aspects, namely access to the customer, and access to the meter data. We will formulate different institutional designs and assess the bottlenecks associated with these designs in terms of the market characteristics and uncertainties.

5.3 Design framework

For providing VAS based on meter data to the customer, several institutional designs are possible. These designs differ with respect to how the information and monetary streams are organized between the actors, i.e. the customer, RGO, supplier and the TSP, providing these services. As a starting point we have taken the proposed market model with the MDC integrated with the supplier as presented in Figure 5 as a starting point. Below we will discuss three institutional designs with differ with respect to:

- The customer sales channel: billing for additional services can broadly be classified in two ways, namely; according to the current supplier model, i.e. by the supplier, or directly by the TSP.
- Physical access to meter data: the TSP can gather data for its services directly using the P1 port at the customer site and indirectly using the CAS via P4.

Both the billing relation and the data gathering relation enable two possible designs, thus in theory four different designs are possible (see Figure 41). However, when the TSP chooses for an explicit presence at the customer site by means of P1 port reading and communication equipment, placing the billing relation with the supplier only increases additional dependency without explicit benefits compared to the other designs. Therefore this design will be discarded. Below, we will discuss the three designs based on their advantages and disadvantages from a business point of view.

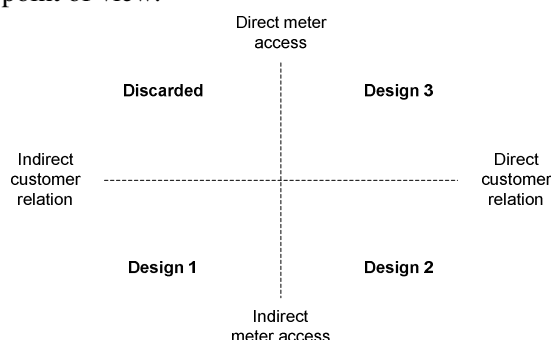


Figure 41 Institutional designs

5.3.1 Design 1

In the first design, the TSP requests usage data from the RGO based on which it delivers specific services to the customer. Because no additional equipment needs to be installed at the customer site, the information flows are transparent from the perspective of the customer and no additional action from the customer is required. To further increase the ease of use of a specific service, the TSP uses the existing billing channel as it exists in the supplier market model, i.e. the service is delivered and billed by the supplier. This had advantages for both the TSP and the supplier as the TSP can leverage the existing customer base of the supplier, and hence can save on marketing and advertisement costs. Furthermore, the cost of operating a back office billing system can be outsourced to the supplier for probably a smaller fee when building and operating such a system themselves.

For the supplier, the advantages lie in the fact that additional services can be delivered to the customer under their own brand name, without exploiting the service themselves. This increases their competitive position, without any significant effort as the additional effort required for billing the additional services will be small. Besides, these costs should be easily compensated by the TSP fee. However, this design also has certain disadvantages for both parties as interdependence is relatively high which requires a vast amount of trust between these parties. A governance mechanism that could manage such a relation is a service level agreement (SLA) between the TPS and the supplier. The RGO, on the other hand, is legally obliged to supply customer data to each authorized party.

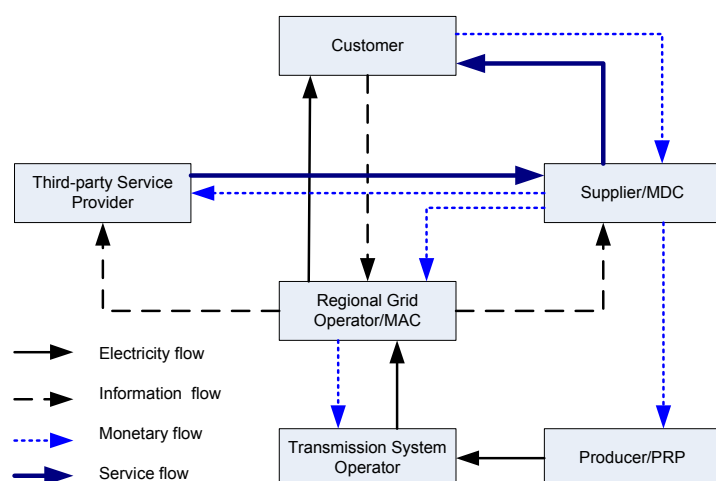


Figure 42 Design 1

5.3.2 Design 2

Compared to the first design, this design differs with respect to the billing relation and hence probably the way the TSP positions itself in the market. Usage data is gathered in the same way as it is requested by the RGO, which is obliged to supply this data using a predefined interval, i.e. each 15 minutes. However, the TSP is totally independent from a supplier and hence needs to market the service themselves. This can be advantageous to the TSP, because it has no strong ties with one supplier and can therefore approach customers from different suppliers more easily. Furthermore, when a customer switches from supplier, the relation with the TSP remains intact.

However in this model, the TSP needs to maintain the relation with the customer themselves. This can be both a treat and an opportunity for the TSP. For parties that already have a billing relation with the customer, this provides an opportunity for bundling additional VAS with existing services. The same advantage holds if these parties already have an administrative system in place to operate the service. However, when this is not the case, the VAS provider needs to build the customer relation themselves which probably asks for a significant marketing budget. On the other hand, as a new entrant on the energy services market, the TSP doesn't suffer from an increasingly deterioration image of most (classical) energy suppliers, due to administrative problems, excessive bills and significant price increases over the last few years.

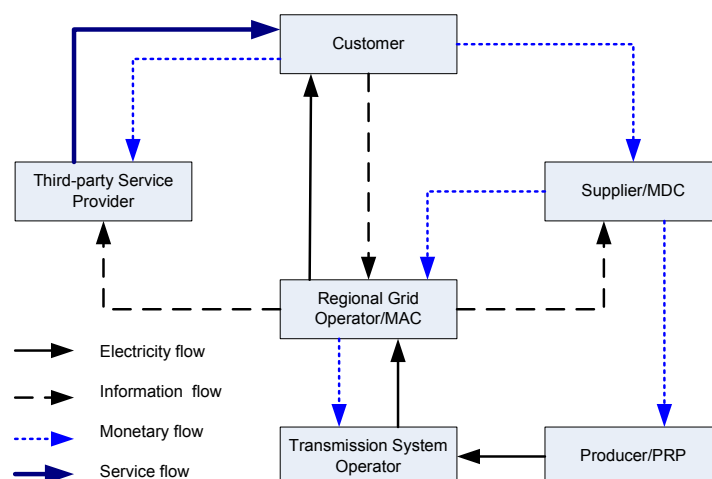


Figure 43 Design 2

5.3.3 Design 3

Compared to the first two designs where the TSP was dependent on the RGO for accessing customer usage data at predefined intervals, the TSP in this design works totally independent of both MDC and supplier. This difference lies in the fact that the TSP individually takes care of gathering, aggregating and interpreting usage data using the P1 port of the meter. Besides independence, this design further has the advantage of acquiring meter data at the times that suits the TSP, with a maximum of every 10 sec according to the current P1 technical specification. However, this approach also has certain disadvantages. First, this approach requires a separate infrastructure for communicating with the meter. Second, it is currently unclear how multiple parties may read the meter using P1. Hence, a first-come, first-serve situation may exist, which is undesirable from a societal perspective. Third, because both billing and data gathering and aggregation are performed by the TSP, the TSP requires not only an access infrastructure, but also a complete back and front office configuration for handling these activities.

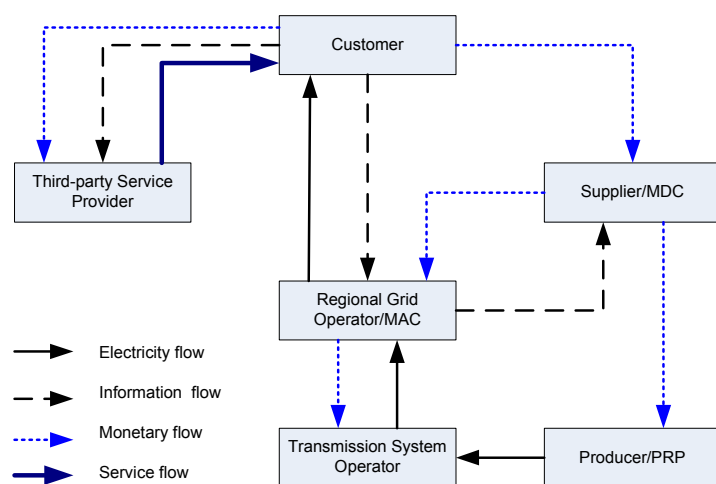


Figure 44 Design 3

The three designs give a high level overview of the possible structures by which a TSP can deliver value added services to the customer. Starting point for the designs have been two important requirements that were derived from the interviews with utilities, namely the access to the customer and access to meter data that enabled the type of services that are central in this research. In the next section, we will analyze the implications of these designs with respect to the market characteristics and the uncertainties associated with service delivery.

5.4 Institutional design issues

5.4.1 Competitive strategy analysis

For the design of a smart meter service offering Porters five forces framework can be useful. Because of the limited number of smart meter services seen today, e.g. prepay pricing and usage feedback through the internet, the VAS market with respect to smart metering can be characterized as a Greenfield situation, especially when looking at TSPs entering the market. Nevertheless the current market model enables not only the energy supplier to deliver energy service to the end user, but also third-parties using the P1 or P4 port of the energy meter. As third

party access to port P4 of the energy meter is guaranteed by law, a constant threat for potential entrants exists.

Although multiply parties may request access to the CAS, i.e. P4, this does not hold for P1, since it is expected only one party can leverage this physical connection. As a result, the first service provider that connects to the P1 port has a significant first-mover advantage. Access to the P1 port of the meter can hence be seen as a strategic tangible resource. This is a disadvantage for the third institutional design, as the first TSP may block access to this high frequency data and thereby limit innovation in the sector.

Furthermore, the number of substitutes on the market is limited and dependent on the type of value added services one considers. Although equipment exists to measure and display the energy usage of individual appliances, this type of information is hardly a treat for more elaborate value added services, which combine information about energy usage, with contextual information such as KWh prices, past savings, usage history, benchmarks etc. For more advanced home automation services, no substitutes currently exist. Hence, the current treat of substitute products and services is minimal.

For the TSP, the barriers of entry mainly concern the investment cost and creating sufficient platform for starting up service delivery. The capital requirements are the largest in the third institutional design, due to the required technology and infrastructure for communicating with the customer. When also taking into account the cost associated with branding and marketing the product, from a perspective of a TSP, the first design is most attractive. In the second and third design access to and knowledge of customers will be an important intangible resource. It is because of this, that current energy suppliers expect parties that have an existing customer relation, such as financial and telecommunications service providers to serve as a TSP for delivering smart meter VAS.

With respect to the buying power of suppliers, the TSP is dependent on the physical infrastructure in the hands of the energy distributor for bidirectional communication with the meter. Because one of the goals of the Dutch regulatory policy is that open access to the distribution network is guaranteed on an equal and transparent basis, each TSP should have access to this infrastructure. Because each party has access to the same meter data via the CAS, the meter data itself isn't a strategic resource. However, the higher-frequency data accessible via P1 is. Another aspect that will determine the level of dependency of third parties is the way the ports to the physical meter are defined. The minimum requirements of this smart meter for interconnection will enable service providers to design their services based on these protocols, standards etc.

The first steps are currently taken to arrive at such minimum technical requirements by means of the NTA 8130 document. Another aspect of bargaining power of suppliers lies in the acquisition of the hardware and software components required both before and after the smart meter for delivering value added services. The value added service equipment will require an equal amount of standardization, i.e. platform as the smart meter equipment itself. With respect to guaranteeing an open environment behind the meter, a standardization platform is required for communicating with in-house equipment in order to enable truly advanced VAS. However, the more equipment and technology is required at the customer site, the higher the switching barriers for the customer will be, since the service provider would want to protect its assets and want to make sure it can earn back the initial investment.

Because the designs differ with respect to the relations between the different actors on the market, we would expect that this would also determine the forces that influence a competitive strategy.

The third design builds the largest entry barriers for competitors in terms of capital requirements, access to distribution channels and product differentiation, due to the fact that according to the proposed technical specification only one service provider at a time could be connected to the P1 port of the meter and hence leverage the higher frequency of data. Thus access to P1 may be a significant strategic resource. The third institutional design also yields the highest switching barriers for customers, since high initial investments will be transferred to the customer, by means of set-up costs or long term contracts. Furthermore, because in principle each authorized party should have access to the CAS, a continuous threat of new entrants exists. Nevertheless it is expected that a first mover could build a significant advantage, as currently smart meter service substitutes are absent.

5.4.2 Transaction uncertainty analysis

Uncertainty can have many causes and can be associated with many aspects, e.g. technology, macro economics, competitors etc. However, the focal point of our discussions here has been uncertainty due to risks associated with actor behavior in terms of bounded rationality, information a-symmetries and opportunistic behavior. With respect to delivering VAS through the smart meter, these risks can be interpreted as follows. Bounded rationality lies for instance in the fact that it is hard to determine what customers really want and what effect current technological choices have on the future provision of VAS. For that reason we asked energy suppliers how they expect customer objectives would develop. In order to build a viable business model, the service offering should match the needs of the customer both in terms of quality and cost of supply and the technology infrastructure should be “future proof”.

Information a-symmetries stem from the fact that different actors have different types of information at their disposal. For instance, this can be information gathered via the CTS or information about customer segmentation, customer interests, hardware and software requirements etc. Existing electricity suppliers may have a competitive advantage at this point, due to the fact that they know how much energy specific consumers use and what profile they fit. However, this profile information is much less precise than the data received from the smart meter. Therefore information a-symmetries are expected to be small.

Nevertheless, a-symmetries may consequently result in opportunistic behavior, when a party is aware of their information or competitive advantage. With respect to the three institutional designs an opportunity for opportunistic behavior lies in the P1 port at the customer site. Because this port doesn't support multiple connections, one service provider may claim this connection, and thereby limiting the possibilities for other TSPs. In the end it will be the customer however who decides which services to purchase.

In the next section, we will discuss the conclusions with respect to the organizational perspective in terms of the bottlenecks for service delivery.

5.5 Conclusions

Applying the core aspects of the institutional framework to the institutional designs have led to important insights with respect to the fit between possibilities for delivering VAS through the smart meter and the current institutional embedment. As said before, the goal of analyzing the designs is not to determine which design is best suited for service delivery, but to discover what the main challenges and bottlenecks are for service delivery in general. Below, the main institutional bottlenecks of the proposed market model for delivering VAS are listed.

No alignment between individual costs and benefits

The central rationale in the constitution of a viable business case should be the fact that costs and benefits of a smart meter investment need to be attributable to a single party, namely the TSP in case of delivery of VAS. However, this is where the crux in the Dutch situation lies. Namely, in the proposed situation, solely the distributor is responsible for the meter assets, such as instalment and maintenance cost and hence is confronted with the largest cost share. As a result, the strategy of a RGO will focus on optimizing their main objectives, i.e. compliancy with regulations and reduction of cost. Thus, the RGO will opt for a smart meter and a smart meter infrastructure with little functionality.

This is in nature contrary to the objectives of TSP, and hence resulted in a minimum meter functionality that in potential can create a lock in for port P1. This induces strategic behaviour in order to leverage this strategic resource, i.e. high frequency meter data. Furthermore, because for commercial activities third-parties depend on the RGO for bidirectional access to the meter, the cost for providing such services does not lie with the same parties that yield the income based on this information. Hence, there exists a misalignment between the cost of a RGO and the potential revenues of a TSP.

Undesirable separation between regulated and commercial activities

The proposed market model is based on a clear separation between regulated and commercial activities. The regulated activities fall inside the domain of the TSO and the RGO. Thus the physical networks on both a national and regional level are managed by a regulated authority of which the tasks, responsibilities and earnings are clearly laid down in Dutch law.

Commercial activities on the other hand encompass the delivery of energy and the VAS central in this research. However, to optimally leverage the potential of smart meters, parties delivering commercial services should have access to meter data. Furthermore, if these commercial parties want to deliver services which require remote control or remote management, they should be able to communicate directly with equipment at the customer site. The distribution operator on the other hand, is required to collect meter data and distribute this data to the energy supplier for billing purposes, settlement and allocation and reconciliation, but also to third parties that have approval from the customer to using this data. However, it is expected that the data made available by the RGO is insufficient for the service provider.

Although the RGO can communicate with the meter for its own purposes, i.e. maintenance information, fraud data etc, it has no incentive to enable the supplier or other third parties to send commercial data over their infrastructure. Besides the fact that it remains the question if the distribution operator would want such commercial data over its network, in the current market model, the distribution operator falls outside the commercial domain, and is hence prohibited to provide commercial data services which would enable other parties to deliver value added services.

As a result, for truly innovative products, service providers require another infrastructure for communicating with the customer. Hence, the current institutional embedment and division doesn't enable optimal usage of the available infrastructure and thereby inhibits innovation in the sector as an additional infrastructure in potential may create significant financial entry and switch barriers.

Misalignment between the role and functional division

During the analysis of the different roles and their interdependencies it became clear that in the current market model the division of functions are primarily role based. However, the possession

of certain resources, e.g. the physical networks towards the customer and access to the customer is based on the role of the regulated parties, instead of on the functions that should be fulfilled. As a result there exists a misalignment in various aspects, such as between cost and benefits and between commercial and regulated activities. When we look at these aspects from a functional point of view, the following high level functions can be distinguished (see Figure 45).

1. Physical Infrastructural function
2. Electricity transportation function
3. Data communications function
4. Electricity services delivery function
5. Data services delivery function

In the proposed market model, these functions are to some degree combined as shown in Figure 45. The data communications functions currently belong to the MDC is in the future situation divided under the supplier, with respect to meter data management and the RGO with respect to asset management. This furthermore implies a separation of the *data communications function* in regulated and non-regulated activities.

Therefore the question arises, why the data communication function has been split, and the responsibilities for fulfilling this function have shared not only among different parties, but also among parties belonging to different, i.e. regulated and non regulated domains. Here we do not strive at answering this question; however we want to explore the possibilities for an alternative market structure. In Figure 45 below the existing and future role division is mapped onto the existing functions.

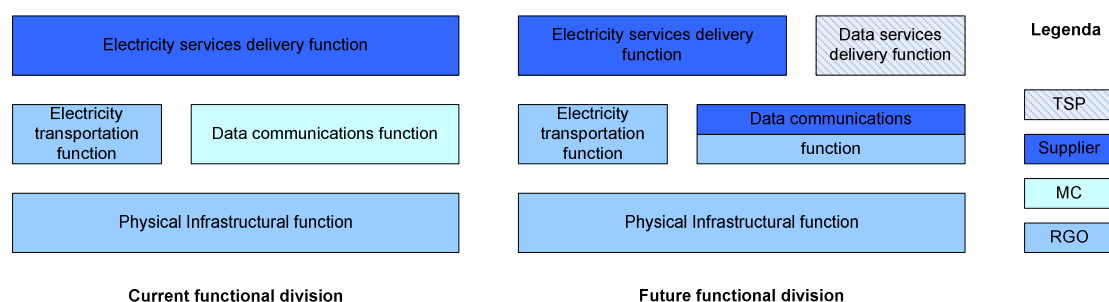


Figure 45 Functional division versus role division

With the introduction of the smart meters the required functions have not been changed, only the *data services delivery function* has been added. Due to a split in both a regulatory/commercial and supplier/RGO function, the proposed situation is unnecessarily complex and is the cause of many of the disadvantages discussed above. Therefore the solution of this problem should be sought in the *data communications function*. In section 6.3 we will present our recommendation with respect to the data communications function.

Decentral architecture inefficiencies

When studying the proposed market model, a high degree of complexity lays in the number of relations each supplier, MDC and RGO has with each other, and with the customer, specially with respect to data gathering and communication. The party that gathers and administers the data from the meter at the customer site has a high number of relations with consequently the MDC, supplier or TSP.

From the perspective of an individual supplier, it must have connections with each RGO and MDC for access to meter data. The degree of these relations is shown in the decentralized RGO/MDC market structure on the left of Figure 46. The arrows in the figure indicate the direction of data communication. With the number of connections, the number of dependencies, risks and effort required to enable communication also increases, therefore this market structure yields a high degree of inefficiency.

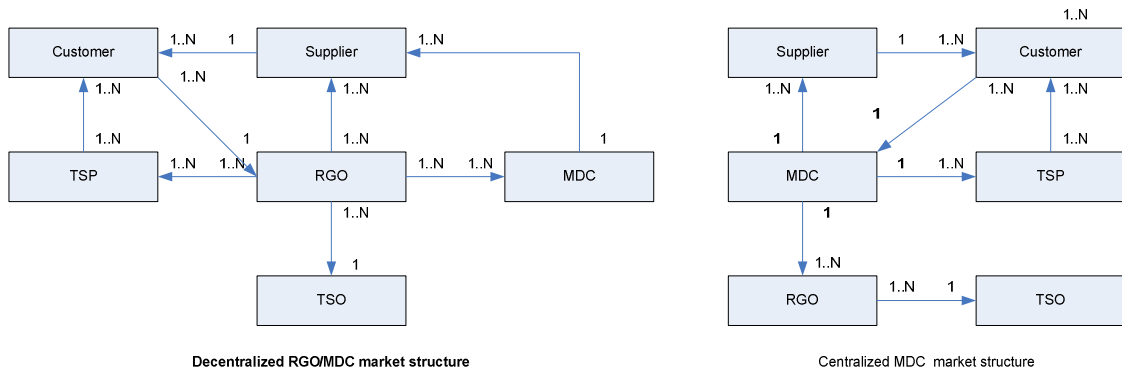


Figure 46 Decentralized and centralized market structures

6 Conclusions and Recommendations

The mandatory introduction of the smart energy meter and in the Netherlands adds to the complexity the sector is currently facing in terms of technological and institutional arrangements. As a national roll out of these meters significantly changes the information streams between the existing parties, parties are confronted with a short time scale for completing the roll out and organizing the new administrative processes.

Improvement of administrative processes together with an increase in operational efficiency is often mentioned as the main goal of the smart meter role out. However, a smart meter architecture also enables the delivery of value added services to customers, and hence enables transsectorial innovation in the sector.

Nevertheless, the short time scale for implementation, uncertainty with respect to future developments and customer demand for value added services leads to a situation where parties see meter data applications primarily as ways to optimize their internal processes.

In this research, we have focussed on a relatively new meter data application, namely the delivery of value added services, i.e. information and automation services to customers. We discussed the current technical design and institutional arrangements from a different perspective, since the delivery of value added services does not solely depend on the availability of meter data, but also depends on how it fits in the current technical and institutional environment.

Therefore the research question of this thesis has been formulated as follows: *“What are the requirements for innovative meter data service delivery to electricity customers and how can these requirements be satisfied in the current technical and institutional design of the sector?”*

The methodology for answering these questions constitutes of literature research, secondary analysis of cases and interviews with both Capgemini and external utility representatives from Eneco, Essent, E-on and Oxxio. Below, the three deliverables derived from the main research question are discussed, i.e. the service requirements for smart meter services (6.1), the bottlenecks for service delivery (6.2) and recommendations with respect to solving these bottlenecks in the technical and institutional design (6.3).

6.1 Service requirements of smart meter services

In order to study the relations between the key variables in delivering value added services through the smart meter we developed a conceptual model. This model served as the basis for the external interviews, where the relations were discussed and the variables further specified.

Specification of these variables lead to an overview of possible services the interviewees expected. Four categories of possible services could be distinguished, namely:

- Usage information services; e.g. presentation of usage data, benchmarking and energy advice.
- Financial incentive services; e.g. Time-Of-Use (TOU) pricing schemes, alternative payment and settlement programs, remote price display and curtailment programs.

- Cross-sector and automation services: e.g. promotions via a remote display, local and regional energy management enabled by micro combined heat and power plant (micro-CHP), home automation products and a home gateway for security applications
- Internal applications: e.g. fraud detection and prevention, increasing forecasting accuracy, automation of administrative process, load management incentive programs and a change in the current profiling system.

Consequently, we have updated the model and based on the expected services, key variables and relations, we derived the service requirement for value added customer services. These requirements can be divided in functional requirements and boundary conditions for service delivery:

Functional requirements:

- Effective usage feedback
- Suitable customer incentives
- A suitable display device

Boundary conditions for service delivery:

- Compliancy with distributed generation
- A healthy customer relationship
- A suitable penetration rate
- Meter functionality
- Physical meter access
- Meter data management

How the functional requirements of smart meter services may be satisfied will depend to a large extent on the type and characteristic of the service. What these requirements have in common is that they should facilitate a change in customer behaviour; therefore how the service provider settles these requirements is an individual design choice.

The boundary conditions however, should be satisfied by the current technical and institutional designs in the sector. A *healthy customer relationship* is primarily determined by the company image and a *suitable penetration rate* which is guaranteed by the Dutch governmental policy. Furthermore, *distributed generation*, is a strong trend in the sector, however, discussing these issues falls outside the scope of this research. However, for satisfying the other boundary conditions, we have analyzed both the current technical and institutional setting. We will reflect on the fit between these requirements and the current designs in section 6.2

6.2 Bottlenecks for service delivery

In order to determine how the functional requirements and boundary conditions could be satisfied, we firstly analyzed the technical design of the smart meter. We hence discussed the technical design issues with respect to the *meter functionality*, the *physical meter access* and *meter data management*. These analyses identified significant bottlenecks with respect to the choices currently made in the sector concerning the ports of the meter, their characteristics and the position of the regional grid operator with the exclusive right to directly access the meter via port P3.

Consequently, we translated the functional requirements to two design choices a service provider has to make when delivering value added services, i.e. how to bill the customer and how to gain

access to meter data. Based on these choices we have developed three institutional designs which we have analyzed from an organizational perspective. Hence, we developed insight in both the critical design issues and drawback of these designs in terms of fit with the existing institutional environment, such as the proposed market model and technical codes.

From these analyses we concluded that delivering value added services in the proposed institutional environment has significant drawbacks in terms of entry and switch barriers, customer lock-in, capital requirements and other strategic resource advantages which thereby clearly limit service delivery to the customer and innovation in the sector in general. The disadvantages of supplying VAS in the current institutional environment can be attributed to:

No alignment between individual costs and benefits

The central rationale in the constitution of a viable business case should be the fact that costs and benefits of a smart meter investment need to be attributable to a single party, namely the service provider in case of delivery of value added services. However, in the proposed situation, solely the distributor is responsible for the meter assets, such as instalment and maintenance cost and hence is confronted with the largest cost share. As a result, the strategy of a regional grid operator will focus on optimizing their main objectives, i.e. compliancy with regulations and reduction of cost. Thus, the RGO will opt for a smart meter and a smart meter infrastructure with little functionality, which is contrary to the requirements of a service provider.

Undesirable separation between regulated and commercial activities

The proposed market model is based on a clear separation between regulated and commercial activities. As a result, the responsibilities and earnings of the regional grid operators are clearly laid down in Dutch law. Since the regional grid operator receives a predetermined fee for maintaining the infrastructure and instalment of the meters, it has no interest to invest additional effort in enabling commercial services over their network, besides the fact that it is legally prohibited to do so. As a result, it is expected that the data and the communications channel made available by the grid operator is insufficient for innovative service delivery. Hence, a service provider requires an additional infrastructure for access to high frequency meter data and bidirectional access.

Decentral architecture inefficiencies

In the proposed market model, each supplier and service providers needs to contact each regional grid operator for access to customer data. As a result, the number of connections between the parties becomes increasingly large. With the number of connections, the number of dependencies, risks and effort required to enable communication also increases, therefore this market structure yields a high degree of inefficiency.

During the analysis of the different roles, functions and their interdependencies it became clear that in the current market model the differences between parties are primarily role based. With the roles we describe a specific party, and with the function we describe a specific task and responsibility. Thus, in the current design, the regional grid operator has two different tasks, i.e. maintaining the physical infrastructure and enabling the electricity transportation function.

In the future market model, one task/responsibility is fulfilled by two different parties, which are from a different regime (regulated versus commercial). This is the main cause for the bottlenecks discussed above, resulting in significant entry barriers, customer lock-in and strategic behaviour. The difference between the current and future functional division according to the new market model is shown in Figure 47.

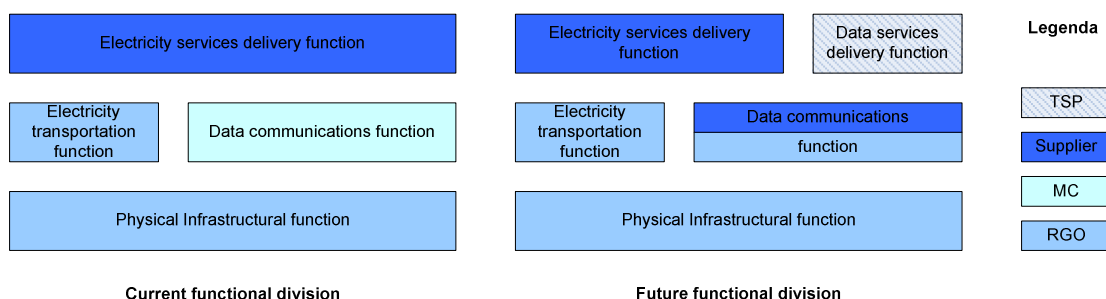


Figure 47 Functional division versus role division

Yet, the *data communications function* is subject of both a change in the technology due to the introduction of the smart meter, but also subject of regulatory change due to the new retail market model. As a result, service delivery in the current technical and institutional environments is significantly hindered because of misalignment between these designs.

6.3 Recommendations

In the preceding sections, we have presented our argument that the main drawbacks for delivering value added services based on smart meter, namely significant entry barriers, a high degree of dependency on the regional grid operator, possible customer lock-in and opportunistic behaviour due to strategic resources, are to a high degree related with this misalignment between roles and functions in the current institutional designs.

Furthermore, we elaborated on the interrelations between technical and institutional design issues and the implications for service delivery. Hence, our conclusions and recommendations to solve the service delivery bottlenecks cannot be attributed simply to a single technical or institutional design choice. Because these bottlenecks are primarily a result of the role and functional division in the institutional environment, we structure our recommendations for increasing the alignment between service delivery, technology and institutions using the functional overview as presented in Figure 48 below.

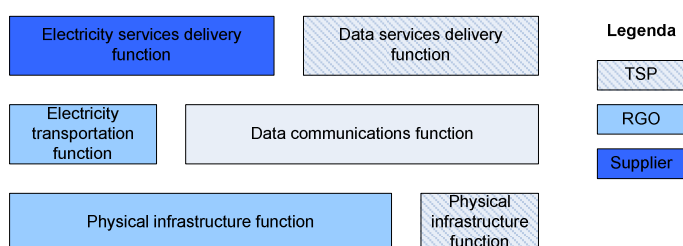


Figure 48 Basic functional overview

Because third-party service providers require an additional infrastructural for supplying information and automation services, another *physical infrastructural function* is added. An important notion is that for *electricity services delivery*, *data communication* is required, because of the necessary administrative process. However, for *data services delivery*, *electricity transportation* is not a requirement. For this reason, existing suppliers expect third-party service providers to start data service delivery, such as the value added services discussed throughout this thesis.

Furthermore, the *data communications function* can be performed by both the regional grid operator and the third-party service provider. The first belongs to the regulatory domain and the second to the commercial domain. The fact that an additional infrastructure is required, besides the physical infrastructure of the regional grid operator, points to significant flaws in the market structure.

In order to improve this situation, we firstly recommend mitigating the necessity for a third-party physical infrastructure function. The required additional function is the result of the lack of bidirectional communication possibilities and access to high-frequency meter data for the data service provider. Therefore the P1 and the P3 port of the meter should have the same characteristics, i.e. both support bidirectional data and high frequency data.

Second, we recommend reconsidering the division of roles in the *data communications function* between regulated and commercial parties. Because the regional grid operator is responsible for the physical metering asset for enabling the *electricity transportation function* we recommend that the *data communications function* will also be placed with the regional grid operator. We further recommend that this is done under the precondition that the regional grid operator fully leverages the new functionality of the P3 port, i.e. that it stores all available meter data in a central access server and consequently allows third party to access the central access server for obtaining this meter data and sending bidirectional steering messages to the meter.

This way we overcome the preferred role of the regional grid operator for accessing the P3 port, since the connection with the meter becomes truly transparent. Thus the regional grid operator and third-parties have equal rights with respect to operating the meter. As a result, service providers may choose their own strategy for delivering information and automation services to the customer, independent of the regional grid operator.

Furthermore, the central access server should be based on an open architecture, e.g. web services, and an appropriate data standard, such as ebXML. However, further research is required to formulate the exact data specification.

Third, we recommend to solve the decentral architecture inefficiencies by aggregating the *data communications functions* of the different regional grid operators in one central data register. A central access server will be advantages for both existing parties and third-party service providers. For existing parties, aggregated information can be used for fraud reduction, manage switching processes and administration of distributed generation activities. Furthermore, it relieves the suppliers and service providers from the need for contracting separate regional grid operators and meter data companies for gathering information for delivering energy information services.

As a result, the complexity of the institutional setting is reduced, due to the fact that the number of relations between the parties are reduced and become increasingly uniform. This decreases the need for different governance structures, and hence simplifies the institutional embedment. Furthermore, from a regulatory point of view this also increases the ease of supervision.

6.4 Suggestions for further research

During the research project we have identified several knowledge gaps and opportunities both related and derived from our conclusions and recommendations presented above. Firstly, we will discuss our suggestions for further research that could increase the validity of our current results.

Second, we will present additional suggestions based on the opportunities we identified during the research project.

First, our methodology for deriving the requirements for smart meter services methodology consisted of literature study, desk research, secondary analysis of cases and interviews with both Capgemini professionals and utility representative. We choose this approach, because of the exploratory character of our research. Thus, we expected that it would be hard for customers to determine the desired functionality of possible value added services. Furthermore, it is the strategies of the utilities that suffer from the bottlenecks in the current technical and institutional designs. However, by excluding the customer, our analysis lacks significant empirical validity with respect to customer demands for such services. We therefore recommend further research with respect to these customer demands, for instance by means of conjoint analysis.

The second suggestion for further research derived from our recommendations focuses on the technical implementation of a central data register. We discussed the integration of the different central access servers of each regional grid operator in terms of the advantages this would bring with respect to delivering information services and optimizing the administrative process in the sector. Although we noted that a modular approach using a common data standard such as ebXML is recommended, we suggest to further study the exact data specification requirements, access rights and privacy issues concerning the integration of customer data at a centralized location.

Furthermore, we identified several opportunities that are indirectly related with the introduction of smart meters in the Dutch energy sector. The first opportunity that we suggest for further research is to analyze the opportunities smart meters bring for regional grid operators in terms of building an intelligent or smart grid. Although we discussed several internal applications of meter data, these applications primarily focused on the administrative processes in the sector, instead of on asset management, outage control and maintenance planning. As grid operators suffer from an aging workforce, an intelligent grid may be a solution to mitigate these problems. Therefore we suggest studying these possibilities and implications further.

Finally, besides the introduction of smart meters, our analysis has identified a second trend that is bound to significantly change the processes in the Dutch energy sector in the upcoming years, namely distributed generation. Although we already recognized that further smart meter applications should be compliant with distributed generation, the implications of, for instance the installment of micro combined heat and power plants (micro-chp), are significantly larger from both a service and governance perspective. Therefore we recommend additional research with respect to the implications of the placement of micro-chp's with customer households in terms of the network and information requirements needed to efficiently handle the reversed energy streams and administrative processes. This problem can be described as a multi-level optimization problem influencing the requirements of the smart meter.

7 Reflection

During the research, choices have been made with respect to several aspects of the research project. These choices were based on a thorough consideration and assessment of the pros and cons; however these choices implicitly determined the type of outcomes and thereby the limitations of our research. In this section, we will reflect on the choices made during the research project. The choices regarding the *problem statement and research questions*, *research method* and the *outcomes* of the research will be discussed below.

7.1 Reflection on problem statement and research questions

The problem statement encompasses two different perspectives on the introduction of the smart meter in the Dutch households. The first is a commercial perspective. Although the energy supplier is currently the sole supplier of electricity and information service to the customer, they are faced with new opportunities the meter brings with respect to service delivery to the customer, and threats of possible new entrants starting to deliver new meter data services. The explorative part of the research focused on the commercial aspects, as we determined the important variables and expectations with respect to service delivery. Consequently, we analyzed the technical design issues, a service provider should take into account. These results are relevant for both existing suppliers and other parties considering service delivery in the utility sector. Furthermore, these aspects provided a starting point for translating the service requirements towards a technical architecture.

The second perspective is a governance perspective, as we discussed the implications for service delivery with respect to the current technical architecture of the meter and the institutional arrangements in the sector. Our recommendations are primarily of the latter type, as we discussed how to solve the generic bottlenecks associated with service delivery on a macro level. The usability of these results can primarily be attributed to the regulatory bodies responsible for the Dutch energy policy.

Because the explorative research with respect to the first perspective, the service requirements functioned as a starting point for the second perspective. Therefore our conclusions with respect to the bottlenecks for service delivery only apply to the formulated service requirements.

7.2 Reflection on the research method

For answering the different research questions, we have presented an overview of different research methods. The design of the conceptual model in chapter 2 and 3 was based on a trilateration of methods, namely desk research, secondary analysis of cases and interviews.

The performed desk research and case analysis were primarily aimed at understanding the sector and identifying the important variables for service delivery. The first round of interviews was therefore unstructured in nature. Because these interviews were held solely with Capgemini utility professionals, the results may suffer from a bias as we only spoke to utility professionals from one organization, thereby neglecting the transsectorial character of the research.

Consequently, we externally verified the conceptual model with four representatives also from the sector, i.e. Eneco, Essent, E-on and Oxxio. Although this external validation proved valuable for updating the conceptual model and identifying expected smart meter applications, its general external validity is questionable because of the following reasons: (1) the number of interviews was too small to be statistically significant, (2) the interviewees were all part of an existing party within the utility sector and (3) the interviews were pre-structured by the design of the conceptual model and interviews with Capgemini professionals. As a result, the transsectorial character of possible value added services is insufficiently represented, and therefore the meter data applications focuses primarily on energy and information services, instead of cross-sector and automation applications.

Nevertheless, these services functioned as the starting point for determining the technical requirements and fit with the institutional arrangements in the sector in the second part of this thesis. The architectural approach used in chapter 4 enabled us to discuss the technical design issues associated with a smart meter role out on different levels of aggregation. We extracted the technical design issues for third-party service delivery; however we refrained from explicitly recommending certain architecture or software packages due to the fact that our recommendations here are aimed at energy policy makers, instead of on individual service providers.

In chapter 5 we used two requirements for service delivery to analyze the implications of different designs for service delivery. We explicitly choose for a design approach to maintain consistency with the first chapters of this research, i.e. the service delivery perspective. Hence, the analysis of several institutional designs yielded the possibility to study the requirements with respect to the technical and institutional alignment.

7.3 Reflection on the results and recommendations

The consequence of analyzing a dynamic market is that process of analyzing itself also is dynamic and iterative process. However, there are certain disadvantages associated with this approach, as one can keep updating both the analysis and the results. Therefore a paradox exists between the topicality of the work and the depth of analysis. In this research we choose to balance these objectives, by taking into account the expected future developments at the start of this research (Q1 2007) with respect to the market model for retail users, unbundling of the energy value chain and the technical specification of the smart meter. Now (Q3 2007) these expectations still stand, however, they have been specified in a higher level of detail by the sector.

The results and recommendations should be interpreted according to their specific perspective. The first part of this thesis focused on the service requirements for delivering value added services. These requirements were primarily aimed at energy information services, due to the background of the interviewees discussed above. With respect to the expected services, we focused primarily on the customer, and presenting suitable incentives for changing customer usage behavior. Because of the fact we only asked energy suppliers about their perception on customer drivers instead of the customer themselves, the validity of these perceptions require further validation.

The first part of this research was primarily divergent in nature, as we also included meter data application that could increase the operational processes of existing utilities. Although this was not the focus of this paper, many of these applications required a change in customer behavior, therefore these insights proved valuable during the research project.

Our functional recommendations with respect to service delivery are not exclusively bound to the Dutch utility sector. Besides the Dutch utility interviews, the way customers react to energy incentives has been the focus of several international studies. However, the boundary conditions for service delivery are largely a result of the specific Dutch retail market model and the technical specification of the meter. Therefore the recommendations with respect to the second part of this thesis, i.e. the discussion of the technical and institutional bottlenecks for service delivery, solely apply to the Dutch sector.

However, since the Dutch government is a forerunner in both regulatory policy and the installment of smart meters, the recommendations with respect to the division of functions, the responsibility of the different parties and the characteristics of the different meter ports could prove valuable guidelines for countries outlining their future policy.

Smarter Metering

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Appendices

Appendix 1 The energy value chain

In this appendix we will discuss the energy value chain from a sector wide perspective as opposed to the main text, where the actors, roles and developments relevant for the introduction of smart meters are highlighted. Figure 49 provides an overview of the classical energy value chain, how it exists as yet, and the relevant issues that play a role in each part (Fens, 2005). From *generation* go *supply* of electricity to the customer, several roles can be distinguished. We will discuss these roles and the development especially relevant for that role in more detail below, except for the *supply* and *customer* parts, which are discussed in the main text.

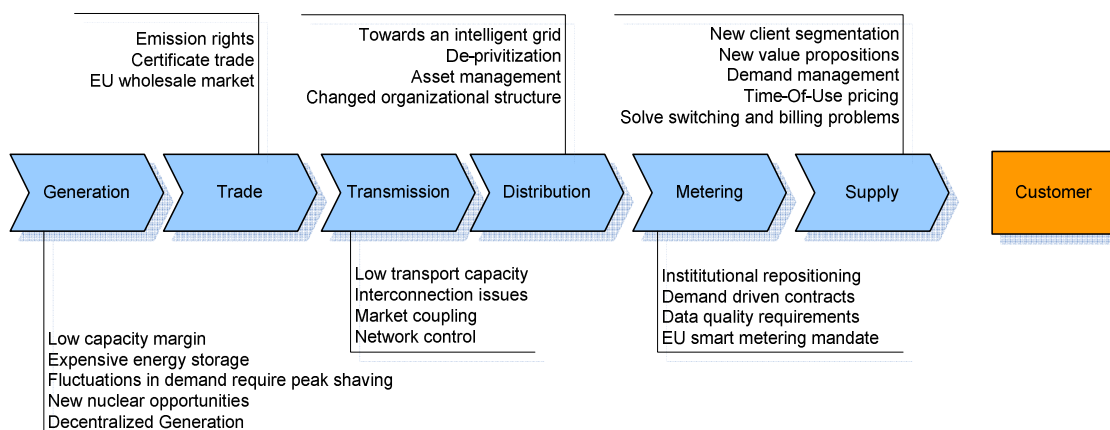


Figure 49 Impacts on the energy value chain

Appendix 1.1 Generation

In the Netherlands several utilities have production plants to produce energy from gas/coal or renewables. The generation market is fully privatized. Large energy producers are Essent, Nuon, Electrabel and Eon, although the amount of energy produced in the Netherlands is complemented with a significant yearly import. The growth of national production capacity is unable to keep up with the growth in national demand, which increases import dependency.

Furthermore, high cost associated with energy storage increase the need for accurate forecasts and capacity planning and management in order to minimize energy peaks and spot market purchases. Revisions of nuclear power policies opened up new opportunities for European Pressurized Reactor (EPR) nuclear power plants, while older plants are being shut. With the installment of a new Dutch government, nuclear energy generation is back on the agenda (Energeia, 2007).

Opposite of centralized generation is distributed generation (DG) which is one of the trends visible in the energy sector. Combined heat and power plants, so called micro CHPs, enable the local generation of electricity, while at the same time improving energy efficiency. A step further is the delivery of customer generated energy back to the network. Hence, combining local generation of solar, water, wind or bio power may become a profitable opportunity for the customer and a technical challenge for the network operator. The key issues that describe energy generation are (Ribbers & Olde Rikkert, 2006):

- Low capacity margin
- New nuclear policy
- Problems associated with electricity storage
- Decentralized Generation of energy
- Supply management: peak shaving

Appendix 1.2 Trade

Trade takes place at energy market places such as the Amsterdam Power Exchange (APX), where electricity can be bought and sold by producers and distributors, but also by large companies and professional traders. The core activity for the APX concerns the spot market for electricity, involving anonymous day-ahead contract trades (for next day delivery) on an electronic trading platform using an auction system.

The exchange provides for the financial settlement of the contracts and the publication of a daily price index. For planning of day to day capacity the E-programme is formulated for settling the imbalances with suppliers and informing Tennet about the expected transactions for the next day. Program-Responsible Parties (PRP) are parties that are connected to the energy grid responsible for managing, i.e. predicting, and administrating the expected electricity supply and consumption from the grid. These individual energy programs are supplied to Tennet on a daily basis. On the basis of these programs Tennet and the other grid administrators ensure that the actual production and consumption of energy is measured. Consequently, the sum of each PRP energy balance is reported to Tennet, which settles the differences between the agreed, i.e. expected volume and the actual measured volume. Especially the following developments will determine what will become of energy trade:

- Towards a wholesale European energy market
- Emission rights and certificates trade

Appendix 1.3 Transportation

Tennet is the Dutch state owned Transmission System Operator (TSO) which operates and maintains the high voltage / pressure transport systems in the Netherlands and is responsible for international interconnections. Furthermore, they are responsible for balancing demand and supply and facilitation of settlement. Payment for the services by Tennet is part of the grid fee collected by the grid companies.

There are two international organizations that Tennet deals with regularly in order to manage international allocation of energy. The first organization is the UCTE, l'Union pour la Coordination du Transport de l'Electricité (Union for the coordination of electricity transmission), is a technical alliance of 22 continental countries, whose grids are physically connected with each other. The UTCE coordinates the interests of the grid administrators (TSOs) in order to guarantee safe and reliable operation of the connected grids. For this reason every TSO has to concur with the rules of the UCTE, which focus on e.g. a stable electricity frequency and voltage, ensure sufficient spare capacity and minimize transmission losses.

The second international organization of importance is the ETSO, which is a joint venture of four regional European grid organizations in response to the European liberalization of the electricity market. ETSO is a members' organization which is made up of the 32 grid administrators (TSOs)

of all 15 Members of the European Union, as well as Norway and Switzerland. ETSO is the discussion partner for the European Commission with regard to the commercial operation of the European electricity market. Within ETSO, workgroups tackle e.g. the tariffs for international energy transmission and the capacity problems at the borders. These issues can be summarized to:

- Paradoxical policy: stringent regulation versus the free market system
- Control and insight into network status
- Investment issues transport capacity
- Interconnection issues
- Market coupling

Appendix 1.4 Distribution

Where Tennet is stated owned and operates on a national scale, regional grid operators (RGO) take care of local distribution of electricity. Grid companies have a local monopoly where they operate and maintain the medium and low voltage / pressure grids. The four main operators in the Netherlands are Eneco, Continuon, Essent and Delta. Regional grid administrators are impartial, hence non-discriminatory access to the grid should be guaranteed. Because grid companies are the physical connection of the consumer to energy grid and therefore they often perform billing for the transport, distribution and metering fees and they provide usage information for the settlement processes with other parties. Hence, the following challenges for the distribution parties can be formulated:

- Demands on network quality and intelligence
- Stringent information and information exchange requirements
- De-privatization: distribution networks to TSO
- Asset management

Appendix 1.5 Metering

The metering market is currently a free market, although future developments are uncertain. The metering party that takes care for registration and measurement of the data should be authorized by Tennet. Metering for the consumer market is often supplied by the grid company and provides metering services such as meter data collection, verification and distribution of information to other parties in the value chain. Although in theory the consumer is able to choose their own metering company separately from supply or distribution, in practice this process is very obscure. However in the bulk market, independent metering companies are active. The following trends are of importance for the metering market:

- Institutional positioning: regulated versus non-regulated
- Demand driven contracts
- Focus and requirements for data quality
- Smart metering

Appendix 1.6 Supply

The supply market in the Netherlands is fully deregulated and currently many new entrants are starting to delivery energy to both business and consumers. However, suppliers often limit themselves to delivery of energy, instead of other services. Nevertheless, many future developments, products and services will focus on the consumer. However, currently suppliers

are mainly struggling with the results of a deregulated market, i.e. managing supplier switches and correct billing. Yet, in the near future the following trends are expected to determine the supplier landscape:

- New client segmentation
- New value added services
- Demand management
- New pricing schemes (Prepay and Time-Of-Use)
- Reduction of cost to serve
- Solve administrative, i.e. switching and billing problems

Appendix 1.7 ECH and B'con

Another party involved in energy delivery and administration in the Netherlands is the Energy Clearing House (ECH), which is a market facilitator that operates as a message hub between market parties to facilitate the switching process. Furthermore, ECH also prevents invalid contracts and the European Article Number (EAN) codebook. B'con is also involved in the quality of service delivery, and monitors the quality of the administrative processes in the sector.

Appendix 2 Analysis of supplier objectives

In Figure 50 an overview is given of success factors of a supplier business model that strives towards business continuity. Although this picture only provides a general overview, important aspects of a utility business model can already be identified in this early stadium. The aspects that are directly influenced by the introduction of smart meters are shown in blue.

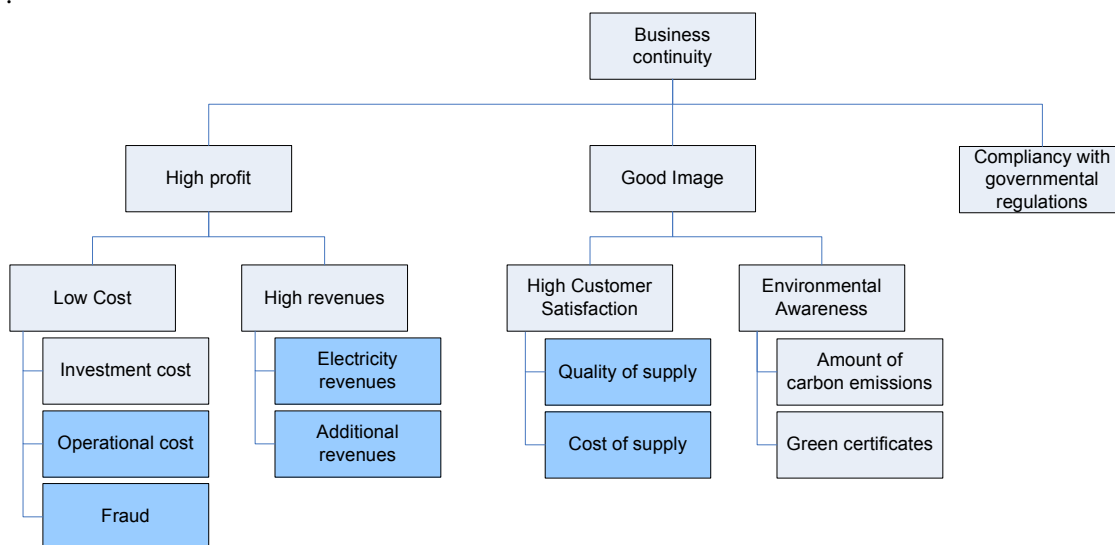


Figure 50 Supplier goal analysis

Appendix 3 Analysis of customer objectives

In Figure 51 a decomposition is made of generic customer objectives when choosing an electricity supplier. The aspects that are influenced directly by the delivery of home automated services are indicated in dark blue. Although these factors can be specified at a higher level of detail, this level of abstraction provides sufficient clarity for setting the scope of this research.

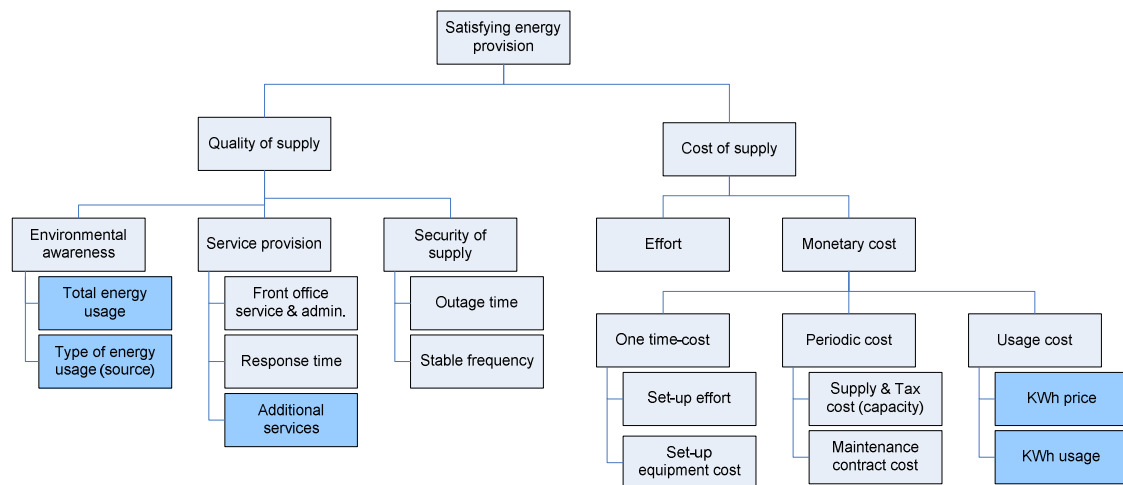


Figure 51 Detailed analysis of customer objectives

Appendix 4 The STOF business model framework

Appendix 4.1 *STOF introduction, method and delineation*

Although the concept of a business model can be defined and classified in many ways, varying from descriptive to prescriptive models, the majority of research focuses on the individual problem owner, the internal relationships of that problem owner and the products and service which is to be delivered (Tapscott, Lowi, & Ticoll, 2000; Weill & Vitale, 2001). Yet, little attention has been paid to describing the linkages within organizations in complex value chains or networks, where complex sets of resources and capabilities work together to create economic value through relationships and interdependence.

In nowadays developing and specialized markets the tendency of flexible value webs or value network replacing traditional linear value chains is clearly visible (Miller & Lessard, 2000). This also holds for the energy delivery, however, a distinction should be made with respect to the delivery of the primary product, namely energy as a commodity good and secular services, such as value added services, billing, etc.

With respect to delivery of energy, the network can be best described using the classical value chain, as shown in Figure 49. However, new types of services and new types of products require different resources and capabilities, and thus different institutional arrangements. For these secular services the relations and interdependencies between the involved parties can be best described using a value network. For this reason an approach is required that takes into account resource dependencies and focuses on multi-actor collaboration. Therefore Faber et al. (2003) have developed the STOF business model framework (Figure 52) which looks beyond the individual firm and considers the business model of a networked enterprise.

Although the methodology of Haaker, Bouwman and Faber (2004) was originally intended to develop mobile telecommunications services, many similarities and parallels exist between introduction new services in the telecommunications and the utility market. The STOF business model comprises four different domains, which together determine what network and customer value can be delivered. Furthermore, three types of environmental drivers can be distinguished, which influence these domains. In this section these domains and drivers will be discussed shortly, before they will be used to discuss the implications for value added service delivery using smart meters.

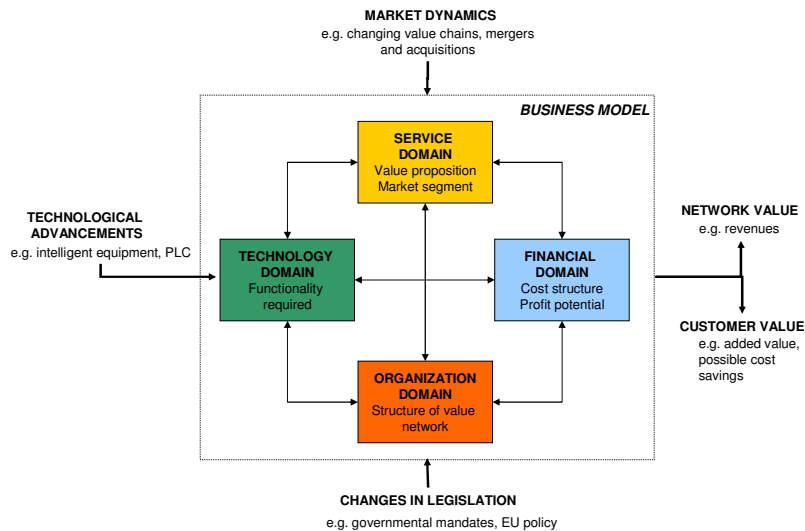


Figure 52 STOF business model framework

The STOF business model framework can be described by distinguishing between business model components, business model drivers and delivered value. The common business model components that can be distinguished are shortly discussed below. For an extensive description and scientific derivation of these components we refer to Haaker, Bouwman and Faber (2004).

- The service domain describes the value proposition and the market segment at which the offering is targeted. The central concept in this domain is *value*, which is seen as the total of benefits and costs of the product or service as perceived by the customer. In this research, it is hence related to the value delivered by means of smart meter services, which can focus on each of the customer objectives as stated in Figure 7. More specifically, the requirements with respect to the service domain will be investigated by means of an analysis of the different dynamics and interviews with Capgemini professionals and utility representatives, elaborated upon in chapter 3.
- The technology domain describes the required technical functionality for realizing the service offering. The required technical functionality will depend on the characteristics of the service and the related service requirements. These requirements relate to different technical components, described by the technical architecture. We will use the Integrated Architecture Framework to discuss these components. Because it is not our goal to design an explicit product or service, in we will present our conclusions in terms of technical design issues regarding the technical architecture in chapter 4.
- The organizational domain describes the structure of the value network required to create and distribute the service and the position of the service provider in this value network. The position of the service provider can be described by an institutional design which discusses the relations in terms of monetary, physical and information flows between the associated parties. These flows are determined on one hand by the regulatory arrangements and on the other hand the service provider strategy. In chapter 5 we will analyze different institutional designs in order to determine the effect on service delivery and the metering market in general.

- The financial domain describes the way a value network intends to generate revenues from the service offering and the way risks, investments, and how revenues are divided across the value network. Since the goal of this research is not to specify a business model in financial terms, the contribution of the financial domain falls outside the scope of this thesis.

The environmental drivers that influence these domains and determine the outcome, i.e. network and customer value are (1) market dynamics, (2) technological advancements which influence primarily the technology domain and (3) changes in legislations. In the next section we will discuss the drivers currently visible in the utility sector in order to get an overview of the key variables and their relations with respect to delivering smart meter services.

Appendix 4.2 *STOF business model drivers*

Market dynamics

When describing the energy markets two types of markets need to be distinguished, namely the energy demand market and the energy supply market. In turn, these markets are influenced by both competitive behavior at the supply side and consumer behavior on the demand side. In order to discuss these subjects, it should be clearly defined how the demand side and supply side are defined in terms of the energy value chain. On a high level, the energy producers are part of the supply market and the customers, i.e. home users constitute the demand market. However, within the value chain, more detailed supply-demand relations can be distinguished, of which the roles are discussed in section 2.1. This section, on the other hand focuses on business model drivers that influence multiple parties in the supply chain from both a supply and demand perspective.

Globalization

Although the opening of the energy markets has made Europe the natural playing ground for incumbent energy players, competition on the retail market varies from country to country. Furthermore, the European energy market is still divided into electricity zones which make that national development strategy focuses primarily on neighboring countries. Furthermore, electricity is expected to remain a relatively local product, due to the high cost of transportation in terms of leakage and capacity planning. However, initiatives from the European Commission to complete market mechanisms are numerous and provide further evidence that deregulation of European energy markets is still progressing. Key initiatives are:

Whole sale power markets:	overall 14 whole sale markets are operating in Europe with an increasing share in total volume.
Emission right initiatives:	several initiatives are visible for managing and trading energy emission rights, e.g. Pownext.
Market coupling initiatives:	represent the most dynamic and flexible way of coupling the different electricity markets and electricity zones through interconnection, i.e. market coupling between France, Belgium and The Netherlands.

The creation of one EU market is unlikely, due to the inherent characteristics of electricity, transport losses and interconnection requirements. Therefore it is expected that regional markets will emerge, such as a North-West European market, consisting of The Netherlands, Germany, France, Belgium and Luxembourg.

Mergers and acquisitions

Consolidation in the European utility market is expected after the national markets are fully liberalized. The recent intention of Dutch utilities NUON and Essent to combine forces in a national merger is just one of the first signs. Furthermore, large foreign operators are entering the Dutch market such as German E-on which bought the Dutch supplier RWE energy and Centrica PLC bought Dutch entrant OXXIO. Taking into account the cash position of foreign “national champions” and the attractiveness of Dutch suppliers after a possible unbundling would create a fertile breeding ground for further consolidation.

Market restructuring

Regulatory changes have changed the traditional roles in the energy value chain and hence influence the utility landscape as described in chapter 1. However, because it is still uncertain if the government will require unbundling of the distribution and supply components, we can currently only speculate on what the future market roles will be and how these requirements influence the utility business model. Furthermore, the creation of several incentive structures to reduce the reduction of carbon emissions during generation and overall energy usage such as the National Allocation Plans (NAPs) and the Emissions Trading Scheme (ETC) caused the creation of trading markets for emissions and green energy certificates. On 1 January 2005 carbon emission trading began in the EU. Other market roles that become more and more visible is that of the energy market broker, where energy can be bought and sold by energy suppliers and other wholesale users on the energy spot market.

Environmental awareness

Environmental awareness is of increased visibility in both energy production and energy consumption. Environmentally sound production of electricity receives much attention from electricity generators as a result of the Kyoto agreement to reduce Dutch carbon emissions by 6% in 2012 (United Nations, 1998) and financial incentives of emissions trade. Under the EU agreement member states have agreed on a significant reduction in greenhouse gasses emissions, an increase in energy efficiency and increasing usage of bio fuels and renewable energy sources in 2020 compared to the 1990 situation. The Dutch government has ratified this agreement to some extent, shown in Table 2 below.

Because energy production in the Netherlands belongs to the forerunners in terms of energy efficient generation, continuing this strategy with future investments will contribute to 15% reduce of the carbon emissions required by the Kyoto agreement (EnergieNed, 2005). The carbon emissions per person in the Netherlands are higher then the European average. Because of the total emissions of about 190 million tones almost 50% can be attributed to energy consumption (EnergieNed, 2005), a small change in consumer behavior can have significant results on a national level.

Although the introduction of green energy was initially a success, recently more and more customers choose for conventional energy. The main cause for this change can be mentioned an increased price awareness of the customer, primarily as a result of increased competition and transparency on the energy market. Furthermore, practical studies have proven that customers are sensitive to price incentives if information about energy usage is displayed timely and in the right way (Wood & Newborough, 2003). For this reason Time of Use (TOU) pricing yields great promises besides managing network load, also for reducing energy usage in general.

Table 2 EU and national targets 1990-2020

	EU agreement	Dutch situation
Reduction in greenhouse gasses emissions	20% - 30%	30%
Improvement of energy efficiency	20%	2% per year (~32% in 2020)
Percentage of renewable energy sources	20%	20%
Of which bio fuels	10%	N.a.

Changes in legislation

Liberalization and privatization

Liberalization and privatization of the Dutch energy sector have a long, burdensome and complex history even before general public became aware of its consequences. For a complete overview of the developments regarding this history we refer to the article by De Jong (2006) which elaborated on the steps taken from the EU Directive for the electricity market (1996) to the status of developments at the end of 2006. What becomes clear from his analysis is the continuing balancing between market forces and governmental regulations for striving towards a competitive market, where security of supply is guaranteed for a fair price.

As unbundling to different extents, has been a central theme from the adoption of the Electricity Act of 1998 towards current discussion in the Dutch senate, it is expected that it will continue to determine both the national and international energy landscape for the upcoming years. Another issue that caused much discussion during these years is the definition of the market on which to apply the NMA/Dte competition rules. Initially this inhibited the creation of a “national energy champion” as in the surrounding countries, and now is subject of debate concerning enabling security of national supply.

Although the Dutch privatization and liberalization policy has been amended many times, and is still subject to significant and emotional debates, past decisions are still influencing future policy. An example of such is the discussion about differences between economic and legal unbundling, as a result of the fact that all Dutch networks had been sold in the 1990s to US investors which leased back the use of these networks under long-term arrangements (Cross Border Leases – CBLs) to create fiscal advantages for both parties (De Jong, 2006). It is expected that legal unbundling will elicit significant insurance claims from these parties. Hence, it can be concluded that not only current and future legislative issues matter, also path dependency of previous decisions need to be taken into account.

EU and NL regulation

The Dutch government debates to regulate ownership unbundling by law as from January 1st 2008 [elaborate + source], because they expect that if competitive suppliers get access to the energy grids, i.e. distribution networks, this leads to better services for customers, fair competition and competitive prices. Equal third party access to the grid is required to enable a level playing field for competition. However, the Dutch reform plans go far beyond the requirements of the Second European Directive which imposes only the legal unbundling of transmission (by 2005) and the distribution (by 2007) networks (Societe Generale Cross Asset Research, 2006). Therefore the Dutch utilities are more vulnerable for hostile takeovers compared to their European competitors. For this reason Dutch utilities are firmly opposed to this legislation.

The Dutch energy sector is regulated by the NMA/DTe which safeguards access to the electricity grid and guarantees transparency and access to information. Furthermore, NMA/DTe protects customers to potential malpractices of dominant providers. Because DTE requires that unbundling cost are not passed on to customers, Dutch utilities are faced with significant investment costs. Another reason is to ensure security of supply in case of foreign takeovers in a further liberalized West-European market, because the distribution grid can remain in hands of Dutch regulator, foreign ownership of supply companies would not threaten energy delivery.

However, unbundling of the distribution and service networks is also considered to have considerable drawbacks. Because the cost of disentangling grid companies is considerably large, the competitive advantage of Dutch utilities as a result of efficiency caused by a high degree of integration is expected to disappear. On the other hand, further separation will increase the requirements for information exchange between the different parties leading to even more troublesome billing and switching processes. Furthermore, an increasingly tighter tension between energy supply and demand could lead to energy crisis such as in California in 2000-01, power cuts as in Italy and the US in 2001-02, as energy peaks as a result of e.g. extreme weather conditions cannot be absorbed anymore. Therefore, investments in capacity are necessary; however, these are restrained in the current uncertain climate.

The Dutch electricity industry is relatively small compared to the surrounding countries, and Dutch utilities have a limited size compared to German utilities RWE and E.on, French Edf and the Belgium utility Electrabel. This is partly due to different governmental policies, as these countries explicitly choose for creating a “national champion” which shall have a strong positing in a liberalized EU market, supported financially by the local governments. This however, creates disparities in the effects that regulations have on the competitive position of these utilities compared to those of Dutch utilities. Furthermore, the reform plans of surrounding countries don’t obliges utilities to legally and financially separate distributive from supplier activities, which further decreases the Dutch utilities competitive position, and makes them vulnerable to foreign takeovers. Therefore it can be concluded that disparities in market regulations among neighboring countries inhibit equal competition on an EU level (Energieraad, 2004).

With respect to energy metering the ministry of EZ has the intention to execute EU guideline 2006/32/EG which respect to the requirements for metering systems in the retail market. To translate this guideline to the situation in the Netherlands the NTA 8130 working group under commission of NEN formulated standards in accordance with the original goals of the guideline (NEN, 2006):

- Institutional improvement of customer oriented processes by giving suppliers direct access to processes
- Improvement of the free market system by reducing switching limitations
- An optimal usage for a maximum number of parties with respect to the advantages smart metering systems with emphasis on possible energy savings
- Open access to the energy meter in order to enable third parties to deliver innovative commercial meter data services and enabling platform creation
- Cost reduction due to more efficient grid management and data exchange

Special attention is paid to ensuring interoperability and compatibility with respect to the communication infrastructures since this is regarded as the starting point for an efficient operation of the energy and energy services market. A detailed overview of the technical aspects of the NTA 8130 system specification is given the main text.

These standards are to be applied within the current energy law (1998) in the Netherlands which is specified in different technical codes which describe the way grid companies should behave towards customers with respect to functionality of the distribution nets, metering and information exchange and system services. The relevant codes are the “netcode”, “meetcode” and the “systeemcode”. Furthermore, several tariff codes are in use to regulate billing and payment between the various parties.

Technological advancements

Advancements with respect to telecommunications and information technology in the recent years have paved the way for the existence of a variety of communications equipment in our homes. For their connection to the world wide web, cable television networks or the telephone grid customers have a large variety of choices available, as many providers are able to deliver a complete or partial service offering. For delivering these services, different types of physical infrastructures are available, such as the cable network, the POTS telephony network and wireless networks.

A significant trend that can be identified is that of convergence which implies that individual suppliers are more and more able to deliver a complete service package over one proprietary infrastructure using one specific platform. Recently, several initiatives have emerged where the energy grid is used as infrastructure for delivering such service, using Power Line Communications (PLC) technology. In the light of introducing smart energy meters which require a bi-directional communications link, this development adds to the number of implementation possibilities. In this section, several important developments will be discussed. How they are related to the roll out of smart meter is shown in Figure 53 below.

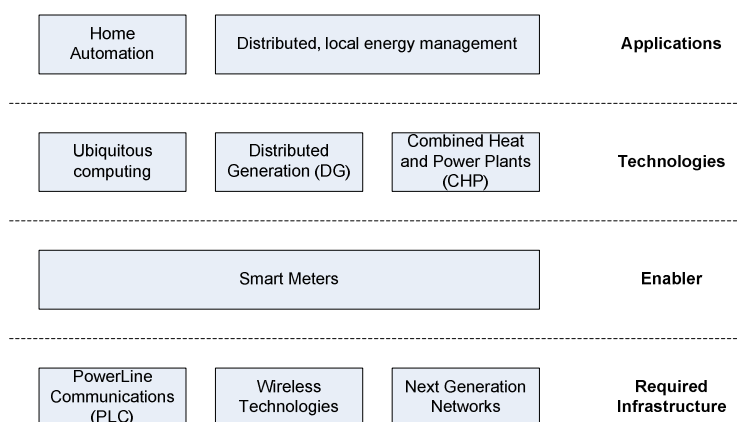


Figure 53 Technology relations with smart meters

Distributed Generation (DG)

Currently, electricity is produced by national or international parties and distributed to the customer using the national electricity grid. Hence, the flow of energy is unidirectional as visualized in the energy value chain of Figure 49. Opposite of centralized generation is distributed generation (DG) which is one of the trends visible in the energy sector. The innovative property of distributed generation is that instead of only subtracting energy from the energy grid, consumers or enterprises can also supply energy back to the energy network, continuously or when a local excess capacity is reached. Currently, in the greenhouse environment of Westland, horticulture gardeners experiment with such solutions.

In order to create a billing structure that settles the amount which is produced locally and the amount that is subtracted, detailed information is required about the pricing scheme and production and usage quantities. However, current metering infrastructure is unable to provide for this information, increasing the need for a smart metering infrastructure.

Micro Combined Heat and Power Generation (micro-CHP)

Micro-generation is defined as a notion of simultaneous generation of both heat and power in an individual dwelling. It offers an elegant and economically viable way to meet the residential power/thermal loads and Kyoto targets by demonstrating superior environmental performance with high efficiency and low harmful greenhouse gas emissions (Entchev et al., 2004). Heat produced during on-site electricity generation can be recovered and used to satisfy space and water heating and cooling using stirling engines originating for the space travel industry. However, before introducing micro-generation systems in large quantities a number of issues should be resolved in terms of system integration, interconnect, reliability and safety. What primarily holds for Distributed Generation, also holds for CHP in terms of (near) real time information requirements, as superfluous energy can be delivered back to the grid.

All-IP technology and other next generation networks (NGNs).

Next Generation Networking (NGN) is a broad term to describe key architectural evolutions in telecommunication core and access networks that are expected to be deployed over the next 5-10 years. For an overview of currently available technologies see Fijnvandraat & Bouwman (2006). The general idea behind NGN is that one network transports all information and services, e.g. voice, data etc, by encapsulating these into IP packets. NGNs are commonly built around the Internet Protocol, and therefore the term "all-IP" is also sometimes used to describe the transformation towards NGN.

In the Netherlands, KPN is currently implementing its all-IP NGN strategy as a response to increased communication needs and competition from other infrastructure providers. The goal of KPN is to build an IP based network which is independent of one infrastructure for delivering a wide range of services to their customers (KPN, 2005). This enables KPN to deliver a wide range of services independent of the customer location and device. With respect to smart meters this development yields several possibilities as it adds to the number of options available for enabling bi-directional communication between the energy meter and the utility. However, KPN could become a competitor for the utility in terms of delivery of value added services as the architecture of the meter should enable every third party to read meter data using port P1 internally and P3 externally. As KPN strategy is to focus on services that increase leisure, safety and care for the customer, this development should be considered.

Wireless technologies

KPN's all-IP strategy involves both increasing the bandwidth of the access and transport network by means of optical fiber or VDSL technology. However, the primary interest for the network company with respect to roll out of smart meters is the connection between customer premises and switching equipment, also known as the last mile. Since for basic smart meter services the requirements with respect to bandwidth and frequency of interaction are limited, wireless technologies, such as WiFi and WiMAX are a suitable and scalable technology for bridging this last mile in high density areas. In low density areas, GPRS or – in the near future – UMTS technology should be considered. Because connection every household directly to the grid network can be very costly, as high cost are associated with these last mile connections, meshed network technology provides opportunities for reducing these cost. Although meshed network technology is independent on the type of transmission, i.e. GPRS, RF, WiFi or WiMAX, RF

seems most suited for short range communication due to the low installation cost compared to the other technologies.

On the other hand, an infrastructure is required to communicate in-house with intelligent or sensor equipment and displays for delivery of home automated services and displaying information about energy usage. Because most in-house equipment is connected to the in-house energy infrastructure, communication using this infrastructure could be the preferred solution, especially because many vendors, such as KPN are introducing so called “no new wires” equipment for using the in-house powerlines. Examples of broader initiatives are the Homeplug Powerline Alliance and the Universal Powerline Association. Other wireless technologies such as Bluetooth are often restricted to a limited range. Ultra Wide Band (UWB) technology however could be used to overcome these range restrictions. In the NEN 8130 expansion (Ministry of Economic Affairs, 2007a) it is advised that the P1 port for connection with home equipment should make use of RF technology.

Powerline Communications (PLC)

Communication and data transmission over the energy network, commonly referred to as Powerline Communications (PLC) have been subject of many pilots during the last decade. Although in the Netherlands the cable and telephony network have a high coverage, in surrounding countries, many households remain unconnected due to high investment cost. Considering the fact that the electricity grid has a worldwide coverage of around 95%, PLC in potential can increase the customer base for delivering services significantly, without major investments. Commonly, PLC initiatives can be distinguished in access PLC technology and in-house PLC technology, discussed above.

An access PLC technology solution brings a broadband internet connection to the customer premises through the low voltage energy grid. Because on these networks electricity is transported at a different frequency than data, no interference takes place. However, at the high voltage network, the energy current behaves differently, which causes significant interference with data communications. Therefore at this point, the data stream needs to be decoupled from the energy network, for instance by means of a wireless connection or fiber connection to the internet backbone. Several initiatives, e.g. RWE Powernet and EnBW in Germany and NUON in the Netherlands, failed to meet expectations with respect to customer adaptation, although price and performance levels were comparable with DSL and Cable connections. Hence, these programs were discontinued. This again proves the earlier issued statement that adoption of innovative technologies is hard to predict, despite the nature of the product or service (De Marez & Verley, 2003).

PLC technology for in-house communication, on the other hand, is being adopted increasingly by the consumer market as a flexible solution for distributing an internet connection in-house. Furthermore, PLC equipment is increasingly being developed for transporting other types of IP-based media, such as audio, video and voice. In general, two primary uses within the context of the home network can be distinguished, namely data networking and home control. In combination with an all-IP platform discussed above and open loop technology and open standards, PLC in-house technology provides ample opportunities for communication between home automated equipment and the energy meter.

Ubiquitous Computing (UC) and Domotics

Ubiquitous computing is a model of computing in which computer functions are integrated into everyday life, often in an invisible way. In a ubiquitous environment computers are integrated into devices which are often automatically controlled based on e.g. environmental factors or

predefined and timed decision rules. An example of ubiquitous computing which focuses solely on household appliances and buildings is domotics.

Domotics can be applied to several extends such as for saving power, increasing comfort, personal and patrimonial protection or for ordinary automatic communications. The increasing number of technologies available for short ranges wireless and wired communications has fueled the number of initiatives, such as ZIGBEE. Home automation is just one example of domotics, but possibly the most promising considering the increase in consumer awareness with respect to energy usage and the number of security services currently delivered by the utilities. Hence, smart meters provide the platform for a further development and implementation of ubiquitous computing as these intelligence devices can be supplied with timely input information, such as energy rates. This can result in more effective automated management of home automated equipment or services.

However, utilities are just one of many parties interested in the home automation market. Because many other parties each have their advantages with respect to their customer base, experience with home automated equipment, technological infrastructure, customer appliances and hard- and software, partnerships to optimally leverage synergies is expected. Yet, energy suppliers are an attractive party due to their large customer base. Practical studies (Datamonitor, 2001) have shown on the other hand that the potential uptake for home automation services is determined by four primary factors:

1. Household income
2. House hold size
3. Technology uptake and familiarity
4. Socioeconomic drives

Hence, segmentation of the customer market for delivering such services seems an adequate method for creating an optimal market strategy. Furthermore, home automated services are well suited to be bundled with energy supply. Different value propositions can be aimed at different target customer segments, such as a cost proposition by giving discount on bundled services, a convenience proposition by delivering one bill and a single point of service or a creative proposition which optimally leverages the new market channel. An overview of possible home automated services and their requirements in given in Table 3.

Table 3 Home automation overview

type of service	security & safety	comfort and control	Flexibility and savings
Layer			
Infrastructure	Limited in-house external infrastructure coupled with external 3rd party supplier network	In-house commodity network: heating, lightning, energy with coupling with commodity supplier network	Wireless in-home networks: GPRS, WIFI, RF, Bluetooth Wired in-home networks: UTP, PLC (homeplug) with online feedback and comparison
System	technical alarms: monitoring medical alarms burglary alarm simulation of presence	heat and ventilation central control remote control automatic data registration (data centric) supply side management	usage display and feedback usage benchmarking and advice efficiency improvement
Appliances	switches sensors smart alarm systems emergency lightning	air conditioning heating system lightning commodity usage energy curtailment	central energy display appliance energy display usage benchmarking TOU price display personalization

The current domotica market is primarily focused on care appliances to support the elderly in living independently. Furthermore, several independent technology packages are available on different niche market, such as security and home control. However, the uptake by the general public of these types of technologies is minimal, because the acceptance threshold of the customer remains too high, primarily due to the high cost associated with installation and rewiring. Using the available in-house infrastructure, such as the power network and the smart energy meter can lower these thresholds. Another aspect that inhibits large scale uptake of domotics equipment is the lack of a common communications standard. Although many providers currently deliver a equipment labeled with “home control center” and “home automation box”, the technologies used to control household appliances, lightning or other equipment is often proprietary. Even with recent open all-IP initiatives, interoperability problems remain.

A particular characteristic of the domotics industry is that, as opposed to for example the telecommunications industry, the elderly are the early adopters of these technological products. Hence, this asks for a different kind of branding and marketing strategy in order to lower the adoption barriers, for instance by gradually introducing entertainment instead of only care and comfort only.

Appendix 5 Smart meter key attention area's

In Figure 54 below an overview has been given of the meter data applications that were identified using a literature study.

	Customer oriented applications	internally oriented applications
Meter data applications	Time-Of-Use (TOU) pricing	
	Energy curtailment (macro level)	
	Energy mangement (micro level)	Billing effectiveness
	Monitoring (status & equipment)	Balancing
	Home control	Operational savings
	Usage display	
	Usage benchmarking	
	Savings advice	
Service bundling	Security services	
	Gas and water services	
	Telecommunications services	
	Care services	
	Heating services	
	Entertainment services	

Figure 54 Smart meter business model key attention areas

Appendix 6 Economic contribution to the field of strategic management

Appendix 6.1 Theory on Competitive advantage

The economic contributions to the field of strategic management can be divided into several paradigms. One of the first paradigms that emerged in the 1960's was the structure-conduct-performance (SCP) paradigm. According to the SCP paradigm the structure of the industry determines the conduct of the firms in that industry, and conduct in turn determines industry performance. Although feedback relations are also possible according to the SCP approach, the main premise was that by analyzing performance of the industry structure, the performance of firms could be explained. One of the core theories of the SCP paradigm is Porters theory on competitive advantage (Porter, 1980, 1985) and the model of forces driving industry competition. The important of the environment on strategy is expressed in Porters five forces framework (Figure 55) which aims at finding a position where institutional features of the industry allow the firm to defend its position against competing force and influence them in its behavior.

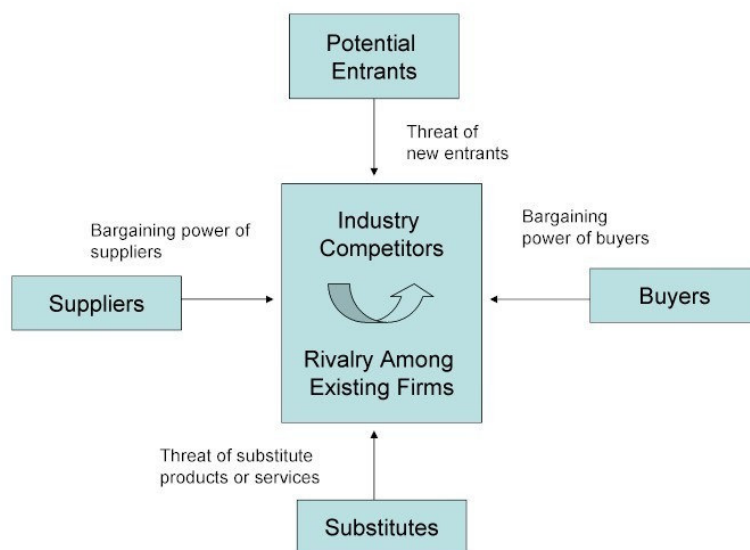


Figure 55 Porter five forces framework

According to Porter, there are five forces that determine industry attractiveness from the perspective of an individual firm. Next to competitive rivalry among existing competitors within the industry, these forces can be divided into those which increase the level of competition: threats of new entrants and substitute products and services, and those which portray the dynamics of the supply chain for the industry: bargaining power of buyers and suppliers. For a complete overview we refer to Porter (1980, 1985). Because here we discuss the design of new smart meter products and services, entry barriers are of special importance. According to Porter (Porter, 1980), barriers of entry include:

- Economies of scale

- Capital requirements
- Government policy
- Switching cost
- Access to distribution channels
- Product differentiation
- Proprietary product technology

Because the five forces framework discusses the trends on a relatively high level, it is important to exactly define the market on which these forces will be studied. For example when looking at the delivery of energy to the customer, the situation is totally different from looking at the niche market for delivering value added services, or at the meter market for installing the smart meters. With respect to the delivery of energy, competition is primarily determined by the threat of potential new entrants and existing industry competitors. Because energy is a commodity product, the bargaining power of buyers is limited and because of the nature of the product, yet no viable substitutes exist. Furthermore, the bargaining power of suppliers, i.e. the distribution companies is negligible, due to the obligation to allow access to the regulated networks.

However, when applying Porters model to the market for delivering value added services to the customer, the situation is totally different as there are almost no current offerings, hence the rivalry among existing firms and the threat of potential entrants is limited. In addition, the degree of threat for substitute products depends on the nature of the service that is delivered (see Figure 54). The bargaining power of suppliers, on the other hand, will be determined by the meter equipment suppliers, which in turn is dependent on the degree of standardization. When a proprietary meter is chosen, the bargaining power of suppliers will be considerably higher because of vendor lock-in, then when the equipment is standardized and can easily be replaced. How these aspects differ with respect to the institutional designs will be discussed in the main text.

Appendix 6.2 *Resource based View*

In contrast to Porters theory, which is an environmental view on competitive advantage the resource based view has a more inwards perspective. The relation between internal and external analysis is shown in Figure 56 below (Barney, 1991). According to the resource based model, a competitive advantage is always based on the possession of certain resources. The extent to which a competitive advantage is sustainable depends on how difficult (in terms of time, money or effort) it is for competing firms to acquire these resources. Resources are defined in a general sense, as they can include financial resources, tangible resources (such as equipment and buildings) and intangible resources (such as patents, tacit knowledge, brand names, experience and organizational routines) (Douma & Schreuder, 1998).

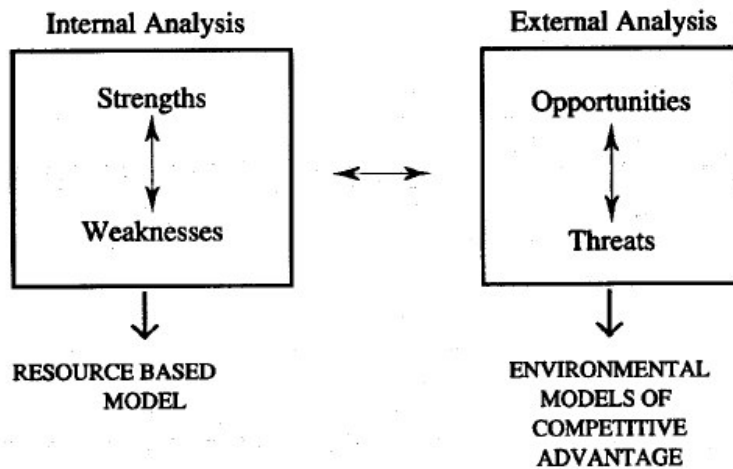


Figure 56 The relationship between internal and external analysis of strategies

The main weakness of environmental models of competitive advantage is that they adopt two simplifying assumptions about a firm's competitive position, namely that firms within an industry have the same type of resources at their disposal and that resource heterogeneity is decreased due to high mobility of resources (Barney, 1991). The resource based view is primarily a reaction to these criticisms, as resource heterogeneity and immobility of resources are, according to Barney (1991), the main differentiators for creating a sustainable competitive advantage. To have this potential, the firm resources must have the following characteristics (Barney, 1991): (1) it must be valuable, i.e. it must exploit opportunities and/or neutralize treats in the firms environment, (2) the resource must be rare, i.e. not available to a firms competitors, (3) it must be imperfectly imitable and (4) no strategic substitutes must exist that have the same characteristics with respect to characteristic 1-3.

Although the internal and external approaches are fundamentally different, the tools used to apply these approaches to a specific situation have many similarities, for example the relation between Porters entry barriers and the resource position barriers discussed by Wernerfelt (1984) as he defines the relation between the two as follows: "[...] an entry barrier without a resource position barrier leaves the firm vulnerable to diversifying entrants, whereas a resource position barrier without an entry barrier leaves the firm unable to exploit the barrier". This is just one example of how a firms and competitors resources and capabilities influence the forces defined by Porter and hence proves the relation and partial overlap between these theoretical paradigms.

The crucial question is how to approach the resource based theories of the firm as two types of approaches can be distinguished, namely a resource and a product perspective. As each approach has their strengths and weaknesses, one is not necessarily better then the other. This depends however, on the goal of applying these theories. From these perspectives, two different approaches can be derived (Wernerfelt, 1984):

Product approach: When it is clear what the technical requirements of the desired products and services should be, these requirements can consequently be translated to resource and capability requirements. The next step would be determining to what extent these are available to the organization or what parties and governance

structures are required to obtain these resources and capabilities. The approach can also be described as a top-down approach.

Resource approach: In this approach, the first step consists of determining the resources and capabilities available to the organization and making an inventory of relations with other parties in terms of contracts i.e. This will result in an overview of what resources are available at what internal and external cost. This overview should consequently be translated to possible products and services. This approach can be described as a bottom up approach.

Because this thesis has a mainly exploratory character, and the customer requirements are for a service provider crucial in determining what products and service to deliver, the product approach suits this research best. Because the external aspects, namely the environmental treats and opportunities are discussed using Porters five forces model, here we will focus on the strengths and weaknesses of a firms' position to deliver value added services to customers.

As discussed before, the term resource is very broad. In order to say something meaningful about the relation between parties with respect to these resources and capabilities, it should be clear what exactly we are comparing. Hence, the following resources are distinguished (Douma & Schreuder, 1998):

Financial resources: financial resources include the monetary funds available to the design and the delivery of services to customer. Although installment of the smart meter asset will be the responsibility of the RGO, additional equipment may be necessary to read the P1 meter data, to display information at the customer home or to communicate with one owns back end systems. However, since is not the goal of this research to build a quantitative business case by means of a revenue-cost model, a further financial specification falls outside the scope of this thesis.

Tangible resources: tangible resources include the equipment, i.e. hardware and software to deliver services to the customer. Although many parties already have a physical connection, by means of the energy grid, PSTN or cable networks to the customer, an infrastructure for communicating with the customer may be vital requirements for delivering value added services. Other tangible resources include assets in the customer home, such as display's or equipment to monitor, such as central heating or future micro CHPs. In the latter case, also an in house infrastructure is needed, such as PLC or wireless communications.

Intangible resources: intangible resources include the soft skills such as experience and routines, but also patents, e.g. communication protocols or hardware technology. Because it is hard to identify what intangible resources are required to design and deliver value added services, they will be not part of the analysis.

Hence, the strengths and weaknesses of different market parties will be discussed in terms to what extent they poses or have access to the tangible resources that are required to deliver the products and services as specified in the different designs.

Appendix 6.3 *Resource Dependencies*

Another early approach to organizational behavior and strategy is described by Pfeffer and Salancik (1978) as the resource dependency perspective. Although the title would suspect otherwise, in their argumentation they take the argument by Porter e.g. that the (competitive) environment of the organization determines the optimal strategy, a step further by stating that organizations are in fact externally controlled. That is, organizations comply with the demand of other parties, or they act to manage the dependencies that create constraints on organizational actions. Hence, organizations should not be seen as self-directed, autonomous actors pursuing their own goals, but as actors that are in a constant struggle for resource autonomy and discretion. For that reason, organizations are dependent on the interactions with other parties who control the required resources that are not under the organizations control. Because the organization does not control these resources, acquisition may be problematic and uncertain, except for the parties that have these resources. Therefore, these parties have control over other organizations, as they control the provision of resources. For that reason contractual arrangements exist in order to reduce this type of uncertainty.

Parties differ in the extent to which the organization is dependent on their resources and activities. Participants that provide resources that are not critical to the organization constitute the social environment of the organization. On the other hand, actors who control critical resources are often in the position to directly influence the actions, or enable non-actions, of an organization. In this sense, we can speak of the social control of organizations. Important conditions that facilitate this control of organizations include (Pfeffer & Salancik, 1978):

1. The actual possession of the resource
2. The criticality of the resource to the organization
3. The substitutability of the resource
4. Insight into the organizations processes
5. Available course of action of the organization
6. Interdependencies between the organization and resource supplier

Organizations seek to avoid dependencies and external control in order to retain their autonomy for independent action. The dilemma between the maintenance of discretion and the reduction of uncertainty leads to contradictory activities and suboptimal performance. The dilemma between autonomy and certainty is the core of many economic and contracting theories. The use of this resource dependence perspective is just one method for understanding the organization of coordination. TCE for instance, will be used to discuss another paradigm. The main argument of the resource dependency framework however is that the influence of the organizations environment and the context of the organization goes beyond uncertainty with respect to accessibility of resources. Management of interdependencies and the use of secrecy to avoid external influence and reduce conflict and the limitations of secrecy with respect to avoidance of external control underline that the effect of acquiring resources clearly limits organizations in the degrees of freedom with respect to their strategies.

Where the resources based view focuses primarily on the direct consequence of having (or not having) certain resources for delivering products and services, the resource dependency framework adds up to the complexity, since the organization itself is also influenced by these external resource dependencies. Where the resource based view complements the weaknesses of earlier theories of the firm, the resource based perspective can be seen as a theory which combines both approaches into a theory that tries to explain the dynamics of the market stemming from interdependencies and uncertainty. It is therefore not surprising that a high degree of

overlap exists between the conditions 1-6 mentioned above and the core aspects of theories of the firm and resource based theory. Condition 3 and 5 are comparable to one the forces defined in Porters framework, namely the treat of substitute products (3) and the dependency on the supplier (6). Furthermore, condition 1, 2 and 4 correspond to the internal analysis, i.e. strengths and weaknesses of the resource based model. Hence, additional explanatory power lies in condition 5, namely the courses of action available to the organization. A way to determine the consequence of alternative courses of actions is by means of institutional designs and hence has been practiced in this research.

Appendix 7 Economic theory of organization

Appendix 7.1. Neoclassical Economics

Literature shows the development of different economic theories, which are meant to study and explain societal developments and organizational structures. Generally, three classifications of theories can be distinguished, namely: Neoclassical Economics (NCE), New Institutional Economics (NIE) and Original Institutional Economics (OIE). Neoclassical economic approaches are characterized by the fact that emphasis lies on behavior of the firm, instead of at the market, which is characterized as an equilibrium situation where perfect competition exists. These approaches have been discussed in appendix [7].

Appendix 7.2. Original Institutional Economics

The objective of OIE on the other hand is to understand processes of change in institutional development. The understanding of complex processes, interactions, feedback loops and institutional dynamics plays a central role in this (Groenewegen, 2001). Because processes fall outside the scope of this report, OIE is limitedly suitable. This is increased by the fact that OIE is characterized by the existence of many trade-offs, which clearly limits the applicability due to its abstractness and rigorousness (Nooteboom, 1993).

Appendix 7.3. New Institutional Economics

The third economic approach is NIE which focuses, on the institutional arrangements between different actors in order to minimize the cost of arriving at these arrangements, labeled Transaction Costs (TC). NIE takes both the actors and their environment into account and TCE can be applied in both a normative and a positive way. The normative approach discusses how, based to the actors and their environment the arrangements should look like in an optimal situation. The positive way on the other hand takes the current arrangements as a starting point and strives to determine how this situation influences the environment and actor setting. Furthermore NCI consist of three sub theories; property rights theory (PRT), agency theory (AT) and transaction cost economics (TCE). Since the latter discusses the link between transactions and government structures, this theory is most interesting for discussing organizational en institutional designs. The purpose is to explain governance structures that match specific types of transactions in a way transactions can be coordinated at minimal costs. Two extremes of governance structures are markets and hierarchies. Factors that determine contracting and organizational and hence determine the place on the continuum are:

- Asset specificity
- Frequency of contact
- Uncertainty

Frequency concerns the recurrence of the transaction, i.e. does the transaction occur with a high frequency or only occasionally? This number of occurrences of the transaction is one of the determining factors of the transaction costs. It is relevant in two respects, it concerns reputation effects and setup costs (Williamson, 2005). Williamson defines uncertainty as “the source of disturbances to which adaptation is required” (Groenewegen, 2005). The source of these disturbances can be either from inside the firm, residing in the bounded rationality of the actor, or outside the firm residing in opportunistic behavior of the actors or the environment, e.g. the

economic climate. As Williamson states, the main predictive power of the theory of TCE resides in the conjunction of these disturbances with the specificity of the asset (Williamson, 2005). Although a conjunction is made with the frequency and disturbances in the transaction, asset specificity can be considered as the main factor determining the explanatory power (Groenewegen, 2005). Stated stronger: “TCE maintains that the principal factor that is responsible for TC differences among transactions is variations in asset specificity” (Riordan, 1985). Due to the evident importance of this factor it is further explained. Asset specificity is about the type of investments related to the transaction (Groenewegen, 1995), i.e. are the investments made for the asset specific for this asset or can they be re-used in consequent transactions? Clearly the specificity of the asset can reside in different sources depending on the type of asset. Riordan and Williamson (Riordan, 1985) define at least four different forms: site, physical, human and dedicated assets. Site specificity refers to the specialization by proximity. Physical assets can be specialized in the sense that they can only be used for this transaction. Specialized human assets arise from firm-specific training or learning by doing, i.e. experience. Dedicated assets refer to the building of continuous business. Expectations of consequent business can be a reason for large discrete investments (Williamson, 2002).

High asset specificity, high uncertainty and low frequency will be more efficiently arranged through a hierarchy. Hence, a low asset specificity, low uncertainty and high frequency will be more efficiently governed through a market structure. For this reason changes in institutions, coordination and contracting can be best explained best by changes in governance structures.

When comparing the TCE approach with theory on resource dependencies, the similarity of concepts between the availability of and access to tangible resources and asset specificity becomes clear. Although the latter is just one of the aspects that determine the type of transaction, this indirectly influences the market structure and the strengths and weaknesses of individual parties with respect to those tangible resources or assets. In section 5.3 we will look more closely to how these aspects relate to the different institutional designs.

Appendix 8 Interviews (partly in Dutch)

Appendix 8.1. Interviewees and conferences

During the research project two rounds of interviews were held. The first round of interviews was held with internal Capgemini professionals and was of explorative, informal nature. Therefore, these interviews were not formally documented. The second round of interviews was held with external utility representatives in order to validate the conceptual model and determine what type of value added services they expect. An overview of interviewees is given below.

The Capgemini professionals were chosen based on their knowledge about current developments in the utility sector, specifically with respect to metering. Furthermore, all account managers of the Dutch energy suppliers have been interviewed based on their knowledge about the current strategies of these parties.

The utility representatives themselves have been approached both directly, via the congresses shown below and indirectly via Capgemini account management. The utility representatives were responsible for several commercial metering programmes and initiatives. Although several representatives were prepared to cooperate, other parties feared that openness with respect to this subject would harm their strategy and therefore refused. Nevertheless, by interview representatives of E-on Benelux, Essent, Oxxio and Eneco we have a healthy representation, both in terms of innovativeness and in terms of market share.

Table 4 Overview of interviewees

Capgemini Professionals	Utility Representatives
Alex Bouw Keith Deaney Peter Meulmeester René Wijshake Wilco Polak	Barry van de Merbel, E-On Benelux Erik Boonstoppel, Essent Hilbrand Does, Oxxio Richard Bevelander, Eneco

Furthermore, during the research project several conferences were visited where valuable insights were derived. The following conferences were visited:

- Congress Trends in Energy 2007, march 13, Utrecht
- Congress “Domotica in de leefomgeving”, april 11, Eindhoven
- Congress “Energy and ICT”, march 25, Rotterdam

Appendix 8.2. Interview Questions

In section 3.4 the important aspects of the conceptual model have been discussed. In order to determine if the relations shown in the conceptual model agree with empirical findings, these relations are tested using several interview questions which form the basis for interviews with utility representatives. The important variables for answering the research questions of the conceptual model have been used as a starting point for the interview questions. In Table 5 the relation between the conceptual model component and the interview questions are shown.

However, often several conceptual model components have been combined in one generic question. In that case, the questions primarily focuses on a high level construct, of which not all aspects that have a relation with that construct are to be discussed.

Table 5 Interview Questions

Interview Question			
ID	Question	Question type	Conceptual model component
1	Without the EU mandate to install smart meter by 2008, would the supplier still want a smart meter role out and why (not)?	specification	business case
2	Besides electricity delivery, what do you think that are possible sources of additional revenue enabled by smart meters and a smart meter infrastructure (operational meter)?	specification	sources of additional revenue
3	What do you think are the key variables on which customers base their choice for an energy supplier and evaluate the quality of supply?	relational	customer adoption
4	What applications do you see at the customer side for using and displaying meter data?	specification	meter data applications
5	Will the energy supplier seize onto the possibilities applying individual meter data in the customer home?	relational	customer oriented applications
6	Do you expect initiatives from third parties with respect to delivering services based on meter data, such as home automation services?	relational	competition
7	Do you consider these services a threat or opportunity for the energy supplier?	relational	competition
8	Do you see possibilities for bundling electricity supply with additional services?	relational	service bundling
9	What services do you think are most suited to be combined with electricity delivery and what are the main advantages from a customer perspective?	specification	service bundling
10	What possibilities exist for the energy supplier to reduce operational cost using smart meters and what are the expected benefit (billing meter)?	relational	operational cost
11	How can the customer be motivated to reduce energy usage at peak times?	specification	customer oriented applications & internally oriented applicatons
12	In what ways do you expect that consumer energy settlement or price schemes will be subject of change and how do you expect that customers wil react to these changes?	specification	customer oriented applications & internally oriented applicatons
13	To what extend do you think reducing energy usage for customers and energy management in home is a matter for the energy supplier?	relational	revenues & cost

Appendix 8.3. Interview Eric Boonstoppel, Essent Network

Erik Boonstoppel, Essent netwerken

Netwerkwerk bedrijf Informatie Management en beheer

Cluster KIS: Klant Informatie Systemen (informatie, facturatie, reconciliatie en switch management). Projectverantwoordelijk Beheer in Slimme meter werkgroepen

1. Als de Europese verplichting om slimme meters te plaatsen er niet was geweest of op dit moment zou worden afgeblazen, zouden de meters dan nog geplaatst worden?

In dat geval verwacht ik niet dat het op dezelfde schaal en in hetzelfde tempo uitgerold zal worden. Bij bepaalde huishoudens kan het interessant zijn, bijvoorbeeld daar waar je moeilijk binnen komt of die moeilijk te bereiken zijn. Andere gevallen waar het interessant kan zijn is fraude bestrijding, waar je nu ook al prepaid modellen ziet verschijnen. Dit is allemaal eenvoudig en goedkoop op afstand te regelen. Ik zie het dan als een extra dienst aan de klant, als zij bijvoorbeeld geïnteresseerd zijn verbruiksgegevens. Voor de netbeheerder biedt het voordelen dat je niet 1x per 3 jaar langs de klant hoeft. Voor alle klanten er is geen positieve business case voor

de netbeheerder, zoals de situatie nu is bij een uitrol bij 6 jaar. Voor specifieke groepen, kan de business case wel positief zijn, afhankelijk van de operationele besparingen.

2. Wat zijn naast het leveren van elektriciteit mogelijke inkomstenbronnen voor de leverancier, mogelijk gemaakt door de slimme meter of slimme infrastructuur?

De leverancier kan de gebruiksgegevens gebruiken om deze weer te geven, in bijvoorbeeld energie advies. De vraag is echter wat de commerciële waarde van deze informatie is en of het dus als inkomstenbron gezien kan worden. Verder zijn er, vanuit het netwerkbedrijf, niet echt inkomstenbronnen aan te wijzen.

3. Wat zijn voor de consument de belangrijkste variabelen waarop ze hun keuze voor een energieleverancier kiezen, en de kwaliteit van levering beoordelen?

Prijs en servicegraad zijn de belangrijkste indicatoren. Onder servicegraad valt vooral de administratieve afhandeling van verhuizingen, facturen e.d. De laatste jaren is prijsbewustheid van de consument groter geworden, vooral door een toename van de energieprijzen. Netwerkkosten zijn gereguleerd, dus de leverancier moet het verschil maken. De ene groep klanten is hier gevoeliger voor dan de andere. Er blijft voor deze klanten een psychische drempel, o.a. door het imago van de sector.

4. Wat zijn mogelijke toepassingen voor het weergeven of gebruiken van meter data in de woning van de consument?

De marktdiscussie die nu speelt is hoe het verbruik weergegeven moet worden op de meter, in KWh of in Eurowaarden. De vraag blijft bovendien hoe vaak met op de display kijkt en vervolgens handelt op basis van die informatie, zoals de wasmachine uitzetten. Er is altijd een groep gebruikers die geïnteresseerd is in deze informatie, maar dit is een heel klein percentage van de markt. Je kunt het verbruik vergelijken met de automarkt, als de benzine 2x zo duur wordt gaat men niet 2x zo weinig autorijden. Toegankelijkheid van informatie aan de kantzijde is dan heel belangrijk, zoals bv via internet. De consument zal bewuster worden van het energieverbruik, maar ik verwacht niet dat hij hier anders door zal gaan handelen. Vanuit de netbeheerder is vooral load balancing van belang. En ontwikkelingen zoals micro-WKKs, hoe dit te managen op middenspanning niveau. Fraude bestrijding is ook een belangrijk punt. Je weet nu ook de omvang van fraude, maar dit is op landelijk niveau en weet je pas achteraf, als de meterdata bekend is. Tot middenspanning is er inzicht in de energiestroom. Bovendien is niet alle meter data op hetzelfde moment beschikbaar en is deze data niet precies genoeg. Fraude zal echter niet significant bijdragen aan een positieve business case, het zal slechts bijdragen in de kostenbesparingen.

5. Zal de energieleverancier gebruik maken van deze mogelijkheden?

Ik zie dit soort toepassingen vooral bij het nieuwe meet data bedrijf. Waarschijnlijk verschillen de visies tussen klassieke leveranciers en innovatieve nieuwkomers op de markt. Een benchmark tussen gelijksoortige huishoudens zal zeker de interesse hebben van relatieve veelverbruikers, waarbij zij zich zeker af zullen vragen wat de redenen zijn voor het hoge energiegebruik. Dit kunnen bewuste redenen zijn, zoals een waterbed. Ook hiervoor geldt dat bewustzijn niet noodzakelijk hoeft te worden omgezet in handelen. Als netbeheerder weet je de gezinssituatie niet, de leverancier krijgt alle data 2 maandelijks van de netbeheerder, en zou hiertoe beter in staat zijn, zoals het gebruik van marketing tools voor het definiëren van gebruikersgroepen.

Voor de netwerkbeheerder zal het op korte termijn veel belangrijker zijn dat alle systemen met elkaar kunnen communiceren, onafhankelijk van het type meter. Een standaard of open source gedachte is echt noodzakelijk om voldoende dekkingsgraad te krijgen. De P1 poort moeten de externe dienstenaanbieders maar uitzoeken, voor de netbeheerder is vooral de P3' en de P4 poort

van belang, voor het uitlezen van meterdata en communicatie naar de netbeheerder. Deze communicatie wil je uniform hebben, ongeacht het type meter. Sinds kort wordt deze discussie ook meegenomen in het NTA document. De vraag is of meterleveranciers dit mogelijk willen maken en de afgeschermdde protocollen willen opgeven. Ik verwacht wel dat we een probleem krijgen als ze dit niet doen, dan krijg je veel parallelle systemen en moet je maatwerk gaan bouwen om deze informatie gezamenlijk te verwerken. Anders heb je niets aan je slimme infrastructuur.

6. Zullen derde partijen gebruik maken van deze meter data voor het aanbieden van diensten, zoals "home automation", aan de consument?

Ik denk dat het kan, maar de vraag blijft of de klant hier toegevoegde waarde in zit. Het is leuke data, maar is het ook waardevolle informatie. De vraag is ook of je wilt besparen, t.o.v. het afschakelen van apparaten. Ook het gebruiken van apparaten op andere tijdstippen heeft wel wat randvoorwaarden, zoals energie verbruik van de timer, en de apparatuur zal ook duurder zijn dan gewone apparatuur. De verschillen in tarieven moeten dan ook groot genoeg zijn wil de consument zijn handelen wijzigen.

7. Is deze ontwikkeling een kans of een bedreiging voor de elektriciteitsleverancier?

De netwerkbeheerder is verplicht data aan te leveren aan gecertificeerde bedrijven, dus vanuit de netwerkbeheerder is dit neutraal. Vanuit de leverancier is dit meer een kans, aangezien hij ook dit soort diensten kan aanbieden, bijvoorbeeld gelieerd een Overige Diensten Aanbieder (ODA).

8. Wat zijn de mogelijkheden voor het aanbieden in pakketvorm (bundelen) van levering van elektriciteit en overige diensten?

De leverancier kan een sterk pakket aanbieden aan de klant, als de klant een single point of service heeft. Een aanbieder voor meerdere diensten kan de klant een simpele oplossing bieden voor wat hij wil hebben, dit is wat de klant zoekt. De meter is eigendom van de netwerkbeheerder en het communicatiekanaal ook, voor toegevoegde diensten waarbij apparatuur communiceert via dat datakanaal en de meter moet de leverancier dus zorg dragen voor het verwerken en doorcommuniceren van deze data. Dit zijn geen gereguleerde diensten. De netbeheerder is echter geen commerciële organisatie, werkend met gereguleerde tarieven en een expliciete functieomschrijving; het bewaken van de leveringszekerheid. Dit creëert een spanningsveld op het moment dat er commerciële diensten via de infrastructuur geleverd worden. De netbeheerder zal zich hier niet snel mee inlaten, los van het feit of het wettelijk is toegestaan deze informatie te communiceren. Het zal afhangen van hoe de P1 poort aansluit bij de dienstenaanbieder. Deze dienstenaanbieder zal dan zelf voor een eigen infrastructuur moeten zorgen. De infrastructuur kan binnen het huidige wettelijk kader hiervoor niet gebruikt worden, los van het feit of er een duidelijke drive voor de netwerkbeheerder is om deze infrastructuur te gaan exploiteren. De netbeheerder is geen commerciële, flexibele organisatie, waardoor nieuwe bedrijven of bestaande bedrijven als KPN dit waarschijnlijk veel sneller kunnen.

9. Welke diensten zijn hiervoor het meest geschikt zijn en wat is de toegevoegde waarde voor de consument?

Fraude, verbeteren van load balancing worden mogelijk gemaakt. De impact van load balancing en forecasting is moeilijk in te schatten. Met slimme meters wordt de periode waarover je wilt voorspellen veel kleiner, dus wordt de behoefte aan informatie ook kleiner. Je kan bovendien veel nauwkeuriger voorspellen, omdat je bijna real time informatie hebt, die je direct met bijvoorbeeld weersinvloeden kunt gebruiken. Anderzijds, is de kwaliteit cq nauwkeurigheid van forecasting op dit moment lastig in te schatten, dus dit geldt ook voor mogelijke besparingen en verbeteringen.

10. Welke mogelijkheden bestaan er voor de elektriciteitsleverancier om de operationele kosten te verlagen door gebruik te maken van de slimme meter?

De NTA heeft de optie om in geval van code rood collectief af te schakelen. Een mogelijke tussensituatie zoals in Florida a.h.v. convenience loads is hier ook denkbaar. Ik verwacht niet dat je het als netbeheerder kan maken om direct volledig af te schakelen omdat je niet weet wat daarachter hangt, vanwege de sociale consequenties, bijvoorbeeld nier dialyse patiënten. De klant zal dan via de leverancier een bepaald contract hebben, waardoor hij tot een bepaald niveau geknepen kan worden. De vraag is echter hoe ga je dit administreren en welke rol spelen de leverancier en de netbeheerder hierin. De leverancier blijft de toegang tot de klant, de contactpersoon. Een andere vraag is welke partij beslist wie en waar afgeschakeld wordt. In het nieuwe marktmodel, zal het leveranciersmodel dat niet de netbeheerder zijn die contract met de klant. In het geval van afschakelen kan de netbeheerder deze verantwoordelijkheid ook neerleggen bij de leverancier. Hier is ook een heel ander wettelijk kader voor nodig. De marktmodellen zijn nu nog in ontwikkelingen en wordt hier niet direct rekening mee gehouden. De vraag is bovendien of er behoefte is aan dit soort diensten.

11. Hoe kan de consument gemotiveerd worden om het energieverbruik in piek perioden te verlagen?

Klassiek geval is een nieuwsuitzending waarin consumenten worden gevraagd b.v. airco's af te schakelen. Het blijft natuurlijk de vraag of klanten individueel meewerken. Het besef zal er vaak wel zijn bij het 1^e apparaat dat je aanzet, maar geldt dit ook voor de 2^e? Als deze besparingen gelijk in eurowaarden kunnen worden weergegeven, zal de bereidheid bij consumenten groter zijn. Nu is die incentive er niet en moet je maar hopen dat voldoende consumenten daadwerkelijk afschakelen. Weergave van eurowaarden zal voor de consument de belangrijkste factor zijn.

12. Welke veranderingen in energie verrekening en afrekening zijn te verwachten en hoe zal de consument hier op reageren?

Ik geloof voor het merendeel van de consumenten niet in een hoge mate van prijselasticiteit. Een voorwaarde is dat het bespaargedrag direct zichtbaar is voor de consument. Een keer per jaar heeft dus geen zin, dus dit moet gebruiksvriendelijk worden weergegeven, bv via internet. Er zal een groep zijn die het leuk vindt zeer gedetailleerd inzicht te hebben in zijn verbruik en hier ook in grote mate prijselastisch op zal reageren, maar over het algemeen verwacht ik dat de prijselasticiteit erg laag is wat betreft incentives voor het verlagen van energieverbruik.

13. Is het verlagen van het energie verbruik en het managen van energie verbruik in huis een verantwoordelijkheid van de elektriciteit leverancier?

Zoals het netwerkbedrijf als energieleveranciers profileren zich als maatschappelijk verantwoord. Ik denk niet dat dit puur winstbejag is, maar ook image building en een achterliggende ideologie. Ik denk dat een aantal bedrijven zich daadwerkelijk willen positioneren als maatschappelijk verantwoord. Micro-wkk's leveren ook energie terug aan het net, waardoor je direct met de netbeheerder te maken heeft. De leverancier factureert alleen het verschil tussen geleverd en terug geleverde energie. Ik denk dus ook niet dat micro-wkk's en aanhangende zaken bij de leveranciers liggen. Als je micro-wkk's kan sturen, dan is de vraag wat er gebeurt in het locale net als iedereen energie gaat terugleveren bij een hoge prijs. Je kan dan grote schommelingen in de prijs krijgen of een te groot vermogen. Als dit niet gebruikt wordt en dus verloren gaat is dit natuurlijk ook niet maatschappelijk verantwoord. Ik denk dat energiebedrijven oprecht bezig zijn om slim en verantwoord energie te verbruiken. Gezien het conflicteren belang blijft het echter lastig om te bepalen.

Smarter Metering

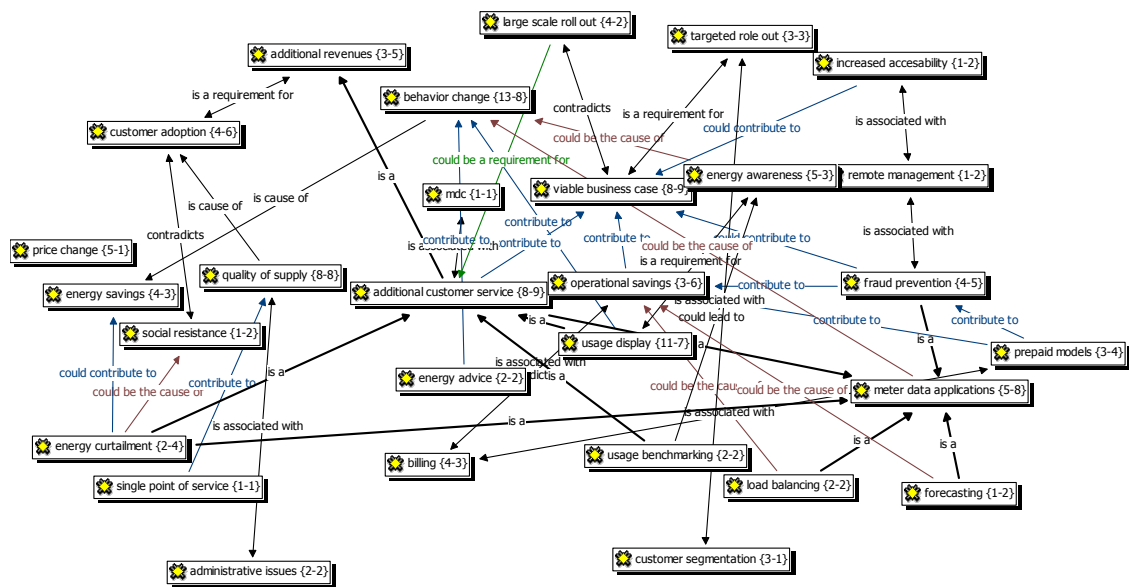


Figure 57 Interview analysis Eric Boonstoppel

Appendix 8.4. Interview Richard Bevelander – Eneco slimme meter platform

Richard Bevelander, ENECO Energie
Manager slimme meter platform

1. Als de Europese verplichting om slimme meters te plaatsen er niet was geweest of op dit moment zou worden afgeblazen, zouden de meters dan nog geplaatst worden?

We waren al begonnen voordat de Europese regelgeving eraan zat te komen. Dit deden we alleen voor specifieke klanten, die hierop zaten te wachten, aangezien hier een business case voor te maken was. Voor alle andere klanten niet. Bij de kleinverbruikers zou het ingezet worden om de klant te binden, of liever nog om klanten in “vijandelijk” gebied te kunnen werven. De slimme meter zou dan alleen worden ingezet bij klanten waarbij het mes aan twee kanten snijdt; waar wij minder kosten hebben, zoals bv bij slecht betalende klanten incassokosten, prepaid is hier een goed voorbeeld van, en waar klanten iets aan hebben, zoals inzicht in gebruik, als ze daar behoefte aan hebben. De businesscase was gericht op een doelgroepenbenadering gericht om deze klanten actief te benaderen en te werven. De businesscase was dan ook gebaseerd op de waarde die een nieuwe klant heeft. In het huidige model is dit volledig van de baan, aangezien ieder huishouden slimme meters krijgt. Hierbij mag er geen voordeel meer zijn voor de leverancier (level playing field), een van de redenen waarom de uitrol bij de regionale netbeheerder is neergelegd. Er is op dat gebied van marktwerking dan ook nauwelijks sprake meer en je moet het echt in de toegevoegde dienstverlening gaan zoeken om het verschil te maken. Dit model is ook wel weer een kans, op het moment dat iedereen een slimme meter heeft en alle data beschikbaar is. Je kan hiermee dan leuke diensten aanbieden, alleen duurt het even voor we zover zijn. We zouden juist slimme meters op willen hangen bij afnemers die nu nog niet tot onze klantengroep behoren.

2. Wat zijn naast het leveren van elektriciteit mogelijke inkomstenbronnen voor de leverancier, mogelijk gemaakt door de slimme meter of slimme infrastructuur?

Uiteindelijk zijn die inkomsten er wel. We zien het niet meer als inkomstenbron, omdat er geen volledige business case meer ligt voor alle aansluitingen. Het is dan ook een investeringsmodel waarbij door de toezichthouder wordt vastgesteld hoeveel je erop mag verdienen. Als je daar slim mee omgaat kan je er natuurlijk wel klanten mee aan je binden, maar we zien dit niet als extra inkomstenbronnen. Het kan wel zo zijn dat je diensten nodig hebt om slimme meters uit te rollen. Voor andere Eneco-onderdelen zijn er ook mogelijkheden. Er zijn bijvoorbeeld veel monteurs nodig en Eneco Infra is de grootste aannemer van Nederland, waar veel andere maatschappijen het installatiewerk hebben uitbesteed. Ondanks dat we het druk zat hebben met de uitrol van onze eigen 4 mln meters, ligt hier wel een kans. Bovendien heb je een platform nodig om deze meters uit te lezen, dit hebben we al, want dat doen we al geruime tijd.

3. Wat zijn voor de consument de belangrijkste variabelen waarop ze hun keuze voor een energieleverancier kiezen, en de kwaliteit van levering beoordelen?

Klanten gaan vaak bij een bepaalde leverancier weg uit frustratie, of als het prijsverschil erg groot is. Op dit moment is dat laatste niet het geval, dus is het vooral uit ontevredenheid over bijvoorbeeld een foute nota of een te laat verwerkte verhuizing dat klanten opstappen. Daarnaast is het een stukje imago waar de klant voor kiest. Eneco richt zich nadrukkelijk op een groen imago, waarvoor klanten specifiek kunnen kiezen. Ik heb niet het idee dat klanten massaal overstappen, zoals in de UK: ik meen 3-4% in vergelijking met 25% in de UK het eerste jaar na liberalisering.

4. Wat zijn mogelijke toepassingen voor het weergeven of gebruiken van meter data in de woning van de consument?

Je gaat er dan vanuit dat de data vrij toegankelijk is en dat het haalbaar is om deze data uit te lezen. Dat zie ik nog niet direct gebeuren omdat de vraag is of de data via de zogenoemde P1 poort bij de klant beschikbaar komt, dezelfde is als de data die via de CTS toegankelijk wordt gemaakt. Het gaat er om wat je met deze data doet. Als je dit weet te vertalen naar iets wat de klanten snappen, kan dit het gedrag tijdelijk beïnvloeden en hopelijk wat structureler. Als het vertaalt naar geld zijn klanten hier vaak wel door ge-triggered, voor andere klanten werkt dit misschien sterker als je het vertaalt naar CO₂ uitstoot o.i.d. In ieder geval moet je het uitdrukken in iets wat de klant begrijpt in plaats van naar abstracte begrippen als de KWh of m³ prijs. We hebben proeven gedaan met prepaid, waarbij we energieverbruik op woningniveau hebben gemeten. Wat we hier zagen is dat klanten wel gingen experimenteren en bijvoorbeeld gingen kijken wat het kostte om een wasje te draaien door het verschil af te leiden in energie tegoed. Op basis van een lijst van energie slurpers die aan de klant werd gegeven gingen zij experimenteren en konden we vervolgens advies geven. We wisten niet per klant wat zij in huis hadden staan, maar we maakten wel het energieverbruik en de kosten van het verbruik inzichtelijk. Mensen keken ook vaak op dit display, daarom hebben we een remote display ontwikkeld dat mensen bv op de keukentafel konden zetten. Het is moeilijk om te vergelijken of klanten hun gedrag blijvend veranderen. We hebben het ze direct gevraagd, en de klanten dachten van wel. Dat is voor ons het belangrijkste. Een grove berekening geeft aan dat er structureel tussen de 5% en 10% werd bespaard. Het is wel zo eerlijk dat je de geldende tarieven in rekening brengt bij de klant. Het lijkt bijvoorbeeld ook eerlijk de APX prijs inclusief een bepaalde opslag in rekening te brengen. Als deze prijs zichtbaar is voor de klant kan die op dat moment zelf bepalen of hij energie af wil nemen en of je energie terug gaat leveren en hier zelfs mee kan verdienen. Ik zie mensen echter niet zo snel day-traden met de APX. Als je via decentrale opwekking ook terug kan leveren, kan je hier echt op gaan managen, zodat je je airco uit laat omdat je weet dat dit je bijvoorbeeld 10 euro kost. De glastuinbouw redeneert op een zelfde manier en bekijkt wanneer het gunstig is om af te nemen of terug te leveren. Als je consumenten zou verenigen kan je een zelfde effect bewerkstelligen. Als je meter data hebt van al deze consumenten kan je dat gaan aggregeren en

op basis daarvan gaan managen. Dit zullen klanten niet zelf doen, maar het kan een dienstenleverancier zijn die dit collectief aanbiedt en dit voordeel doorberekend naar de klant.

5. Zal de energieleverancier gebruik maken van deze mogelijkheden?

Ik verwacht en ik hoop van wel. Het zou leuk zijn om te weten wat je verbruikt ten opzichte van de rest van je wijk of van de stad. Dit is echter niet iets waarmee je dagelijks aan de gang gaat. Als er een financiële prikkel achter zit kan dit wel interessanter worden. Energieleveranciers kunnen deze data aan de andere kant weer gebruiken voor diensten die niet direct energie gerelateerd zijn via die P1 poort. Je kan allerlei signaaltjes doorsturen naar de klant. Denk bijvoorbeeld aan een broadcast-sms. Als iedereen een P1 poort heeft kan je die ook voor dergelijke veiligheidstoepassing gebruiken. Vanuit de overheid is veiligheid een belangrijke toepassing en zeker voor applicaties die een signaleringsrol hebben. Bijvoorbeeld monitoren van apparatuur of het detecteren van gaslekken. Op dit moment heeft iedereen echter al meerdere communicatielijnen in huis, dus ik verwacht eigenlijk niet dat dit nu de “gateway to heaven” is.

6. Zullen derde partijen gebruik maken van deze meter data voor het aanbieden van diensten, zoals "home automation", aan de consument?

Ik denk dat er wel partijen zullen zijn die er bovenop zullen springen zodra de penetratiegraad voldoende is om diensten te kunnen gaan aanbieden. Ik denk dat dit partijen zijn die er ook verstand van hebben, hoe je dit soort dingen doet. Wat je ziet naast kleine partijen die zich richten op slimme diensten is er ook interesse uit de bankwereld, die zich met name richten op variabele betaalmomenten door billing over te nemen van de leverancier. Hetzelfde geldt voor telecombedrijven, die merken dat het nu hoofdzakelijk om communicatie gaat en zelf veel ervaringen hebben met billing. Telecombedrijven presenteren zich ook steeds meer ICT bedrijf, waardoor deze werelden steeds meer op elkaar gaan lijken en we naar een geïntegreerd model toe gaan.

7. Is deze ontwikkeling een kans of een bedreiging voor de elektriciteitsleverancier?

Als ze niks zouden doen denk ik dat het een grote bedreiging is. Als je echter op het juiste moment, de juiste richting kiest biedt het ook zeker kansen. De markt is heel erg aan het veranderen waar na 150 jaar ineens nieuwe producten bijkomen die je ook moet vermarkten en aan de man brengen. Deze producten moeten niet alleen verzonden worden door marketing, maar ze moeten ook daadwerkelijke gerealiseerd kunnen worden. Het huidige model gaat op zijn kant, wat voor nieuwe partijen heel veel mogelijkheden biedt, zeker omdat ze weinig of geen historie met zich meedragen.

8. Wat zijn de mogelijkheden voor het aanbieden in pakketvorm (bundelen) van levering van elektriciteit en overige diensten?

Ik verwacht dat telecom producten en bancaire producten naar elkaar over gaan lopen. Als je nu hogere termijn bedragen betaalt ben je eigenlijk ook aan het sparen. Ik verwacht dat een energiebedrijf geen bank wil spelen, maar een bank wil wel bank blijven spelen, zodat je bijvoorbeeld kan sparen voor je hypotheek of je kunt speculeren op de APX prijs.

9. Welke diensten zijn hiervoor het meest geschikt zijn en wat is de toegevoegde waarde voor de consument?

Het leveranciersmodel en het capaciteitstarief kunnen het voor de consument al een stuk helderder maken. Een tussenweg waarbij je vaker standen hebt van de consument had ook al voldoende geweest om aan de wettelijke eisen te voldoen, maar hier heeft niet elke consument een slimme meter voor nodig. Op lange termijn wil je wel dat elke klant een slimme meter heeft voor innovatieve diensten, maar op korte termijn verwacht ik niet heel veel toegevoegde waarde voor de consument. Bij veel producten, zoals domotica, is de klant vaak niet bereid hier veel

voor te betalen, dus is de business case vaak erg dun. Als er financiële incentives zijn om dit soort producten af te nemen zie ik er in de toekomst wel een markt voor. Voor andere domotica, die bijvoorbeeld bijhouden of je koelkast leeg is zie ik voorlopig nog weinig markt. Bovendien is het soort techniek wat bijvoorbeeld je wasmachine aanstuurt vaak erg kwetsbaar, en moet je er veel aan doen. De consument wil nu juist zo min mogelijk gedoe. Ik geloof wel in de ontwikkeling van een smart grid in huis, waarbij de micro-wkk's gekoppeld kunnen worden zodat je in huis, of op wijkniveau een soort van energiemanagement kan doen.

10. Welke mogelijkheden bestaan er voor de elektriciteitsleverancier om de operationele kosten te verlagen door gebruik te maken van de slimme meter?

Er is een hele reeks business cases geschreven, maar voor Nederland als geheel zie ik persoonlijk voorlopig weinig kostenbesparingen. Door slimme meters op te hangen voorkom je bijvoorbeeld nog geen fraude, je signaleert het alleen iets eerder. Bovendien vind fraude plaats voor de meter, dus je weet wel dat er fraude is op wijkniveau, maar je weet niet waar het plaats vindt en hoe je het kan verhelpen. Forecasting zou iets beter kunnen worden, maar daarvoor hoef je niet heel Nederland van een slimme meter te voorzien. Steekproefsgewijs zou dit een stuk beter kunnen en dus ook een stuk goedkoper. Voor de hele populatie was er volgens ons geen sluitende business case. Er wordt nu een enorme investering gedaan die als alle netbeheerders goed hun werk doen ook grote kansen biedt voor nieuwe diensten. Het duurt alleen wel even voordat de uitrol klaar is. Het kost nu al veel moeite om een technische standaard af te spreken. Ik ben wel voor een modulaire aanpak, waarbij je het meterologie gedeelte apart ziet van het communicatie gedeelte met het ook op verschillen in afschrijvingstermijn.

11. Hoe kan de consument gemotiveerd worden om het energieverbruik in piek perioden te verlagen?

Je kan het op heel veel manier doen. Het komt er uiteindelijk op neer dat je de klant bewust maakt van wat hij doet. Dat je zijn gedrag inzichtelijk maakt en hier consequenties aan verbindt. Je kan het met grafieken doen, via verschillende communicatiemiddelen en media. De boodschap kan ook verschillen, van aantallen bomen tot oliereserves. Daar geloof ik wel in. Ik verwacht dat leveranciers hier wel creatiever in worden. Het gaat om de terugkoppeling, niet alleen consequenties op langere termijn, maar ook directe feedback over zijn gedrag. Aan de andere kant geloof ik ook niet dat je te specifieke informatie moet geven, aangezien die niet representatief is voor het gebruik over langere termijn, is zoals je verbruiksmeter in de auto bij gas geven sterk oploopt. Als je dat extrapoleert denk je ook dat je op een tank niet ver zult komen. Je moet het verbruik dus wel over een bepaalde periode laten zien.

12. Welke veranderingen in energie verrekening en afrekening zijn te verwachten en hoe zal de consument hier op reageren?

Je moet de tariefstructuur los zien van het betaalmoment. Ik geloof absoluut dat we naar dynamische tarieven gaan, die afhankelijk van iets of van wat je met de klant hebt afgesproken. Hoe je hier uiteindelijk voor betaald, of dat prepaid of postpaid is maakt eigenlijk niet uit. Zeker niet wanneer je het met redelijk actuele data kan berekenen. Het energiebedrijf kan van bepaalde klanten willen dat ze vooraf betalen, i.v.m. wanbetaling bijvoorbeeld, maar als klant wil je gewoon dat je de keuze hebt. Achteraf betalen zou een duurder product kunnen zijn dan vooraf betalen. Bij huidige betaalrekeningen werkt dit hetzelfde en betaal je rente over het bedrag dat je rood staat, en is dit vooraf overeengekomen. Veel anders werkt dit niet met de huidige voorschotbedragen. Ik zie ook gebeuren dat een leverancier een bundel aanbiedt met een bepaald verbruik. De klant heeft dan ook helemaal geen inzicht meer nodig in het verbruik, behalve als de gebruiker hier consequent boven zit. Alleen de leverancier hoeft dan te weten wat er werkelijk verbruikt wordt. We zijn nu in de sector zo hard bezig met zijn allen om die meters uit te rollen,

dat we er bijna niet aan denken om leuke diensten aan te gaan bieden. Qua conceptontwikkeling zijn we hier binnen ENECO wel mee bezig.

13. Is het verlagen van het energie verbruik en het managen van energie verbruik in huis een verantwoordelijkheid van de elektriciteit leverancier?

Het is wel de maatschappelijke verantwoordelijkheid van een energiebedrijf verantwoordelijk met energie om te gaan. Als we dat als leverancier kunnen doen moeten we dat ook zeker niet nalaten. Je ziet ook dat steeds meer bedrijven zich als zodanig profileren, Eneco loopt daarin voorop. We proberen de klant dan ook een klein beetje op te voeden, maar ik denk dat alle leveranciers wel een bepaalde maatschappelijke verantwoordelijkheid hebben in bijvoorbeeld het aanboren van duurzame bronnen.

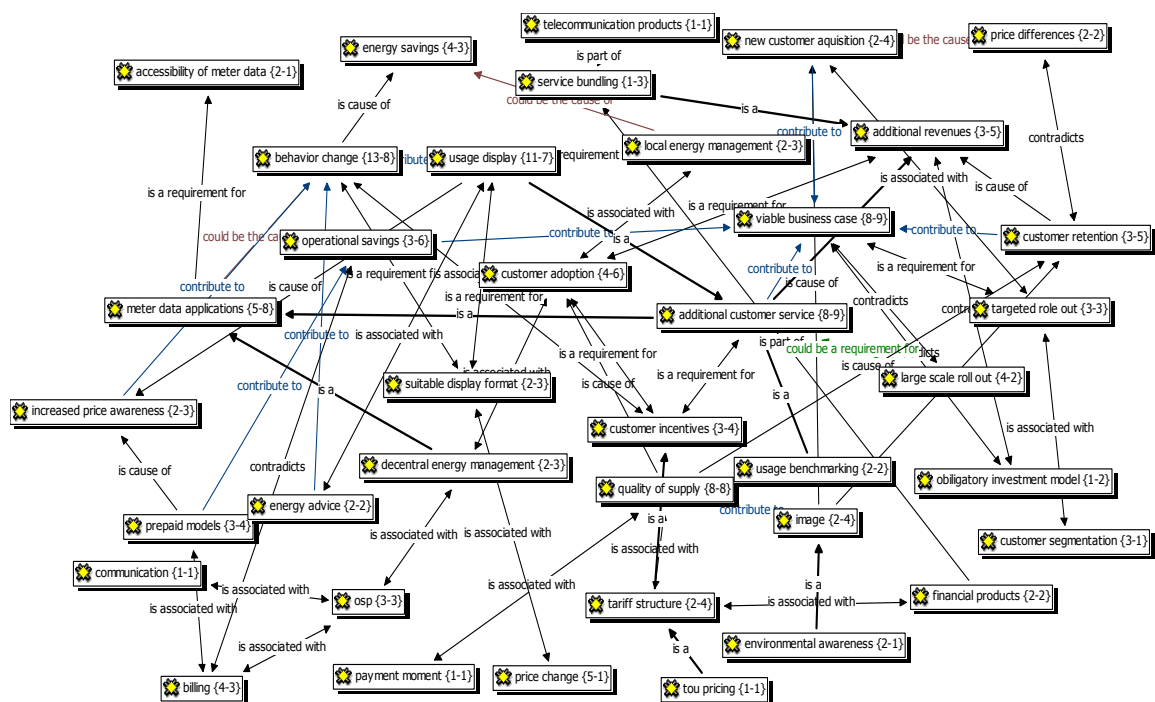


Figure 58 Interview Analysis Richard Bevelander

Appendix 8.5. Interview Barrie van de Merbel, E-On Benelux

Barrie van de Merbel – E-On Benelux

Manager operational support, afdeling delivery and dispatch, waaronder smart metering

1. Als de Europese verplichting om slimme meters te plaatsen er niet was geweest of op dit moment zou worden afgeblazen, zouden de meters dan nog geplaatst worden?

Ja, ik zie dit zeker zitten. We doen dit al een jaar of 6-7 voor grootindustriële gebruikers, waarvan je de verbruiksgegevens (near) real-time kan volgen. Dit heeft zeker voordelen. Op het moment dat je één b2c klant hebt zegt dit niet zoveel, maar voor een cluster b2c klanten kan je hier zeker op sturen. Of de investeringen tegen de kostenbesparingen opwegen is altijd lastig in te schatten. Je kijkt dan puur vanuit het gezichtspunt van de netbeheerder, waarvoor ik denk dat er uiteindelijk wel een break-evenpoint is. Als je het zelf zou uitrollen zou je dit doen voor

specifieke doelgroepen, maar als het gebeurd aan de hand van wetgeving moet je het totale plaatje bekijken. Vanuit de leveranciers is het echter sowieso interessant, omdat de meeste kosten bij de netbeheerders liggen.

2. Wat zijn naast het leveren van elektriciteit mogelijke inkomstenbronnen voor de leverancier, mogelijk gemaakt door de slimme meter of slimme infrastructuur?

Je moet de slimme meter dan anders gaan benaderen. Je moet dan wat verder kijken in de richting van o.a. load management, waarbij je klanten op een display de stroomprijs laat zien. Een lage stroomprijs kan je dan op verschillende manieren weergeven, bijvoorbeeld aan de hand van een kleurtje, waardoor de consument weet dat hij nu bijvoorbeeld kan gaan wassen, drogen etc, aangezien wij dan de stroomprijs voor een vaste periode garanderen, zoals een half uur of meerdere uren. Hier kan je aan denken. Je kan ook combinaties verwachten met winkelketens om via het display bepaalde producten aan te prijzen, je kan het ook koppelen met telefonie, kabel etc. Ik verwacht wel initiatieven van energiemaatschappijen. Hier doen we zelf ook een studie naar, maar ik verwacht zeker een actieve rol ook van andere de leveranciers.

3. Wat zijn voor de consument de belangrijkste variabelen waarop ze hun keuze voor een energieleverancier kiezen, en de kwaliteit van levering beoordelen?

Dit is eigenlijk de belangrijkste vraag. Zelf denk ik dat de consument wil weten wat nu het verbruik is in huis. Er zal ook een kleine groep zijn die geïnteresseerd is in meer informatie, maar die mensen zullen dat vooral willen vanuit interesse in de techniek. Als je kijkt naar de doorsnee burger, gaat het maar om één ding: hoeveel brengt het me op als ik zo'n ding ophang. Die denken niet verder. Een Nederlander blijft een kuddedier, en heeft dus een heel algemeen verbruikspatroon. Iedereen staat om 7 uur op en doet om 23h het licht weer uit. In het buitenland zitten hier grotere verschillen in, waardoor je meer uit kunt gaan van een doelgroepen benadering, wat in Nederland niet op gaat. Met de factor prijs of door andere producten aan te bieden verwacht ik wel dat je zo'n markt kan maken, maar dit zal geleidelijk moeten groeien. Ik verwacht dat de prijs, samen met de prikkels vanuit het milieu en de wetgeving de belangrijkste drijfveel zullen zijn. Wetgeving is dan verplicht, maar ik verwacht dat met name milieu wel een goed middel kan zijn wat de klant kan waarderen om zijn verbruik buiten de piekperiodes te verspreiden. Je moet met alles wat je de klant voorlegt wel kunnen aantonen dat er een verandering is t.o.v. het oude gebruik, bijvoorbeeld uitgedrukt in een CO2 besparing. Het duurt echter een tijd voordat je de klant zo ver hebt dat hij bewust is dat zelfs een kleine verandering al belangrijk kan zijn op landelijk niveau. Je moet met name in grote aantallen denken. Om dit in kaart te brengen hebben we gekeken naar het percentage gebruikers dan in de beginperiode van groene stroom is overgestapt, aangezien je deze situatie kunt vergelijken. Je ziet dan dat er een vast percentage van ong. 15-20% van de huishoudens is die gevoelig is voor de laatste snufjes en prikkels. Daarnaast heb je nog een grote groep die alleen prijsgedreven is. Als je kijkt naar Eenergie:direct en de mensen die hiernaar overstappen, is dit ongeveer 30%. Ik verwacht dat deze groep wel zal toenemen. Van deze mensen kan je na een eind van hun contract verwachten dat ze op zoek gaan naar een nieuwe leverancier. Daarnaast heb je een groep mensen die zich vooral zal richten op de dienstverlening, zoals correcte rekeningen e.d. Maar dit is vaak niet de groep die switched. Maar het is wel een gegeven dat de rekening veel nauwkeurig wordt en hiermee de dienstverlening beter wordt. Als de relatie vervolgens goed is, is het de kunst om nog meer producten hiermee te bundelen en extra producten aan te bieden. Het gaat dan vooral om imago en ervaringen waarvoor klanten voor een energieleverancier kiezen.

4. Wat zijn mogelijke toepassingen voor het weergeven of gebruiken van meter data in de woning van de consument?

In het beginstadium zie ik hier helemaal niets, want de huidige codes houden hier helemaal geen rekening mee. De netbeheerder die de meter plaatst, zal dit tegen zo laag mogelijke kosten doen,

dus daar hoeft je geen extra functionaliteit van te verwachten. De p1 poort biedt wel de mogelijkheid om verbruik af te lezen. Mensen kunnen ook actief bijdragen aan de stabiliteit van het net, bijvoorbeeld bij schaarste. De leverancier zou bijvoorbeeld bij een hoge APX prijs de kant een vergoeding kunnen geven als hij op dat moment minder energie verbruikt.

5. Zal de energieleverancier gebruik maken van deze mogelijkheden?

Ik verwacht dat de energieleverancier dit in samenwerking zal doen met een derde of vierde partij. Zoals je nu BCC ziet die groene producten aanprijst, kan je dit gaan combineren, bijvoorbeeld: bij het kopen van een zuinige wasmachine, korting op je energierekening. Of korting op een groene machine, bij een bepaald contract. Dit zal niet voor iedereen gelden, maar je kan deze informatie wel laten zien op een schermje. Via de P1 poort is dit soort diensten lastig, omdat je alleen verbruik of prijsinformatie af kan lezen. Hoe de leverancier en derde partijen de klant gaan bereiken met gerichte adviezen of producten dat is een lastig vraagstuk vanuit de leverancier. Als je extra diensten wilt aanbieden is de meter die de netbeheerder ophangt niet voldoende, dus dan wil je daar een luxe meter gaan ophangen. Als de klant echter switched na een jaar, ben je die investering volledig kwijt. Hier lopen op dit moment studies naar hoe we dit vorm moeten geven. We zoeken naar manieren waarop we mensen kunnen triggeren, en dit is geen gemakkelijk marketingverhaal. Ik denk niet dat het haalbaar is voor consumenten om de P1 poort op basis van seconden waarden uit te lezen, zeker niet voor de hele groep. Je kunt wel verschillende bestaande infrastructuren koppelen, waardoor je kosten kunt gaan delen. Je kan dan ook over hele andere marges gaan praten. Ik vermoed dat de markt na 10-15 jaar nieuwe meters zal gaan willen, omdat het communicatiegedeelte niet meer voldoet. Dit is een gevecht tussen de netbeheerder en de leverancier. De netbeheerder wil zo min mogelijk om de kosten te drukken, terwijl wij met load management aan de gang willen en dus wat meer functionaliteit willen zien. Binnen het huidige marktmodel kiest de netbeheerder niet voor wat de klant of wat de maatschappij eigenlijk zou willen. Ook dit domain zou naar mijn idee vrij moeten zijn.

6. Zullen derde partijen gebruik maken van deze meter data voor het aanbieden van diensten, zoals "home automation", aan de consument?

Deze partijen zijn hier al druk mee bezig. Het is nog niet concreet en op dit moment kan je er eigenlijk pas over na gaan denken als je het hebt over nieuwbouw, waarin deze apparatuur gelijk wordt verwerkt. Ik zie hier zeker toekomst in, maar voorlopig alleen nog bij nieuwbouwprojecten of eventueel bij renovaties. Draadloos kan een oplossing zijn, maar je zit dan toch vast security eisen en vrij dure apparatuur. Je kan wel ver gaan, dat bijvoorbeeld de wasmachine aangaat op basis van een bepaalde energieprij. Ik ben ervan overtuigd dat de intelligentie op een gegeven moment in de apparatuur zelf komt te zitten. Een tussenstap is dat er apparaatjes tussen zitten die deze stuursignalen oppikken en vervolgens apparatuur in- of uitschakelen.

7. Is deze ontwikkeling een kans of een bedreiging voor de elektriciteitsleverancier?

Ik zie dit als een kans om de concurrentiepositie te verbeteren en om de milieudoelstellingen na te streven. Ik denk dat je met dit soort producten beter de doelstellingen bereikt dan bijvoorbeeld met windmolenparken die draaien op subsidie. Dit is bedrijfseconomisch nu niet rendabel, omdat je energie niet efficiënt kan opstaan.

8. Wat zijn de mogelijkheden voor het aanbieden in pakketvorm (bundelen) van levering van elektriciteit en overige diensten?

Je kan het doen met apparatuur of telecommunicatie en kabel. Of je kan op basis van de prijs switchen tussen gasprijs en elektriciteitsprijs zoals gebeurd bij micro-wkk's. Je hebt het dan ook weer alleen over nieuwbouw, omdat het in bestaande bouw niet efficiënt is en simpelweg te duur. Ik zie hier wel brood in, want binnen nu en 5 jaar worden de micro-wkk's echt uitgerold. Vervolgens kan je aan de hand van smart meters echt lokaal gaan managen. Ik verwacht dat in

eerste instantie het initiatief hiervoor zal liggen bij de leverancier. Als de consument eenmaal wat gewend is zal de vraag naar andere producten ook toenemen. Het is dan ook de uitdaging om in eerste instantie een dusdanig goed systeem weg te zetten, waardoor je de klant bindt en hij niet meer over wilt stappen.

9. Welke diensten zijn hiervoor het meest geschikt zijn en wat is de toegevoegde waarde voor de consument?

Dit zijn niet alleen diensten die gericht zijn op kosten, maar het is ook een ervaring- en vertrouwenskwestie. Nu is er ook nog 40% wat potentieel een besparing van 10% te realiseren heeft door te switchen. Nu hebben mensen nog geen zin om te gaan switchen, omdat er nog heel veel fout gaat, vooral bij de netbeheerder. Het imago van de sector of van een partij heeft hierop zeker invloed. Des te meer is het voor de nog relatief onbekende leverancier het moment om hier op in te springen. Maar je moet jezelf dan wel duidelijk profileren en goede kwaliteit leveren. Eenmaal een deuk in het imago is moeilijk weg te poetsen.

10. Welke mogelijkheden bestaan er voor de elektriciteitsleverancier om de operationele kosten te verlagen door gebruik te maken van de slimme meter?

Hierbij spelen balancing en forecasting een belangrijke rol. Als je ervoor kiest om de data zelf op gaan halen, is het doel om ervoor te zorgen dat de rekening klopt. Dit is nu nog een enorme uitdaging. Zeker als je het zelf gaat ophalen, beheer je zelf de data. Als je dit niet goed doet is de rekening niet goed, is de data niet goed en kom je echt in een neerwaartse spiraal. We denken er dan ook aan om echt zelf contact te leggen met de meter en zelf een MDB op te zetten via de P1 poort. Ik denk dat forecasting een stuk nauwkeurig kan dan zoals we dat nu doen met de standaardprofielen. Er relatief weinig aandacht geschonken aan deze profielen en in de realiteit zit er nog aardig wat verschil tussen het jaarverbruik en de voorschotbedragen. Met de slimme meters speelt dit niet meer, omdat je direct weet wat je bijvoorbeeld een dag geleden verbruikt hebt. Enerzijds kan je deze data direct gebruiken om te billen, anderzijds om je forecasting te verbeteren. Hoe groter je klantenportfolio hoe groter de schaalvoordelen. Ik denk dat je ook meer inzicht krijgt in waar fraude vandaan komt. E-on Zweden en E-on UK hebben al een soort van monitoring systeem waarmee het low voltage netwerk in kaart wordt gebracht. Het blijft echter moeilijk om de vertaalslag te maken naar de individuele gebruiker. Je moet hiervoor inzicht hebben in het hele net, dus van verschillende leveranciers, dan kan je pas precies bekijken waar fraude plaatsvindt. Als we dit allemaal gaan doen, moet het in de toekomst goed traceerbaar zijn. Je zou dit eigenlijk gezamenlijk moeten doen, bijvoorbeeld in een landelijk, centraal, MDB. Niet alleen voor fraude, maar ik denk ook dat het een stuk efficiëntere oplossing is voor het opslaan en aggregeren van de data. Dit zou zowel in het gereguleerde als commerciële domein kunnen liggen. Gereguleerd kom je bijna niet onderuit, omdat er anders een monopoliepositie ontstaat. Commercieel zou echter wel een stuk sneller kunnen.

11. Hoe kan de consument gemotiveerd worden om het energieverbruik in piek perioden te verlagen?

Prijs kan één ding zijn, maar mensen lopen voor 5 euro ook niet zo hard meer. Zeker geen tweeverdieners die niet veel mogelijkheden hebben om hun gedrag te veranderen. Daar heb je dan die derde partijen voor nodig, om een andere incentive te geven en het gedrag te veranderen. Ik zie wel een goede markt in ontwikkelingen die wat verder gaan, zoals het op afstand afschakelen wat al een tijdje in de VS, zoals bij E-on US, gebeurt. De wetgeving is daar ook wel een stuk soepeler, maar als de consument er hier ook vrijwillig voor kiest moet je deze discussie met de regering wel aan kunnen gaan. Ik zie dit niet zo snel per huishouden, maar vooral op wijkniveau in overeenstemming met het netbedrijf, om de stabiliteit te bewaren.

12. Welke veranderingen in energie verrekening en afrekening zijn te verwachten en hoe zal de consument hier op reageren?

Nu is het betaalsysteem gebaseerd op de voorschotnota en ben je dus eigenlijk twee keer een rekening aan het sturen. Straks kan dat 1 keer achteraf of zelfs direct na een validatie check. Voor een bepaalde doelgroep denk ik dat prepay aantrekkelijk is. Ik denk dat een normaal huishouden hier niet op zit te wachten, maar voor studenten of bouwbedrijven kan dit wel interessant zijn. Je gebruikt dan alleen stroom als je smart card in het contact zit. Daarnaast is het voor de minima erg interessant. Ons motto is niet om klanten af te schakelen als ze niet betalen, wat een veel gehoord voordeel is in de markt. Zo zien wij dat niet, afsluiten is het laatste middel dat er bestaat. Er zijn wel toepassingen te verzinnen m.b.t. veiligheid om bijvoorbeeld de stroom af te sluiten in bepaalde situaties, zoals brand e.d, waarbij je kan overleggen met lokale instanties, zoals brandweer. TOU pricing op kleine blokken zie ik technisch en praktisch niet zo zitten. Veel apparatuur heeft langer nodig om efficiënt te kunnen werken, zoals een boiler, dus zit je al snel vast aan blokken van uren. In dat geval kan je wel in die goedkope blokken incentives aanbieden. Wat wij willen is de pieken uit het verbruik en uit de prijzen halen. Dit wordt veroorzaakt door de consument en door het bedrijfsleven. Dit laatste is erg lastig, je moet het echt financieel kunnen bewijzen en voorrekenen. Het gaat bij consumenten om zulke kleine bedragen, dat dit erg moeilijk voor te rekenen is. Je zou een boiler bijvoorbeeld hier wel op kunnen sturen, maar dan moet dit wel automatisch gaan.

13. Is het verlagen van het energie verbruik en het managen van energie verbruik in huis een verantwoordelijkheid van de elektriciteit leverancier?

Hier zit een spanning in tussen enerzijds omzet en anderzijds een stukje maatschappelijke verantwoordelijkheid. Dit laatste heeft bij ons prioriteit, want we vinden dat je de insteek moet hebben dat je van de fossiele brandstof af moet. De nieuwe technieken laten nog op zich wachten en zijn nog niet kostenefficiënt. Je moet de consument dus echt bewust maken dat er iets moet veranderen. Het probleem dat we hebben ligt wereldwijd en niet alleen binnen Europa of Nederland. De Kyoto discussie is hier een goed voorbeeld van. Bij individuen ben je echt in de marge aan het werken, en daarom is de incentive ook niet zo groot. E-On wil zich wel positioneren als “groen”, maar de wetgeving werkt hier niet aan mee, en alles wat je wilt moet je allemaal zelf betalen. Je ziet dan ook een soort van platformen ontstaan, zoals CO2 resten die gebruik worden om tuinders van CO2 te voorzien. Op dit moment werkt dat op globale schaal een stuk beter en leidt het tot schaalvoordelen. Je moet dan wel rekenen met een lange termijn van 20-30 jaar. Met nieuwe producten is dit heel erg moeilijk.

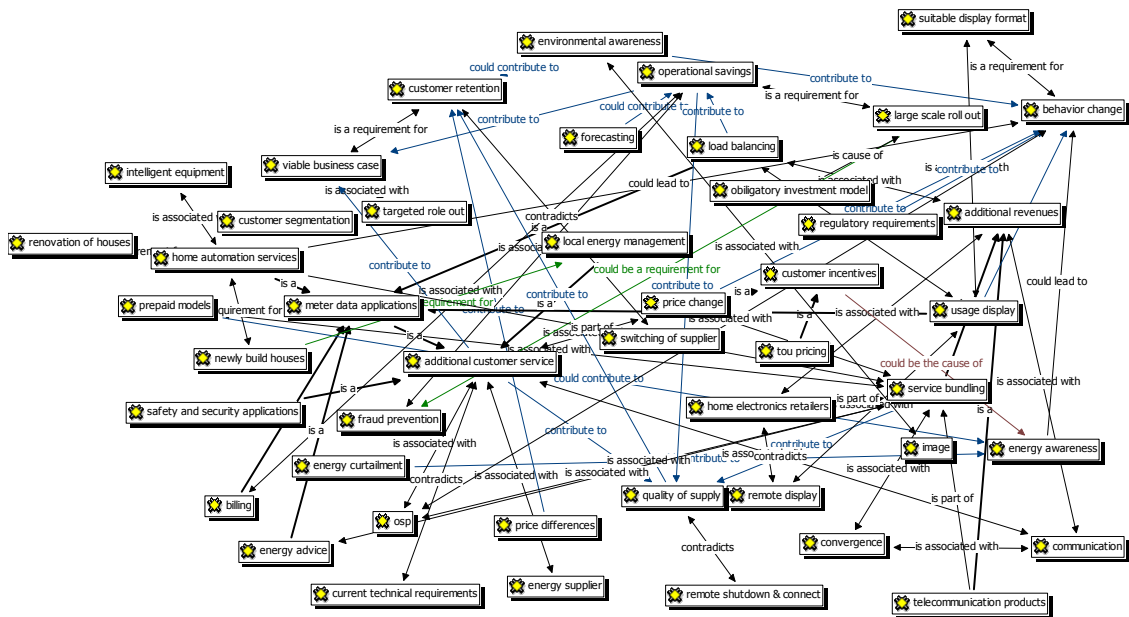


Figure 59 Interview Analysis Barry van de Merbel

Appendix 8.6. Interview Hilbrand Does – Oxxio

Hilbrand Does

Metering manager Oxxio

1. Als de Europese verplichting om slimme meters te plaatsen er niet was geweest of op dit moment zou worden afgeblazen, zouden de meters dan nog geplaatst worden?

Ja, we waren hier al mee begonnen omdat we denken dat het toegevoegde waarde biedt aan onze klanten. Inhoudelijk zal het er niet anders hebben uitgezien. Ik verwacht wel dat het sneller had gegaan zonder de hele discussie over de metermarkt. Ik verwacht dat we dan ook meer resultaat hadden gehad. Ik heb wel mijn vraagtekens bij een landelijke uitrol, omdat het niet bij alle klanten evenveel oplevert. De besparingen zijn in sommige gevallen evident. Ik verwacht dat we onze klanten kunnen helpen bij energiebesparing, dit komt ook terug in de maatschappelijke business case. Ten tweede zijn er de efficiency voordelen m.b.t. de switch en mutatieprocessen in de sector. Hiervoor zou overigens een landelijke uitrol wel noodzakelijk zijn. Hoewel je ook daar ziet dat de markt zodanig is dat er minder dan 10% switched. Ten derde zijn er efficiency voordelen in termen van beheersen van netverliezen en fraudebestrijding. Dit is net zo doelgroepgericht, waar ook voor geldt hoe groter je het inzet hoe groter de voordelen zullen zijn. De schaalvoordelen zullen niet zo groot zijn. Nederland is te klein om echte inkoopvoordelen te bewerkstelligen. Installatievoordelen zullen er wel zijn, maar maken slechts 30% uit van de totale investering. Als je hier 10% op kunt besparen scheelt dat maar 3% op de totale investering.

2. Wat zijn naast het leveren van elektriciteit mogelijke inkomstenbronnen voor de leverancier, mogelijk gemaakt door de slimme meter of slimme infrastructuur?

Additionele diensten, zoals het verkopen van LED lampen om energie te besparen, zoals we nu doen. Of bijvoorbeeld adviesdiensten. Een soort periodieke service, waar klanten zich op kunnen abonneren, zoals op maat gesneden advies op basis van het recente verbruik van de klant. Ook kunnen we de klant pro actiever gaan benaderen, bijvoorbeeld een klant die bij Oxxio aanklopt om zijn nieuwe huis energie efficiënt in te richten.

3. Wat zijn voor de consument de belangrijkste variabelen waarop ze hun keuze voor een energieleverancier kiezen, en de kwaliteit van levering beoordelen?

Onze ervaring is dat het op dit moment nog hoofdzakelijk prijs gerelateerd is en dat het een low interest product is. Ik heb het idee dat de prijs niet alleen meer is gerelateerd is aan de tarieven, maar ook aan het verbruik. Wat de klant kwijt is wordt uiteindelijk bepaald door het gebruik maal de prijs, deze kan je op allebei manieren beïnvloeden. We richten ons dan ook steeds meer op het laatste. Ik denk dat op langere termijn toch ook de service en betrouwbaarheid een doorslaggevende factor zijn. Dit is de laatste jaren heel stabiel. Ik heb niet het idee dat klanten een andere doelstelling nastreven dan een lage prijs en kwaliteit. Wij richten ons niet specifiek op doelgroepen, maar op de hele consumentenmarkt. Wij onderscheiden ons op 4 kenmerken: voordeel, innovatief, betrouwbaarheid en duurzaamheid. Duurzaamheid en innovatie krijgen de laatste jaren meer aandacht, waar dat eerst vooral voordeel was. Nu is dat het nog steeds, maar je moet kijken of dit ook op lange termijn stand houdt. We zijn nu ook betrouwbaarheid verder aan het invullen, door bijvoorbeeld certificering van onze callcenters en proberen we het duurzame bewustzijn uit te breiden. Een vorm van innovatie kunnen ook andere contractvormen, zoals pay-per-use zijn.

Het image van de sector is nog steeds niet best en wordt met name bepaald door slechte switch en verhuisprocessen. Hier hebben wij met name als nieuwkomer de meeste hinder van bij het veroveren van de markt. Doordat klanten geen vertrouwen in het switchen hebben wordt er minder geswitched, daar hebben wij last van. Aan de andere kant helpt het ook mee als klassieke bedrijven aangeven dat ze veel geld verdienen, dan gaan klanten ook wel op zoek naar een nieuwe leverancier.

4. Wat zijn mogelijke toepassingen voor het weergeven of gebruiken van meter data in de woning van de consument?

Nu geven wij de klant op dagelijkse basis het uurverbruik terug. Dit is voor ons een belangrijke conditie geweest tijdens de NTA discussie, dat dit overleefde bleef. Wij zien dit eigenlijk als een minimum vorm van dienstverlening, waar de techniek voor beschikbaar is en de kosten acceptabel zijn. Ik kan me voorstellen dat via de locale interface je direct deze gegevens via je pc of display uit kan lezen. De theorie zegt dat de beste vorm van feedback een combinatie is van permanente betrokkenheid en een analytische benadering waarmee je een overzicht hebt en kan bepalen wat er echt aan de hand is. Energie advies gaat een stap verder, en ik kan me ook wel voorstellen dat het daarna richting domotica gaat.

5. Zal de energieleverancier gebruik maken van deze mogelijkheden?

De diensten kant zal lastig zijn om dit als zelfstandige partij zo in de markt te zetten via een marktkanaal. Ik verwacht dat het met name de energieleveranciers zullen zijn dit deze diensten in de markt zullen zetten.

6. Zullen derde partijen gebruik maken van deze meter data voor het aanbieden van diensten, zoals "home automation", aan de consument?

Het zijn vrije marktpartijen. Er zijn aanbieders van dit soort producten, maar ik verwacht dat zij meer op de techniek gaan zitten dan op de diensten, zoals installatiepartijen die dit zullen installeren bij de klant. Wat betreft home automation vind ik het lastig. Het hangt heel erg af van welke apparaten er op de markt komen. Je kan ook wel wat doen met verloopstekkertjes die aan- en afschakelen o.b.v. de huidige energieprijzen. Ik geloof zelf wel in regelsystemen in combinatie met locale opwek, waarbij je apparatuur aan gaat op het moment dat je zonnecollector energie levert. Ik zie ook wel meelifters, die ook wel diensten op het gebied van zorg of beveiliging willen aanbieden. Doordat de communicatie nu in het gereguleerde domein komt te liggen zie ik

dit als de grote bottleneck voor dit soort diensten. Ik zie dit dan ook niet zo snel via de slimme meter gebeuren. Met de keuze voor het marktmodel is ook de keuze voor zo'n home gateway verlaten.

Uiteindelijk zal een aanbieder zo'n kastje willen hebben, wat het op afstand kan beheren en aanpassen. Hier zit naar mijn idee ook de business case, niet alleen aan het verkopen van die kastjes, maar ook in het onderhoud en beheren ervan. Als je de input van de meter hebt, zal het regelen altijd lokaal plaatsvinden. Het beheren van dit apparaatje is echter de grote uitdaging. Dit kan door de klant zelf gebeuren, waarbij het neerkomt op de gebruiksvriendelijkheid, of een automatische of op afstand instelbare regelsystemen. Maar deze diensten hebben wel een communicatie infrastructuur nodig naast het elektriciteitsnetwerk, want infrastructuur is in beheer van een partij die geen commerciële drive of belang heeft om dit soort diensten aan te bieden. Wij waren in beginsel geen voorstander van het huidige marktmodel, omdat je iets dichtgooit wat naar ons idee niet nodig is. Ik zou liever de metermarkt houden zoals die nu is, maar dan met de verplichting dat de meterstanden 2 maandelijks worden doorgegeven. Mijn voorbeeld is altijd Scandinavië geweest; reguleer niet op het ophangen van de meter, maar op de toegankelijkheid van de data. De NTA kan dan wegvallen, als je de maar een soort van SLA hebt op de output en niet zozeer op het process. Partijen kunnen het dan zelf in gaan richten en kunnen verschillende communicatie infrastructuren gebruiken. Dan krijg je pas echte marktwerking.

7. Is deze ontwikkeling een kans of een bedreiging voor de elektriciteitsleverancier?

Dit is als kans, waardoor wij ons als vrije marktpartij kunnen onderscheiden. Wij maken veel gebruik van partijen die iets toe willen voegen of kennis willen delen.

8. Wat zijn de mogelijkheden voor het aanbieden in pakketvorm (bundelen) van levering van elektriciteit en overige diensten?

Ik denk dat je productonderscheid verder gaat dan alleen gecombineerde pakketten en tarieven, maar of dit altijd in combinatie gaat met gebundelde pakketten zal de markt leren. Sommige partijen zien het echt als uitbreiding van het leveranciersmodel incl. veel diensten en services, andere partijen zullen dit onzin vinden en blijven gewoon alleen stroom leveren.

9. Welke diensten zijn hiervoor het meest geschikt zijn en wat is de toegevoegde waarde voor de consument?

Adviesdiensten, variabele tarieven, wisselende tariefsoorten. Als je domotica producten doortrekt kan je ook aan dit soort services denken. Het hoeft niet dat de energieleverancier de aanbiedende partij is, maar je ziet nu ook al veel "second labeling", dat een andere partij, zoals een verzekeraar of bank de energie verkoopt. Ik vergelijk het altijd een beetje met de telecommarkt, waarbij de markt heel erg is veranderd wat niemand had verwacht. Tarieven per seconde had niemand verwacht, totdat een buitenstander dat ineens ging doen. Je ziet toch dat dit soort initiatieven de service voor de klant verbeterd door een toegenomen transparantie. Dat is toch het voordeel van de marktwerking en het neerleggen van de juiste structuur.

10. Welke mogelijkheden bestaan er voor de elektriciteitsleverancier om de operationele kosten te verlagen door gebruik te maken van de slimme meter?

Het belangrijkste is toch wel dat de standen correct binnenkomen en altijd beschikbaar zijn op het moment dat je ze wilt hebben. Dat is je grootste winst, want dan kan je de switchprocessen automatiseren, je facturatie doen op het moment dat jij dat wilt en dat je meterstanden ook echt overeenkomen met het verbruik. Ook dit is dan veel transparanter, omdat je geen verschillen hoeft te verklaren en je krijgt ook geen discussies over het voorschotbedrag. Al dit soort dingen zijn de belangrijkste kostenbesparing, maar ook één die direct een effect heeft bij de klant. Het mes snijdt als het ware aan 2 kanten. Een ander voordeel is moeilijker om hard te maken is dat het ook leid tot voordelen op het gebied van inkoop en forecasting, door een herziening van de huidige

profielen systematiek. Als je echt wilt profiteren, zal je dit moeten veranderen. Deze profielen zijn wel redelijk nauwkeurig, maar je hebt geen incentives om hiervan af te wijken. Als je de klanten echt wilt stimuleren om iets anders te doen gaat dit niet meer op. Landelijk gezien zijn de profielen wel goed uitgemiddeld, maar op individueel niveau is hier nog veel te verbeteren. Ook de opkomst van lokale opwek vraagt om nieuwe profielen en moet je echt individueel gaan sturen. Het voordeel van slimme meters m.b.t. fraude is dat je niet afhankelijk bent van een fysieke inspectie, maar dat je signaleert dat er iets veranderd is of als er iemand aan de meter is geweest. Fraude voor de meter zal je houden, maar wellicht zal je op blokniveau dit beter kunnen detecteren. Ik vraag me af of dit soort methoden slimme fraude kunnen voorkomen. Domme fraude zal je wel kunnen voorkomen. Hoe deze verhoudingen liggen is moeilijk in te schatten, hier zitten we als leverancier te ver vanaf. Het is dan ook de vraag of het de moeite waard is om data van alle leveranciers en de netbeheerder in een gebied te hebben om deze slimme fraude tegen te gaan.

11. Hoe kan de consument gemotiveerd worden om het energieverbruik in piek perioden te verlagen?

Je zal dan echt van de huidige profielen systematiek af moeten stappen. Want als leverancier ben je gedwongen om op deze manier in te kopen en heb je dus geen incentive om de consument TOU tarieven in rekening te gaan brengen. Ik geloof niet dat je dan elke klant gelijk als individu moet gaan benaderen, maar je moet wel iets kunnen doen met het zelf aanmaken van profielen e.d. Je kan dan veel gerichter gaan segmenteren dan dat nu gebeurt met dag, nacht en dubbeltarief. Er zijn een aantal methodes voor om een consument bewust te maken van de verschillen in tarieven. Dit kan grofweg op 2 manieren, namelijk door het verlagen van de drempelwaarde, die je zelf kan beïnvloeden. Als je dit van tevoren met klant afspreekt. Ten tweede is feedback over de actuele tarieven, want naar mijn idee niet via de meter hoeft, maar dat kan ook op een andere manier, of over een andere infrastructuur. Prepaid is ook een goed voorbeeld om de consument te motiveren.

12. Welke veranderingen in energie verrekening en afrekening zijn te verwachten en hoe zal de consument hier op reageren?

Ik verwacht dat het voorschottarief er op een gegeven moment wel uitgaat. We hebben een marktonderzoek gedaan, waarbij klanten aangeven dit nog niet te willen. Een leverancier loopt hierdoor natuurlijk ook wel meer risico, omdat je cashflow minder stabiel is en erg afhankelijk van zomer of winter. Het is ook een verouderd begrip. Vroeger betaalde je je telefoonrekening ook op voorschot. Mensen hebben daar nu nog niet het geloof in. Het is ook een stukje vertrouwensrelatie die ontbreekt. Maar we gaan toch naar het achteraf betalen van gebruik.

13. Is het verlagen van het energie verbruik en het managen van energie verbruik in huis een verantwoordelijkheid van de elektriciteit leverancier?

Voor ons is het gemakkelijk om hier “ja” tegen te zeggen. Het gaat ons om zoveel mogelijk klanten te krijgen en die klanten zo winstgevend mogelijk te laten zijn. Winstgevendheid is afhankelijk van de marge tussen inkoop en verkoop. Deze marge is erg laag, dus het is relatief eenvoudig om een stukje marge weg te geven, als je hier wat voor terugkrijgt. Uiteindelijk wordt de marge ook bepaald door het verloop van de klant. Het komt er dus op neer dat je beter een klant langer kan houden, tegen een kleinere marge. Puur theoretisch gezien is het dus een taak van de leverancier. Wetgevend gezien ligt die taak bij de netbeheerder. Je hebt toch een stukje maatschappelijke verantwoordelijkheid, wat ook meespeelt aan het pakket dat je aan de klant kan aanbieden en dus ook je concurrentiepositie bepaald. Tenslotte gaat het erom dat de klant tevreden is met zijn rekening, want dan stapt hij niet over. Als je kijkt naar het switchgedrag van de klanten zie je dat de markt eigenlijk pas in ontwikkeling is. Ik verwacht dat de echte concurrent nog moet beginnen.

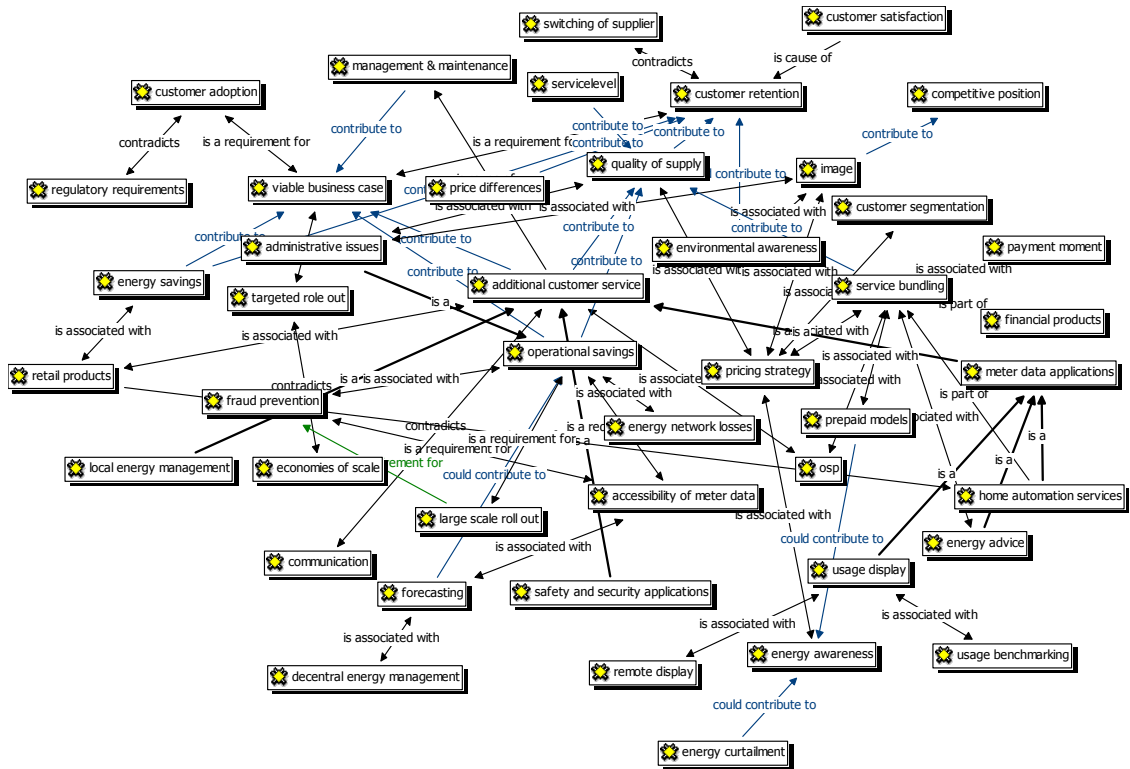


Figure 60 Interview Analysis Hilbrand Does