



**Utrecht University**

# The rise of smart grids from a governance perspective.

A research on the means of governance and upscaling after smart grid pilot programs end.



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# Balance

Advies + Projecten + Interim



*“The world as we have created, it is a process of our thinking. It cannot be changed without changing our thinking.”*

Albert Einstein

## Acknowledgements

As a young spatial planner, I see my field of study going into a major transition. A transition towards planning for sustainability, and the use of digital applications in spatial planning. For me it is exciting, but this makes me also motivated to do something with these transitions.

Writing this thesis is a mandatory part of the master program Spatial Planning and is the final test before graduation. During the last eight months, I worked on this thesis, and it has proved to be one of the most challenging and most exciting tests I have done since the beginning of my study career. However, luckily, I got help from inspiring and skilled people.

I conducted this research in cooperation with Balance bv. This consultancy agency is specialised in project management. With so many experts in the field of energy and project management around me, I got acquainted with this topic quickly. With a nice view and proper coffee, the environment has improved my productivity. Furthermore, I want to thank everybody at Balance who provided me with networks, knowledge, ideas, motivation and fun.

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My thinking about the smart grid, sustainability and energy networks has changed during the last eight months. However, I think that is a good thing. As Einstein quotes: without the change in our thoughts, it is impossible to change the world we created. In the end, even though having critiques on developments within sustainability and digitalisation, I hope that I could add something to these developments.

## Abstract

During the last decades, in the field of spatial planning, both sustainability and digitalisation have been growing in importance. Sustainability is a goal, and with smart applications, we try to speed up the process towards sustainability. A good example of this development is the smart grid. With making our energy network intelligent it is possible to make a more efficient and effective use of the energy. A variety of intelligent energy technologies can be employed. Sustainability is a goal, but also incentives are created for consumers and other stakeholders.

Because of this potential, the last two decades, investments in testing smart grid possibilities have increased. As a result of these investments from governments together with semi-public and private parties in the Netherlands, a vast diversity of smart grid pilots has started and ended. Different technologies have been tested, business cases have been developed, and research has been done on the behaviour of consumers. However, the smart grid is still not implemented on the larger scale. Moreover, because of the liberalisation of the energy network in the nineties, the process of upscaling of smart grids is not only a matter for governmental organisations but as well for other stakeholders. Upscaling of smart grids is not only about the technological development, but also governance processes are highly relevant. Because there exists a gap in the academic literature about the link between governance, smart grids and upscaling considering the Dutch context; this research will identify the key factors of success and failure at the upscaling of smart grid implementation in the Netherlands considering a governance perspective:

*Which key factors of success and failure, considering a governance perspective, could be defined at the upscaling process from smart grid pilots towards large scale smart grid implementation in the Netherlands?*

This research provides three frameworks which define the scope in this investigation. These frameworks conduct defining the smart grid, the means of governance and the types of upscaling. The data derives from interviews and a policy analysis. In the first phase, explanatory interviews were conducted to find out which subjects within the smart grid, governance and upscaling are essential for the success or failure. Then a policy analysis has been done to see what the context is at the moment; the starting point and after that semi-structured expert interviews were conducted to answer the sub questions and the research question.

Many factors are important for the scaling-up of smart grids in the Netherlands. However, within these factors connections can be exposed which develop a couple of key factors. Firstly, there should be a balance between the stimulation of innovation by companies and the patience at the acceptance of innovations by the society. Secondly, the balance between flexibility and strictness at strategy development is necessary; to get to acceptance of innovation, bottom-up processes are critical. However, to remain trust, clear responsibilities among stakeholders and a shared vision guidelines are also important to develop. As well, there exist differences between types of upscaling and subgroups of smart grid technologies. The development is not parallel, and this makes it more complex to get to an integrated smart grid and national/international policy which is important according to several experts. Almost every interviewed expert states that we are now at the last step towards the initiation of commercial niches. However, this final step could mean a minor step but also a giant leap.

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# Introduction

- 1.1. Smart grids
- 1.2. The aim for smart grids
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- 1.4. The research
- 1.5. Societal relevance
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## 1. Introduction

It is striking when reading the tech page how many articles are related to energy and sustainability. But it is not only the news; we also see a growing awareness of the relation between digitalization, energy and sustainability in science nowadays. The academic world is getting filled with new insights on how to tackle global issues. When focusing particularly on the research field of spatial planning (not surprisingly as spatial planner), two global trends have a significant influence on the built environment in the future: Climate change and digitalization (Bisello et al., 2016 pp. 3-4).

In the article of de Jong et al. (2015) the connection between urban form, branding and upcoming trends (climate change and digitalization) is described. It explains how policy discourses through the years have changed towards a more digital and sustainable direction. Smart cities, low-carbon cities, sustainable cities, resilient cities increase in popularity. But in the article of de Jong et al. (2015) is stated that there exists an overlap in what these types of cities promote. Complexities in urban structure, growing demands, density of cities, increasing pressure on infrastructure and the decrease in quality of space; these are all challenges which local governments seem to want to solve with smart technology (Dameri, 2014 pp. 1-6). What Caragliu et al. (2011) noticed, when analysing spatial policy, is the connection between sustainable goals and smart opportunities.

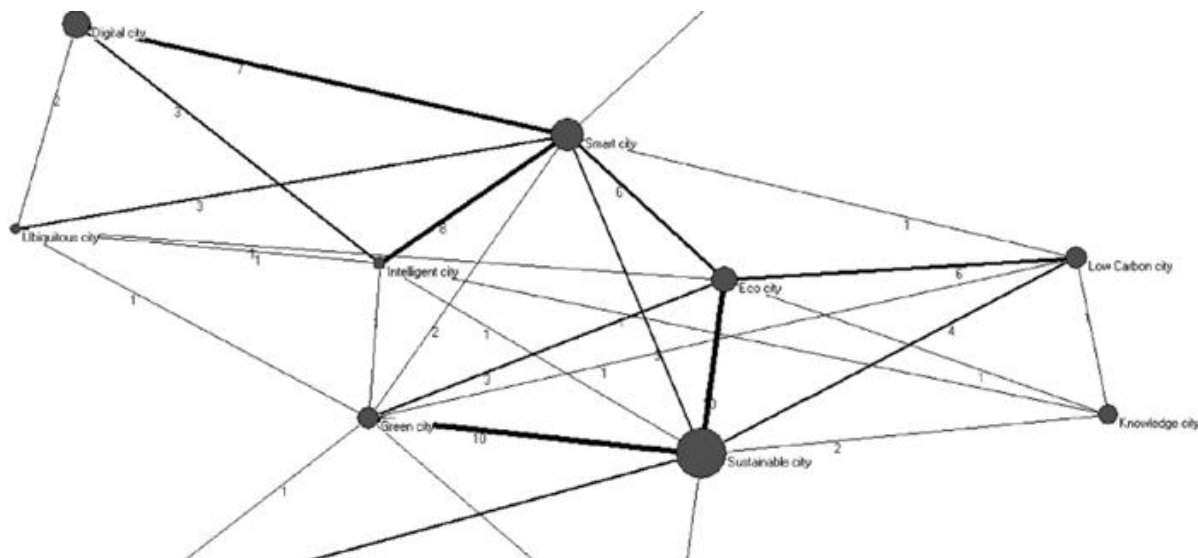


Figure 1.1. The overlap of what cities promote. Source: de Jong et al. (2015).

As shown in figure 1.1., the overlap between smart cities and eco-/sustainable cities is substantial. Thus, sustainability is intrinsically related to smart city practices, but with the use of ICT, Big Data and other technical solutions, the aim of smart city initiatives is often (partly):

*"Forward-looking in terms of preserving and protecting the natural environment and improving and leveraging the built infrastructure. Thus, smart city initiatives have an impact on environment-friendly development, sustainability, and livability of a city. (Alawadhi et al., 2011 p.5)"*

The example what has often been used in this case, as a successful and high potential smart city solution for environmental sustainability goals, is the smart grid (Dameri, 2016; Bolivar, 2015; Caragliu et al., 2011, etc.). Intelligent energy networks (smart grids) make use of this ICT, Big Data and other technical solutions to tackle challenges deriving from our current energy network. Most of these challenges address climatic issues. This high potential can result in an extensive improvement.



Implementing smart grids though, is a complicated matter. In this thesis investigates the upscaling of smart grids in a governance system and provides factors of success and failure.

### 1.1. Smart grids

With pressure from global organisations and targets set by the EU (EU,2016), the transition in European energy networks has pushed further and further towards a low carbon, highly efficient- and intelligent energy system. Since the late 1950's the energy network in the Netherlands has not changed a lot. In the 1990's, the management of energy networks switched from an engineering to a more market driven system. Facing challenges deriving from the ageing energy networks such as the decreasing quality of cable infrastructure, the high carbon intensive energy sources, the energy loss along the energy transport, inefficient transformer systems, it all got delayed because of the liberalisation process during the last two decades (Verbong & Geels, 2007).

Now big leaps must be made towards a new energy network which is efficient in cost and saving energy. The two most important choices which are available at the moment are: renewing the energy networks by replacing cables and upgrading transformer stations and make use of an intelligent system implemented in residential areas, brownfield areas or business districts (Verbong et al., 2013). The last suggestion refers to the implementation of smart grids. Smart grids are an innovative and complex matter, besides that the definition is not always clear (Niesten & Alkemade, 2016 p. 630).

Smart "energy" grids are mostly implemented on the existing infrastructure. Moreover, smart grids relate to the bundle of technical solutions implemented in the energy network that uses digital communication to detect and react to local changes in usage (Oxford dictionary, 2017; Ardito et al., 2013). The vision is that an "intelligent" system connects all energy users with each other. This system tries intelligently aligning supply with demand and balances energy loads between peak and off-peak periods and spaces. Households can profit from this system by getting more aware of their energy use and can consume energy on moments when it is relatively inexpensive. The energy consumption will be more balanced so that energy supply can be better predicted on forehand. Energy efficiency and the use of renewable energy sources are the main incentives (MvEZ, 2012 pp. 15-18). Globally, smart grids represent a vast variety of technological solutions. Every country adapts 'their smart grids' to their challenges. Smart grids differ in form, purpose and the intensity of ICT-use, also combinations of solutions are possible. Together with the fast pace development of technological solutions, this causes an unclear image of what smart grids are and which possibilities it has. Therefore, since the beginning of this decade various countries; USA, China, India, Denmark, Germany, United Kingdom and also the Netherlands, has started to experiment with smart grid projects in different contexts with different technological solutions (Giordano et al, 2011; Beaulieu, de Wilde & Scherpen, 2016; Carvallo & Cooper, 2015).

### 1.2. The aim for smart grids

In recent years, the national government in the Netherlands, together with other parties, invested a substantial amount of 100 million euros in the implementation of smart grids (MvELI, 2011). The RVO (national organisation stimulating Dutch entrepreneurs) believed that after 2015 this yearly investment would continue, for most by operating companies like Stedin, Liander etc. (RVO, 2012) in cooperation with TKI Urban Energy and other parties (TKI Urban Energy, 2017). Also, research programmes were set up, and over 100 researchers began to analyse how smart grids can be deployed. The studies were originated from different fields and perceptions. Public participation, societal influence, engineering, economic potential and more, researchers covered a variety of success factors at implementing smart grids (MvELI, 2011). After the research platform was built because of

the twelve 'proeftuinen' (smart grid pilot projects with involvement of research over a period from 2011-2015) different organisations like Netbeheer and TKI Urban energy began to archive knowledge and projects (Netbeheer Nederland, 2011; TKI Urban energy, 2016). With knowledge derived from demonstration projects, the RVO thinks that scaling up process of successful technological solutions will be stimulated.

Powermatching City demonstrated that The Netherlands (all parties) could save between 1 and 3,5 billion euro (Energiebusiness, 2015) and the USEF (Organization which includes Stedin, ABB etc.) already spoke about taking the lead in the world in making use of intelligent energy systems (USEF, 2016). On the website of the national government they estimate the business case of 7,5 billion euros. Thus, significant incentives for a variety of actors to react on this innovation.

"However, even though many years of public efforts and government money have been invested in order to speed up the development, diffusion and implementation of renewable energy technologies, experiences in different countries show that this is a very slow and tedious process."

In the article of Negro, Alkemade & Hekkert (2012) they elaborate why renewable energy innovations diffuse so slowly. Relating this to the investment of the national government in the Netherlands, one could argue if the RVO will actually realise these ambitions. Although investment in knowledge (pilots) seems to be a lot, still this process to scale-up smart grids is more than only based on financial investment.

### 1.3. The governance of upscaling

*"In many cities, pilot projects are set up to test or develop new technologies that improve sustainability, urban quality of life or urban services (often Labelled as "smart city" projects). Typically, the municipality supports these projects, funded by subsidies, and run in partnerships. Many projects, however, "die" after the pilot stage or never scale up. Policymakers on all levels consider this as a challenge and search for solutions" (Van Winden, 2016 p. 3)*

In the article of Van Winden (2016) research has been done on smart city projects and the ability for upscaling. Upscaling in this sense means: making initiatives a common tool to achieve certain goals and execute this on a scale where it has a substantial contribution. In the case of smart grids in the Netherlands, upscaling is essential. Not only to achieve the climate mitigation goals but also to make use of the full potential what smart grids can provide. Examples: providing an infrastructure for the use of electric cars, the integration of renewable energy sources, and on the other hand to protect neighbourhoods from social exclusion and avoid further complexities in law and tax system (MvEZ, 2012 pp. 15-18). Besides that, social exclusion can emerge when smart grids do not get implemented as a standard tool for "ordinary" citizens (Beaulieu, de Wilde & Scherpen, 2016).

Interestingly, during the whole evaluation programme researchers scarcely focussed on the governance behind the implementation of smart grids (Netbeheer Nederland, 2014). As a popular research subject in spatial planning studies, governance could be a relevant feature to analyse. When one would zoom in on different projects, signals tell that governance relates to developing barriers for upscaling smart grid projects. In the article of Clastres (2011) came forward that difference in incentives among different actors could also influence the success of smart grids. The report of Giordano et al. (2013) also pointed out on the fact that organisational processes around smart grid projects differed, which influenced the outcome. Although most of the articles about smart grid implementation explain how the stakeholder composition changes, that communication is a major factor and even road maps for smart grid implementation including governance are developed. Still,

how to address governance concerning smart grids in the Netherlands is not discussed in an academic framework yet.

In the case of smart grids in the Netherlands, a substantive amount of coalitions is formed during the implementation of various smart grid projects (RVO, 2012). After pilot programs end, the pressure on actors increases: Funding decreases, governmental interference decreases and new entrants arrive in the decision-making process (Laster & Diestelmeier, 2017). Pilot programmes stop but scaling up is the next step (Netbeheer Nederland, 2014; Laster & Diestelmeier, 2017). Governance is a complex matter. Governance causes complexities as well when analysing smart grids. Factors of influence consider for example; conflicting business models, communication, financial resources, change in stakeholder composition, responsibilities etc. (Consilio et al., 2014 pp. 35-36). To make this research an addition for both society and the academic field, it is important to frame governance as a researchable scope in research. Different modes of governance will be divided into sub-groups. When connecting the different aspects of governance with the various types of upscaling, it is possible to address interesting issues. These issues will then be categorised in factors of success and failure. Because for large scale implementation these factors can be used to learn from past mistakes and future possibilities. The following research question and division in sub questions will form a guideline to develop knowledge about governance and large scale implementation of smart grids in the Netherlands:

***Which key factors of success and failure, considering a governance perspective, could be defined at the upscaling process from smart grid pilots towards large scale smart grid implementation in the Netherlands?***

This central question divides six sub questions:

- *What is the current situation of policy around smart grid implementation?*
- *Which actor(s) was/were included in the upscaling process*
- *What are/were their incentives and what role did they have?*
- *What factors of governance are essential for success in upscaling smart grid projects?*
- *What factors of governance are not stimulating the upscaling of smart grid projects?*

#### 1.4. The research

The ambition in this thesis is mainly to investigate the upscaling possibilities of smart grid projects in a critical way with a governance perspective. Providing key issues around the actor organisation after pilot programmes end, will help future studies with choosing constructs, objectives and develop a stronger framework for future smart grid implementation processes. Requirements are: explicate the possibilities of smart grids which I want to include in this research, framing different modes of governance which influence smart grid upscaling processes and separating different types of upscaling. After this introduction, this thesis conducts a theoretical section which provides insights on how smart grid is defined. After this, the research describes different governance models, and the theoretical section will end with comparable studies about upscaling smart grid processes. After recognising the constructs which are measured qualitatively, the empirical part of this research will start.

#### 1.5. Societal relevance

Smart grids have a high potential to solve several problems. From achieving climatic goals to a more cost-efficient way of using electricity networks. Besides these major solutions, smart grids can create more awareness (Verbong et al., 2013). But it also notices where flaws in the energy network could appear, so system errors are solved faster and earlier (MvEZ, 2012 pp. 15-18). In academic terms, this

solution is not only in favour of the government but also in support of the society and their needs. This research will contribute to the organisation within smart grid projects and will connect multiple issues with answers inside the implementation process of smart grids. Because when funds fade away and governmental intervention decreases, it is crucial to find out the best way to organising collaboration among actors. Furthermore, large scale smart implementation could also result in social conflicts when arranging smart grid implementation in the wrong way. Arranging the smart grid implementation in the wrong way could cause social exclusion and lock-in situations. In short, the society could profit from intelligent energy networks, but organising implementation in the wrong way by strategy thinkers and market parties could result in social conflicts. Thus, it is important to research factors of success and failure before the upscaling process begins to avoid bad decision-making.

#### 1.6. Academic relevance

Because of investment in research during the twelve 'proeftuinen' project a lot of research has been done on the implementation process of smart grids in the Dutch context (RVO, 2015; Verbong et al., 2013 p. 118). In the field of spatial planning, there are a couple of links missing. If we transfer the discussion of governance to studies about smart cities, something gets highlighted. In smart city research, governance is often a topic with an important message. Smart means dynamic, and this often means complexity: governance plays a vital role in catching up with smart processes (Bolivar, 2015). That governance is a highly interesting topic to research concerning the smart city discourse can be seen in the number of articles (Deakin, 2014; Doody, 2013etc.). As we zoom into smart grid projects, it is remarkable that the academic attention is substantially less than at research on smart cities in general. Research what has done is in most cases steered by governments or companies, but only independent data analysis could fix the scientific gap. The report of Van Winden (2016) never initiated the importance of cooperation of actors in smart city pilots. But in the conclusion (of the report), it remains as one of the factors of success/failure in upscaling smart pilot projects.

Moreover, there is a lack of the development of frameworks to work with within this topic. The definition of smart grids, governance processes at larger scale smart grid implementation and upscaling itself provide many complexities, and without developing frameworks, it is not possible to create structured academic discussion on this topic. Borlase (2013) mentions that the debate on which direction to take is important to see how complex and inevitable this change is. Smart energy technologies, the same as other innovations, will never take one path of development. Innovation is not only technological development; the smart grid is an interdisciplinary topic where the perspective of the spatial planner cannot be unheard. With knowledge about governance processes, context related topics, infrastructural transitions and the relation with societal issues, spatial planners are necessary to participate in the discussion.

# Theoretical Framework



## Content

- 2.1. Defining “the” smart grid
- 2.2. The governance of smart grids
- 2.3. Upscaling in a governance perspective, why and how?
- 2.4. Conclusion

## 2. Theoretical framework

Even though with explanatory studies a theoretical framework can be considered as more open and less explicit (Reiter, 2013), it is important to define smart grids in the first place. As one could read earlier in the introduction, the definition of a smart grid is far from clear. Smart grids differ in form, use, context, etc. The first section defines the smart grid. The second paragraph elaborates on different modes of governance. It will be possible then to clarify the "right" perspective on governance when analysing the scaling-up of smart grids. With choosing a governance perspective, this research will provide a framework which can be used to connect governance processes with the potential of upscaling. This means that different modes of governance; for example, collaboration, financial resources, the composition of stakeholders etc., will be tested within various types of upscaling like diffusion, expansion etc. This will eventually be done in both theoretical and empirical way. The last paragraph explains the theory behind upscaling which provides an understanding how upscaling processes develop. In the end, three frameworks are developed, where the research will focus on.

### 2.3. Defining "the" smart grid

The smart grid has not one appearance. It is a definition including a variety of mechanisms which are not only integrated within electricity grids but also integrated into heat-, gas grids etc. However, in this thesis, electricity grids will be the main subject of research. On the one hand, smart grids may refer to the bundle of technical solutions integrated into the energy grid, but on the contrary, the fundamental purpose will always consider:

"A smart grid is an energy network (electricity, heat, gas etc.) that can intelligently integrate the actions of all users connected to it – generators, consumers, operators and those that do both – in order to efficiently deliver sustainable, economic and secure energy supplies. A smart grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies. (Ardito et al., 2013)"

This broad description may reveal the difficulty of generalising smart grids. At first both transmission and distribution grids could involve smart grid application. However, in this research the focus will be on the distribution grid. To make the definition of smart grids more accessible, table 2.1. shows the differences between the confessional centralised energy grid and the on a micro level (distribution grid) implemented smart grid.

Centralized energy grid	Smart grid
Electromechanical	Digital
One-way communication	Two-way communication
Centralized generation	Distributed generation
Few sensors	Sensors throughout
Manual monitoring	Self-monitoring
Manual restoration	Self-healing
Failures and blackouts	Adaptive and islanding
Limited control	Pervasive control
Few customer choices	Many customer choices

Table 2.1. A brief comparison between the existing grid and the smart grid. Source: Fang et al., 2012.

Many academics argue how we should approach the term Smart Grid. Also, Fang et al. (2012) rather define the smart grid as a vision than as a proposed definition. For them, it is more a loose integration of complementary components, sub-systems and other solutions. Another important fact is that not

only the academics differ in perception on the definition of smart grids. Also, stakeholders in the energy network define the smart grid in different ways. One actor could think that privacy is one of the main principles, another stakeholder could think ICT should be transparent and stimulated (Yu et al., 2012). Still all visions on what the smart grid is are speculative, innovation develops fast, and most of the smart grid implementation is designed in the form of pilots. So, the "real" smart grid, as described in the definition of Ardito et al. (2013), has never been implemented. These pilots test specific contexts, and the composition of techniques always differ (Borlase, 2013). It is, therefore, better to design a framework of constructs, which can be used instead of one particular definition. Here it is important that technical solutions will collide with most of the constructs. The next paragraph describes this framework.

### 2.1.1. From definition to framework

Due to the nonexistence of the "real" smart grid, it is better to analyse smart grid opportunities from separate techniques instead of the combined use of techniques. Although smart grids could be defined as a bundle of smart energy solutions, blind spots can occur when analysing the smart grid as a whole. For example, in the article of Krishnamurti et al. (2012) is concluded that the potential of smart meters (smart buildings) is substantial. Still, there are key issues among the willingness of customers to participate. In another report (Baltan-Ozkam et al., 2014) they state that energy storage solutions have widely been recognised as potential solvers of the reliability issue which exists among customers. The problem here: the costs are too high, and the technology needs some reconfigurations before it has market potential. When combining these smart grid solutions, it is possible that smart grids are unfairly concluded as too expensive or unreliable. Additionally, pointing out which factors contributed to this fact is not possible. On the other hand, this thesis is written from a planning process perspective. Thus, the focus will be more on governance instruments and upscaling. This thesis investigates the technological potential of smart grids until a certain extent. Thus, in this thesis, the bundle of technologies will be categorised in subgroups, but will not research every single technique. To develop a complete framework, it is important to make a concise review of the literature. Every Author has a different vision on goals of the smart grids and therefore bundle the smart grid in various ways. This paragraph describes important and different opinions about the development of subgroups of smart grid technologies. This review conducts three articles which differ in opinion.

#### *Fangxing et al. (2012)*

Keeping in mind that this article solely focusses on the transmission grid instead of the distribution grid, this article explains how challenges are formed, and smart energy technologies can have an added value. The framework developed in this research supports six goals: resiliency, sustainability, customization, digitalisation, flexibility and intelligence. This framework consists of seven different types of enabling technologies which lead to the achievement of the aforementioned smart features:

1. *New materials and alternative clean energy resources*
2. *Advanced power electronics and devices*
3. *Sensing and measurement*
4. *Communications*
5. *Advanced computing and control methodologies*
6. *Mature power market regulation and policies*
7. *Intelligent technologies.*

In the perspective of Fangxing et al. (2012) a separation of Bulk generation, transmission network, transmission substations and distribution grids is essential in understanding the possibilities of smart grids. Here they address the desirability of interaction between agents on all four levels. The interaction of these agents will ensure economic prosperity and environmental health as a result. This paper only integrated the part of transmission networks and transmission substations. The framework



they developed is therefore not entirely applicable to this research, still, in combination with other views, this will provide a good indication of a usable layout of smart grid technologies.

#### *Samad & Kiliccote (2012)*

It is striking to see how visions on smart grid implementation can differ. The set of goals in this article obviously doesn't comply with the article of Fangxing et al. (2010). Namely, the framework supports Reduction of greenhouse gas emissions and climate change, Economics, Reliability & Energy security. The article states that smart grid applications have not been easily replicable. They mostly one-of-a-kind solutions, custom made for own context.

*"Because recent developments, the barrier to entry for smart grid applications is being dramatically lowered."*

Therefore, the authors try not to be too specific but integrate a more flexible categorisation for technologies in their framework: 1. Energy efficiency 2. Direct load control 3. Storage 4. Distributed generation and cogeneration 5. Microgrids.

The aim of this paper differs with the article of Fangxing et al. (2010). Namely, Samad & Kiliccote (2012) view smart grid technologies as products which can be developed industrially. It implies a less integrative framework of technologies. In other words, this view separates the technologies as individual measurable entities.

#### *Moslehi & Kumar (2010)*

This article introduces a reliability perspective on smart grids. Besides reliability, other goals also play a role in the development of their technical solutions framework:

- Better situational awareness and operator assistance
- Autonomous control
- Efficiency
- Resiliency
- Integration of renewable resources
- Real-time communication
- Improved market efficiency
- Higher quality of service

Five key categories for smart energy technologies:

- Reliability
- Renewable resources
- Demand response
- Electric storage
- Electric transportation

Because of the reliability goals in this article, the framework indicates that it integrates a user perspective. In short, in comparison with the article of Fangxing et al. (2010), generator incentives are less involved in the categorisation of solutions.



### Choice of subgroups

With this overview of different perspectives on categorisation and prioritising of smart grid technologies it is possible to make a better overview of smart grid in this thesis. In the next section the chosen categorisation will be elaborated.

### *Integrating renewable energy*

In the articles of Fangxing et al. (2010) and Moslehi & Kumar (2010), integrating renewable energy resources can be a prior goal but is also seen as a key technology. Solar panels adapted to an intelligent system, wind turbine integration, tidal energy production etc. These are all examples of not only integration but also innovation. Instead of seeing these examples as technologies we could also define it as "smart" technologies. In a distributed energy system, integrating renewable energy resources seem to get better applicable than in a centralised energy system. This is mainly the result of a reduced distance of energy transportation and the easy access to households, facilities and companies to connect their own produced energy with the distribution grid (Sioshansi, 2011 p. 16). Even though renewable energy resources have grown the last couple of decades exponentially, still the energy system and policy are not actually adapted to this transition yet. Especially, when one wants to deliver their energy surplus to the distribution grid in order to make money out of it. This possibility is highly complex. Due to the requirement of new policy, load control and new thinking about flexible energy systems, the transition towards an energy driving solely on sustainable energy production has still significant steps to make. Furthermore, the feasibility of sustainable energy sources is not optimal; electricity (in the current situation) is relatively inexpensive. Thirdly, the variability in energy generation is still pressuring the reliability of the energy supply. At last social acceptance is an important aspect of transition and innovation theories. Still, the integration of renewable energy resources is not entirely accepted by communities according to Wolsink (2013). Thus, the integration of renewable energy cannot be seen as an independent technique. It also relies on the development of energy storage to initiate more reliability, grid automatization in order to get the differentiated load under control etc. As Fangxing et al. (2010) and Moslehi & Kumar (2010) shown us before, there exists a dependency on other smart grid technologies.

### *"Smart" energy storage*

Another key technology within the smart grid domain is energy storage solutions. In the articles of Samad & Kiliccote (2012) and Moslehi & Kumar (2010), storage is a significant technical contribution to the smart electricity grid. Regarding reliability, what will be a major incentive next to efficiency and climate mitigation, intelligent storage enables consumers to be more resilient. The challenge for the development of intelligent electricity networks is to keep the balance of electricity loads and the variables supply and demand. Smart storage can help consumers to react on these two dynamic variables (Roberts & Sandberg, 2011 p. 1142). Until now, energy storage batteries have been "lossy, challenging and expensive". Still, many authors state that energy storage solutions are key in a two-way energy network. Both because it has a positive effect on the reliability of the energy system and it provides consumers with a solution for the waste of their production of energy. In a two-way system, they can sell their own produced energy at peak times (when demand is high) (Rajasekharan & Koivunen, 2013; Wang et al., 2014; Roberts & Sandberg, 2011 etc.). On the other hand, from a critical perspective, some authors state that energy storage batteries with an internal communication system still are in the starting phase of technological development. Especially when focussing on households, smart storage cells still have feasibility issues. Besides the feasibility, future trends are not always confirming the importance of energy storage issues. Lee & Hui (2013) for example investigate future

smart grids and the importance of energy storage. They mention in their conclusion that the development of other communication technologies can reduce the requirement of energy storage. In this case, the use of electric springs is investigated. Finally, energy storage should at least for the near future, be considered as an important component of smart energy grids.

#### *Power generation*

Thirdly, power generation is an important aspect of technologies. Of course, there exists a connection with the integration of renewable energy resources, but electricity generation, in general, includes both distributed power generation and centralised power generation. Smart technologies could be integrated into solar panel systems, wind power plants on a lower scale but also in Nuclear powerplants and coal-fired power stations on a regional/national level. The aim, as spoken of in the articles of Fangxing et al. (2010), Samad & Kiliccote (2012) and Moslehi & Kumar (2010), with smart grids is most often to reduce the use of fossil fuels at producing energy and accelerate the use of renewable resources. But besides the renewable energy integration has grown fast. Also, a lot of investments by governments and private parties have been made into offshore wind energy & solar panel parks which are not directly connected to the distribution grid but also to the transmission network in the Netherlands (Petersen, 2015). Apparently, power generation should be included when researching smart grids. Especially because when implementing smart grid technologies and ideas, the power generation will change (Aghaei & Alizadeh, 2013).

#### *Grid Automatization*

Another valuable solution, which relates to the smart grid is Grid Automatization. Placing sensors, steering energy flows, the self-healing capability; grid automatization is crucial in providing a self-steering service for energy networks. In advance, like Fangxing et al. (2010) and Samad & Kiliccote (2012) stated, the self-steering service provide both efficiency and reliability. Efficiency, because the smart grid can distribute energy flows from one point to another. Because of communication between sensors in houses, on transmitters etc. attached to an intelligent system, energy flows can be coordinated most efficiently. Another value which grid automatization provide is the self-healing capacity of the grid. Because expected problems broached, it enables operators to intervene before this expected problem becomes a real issue. This self-healing capability improves the reliability for all users of the electricity network. Still, some complexities arrive when implementing grid automatization. For instance, in the Netherlands, some privacy issues are blocking the way of progress. Regulation systems are not adapted to the exchange of behavioural data. Because who will be responsible for leaks? Will this data be saved in a database or should it be removed after triggering the smart grid? Wisman & Lodder (2013) elaborate that these issues are not solved yet. Thus, to proceed the transition of grid automatization, a vast variety of policy changes must be initiated. When focussing on governance and upscaling, grid automatization is not only an essential component of smart grids but also a stumbling block for further smart grid implementation.

#### *Smart buildings*

All three articles mention awareness, customer service, smart devices. Smart metering is already introduced on a significant scale and is a device which considers a successful implementation process. Started in the seventies, the smart meters nowadays are a lot more than just a stimulating factor of awareness about people's energy use.



*Figure 2.1.3. Smart home energy applications. Source: Darby, 2010.*

One condition for meters to call them smart meters is the ability to communicate. This regards to the ability to communicate with other devices inside houses but also the communication with the distribution grid and even the transfer of data to the transmission network and generators. In figure 2.1.3. several technologies are visible. The interconnection of all these applications will not only define the technologies as smart but in this case also the building itself. Therefore, it is highly interesting to add smart buildings as one of the categories (Darby, 2010). It is not only the potential; buildings are namely the biggest consumers of electricity (70% of the electricity in the US; in the Netherlands is this 20% use by civil society and 80% of business users (CBS, 2015)). Thus, efficiency here is, when aiming for the decrease in greenhouse gas emissions, of primary importance (Agarwal et al., 2010). Even though the smart meter is on the market for over decades and smart buildings were introduced in the nineties, still steps should be made.

#### *The categorisation*

Figure 2.1.4. shows the framework which is used in this thesis. Every separate category is analysed individually and combined. In this case, it gets easier to see how upscaling works for the individual aspects of the smart grid.



*Figure 2.1.4. Categorisation of technical solutions for electricity grids. Source: ABB, 2017.*

#### *Concluding remarks*

There is not one answer to the question: what is the smart grid? What one could say is that there exists a shared vision about the purpose of smart grids. With a variety of technological solutions adapted to different contexts and the notion that the "real" smart grid has not been implemented yet, it is not desirable to investigate the smart grid in a combination of solutions. Decomposing the smart grid into technological subgroups will help to make influences of single solutions visible. But because both the distribution grid and the centralised energy network integrates smart technologies, there is an extensive and complex system of forces. Thus, the distribution grid (microlevel) will be the primary focus. Generation, however, is impossible to exclude. Secondly, grid automatization is mentioned, it is the keystone technology of smart grids; it gives the energy network its self-steering capacity. Thirdly, renewable integration is important as technology and goal. Also, storage technology is a necessary technology to include. Especially to achieve more balance in the power distribution, storage is a key technology. At last, smart buildings define a subgroup of smart grid solutions. The interconnection of sensors, meters and communication points is necessary to provide a two-way direction of energy flows. Thus, in this research, these subgroups will be analysed on factors of success and failure from a governance perspective.

## 2.2. The governance of smart grids

It is hard to find any planning process related literature without the word governance in it. Buzzword or not, it is not possible to research spatial planning related issues without addressing governance anymore (Jessop, 1998). Focussing on the energy network, the importance of governance research is not hard to evince. The energy discourse is characterized by the involvement of a vast number of stakeholders. Stakeholders with distinctive characteristics and different interests. It coheres with a field of complex interactions and a multi-layered set of institutions, law, regulations and policies (Goldthau, 2014). So, it is not hard to see why governance should be a subject of interest concerning smart grids. Nevertheless, to avoid a web of vague constructs, it is important to define governance in relation to smart grids.

### 2.2.1. Governance defined

When talking about governance, a variety of types can be distinguished: multilevel governance, smart governance, urban governance, self-organisation, good governance and so on. Elaborating the kind of governance is key in researching the phenomenon (Gupta, 2015 pp. 27-40). “Central to the concept of governance is the move away from government to governance.” (Ngar-yin Mah et al., 2012 p. 135) This quote seems to be in line with the liberalisation process within the energy discourse in the Netherlands. As pointed out in the introduction, new organisational forms began to emerge since the nineties. The positions of generators, providers and consumers in a market driven system became stronger. The role of the government decreased in power (Verbong & Geels, 2007). As one could see in the formation of organisations at smart grid projects, next to governmental actors, a lot of private actors intervened (Netbeheer Nederland, 2016). Ngar-Yin Mah et al. (2012) stated that scale is an important factor in formation processes at smart grids. Smart grids, as told in “defining the smart grid”, are mostly implemented on a local scale. Still, the distribution grid interacts with the centralised energy network which causes influences on a bigger scale. This interaction consists of money, using green energy sources, electricity infrastructure, etc. In other words, governance of smart grids should be investigated not only on a level of neighbourhoods or cities but should be analysed as a multilevel process. Where national, regional and local stakeholders are constantly interacting with each other. To conclude, smart grid projects are produced by the liberal character of the energy discourse in the Netherlands and developed a multi-level-multi-actor organisational structure.

#### The actors

Because of the liberal character of the energy discourse, a substantial number of actors are involved. In a multilevel governance, both low scale actors as higher level actors are involved. Here we can separate the parties with an interest in the market and parties with interest in the public good:

Market interest	Public interest
Suppliers (Eneco, Essent etc.)	National Government (RVO & EZ)
Network operators (Stedin, Enexis etc.)	Decentralized governmental institutions (Municipalities, provinces etc.)
Consumers	Consumers
Think-tanks (Consultancy and Knowledge institutions) (TNO, DNV-GL, Balance etc.)	Universities (TU Eindhoven, TU Delft, UU etc.)
Software developers (Siemens, Senfal, Tesla etc.)	Regulators (Policy makers, Judicial Authorities etc.)
Consortia (Powermatching City, Jouw Energie Moment, M4H etc.)	Community groups and consortia

Figure 2.2.1. Actor division. Based on source: Owaineh et al., 2015.

Due to the complexity of interactions among these actors, the governance model deriving from smart grid implementation has several axes:

- The scale, where stakeholders are engaged in
- The difference in interest
- Power: financially and by law

In the article of Uslar, Specht & Vazquez (2010) is mentioned that "obviously cooperation is crucial in pushing the experimental phase of smart grids over "the valley of death" and initiate niche markets". Interesting to see; keeping in mind that this article focuses solely on technology, the development of techniques is proceeding at a high pace. Integrating innovation theory in this discourse, a classical conflict within innovation is innovation (stimulation) and regulation. As one could see in the actor diffusion in figure 2.2.1., two primary interests are covered: the public interest and the market interest. Both with a goal to scale up smart grids, regulation and stimulation can be seen as means for policy (Owaineh et al., 2015). At the other hand, acceptance is of big importance. According to Wolsink (2012, pp. 826-827), the willingness to accept is essential when succeeding smart grid initiatives. Wolsink subdivides two aspects of acceptance among actors and markets

- "Acceptance of the creation of the socioeconomic conditions needed for implementation."
- "Acceptance of all consequences of the innovation."

When achieving acceptance among all stakeholders the chance of implementation and even upscaling of smart grids gets higher.



Figure 2.2. Three dimensions of social acceptance of renewable energy innovations. Wolsink, 2012.

The last division which can be made is between dimensions. In figure 2.2. three dimensions are divided: private sector, public sector and civil society. In Wolsink (2012), a triangular figure has been developed between the same divisions. Different names but with the same perception. In the last section, the importance of acceptance among all stakeholders has been made clear. Figure 2.2. shows the triangular relationship between the three core sectors. It shows both internal acceptance as external acceptance. Change is an inevitable feature in accepting the difference in interest.



So, acceptance of technologies is a complex matter, and the same can be said in the case of policy. This reminds of the importance of thinking about the governance model behind smart grids. In other words, the liberalisation process caused the involvement of a variety of actors with a market interest. The differences in interests, power and scale engagement result in a playfield of stakeholders where challenges within policy and acceptance play a significant role. Financial and technological possibilities play a limited role here. Large companies like Tesla, Siemens, IBM, but also suppliers like Eneco, Nuon, Essent are willing to invest in the future energy grid. Also, technological development develops at a fast pace (Owaineh et al., 2015). So, in this research, the focus on governance is evolved out of policy and acceptance. The next paragraph elaborates on the means of governance. Here the goal is to make a framework where factors of success and failure will be measured.

### 2.2.2. The means of Governance

Besides the specification of the multilevel governance, there exists a bundle of components within the governance concept. Due to the change from electricity networks towards intelligent energy grids, the pressure is rising on these elements (Xenias et al., 2015). In this research three types of these components will be used to search for the main factors of success and failure:

- Stimulation
- Regulation
- Collaboration

These elements are not just indicators for the governance question. However, when analysing articles about standardisation, upscaling and management of smart grids in a governance structure, these three aspects have a significant influence.

Xenias et al. (2015) is one of the articles focussing on key factors in the development of smart grids. They investigated successes and pitfalls of smart grid development. Until now, smart grid implementation is seen more as an item of promotion than an actual means to solve climate mitigation- and financial challenges. A vast number of experts see smart grid implementation as unproven, undeveloped, complex and difficult to implement. In this article, they address which items are useful to investigate to change the vision of the organizations. The article sums up: Standards, Data handling, Market structure, Regulation, Co- ordination, Customer engagement and investment. This comprehensive bundle of sub groups is applicable for the British context. The Dutch context has some difference to keep in mind. In the Dutch case pilots are mostly organised by consortia on higher levels with control of the national government (Economic affairs and national service for entrepreneurship) Due to this difference in levels and contexts it is not possible to apply these subgroups directly on the Dutch case.

Secondly, in the article of McLean, Bulkeley & Crang (2016), they investigate the American context Austin, Texas. Interesting side node, they also research:

*The "opening up" of cities as experimental nodes and its effect on socio-technical urban governance.*

*"We argue that cities are key arenas for allowing the trialling, testing and development of smart products that can help moves in a transition towards a low-carbon economy. "*

The same as in the article of Xenias et al. (2015), this article describes some key elements of succeeding smart grid implementation. Summing these up it turns out that there are similarities but also differences:

- Restructuring means change in vision
- Niche development (Market orientation)
- Creating new forms of politics in a public-private collaboration model
- Management of visions and goal development
- Context-dependency and context-specific
- Economic competitiveness

When comparing these two articles, the differences are substantial. Thus, to feedback on the framework development, it is not a well-thought-out idea to copy one framework and use this in the Dutch context.

The items which are always involved are mainly: Context, business potential, regulation, coordination & management. Strange enough, when focussing on a single solution such as smart buildings this vision doesn't change. For example, in the article of Balta-Ozkan et al. (2013) they mention trust, security, reliability at one hand and the other hand cost efficiency, interoperability and administration. Thus, they see also the two fault of regulation and stimulation which means; stimulation and regulation on policy and economic terms. With the introduction of reliability and transparency, this makes this framework, including a variety of key factors, applying to the Dutch case. Context seems to be important but is often an avoided construct regarding governance of smart grid development. At last, in terms of governance, collaboration cannot be disregarded.

In the article of Chourabi et al. (2012) about factors of success and failure, they made a table about factors which were found in the literature and are fundamental for the governance at smart city initiatives. Chourabi et al. (2012) tried, in their article, to make an overview of factors which, accordingly to their literature review, were most common and used. Thus, the factors (see table 2.1.) seems to be elements where academics are the most agreed on. Off course, a lot of factors can be added, but this is not always interesting for the scope of this research. For example, identification of stakeholders (also mentioned as an important factor) is not interesting when talking about upscaling. It should be done already in earlier stages (To leave out the arrival of new entrants: the part of upscaling discusses that). The choice to exclude and include this stakeholder composition factor is subjective, but in the case of this research, upscaling is essential. Thus, whenever factors focus on the starting phases of smart grid technologies, they are excluded. As well, the Dutch context is important as focus, a lot of literature will refer to different contexts. To conclude, in this research factors will be valued from a Dutch perspective. What means some elements are excluded even though they apply to other settings. Section four describes the starting point of how the smart grid implementation policy exists at the moment.

<i>Key factors for the Collaboration of smart city initiatives</i>
<b>Leadership and champion</b>
<b>Participation and partnership</b>
<b>Communication</b>
<b>Data-exchange</b>
<b>Accountability</b>
<b>Transparency</b>

*Table 2.1. Key factors for the collaboration of smart city initiatives. Source: Chourabi et al., 2012.*

These six factors do not sum up hierarchically. So, there exists no valuation among these factors. In this framework, they see collaboration as a key factor linked with six other factors. Some are already discussed in the constructs; stimulation and regulation, but others are also important to include. Instead of using these constructs as separate elements, the collaboration is used as an umbrella for



these items. Still, this framework will give a well-explained direction because collaboration might be regarded as vague and inconsistent. In the article of Chourabi et al. (2012) 8 factors (including collaboration) are mentioned. However, in this research three frameworks are separated: Technologies, Governance and upscaling. Chourabi et al. (2012) also integrate the application and service in their framework. As mentioned earlier, separation of technologies in a separate frame has more value, especially when focussing on upscaling. The gaps between development and composition of challenges are too significant for combining the technological solutions. Still, because Chourabi et al. (2012) used this framework based on a literature review, these components are well chosen and highly useable to explain collaboration.

### *To conclude*

The means of governance; every article which investigated either barriers or successes of smart grids end up here. They do not necessarily see the actor composition as a challenge, but the cooperation among them. It is possible to overcome Financial challenges because dominant players are willing to pay. Also, technological solutions seem to be full of opportunities and do not lack development. On the other hand, as we know now, smart grids have never been implemented yet. A lot of articles state that this is either the cause of policy or/and acceptance. These two features within the governance discourse will, therefore, be researched. When focussing on those two components, a framework could be developed. In the analysis divides three means of governance; Stimulation, regulation and collaboration Whether we see context as a means or something else, context cannot be disregarded in this study.

When looking closer to the three means, interaction among these four means can be elaborated. Stimulation and regulation develop one axe with conflicts, challenges and influences. Stimulation and regulation define ways for the policy discourse within the governance question. At the other side collaboration and context can be appointed as means for acceptance. To conclude, the framework of governance is clear but how does it relate to upscaling and how should upscaling be defined. The next paragraph explains this.

## 2.3. Upscaling in a governance perspective, why and how?

Whenever we read publications about only smart grid pilots, all publications include a section about upscaling. As mentioned by the RVO and TKI Energy (see introduction) the ambition after this experimental phase is 'off course' upscaling smart grid systems on a higher scale. Upscaling is the ambition, but how will it be organised? In this section, the why and how derived from the literature will be described and will give a direction where to go. The definition of scaling-up has two directions: scaling-up of means (initiatives or programmes) and scaling-up of ends (social-economic and environmental impact). Thus, it is either the quantity of implementation which will change or the reach of projects that will change (Van Doren et al., 2016 p.3). In this research, both will be combined and included.

### 2.3.1. Upscaling, what?

That upscaling, again, is a broad definition is shown in several publications. It is therefore prior to first address what upscaling means considering smart grid projects in the Netherlands. Only then it is possible to explain what success or failure is. In the article of Van Winden et.al. (2016), upscaling is split in four different views on upscaling processes:

- Roll-out
- Expansion
- Replication
- Diffusion

This diversification is based on organisational and transition sciences. Upscaling in other perspectives could differ in explanation.

When talking about Roll-out, a technical solution is successfully tested during the pilot phase. The organisation who was in charge over this pilot, will roll-out the project itself. So, the group will not change, and the system will not adapt to the context. The pilot will just roll-out in the current regime. Roll-out happens with technology which not challenges the current system, which could be difficult considering the smart grid implementation in the Netherlands. The expansion, however, fundamentally differs from a Roll-out because it influences the organisation around the technology. With the expansion, new partners are added during the implementation process. With expansion, it is also possible that the technology will be modified or the geographic context will change. Thus, expansion will always influence the current system, either in governance or technology and geographical context. In the case of smart grids, this can be a way of upscaling in consideration. Replication is often referred as the most challengeable type of upscaling. Either the same partnership or another will replicate the project in a whole different context. It is impossible to copy the same project in a different context (different legal-, institutional-, geographic system and stakeholder composition). There will always be an adaption to the new situation (Van Winden, 2016 pp. 9-10).

At last, according to the literature, this research could add diffusion. Like the other three types of upscaling, diffusion starts after testing demonstration projects. The difference between diffusion and other types of upscaling is that it starts before the commercialisation. It is a spread of ideas, not the actual technological solution. Thus, still solutions must be tested first. There will be a process of building on the original idea. The literature uses the definition of diffusion differently. It is hard to research diffusion because it could evolve everywhere in all contexts, thus finding the right respondents to interview is not possible in this research (Lee et al., 2013 p. 293).

*"These new urban services invert the relationship between the material substrate and the digital layer of the city: they do not just fit in the existing spaces, but modify the physical substrate and remodel the city by changing how people interact (Consilio, 2014 p. 35)."*

As already said, it is unlikely to happen that the technology will fit right away. In the case of smart grids, it is technology which will adapt to the context, but then the context will change again. Thus, it is a process of readapting the technology within the context. It is a process of integration which will never end. Eventually, it reaches a certain point where it is widely spread and that this technological solution is integrated into the system, more than the confessional technical solutions (Consilio, 2014 p. 35). In advance, it is not only possible that the system or/and the technology changes: it is also a possibility that the organisation itself will grow and then gaining the ability to scale-up the technology (financial resources, more capacity etc.). In this research, it is called: organisational growth (World Bank, 2003).

Upscaling has various forms and contexts, but what I want to add is the division between horizontal and vertical upscaling. In figure 2.3.1. Especially in spatial planning perspective this division is interesting to integrate.

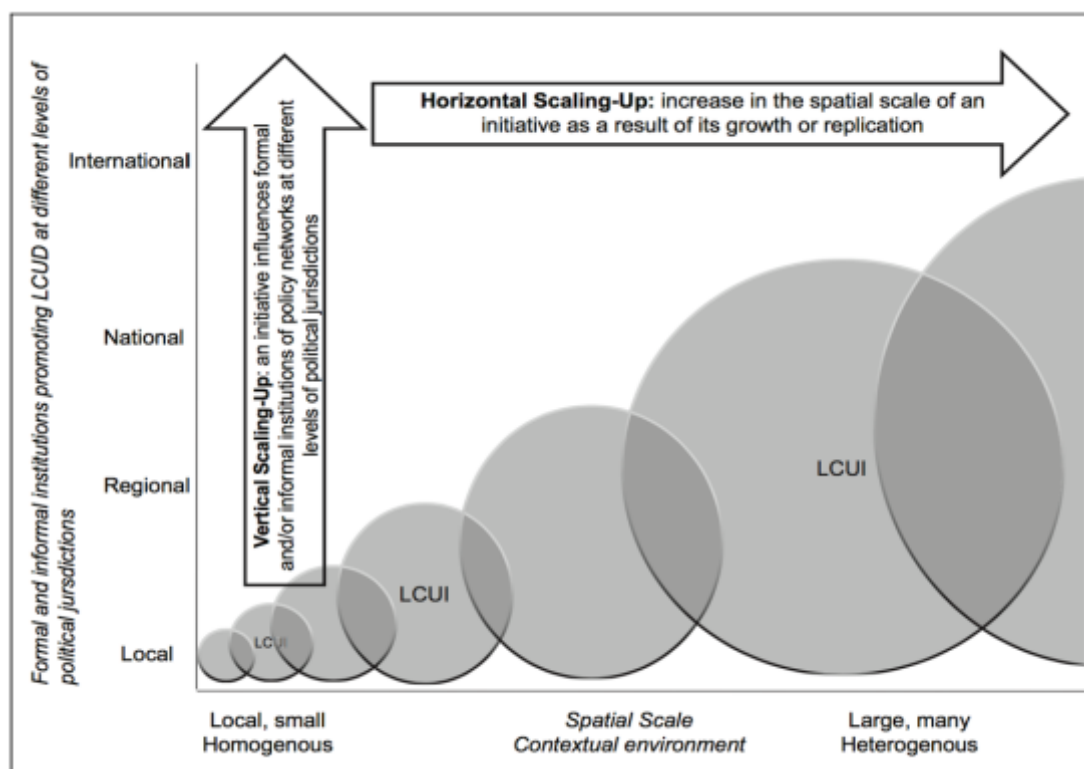


Figure 2.3.1. The spatial and institutional influence of upscaling. Source: Van Doren et al., 2016 p.5.

Horizontal upscaling is defined as scaling-up in a spatial sense. In the case of smart grids, it is interesting to see how pilot programs start on a neighbourhood level, then get implemented on a local scale. The development of the technology should adapt when implementing technologies on higher scales. Summing-up, Doren et al., 2016 also points out that a roll-out is unlikely to happen on a larger scale which is not homogeneous. In figure 2.3.1., it is possible to see how far it is possible to roll-out a technology. As seen in figure 2.3.1., vertical pathways consider changing in institutional roots. Vertical

upscaling refers to the process where the information concerning ideas, values, knowledge or other lessons from individual initiatives connect with institutions at higher administrative and organisational levels with wider-reaching impact. Thus, an individual imitative (for example smart storage batteries) serve as the basis for a wider institutional change (Doren et al., 2016 pp. 4-5).

	Roll-out	Expansion	Replication	Diffusion
Means/Ends	In relation to smart grids, roll-out of technologies will be initiated by the same initiators. But with including more connections (households and companies) to the grid, the impact will grow on the social-environmental domain. So, roll-out is primarily a type of <b>upscaling of ends</b> .	New entrants will influence the governance structure, new initiators stimulate growth in integrating smart techniques. These techniques will change the geographic context or the composition of actors. This change is thus both increasing the socio-environmental impact and the number of programs. So, both <b>upscaling of means and ends</b> can be applied here.	Replication is not about the composition of initiators. This can be the same or differ. Context, here, is the variable. When replicating technological solutions, adaption of these solutions is key. In this case, the socio-environmental impact will not be the goal. However, this type of upscaling enables to adapt programs and initiatives and let it grow. Thus, replication is for most <b>upscaling of means</b> .	The difference between replication and diffusion is that not the solutions will be scaled-up but the ideas (initiatives). The socio-environmental impact in context will not be affected. Instead, diffusion is the clearest form of <b>upscaling of means</b> . Programs of initiatives will differ because of the context and the different composition of initiators.
Horizontal/vertical	Roll-out consists of the characteristic to develop from a central point. Because the composition of initiators doesn't change and it mostly only happens on local level (incidentally on regional level), roll-out has a homogeneous growth. Because the composition of institutions doesn't change it is neither a form of vertical and horizontal upscaling.	Expansion will break through institutional boundaries and change the composition of stakeholders. Different initiators with different ideas has most likely influence on ideas, values, knowledge etc. The connection with higher institutions is likely to emerge. At the other hand expansion will be done accordingly to the same principle of roll-out: connecting from a central geographic point. So, Expansion can be related to vertical upscaling and not to horizontal upscaling.	In comparison with Roll-out and Expansion, Replication has an effect in horizontal way. Replication of technological solutions is a form of upscaling in a large heterogeneous context. Adaption is key here. The influence on higher institutional scale will not emerge. Solutions will be adapted conform the norms, values of a certain area and the composition of initiators will not try to change the institutional context. Thus, replication is a type of horizontal upscaling and not vertical upscaling.	Both horizontal and vertical upscaling can be applied to diffusion. The introduction of technological solutions in heterogeneous contexts and the widespread involvement of initiators will influence institutional boundaries and scalability. Off course, the power of influence can be discussed at diffusion because there exists a change that every group of initiators tries to "invent the same wheel".

Table 2.3.1. Eleborated framework of upscaling forms.

In table 2.3.1. , the combination of upscaling forms is framed. Every cell describes different characteristics. To recognise the type of upscaling, this table is used as an explanation for various kinds of upscaling and clarify which type of upscaling relates to which factors of success and failure considering the means of governance. The next paragraph points out how upscaling can trigger new governance systems.

### 2.3.2. New system, new markets..., new players

In an interview with Frits Verheij (Chairman at TKI Urban Energy) he stated:

*"Upscaling towards a commercialised technology which is widely spread will take a long time, before the full integration there is a phase of the introduction to niche markets. In principle, this is also upscaling, and the process of commercialization has already begun."*

The article of Jolly, Raven & Romijn (2012) also considering this phase in the upscaling as an important one. They point out that it is also interesting to focus more on the new entrants; especially the entrepreneurs. Despite that, the entrepreneurial theme and upscaling belong more to business sciences or economic geography. The role of these entrepreneurs is interesting to include in the stakeholder composition. Entrepreneurs, as new entrants, will not only promote the transition towards a new energy network but will also create niche markets. New markets namely, are created by renewals (innovators). Off course, this can be done by bigger companies with incubated renewals or can be done by start-ups/ entrepreneurs. The interconnection between entrepreneurs and niche markets are therefore essential. This interconnection will be one of the features which give an indication when large scale implementation will start.

In the governance section of this chapter, figure 2.2.1. already showed the composition of stakeholders in the energy-chain. Conflict of interests was likely to appear due to the division of either market or public benefits. In the article of Negro, Alkemade & Hekkert (2012), they also state that the confessional energy system hampers the upscaling of new energy technologies (Hughes, 1983). One factor, according to Negro, Alkemade & Hekkert, which conducts upscaling failures and regards to the difference of interests and the arrival of new players: interaction problems. Here they divide strong communication problems and weak interaction problems. Strong interaction problems appear when individual actors get misguided by network actors. This causes that the network is too closed and actors become reluctant to exit the group or new entrants are blocked on their way to being a part of the network (system). Weak interaction problems, however, occur when there exists a lack of connectivity between actors and complementary innovations. Further on, a shared vision for the future of changes is of vital importance. Otherwise “reinventing the wheel” by different actors is most likely to evolve. Thus, to stimulate upscaling development, interaction among stakeholders is necessary to have a shared vision for the future and provide a flexible and open actor network.

In figure 2.3.2. the different stages of upscaling are visible in relation to time. This model shows the policy what has been chosen for in the Netherlands. Interesting to see; the overlap between large scale demonstration phase and the large scale implementation phase. According to Frits Verheij, the upscale implementation process is near, and the large-scale demonstration has almost ended. It is the stage of strategic choices where all stakeholder must invest in right now. Indirectly, this underlines the importance of this research.



Figure 2.3.2. Upscaling policy smart grids in the Netherlands. Bron: Bongaerts & Verheij, 2014.

Thus, the arrival of new entrants announces the beginning of large scale implementation of smart grids. But now we know that we are at the stage of making strategic choices as well which gives a direction for this research. When talking about strategic decision-making, road maps can be a tool to provide support for stakeholders about which decisions should be made and when. In the article of Lee et al. (2013) they stated:

*"Other definitions of the road mapping process describe it as a demand-driven technology planning process serving market needs, a communication/knowledge management tool supporting strategic decision-making and as a collective approach to developing a strategy in which the integration of science/technological considerations represents a valuable input into product and business planning."*

In this research, the frame with factors of success and failure will contribute mainly to the phase of decision-making. Structuring knowledge is one of the key features at triggering upscale implementation of smart grids. Road mapping is not the only way to structuring knowledge; there are several ways to get from larger scale demonstration projects to the implementation of smart grids with commercialised intentions. Thus, the interconnection between governance processes and upscaling is vital when focussing on the decision-making-strategy phase.

#### *Concluding remarks*

Roll-out, expansion, replication and diffusion; these types of upscaling all develop in their characteristic way. Introducing horizontal and vertical scaling-up clarifies these different pathways. How will projects develop and how will it influence governance. Rather than standing still, new entrants affect the governance system when upscaling starts. In the end, when focussing on the means of governance; stimulation, regulation and collaboration are differentiated among these different pathways of upscaling. Thus, when researching the various types of upscaling, one should be aware of the characteristics which are intertwined with: the stakeholder composition and the interference of new entrants.

The upscaling of smart grids is a commercialised matter. The interference of new entrants (innovators) is fundamental to form niche markets. On the other hand, we see that new entrants are not always powerful enough to push the old system towards a new governance system. This merge of confessional players in the energy-chain with the new entrants has a significant importance for initiating niche markets for smart grids. When focussing on the Dutch context, before creating new markets, strategic choices are important to make. In this research, the frame with factors of success and failure will contribute especially to the phase of decision-making. Structuring knowledge is one of the key features at triggering upscale implementation of smart grids.



## 2.4. Conclusion

The choice of constructs, the variety of measurements, the explanatory character of this research: the development of each of these frameworks is based on subjectivity and urgency. Thus, for every research with the same purpose, a different combination of constructs can be developed, and therefore frameworks can differ and still can get an answer to the research question:

*Which factors of success and failure, considering a governance perspective, could be defined at the upscaling process from smart grid pilots towards large scale smart grid implementation in the Netherlands?*

### 2.4.1. Framing this thesis

When focussing on smart grids, one could place a question mark behind the definition of smart grids. The definition which is used in most literature:

*"A smart grid is an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers, operators and those that do both – to efficiently deliver sustainable, economic and secure electricity supplies. A smart grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies. (Ardito et al., 2013)"*

However, because of the non-existence of the “real” smart grid, the purpose is hard to investigate. Most researchers, therefore, choose to separate smart grid applications and so aim to get a better understanding of the potential and status of smart grids. This research develops different subgroups of techniques. With the knowledge that these subgroups are in a different stage of development either on economic, social, technological or policy. Still, regarding the literature about the definition of smart grids, the subgroups combined approximately define what a smart grid is. Defining the smart grid is chosen based on literature reviews and the urgencies within the development of several smart energy solutions. However, in this research, there are some interesting facts regarding the choice of subgroups. Although the research investigates the five subgroups individually, influences and conflicts exist between these subgroups. So, results must be recognising the influences and disputes between different subgroups.

In the governance section, two important pillars are defined: Policy and acceptance. When focussing on the definition of governance: the decreased power of governmental interference and the increasing influence on decision-making by non-governmental parties, governance of smart grids is a complex matter. The energy system has a rather specific composition of actors which are in most cases non-governmental. Thus, the governance around smart grids went already through a transition since the liberalisation of the energy market since the nineties. Now, initiated by the national government this system, due to the implementation of smart grid technologies, will go into a new transition which will be more affecting governmental issues like social exclusion, city development and so on. Here, it is the issues of policy and acceptance what has to improve to create stronger business cases and initiate successful upscaling of smart grid technologies. Thus, one could divide four main pillars of success at smart grid implementation in a governance system: technology successes, strong business cases, acceptance by stakeholders and customers (also becoming stakeholders: prosumers) and a good policy climate. In the end, policy and acceptance are the pillars where this research will focus on.

To get to this end goal, means of governance are key. In this research, three means will represent the main constructs to measure to frame factors of success and failure. The three means define; Regulation, stimulation and collaboration. Thus, to get from smart grid implementation within a

governance system towards a framework for factors of success and failure, this research focusses on these three means.

The smart grid is defined, a framework is developed out of the governance, at last, the construct of scaling- up is analysed from the literature. The definition of scaling-up has two directions: scaling-up of means (initiatives or programmes) and scaling-up of ends (social-economic and environmental impact). Thus, it is either the quantity of implementation which will change or the reach of projects that will change. In this sense, upscaling processes can differ in form and context. In this research four of these different upscaling processes are described: Roll-out, Expansion, Replication and diffusion. To recognise these different upscaling processes with the various influences on the governance and the other way around, a table is made where the upscaling of means/ ends and the upscaling in a horizontal/vertical way, are integrated to characterise the different upscaling processes.

Finally, as shown in figure 2.3.2., the phase of strategic choices is elaborated. This research introduces several frames to give an overview of factors of success and failure in a structured way. However, what when one uses these frames? The last paragraph describes how actors should be analysed in a governance system at large scale smart grid implementation.



### 2.4.2. Total framework

In order to measure the factors of success and failure considering the governance perspective in a structured way, figure 2.4.1. visualises the overview of frameworks and influences .Within this model not only the frameworks are visualised but also the direction of influences between and within the three different frames.

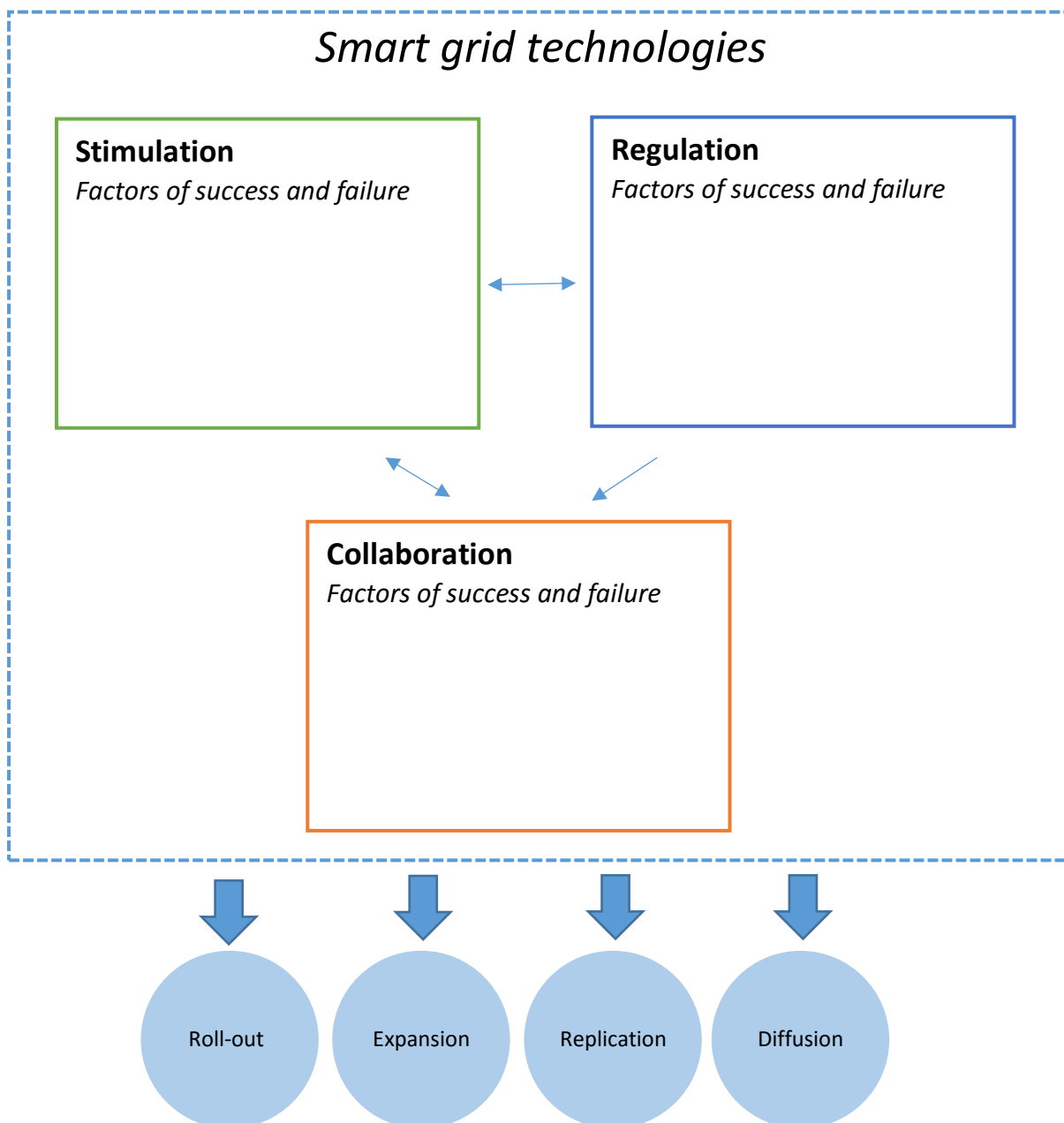


Figure 2.4.1. Integrated model of frameworks and influences.



# Methodology

## Content

- 3.1. Quantitative or qualitative?
- 3.2. Respondents and context
- 3.3. Method and Analysis
- 3.4. Limitations and ethics

### 3. Methodology

This chapter elaborates the method which is used to get an answer on the sub questions and as a result of that; the research question. At first, the empirical strategy is explained. This paragraph describes the choice for either qualitative or quantitative research. Furthermore, this section clarifies the choices about how this study is structured. Secondly, the respondents and context are described, and as well the choices will be elaborated. In the third paragraph, the method and data analysis are elucidated. In advance, both the ethics and limitations of this research are described. In the end, this section answers the question: how to get the answer to the research question.

#### 3.1. Quantitative or qualitative?

As mentioned earlier in this thesis, the explanatory character of this research caused a particular type of literary analysis. No hypotheses were formed, and instead of choosing for theories, frameworks are developed. This because the research is inductive and not deductive. The difference between inductive and deductive refers to theory developing and theory testing. Whereas in much research, theories are tested (deductive) which is often related to quantitative research, this research is in search of constructs and connections (inductive) which are often related to qualitative research (Bryman, 2015).

Therefore, in this thesis, the choice for qualitative research is more suitable. Gathering information is key in finding factors. Preliminary choosing factors is not possible and even not desirable when the literature is not covering these elements at all. Frameworks help with searching for items in a more structured way. Besides, smart grid implementation has never been integrated on a large scale, and therefore not all solutions are implemented by the same combination of stakeholders. With qualitative research, fewer research subjects are needed, whereas to use quantitative research there is a lack of respondents, so significant conclusions are unlikely to find. Although, qualitative research is based on fewer research subjects. It is possible to measure more variables and aspects of single respondents (Boeije et al., 2009). Because the desirable data has to be more accurate and enhanced, the choice for qualitative research is legitimate.

In short, theory developing insists qualitative research. Without hypotheses, enough research subjects and the need for detailed and enhanced information; the choice for qualitative research can be considered as legitimate. Further on in this chapter, the interpretation of qualitative study in this thesis will be more elaborated.

#### 3.2. Respondents and context

Because intrinsically, this research is based on governance processes with the involvement of a vast number of different stakeholders, from different contexts and with different interests. A variety of interested parties should be involved to find the essential issues related to upscaling smart grids. Furthermore, integrating different contexts and types of upscaling is important. As concluded in theoretical section, this research focusses solely on the factors, but still, it is important to know if differences appear in different projects.

##### 3.2.1. Context

Thus, before choosing the research subjects and respondents, it mandatory to focus on projects. Three projects are investigated in five different cities on six various locations. Table 3.1. shows these projects. The detailed context description is placed in chapter 4. Here a geographical analysis and more technical analysis is explained. Still, the choice of context is also methodically important.

Project	City	Location
Powermatching City I & II	Groningen	- Groningen (Hoogkerk)
Jouw Energie Moment 1.0. & 2.0.	Breda, Etten-leur en Zwolle	- Breda (Meulenspie) - Breda (Easystreet) - Etten-Leur (de Keen) - Zwolle (Muziekwijk)
M4H	Rotterdam	- Rotterdam (Merwehavens)

Table 3.1.1. Choice of projects.

The choice for these project is based on three conditions, which interrelates with the selection of frameworks derived from the theoretical section. At first, this research investigates five subgroups of technological solutions. The technical solutions combined, compose the smart grid. In the Netherlands, a variety of smart grid related technologies are implemented, but to oversee and research these technologies only a couple of projects can be focused on. Although the “real” smart grid has not been applied yet (see paragraph 2.1.1.), it is relevant to at least aim for integrating all subgroups spread over de researched projects. In table 3.1.2. is shown which technological solutions are implemented per project. Of course, in this research, there is a focus on the subgroups rather than the variety of technologies within the subgroups. Thus, the individual techniques are not the main subject in this research.

In table 3.1.2. one could notice that every subgroup is represented in the three projects combined. Individually, Powermatching city, in principle, can’t give substance to the subgroup smart energy storage. Some authors (Mwasilu et al., 2014; Rohjans et al., 2010 etc) however, question if e-mobility could be integrated as a type of energy storage. Thus, in the table e-mobility is represented as the smart storage solution. In jouw energie moment, power generation is not described. Of course, solar panels and input from the centralised energy grid are part of the power distribution in these areas. Still, to examine smart grid solutions, this will not be included as features of electricity generation. At last M4H is representing none of the subgroups because the project is not implemented yet. The choice to include this project will be elaborated later in this paragraph.

	Powermatching City	Jouw energie moment	M4H
Integrating renewable energy	Solar panels, HRe- heating	Solar panels	-
“smart” energy storage	E-mobility	Tesla-powerwalls	-
Power generation	Wind turbines	-	-
Grid Automatization	Database, web applications, powermatcher	Integrated computer, flexible price system	-
Smart buildings	Smart meters	Flexible price monitors, smart washing machines,	-

Table 3.1.2. Integration of technological solutions

The second consideration to include these particular projects is based on the duration and size. Power matching city is a project which started in 2009 and after the first phase had ended, a second phase began. The length of this project was six years which integrated several technologies. In the second step, the integration of sustainable energy sources was of greater importance. Although, the smart grid solutions were only accessible for 40 households, this project generated important knowledge about the energy system. So, not only technologies got tested, but also the influence on the energy system and prospects on business models have been investigated.

Jouw energie moment is a bigger project which is also implemented in several contexts. With over 250 households, this project is one of the larger projects in the Netherlands. Also, the duration is substantially longer than other comparable projects. The project started in 2011 and is still developing. In Zwolle, the project ended in 2015, but with the initiative of Senfal to start a new phase, the project is continuing in Breda and expanded to Etten-Leur.

M4H is not started yet, but with the ambition to connect 20000 consumers and the aim to roll-out to a ranch of approximately 1000000 connections. This project, in size, is of a major interest in this research.

	Powermatching city	Jouw energie moment	M4H
<b>Roll-out</b>	X		X
<b>Replication</b>		X	
<b>Expansion</b>	X	X	

*Table 3.1.3. Different types of upscaling per project*

At last, the choice of projects is based on the different types of upscaling. Excluding diffusion is not a problem (see table 3.1.3.). As described in paragraph 3.3.1., diffusion regards to the spread of ideas instead of implementation of the same technology. So, with measuring diffusion, one could ask the different stakeholders if the used technology had also impact on other projects. Table 3.1.3. shows that Powermatching city and Jouw energie moment are a form of expansion. With the introduction of new parties to the project, and so upscaling the project, we can define Powermatching city and jouw energie moment as expansion projects. At the other hand Powermatching city has also characteristics of a roll-out. As stated in paragraph 3.3.1., roll-out is a upscaling process from one central point in the same composition of stakeholders. Quite contrary with expansion, the composition of stakeholders didn't change that much. In this sense, it is better to define powermatching city both as a roll-out and expansion project. Jouw energie moment, is not a roll-out. In phase 1.0. Enexis initiated the project with a different bundle of technologies than in phase 2.0. which Senfal launched. At the other hand, replication is linked with the upscaling process of jouw energie moment. As, in comparison with powermatching city, this project is implemented and scaled-up in different context. Which is an example of replication. Thus, in this research jouw energie moment can be defined as both replication and expansion.

M4H is not implemented yet, interesting though: the consortium already spoke out the ambition to roll-out. From a central point, they want to upscale in the same composition of stakeholders in the same context. The added value of including this project in this research is that the steps are already made to scale up the project. In short, covering all the different kinds of upscaling, these projects are considered as relevant for this study.

In the end, these three projects should be sufficient to indicate factors of governance within the upscaling process of smart grids. The projects not only cover all objects in this research, but the variety of these projects will also give a more critical analysis.

### 3.2.2. Respondents

Besides contexts, the importance of choosing the right representatives for interviews is substantial. However, before choosing the representatives, it is important to see how the stakeholder composition is organised. Figure 3.1.1. visualises the composition of stakeholders in the energy chain. Of course, this model simplifies, so are possible aggregators, customer representatives, construction workers, planners, etc. excluded from this model. This figure simplifies but also shows the primary stakeholders and relations. The energy flow starts at the generator, but with the integration of the “prosumer”, this process differs with the introduction of smart grids. Next, to the generation, operators are key in the smart grid. They oversee the energy networks, interesting is that they must communicate and interact with generators, suppliers and consumers. Suppliers in this system are mostly also generating energy, as do the consumers. Thus, the operators have a central position in the network. Outside of the energy stakeholder network, three actors of importance are added. The government, both higher and lower are necessary to defend the public interest. Technology developers, who influence the system by making it more efficient, sustainable, etc. At last, the figure mentions think tanks. These think tanks could be universities, knowledge institutes or high-level consortia. They test, advice and aim for improvement of the energy network.

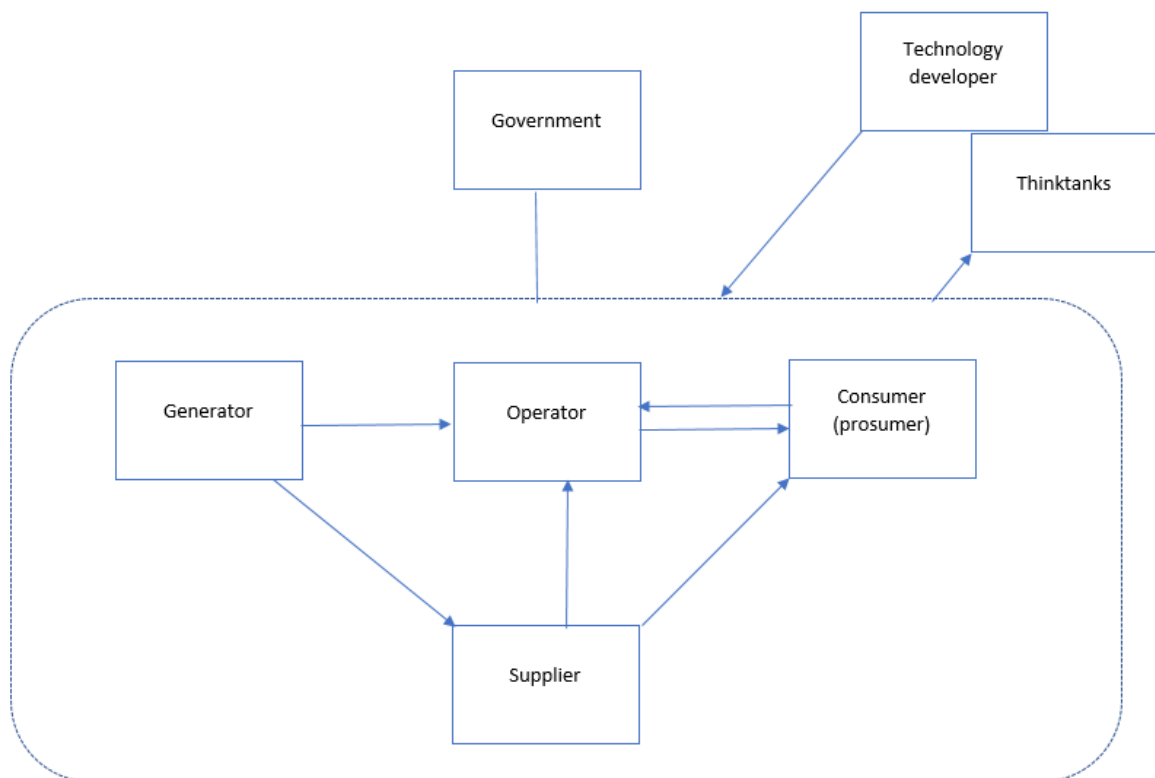


Figure 3.1.1. Simplified stakeholder network in the energy chain.

This explanation is essential for the choice of respondents. To find the right factors of success and failure at the upscaling of smart grids, it is key to aim for objectivity, variety in perceptions and diverse knowledge in this study. It is rather important to ask experts in this research, mainly because they can provide more details about smart grid implementation. The technological possibilities are not the aim of this thesis. Policy and acceptance among stakeholders are better for research from the perception of experts because they either know how to regulate, stimulate, the difference in contexts and collaboration among stakeholders. For acceptance, it could be interesting to add the opinion of the civil society. Wolsink (2013), also said that social acceptance is a major factor in upscaling renewable innovation. But because regulation, stimulation, context & collaboration are the researchable objects, the knowledge of experts about technicalities and the overall vision is better and therefore interesting to include in this research.

### 3.2.3. Final selection of respondents

The selection of respondents is as follows:

<b>Frits Verheij</b>	<b>TKI Urban Energy chairman &amp; former DNV-GL director smart green cities</b>	<i>Phone</i>
<b>Paul Korzaan</b>	<b>Municipality Groningen</b>	<i>Phone</i>
<b>Arjan van Diemen</b>	<b>Sr. Business developer sustainable energy TNO</b>	<i>Phone</i>
<b>Arnold Vis</b>	<b>Port of Rotterdam</b>	<i>Face to Face</i>
<b>Hubert Spruijt</b>	<b>Senfal</b>	<i>Phone</i>
<b>Paul Parea</b>	<b>Gemeente Breda</b>	<i>Face to Face</i>
<b>Elke Klaassen</b>	<b>TU Eindhoven (Initiated by Enexis)</b>	<i>Face to Face</i>
<b>Leo Freriks</b>	<b>Siemens Government affairs manager</b>	<i>Face to Face</i>
<b>Rik van Berkel</b>	<b>Fedet / FME</b>	<i>Face to Face</i>
<b>Roelof uit Beijerse</b>	<b>Gemeente Rotterdam</b>	<i>Face to Face</i>
<b>Nicole de Koning</b>	<b>TNO PhD</b>	<i>Face to Face</i>
<b>Annelies Huygen</b>	<b>Special professor UVA</b>	<i>Phone</i>
<b>Sander Berkhout</b>	<b>Sr. Business consultant Balance</b>	<i>Face to Face</i>

Table 3.2.3. Final selection respondents

Table 3.2.3. shows the selection of interviewed respondents. The blue respondents regard the explanatory interviews. The rest are the interviews done in a semi-structured way.

In this research three types of respondents are chosen to be interviewed:

- Objective specialised experts
- Initiators
- Context involved experts

#### *Objective specialised experts*

- Arjan van Diemen
- Nicole de Koning
- Annelies Huygen
- Sander Berkhout
- Rik van Berkel



#### *Initiators*

- M4H: Siemens (Leo Freriks)
- PMC: DNV-GL (Frits Verheij)
- JEM: Senfal & Enexis (Hubert Spruijt & Elke Klaassen)

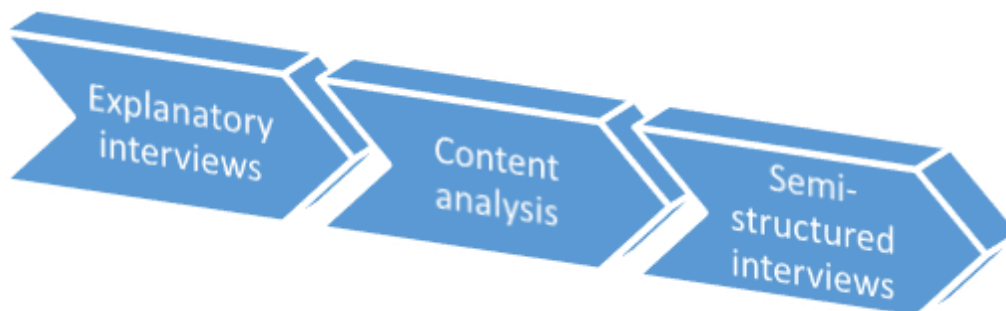
#### *Context involved experts*

- Rotterdam: Roelof uit Beijerse
- Rotterdam: Arnold Vis
- Breda: Paul Paree
- Groningen: Paul Korzaan

In this case both a perspective with an overview on one of the means of governance and context related issues are included in this research. In this case, the aim is to get better data about the success factors and the different types of upscaling.

### 3.3. Method and analysis

The empirical part exists of three steps. As figure 3.3.1. shows, the first part consists of explanatory research. Five interviews with experts in the field. These interviews are unstructured with the goal to find information about the crux in implementing smart grids on a larger scale from a governance perspective. With this information, frameworks can be developed out of related literature.



*Figure 3.3.1. three step data collection.*

The second part consists of a content analysis. This report provides an answer to the first sub question in this research:

What is the current situation of policy around smart grid implementation?

Here regulation and stimulation from a policy view are analysed and described. This section is used to connect the view of experts on change of the energy system towards a smart energy system. Because upscaling is a transitional feature, it is important to have a starting point. Also, at this stage, it is possible to provide conflicts and connections among and inside the means of governance.

The third part conducts the analysis of 10 semi-structured interviews. Each started off with a topic list and some example questions. In this case, the search for incentives and disincentives is critical.



### 3.3.1. Explanatory interviews

With the use of open questions, information about smart grids in general, barriers to implementation and the governance around smart grid implementation was gathered. The information gathered was transcribed into summaries which are included in appendix V. These interviews relate to a literature research. Together this part of the research forms the basis of this study. Frameworks for the definition of smart grids, the means of governance and way of upscaling were developed. Because of these interviews, the frameworks are prepared according to a certain context. In this case; the Dutch context and even more specific, the smart grid pilot program from 2011-2017.

The data derived from these interviews are used in the data analysis as well. Still, in general, the data is not directly connected to any of the sub questions. Thus, in this case, only a couple fragments are used in the coding process. Because with theory development, axial coding is used to create constructs. The constructs are the key factors of success and failure. Because the influence of the different upscaling processes is also important, axial coding is a good method to use. Paragraph 3.3.3. describes the method of coding.

### 3.3.2. Content analysis

Because this subject is context related and it is key to create a starting point, a content analysis is necessary to use. This content analysis is encrypted in the next chapter. It is an introduction to the policy discourse of the energy system in the Netherlands. As pointed out in paragraph 2.2.1., focussing on this research, the policy on energy use, transport and production are divided in two directions: stimulation and regulation.

In this chapter only reviews the smart grid implementation in the current policy system on electricity. Also, because the aim of this research is not to focus on Jurisdiction and legislative frameworks. It focusses more how policy hinders or stimulate larger scale smart grid implementation in a governance situation. Thus, in this case, an in-depth content analysis of law is not desirable.

Out of the explanatory interviews and the literature research, 6 important themes are developed. These topics form the structure of the content analysis. Information about these topics form the core elements of the energy policy about the governance situation regarding larger scale smart grid implementation.

**Privacy**

**Assigning roles**

**Taxes**

**Responsibility**

**Flexibility**

**Funds**

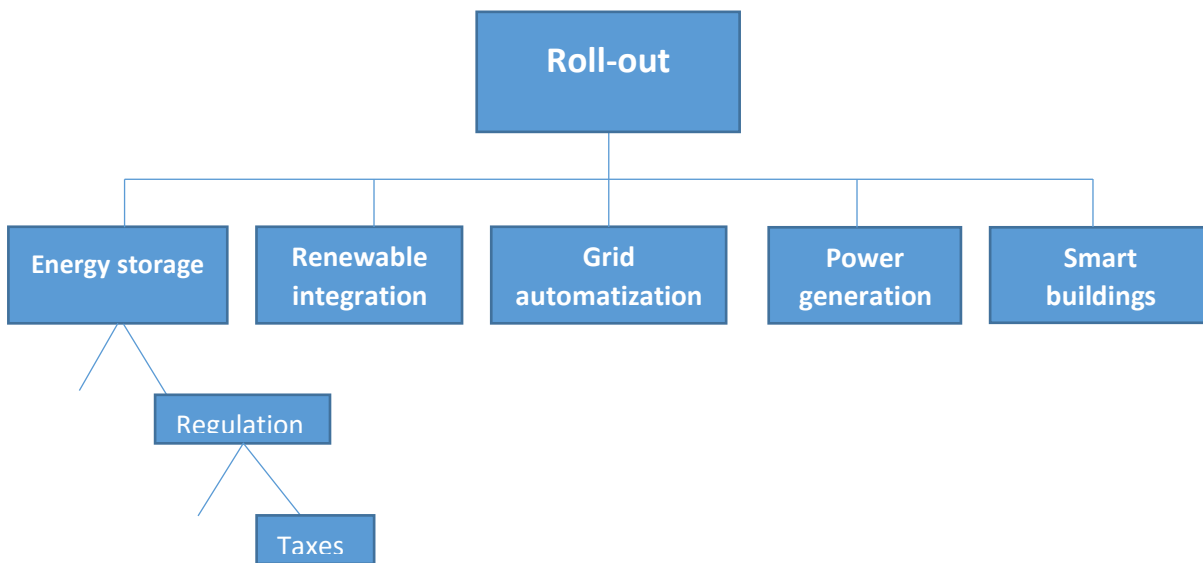
*Table 3.3.2. Predetermined themes for the content analysis*

### 3.3.3. Semi-structured interviews

The results of this research are based on this section. Ten interviews are done with initiators, experts and context related actors like municipalities (see paragraph 3.2.3.). Because the subject is context related, initiated different kind of pilots and smart solutions, specific topic lists should be developed for each of the respondents. Appendix I & II show the different topic lists per group of actors. Thus, the pattern of questions is easier to understand. For example, the municipality of Rotterdam and the municipality of Breda confronted with different kind of smart solutions and the project is in a different

phase. Still, decentralised governments are most of the time not involved in the technical execution but more as a controller. Different kind of questions is asked per subgroup of actors.

The frameworks developed in the theoretical chapter are not only the basis for answering the sub questions, but it also includes the coding scheme. Where normally codes are not created beforehand, this research aims to work within these frameworks. Coding trees are developed for each of the upscaling types. Figure 3.3.3. shows an example of a possible coding tree. With fragments of the transcripts, the codes will be developed. In general, the codes on the lowest level of the coding tree define the key factors of success and failure.



*Figure 3.3.3. Example of a coding tree.*

The transcripts and the coding scheme attached to Appendix III.

#### *Analysing in NVIVO*

Appendix IV shows print screens of the Nvivo output. It shows how the factors are developed out of the fragments of texts. With categorising and coding axially it is possible to connect different visions on factors within a coding tree.

### 3.4. Research ethics

Bryman (2015) implies, with the evaluation of qualitative research, that there exist different criteria. These criteria are divided in credibility, transferability, reliability and confirmability. In this paragraph, each of these criteria is elaborated.

#### 3.4.1. Credibility

Credibility is about the connection between gathered data and the developed theory in research. By choosing the cases carefully and develop topic lists which are related to the theoretical frameworks and sub questions, the credibility of this research is assured.

#### 3.4.2. transferability

Transferability relates to the generalising aspect of research. Is this study generalizable to other cases as well? It is not possible to integrate all specific contexts in this research. Moreover, without statistical

data, it is not feasible to get a representative conclusion. However, in this research three cases are chosen because they all developed in a different way of upscaling. Within these transitions, most of the smart grid technologies are integrated. Of course, the M4H-project is different but still an interesting addition to this research

#### 3.4.3. Reliability

Internal reliability is not necessary for this research because there is only one researcher involved. Focussing on external reliability, the replicability of this research is important. In this research, frameworks are developed, and this methodology chapter tells how to use these frameworks to come to the key factors of success and failure.

#### 3.4.4. Confirmability

Objectivity: is the role of research objective or subjective? In research, the researcher should analyse the data with a critical view but also must be objective. With involving different views on subjects and formulating the same question in various forms to make sure that the answer is the truth, this research aimed at objective data. As well, the data analysis was done in an objective and structured way.

### 3.5. Limitations

Excluding all flaws from a research is impossible. Thus, in this paragraph, the limitations of the Methodology in this research is described.

At first, because it is qualitative research, all conclusions can be considered as indications, but it is not possible to generalise the conclusions. As well are many more stakeholders involved in this research which provides different perceptions or even unknown factors. Because of time limits and focus, these actors are chosen because it includes external experts, initiators of the projects and context related actors. This mix should give a well-integrated combination of factors (see paragraph 3.2.2.).

Some interviews are done over the telephone; thus, it is not possible to see facial expressions or minor differences in tone of the conversation. This is important to value the transcripts. The trust in experts is an issue. Experts can tell unknown features, but it is still hard to verify some explanations. At last, because using fragments of transcripts instead of the whole transcript, due to the coding process could miss some valuable data. At the other hand, it is a good method to structure all data and position it in the coding tree which eventually leads to the key factors.

# Context



## Content

- 4.1. In practice
- 4.2. Conclusion

## 4. Context

The theoretical section of this research mentions context several times. Three different case studies are elaborated in this chapter. This conducts differences in smart grid techniques, stakeholders and geographical context.

### 4.1. In practice

The three projects in this research, as explained in paragraph 3.2., are unique in their stakeholder composition, context, smart grid solutions and the type of upscaling. Therefore, it is important to elaborate these projects individually. This part is the last section of the data analysis.

#### 4.1.1. Powermatching City I & II

In 2009, this project started in Hoogkerk near to the city of Groningen. The pilot, in the first phase, was implemented on a small scale. With HR-e Boilers, heat pumps, PV-integration, smart devices and electric vehicles. The first phase ended in 2011 and because the success of this project, a second phase was developed which was bigger (40 households instead of 22). The focus here was more on the integration of flexibility in combination with decentralised sustainable energy generation. This project was part of the IPIN-program and ended in 2015. Because this was the first project, and many experienced the project as a success, different kind of smart grid projects developed in Groningen as well. Relatively to other smart grid pilot projects in the Netherlands, power matching city can be considered as small. Figure 4.2.1. elaborates why power matching is not only a success in results but also a type of an upscaling project. At first, the feasibility of the technological solutions was measured. “Flexibility has an economic value”, said a representative of DNV-GL. They analysed, when every consumer uses the flexibility system, the value of this scheme could be approximately 3,5 billion euros (RVO, 2015).



Figure 4.2.1.1. Upscaling policy smart grids in the Netherlands. Source: Bongaerts & Verheij, 2014.

Another fact: From the perspective of DNV-GL in this project is that the operator could profit from this system. However, the operator should get access to the data communication system “behind the meter”. This project is created by a group of stakeholders, which is a combination of both think tanks like universities & TNO and energy companies. In table 4.2.1. the different stakeholders are summed up.

Enexis
Essent
Gasunie
ICT Automatisering



<b>DNV GL</b>
<b>TNO</b>
<b>Hanzehogeschool Groningen</b>
<b>TU Delft</b>
<b>TU Eindhoven</b>
<b>Gemeente Groningen</b>

Table 4.2.1. stakeholder composition PMC- pilot.

Enexis as supervising operator is in both involved in the Jouw energie moment- project and power matching city- project. In this project (PMC), not only the consumer is critical, but also the development of feasible business models for different parties is essential. For example, energy suppliers (Essent in this case) gain feasibility by the flexibility of the energy chain because the prediction of stocking-in energy supplies is better (demand driven system). On the other hand, the integration of local energy supplies can also be used to match supply with demand, when the central energy network fails to accomplish this. In short, several parties are involved, and all of them have their incentives to involve in this form of the smart grid (DNV-GL, 2015).

#### Geographical context

Hoogkerk is a village located in the municipality of Groningen. Figure 4.2.1.2. visualises the position of the village is. In the first phase, 22 households spread over the neighbourhood were integrated into the smart grid system. In phase two also the Thomsonstraat in Groningen city was integrated. The pilot in the second phase was adjusted to a more clustered geographical area (DNV-GL, 2015).

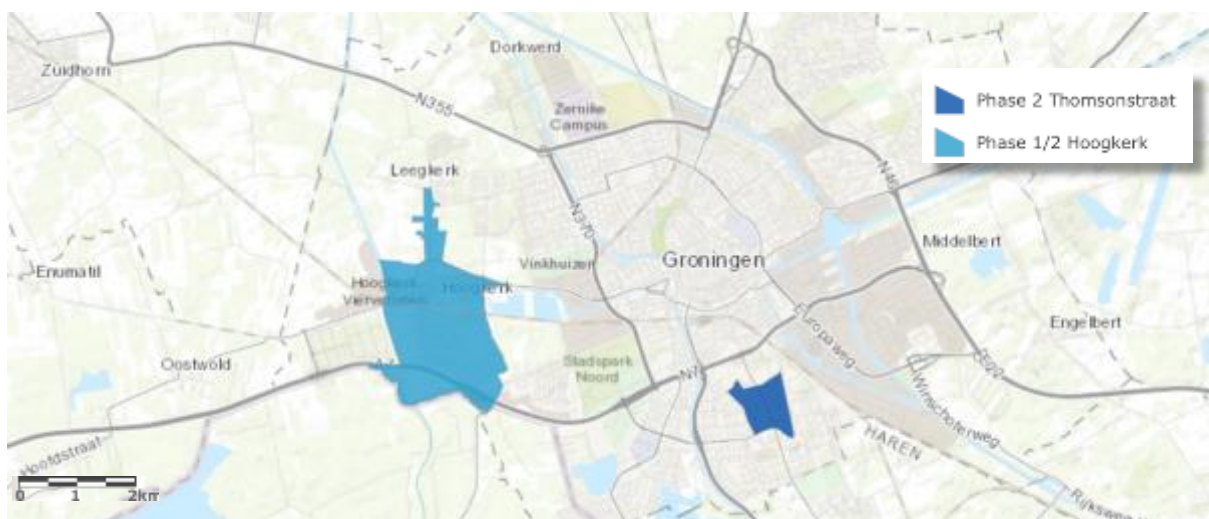


Figure 4.2.1.2. Powermatching geographical area. Source: ESRI GIS, 2017.

#### 4.1.2. Jouw energie moment phase 1.0. & 2.0.

In comparison with PMC, Jouw energie moment is substantially larger. With over 300 connected households, in four different contexts (Muziekwijk, Meulenspie, Easystreet & de Keen), this project should be considered as a large-scale demonstration project.

Other than the heat-system and electric vehicles, as introduced in the PMC-project, Jouw energie moment (JEM) introduced smart washing machines and after that the Tesla Powerwall. The focus of this pilot project was the behaviour of citizens. To get a better overview of the reaction of citizens,

different contexts should get used. This first phase was initiated by Enexis (operator) and the second phase was launched by (senfal), wherein also energy storage has been integrated. Moreover, the second phase also scaled-up in size. According to the results, published by the RVO (2015), the consumers were positive about the smart energy system. Still, the smart automatic system is only used in 20% of the cases. Still, consumers will use their smart devices in their own “smart” way. Price incentives were the main cause of this. Where the pilot ended in 2015, the project areas in Breda got involved in Jouw energie moment 2.0. In comparison with PMC, JEM has a different stakeholder composition. The so-called aggregator, Senfal, is integrated into this system.

<b>Enexis</b>
<b>Woonstichting SZW (only Zwolle)</b>
<b>Eneco</b>
<b>CGI</b>
<b>Flexicontrol</b>
<b>TU Eindhoven</b>
<b>Greenchoice</b>
<b>TNO</b>
<b>Shift</b>
<b>Senfal</b>
<b>Technolution</b>
<b>Enpuls</b>

Table 4.2.2. Stakeholder composition JEM. Source: RVO, 2015; Jouw energie moment, 2017.

In an interview with Hubert Spruijt (Senfal), he said:

*“I want to say one thing more: It is quite hard to find participants, even though we cover the flex costs above the regular price for electricity. Still, we hope to succeed in getting a new phase attached because we see potential in this pilot but also for other parties.”*

Zwolle already ended as one could see in figure 4.2.1.3., but Breda still carried on. It is the responsibility of the municipalities to decide either an experiment can take place or not.

#### *Geographical context*

The same as in the PMC-projects all these locations in figure 4.2.1.3. are newly built areas. Muziekwijk is a typically mixed residential area, with apartments, terraced houses, etc. Meulenspie is an area with mostly detached- and semi-detached houses. Easystreet is an apartment block with mostly students. De Keen is an area comparable with Muziekwijk, mostly detached houses.



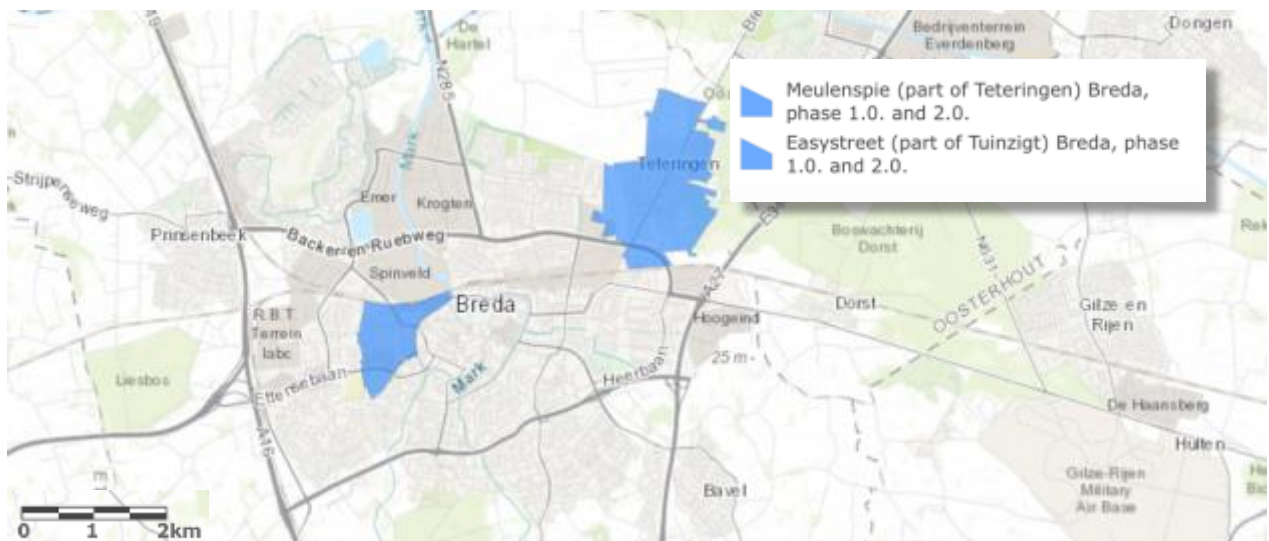


Figure 4.2.2. the areas involved in the JEM-pilot either phase 1, phase 2 or both. Source: ESRI GIS, 2017.

#### 4.1.3. M4H (Merwevierhavens)

Highly significant in this study; this project has not started yet. The project is still in the phase of conceptualisation. Thus, parties are still organising how they want to succeed with this project. However, because of the interviews with the municipality of Rotterdam and with Siemens, the initiator of this project, a couple of important features have been made clear. Leo Freriks (Siemens) told me; “The first phase will mainly focus on the implementation of grid automatization software until the smart meter.”

Also, according to both Roelof uit Beijerse (Municipality of Rotterdam) and Leo Freriks, Lyv smart living will fulfil the role of the aggregator. This means that they will communicate with the prosumers. So, the smart applications will provide data, which will be analysed by Lyv smart living. In this case, the flexibility will get higher, and the flow of electricity is demand driven. The trust among stakeholders is formalised in a letter of intent. In table 4.2.3. the five stakeholders are mentioned who are part of this letter of intent.

<b>Siemens</b>
<b>Stedin</b>
<b>Omnetric</b>
<b>Municipality of Rotterdam</b>
<b>Lyv smart living</b>

Table 4.2.3. Stakeholders related to the letter of intent M4H-smart grid. Stadshavens Rotterdam, 2017.

#### Geographical context

A difference with the other projects as well, M4H is not just a residential area. This area is assigned as an industrial area, because of the Harbor activities. Now, these activities are transferred to the Maasvlakte 2. Roelof uit Beijerse told:

“As a municipality, we do not want to be too strict in assigning areas with certain functionalities. In this area, we want to facilitate organic growth, every company or individual with a creative or innovative idea should have access to the M4H.”

In the development strategy of Merwevierhavens, the mixed land-use is one of the main subjects. Still, there exist some barriers. Land ownership is also spread over different actors: mainly the port of Rotterdam and the municipality of Rotterdam. However, on the other hand, a substantial number of owners has property here, which is not included in the letter of intent.



Figure 4.2.3. M4H-project. Source: ESRI GIS, 2017.

In figure 4.2.3. the location of this project is visualised in the context of Rotterdam. With already the ambition to roll-out, this location could also be important to see how the upscaling geographically develops.

#### 4.2. Conclusion

These geographical contexts are all unique in size, the composition of interested parties and upscaling. With the differences kept in mind and the policy of today, it is possible to provide results from the empirical research. In short, context is an essential factor in the governance.



# Empirical results

*Answering the sub questions*



## 5. Empirical results

In this chapter, after the development of a theoretical framework, the analysed data derived from interviews is used to get an answer on the sub questions. This chapter starts with the policy analysis and the vision of academics on success and failure at smart grid implementation. This is also the starting point of the empirical debate in this thesis.

- What is the current situation of policy around smart grid implementation?
- Which actor(s) was/were included in the upscaling process?
- What are/were their incentives and what role did they have?
- What factors of governance are critical for success in upscaling smart grid projects?
- What factors of governance are not stimulating the upscaling of smart grid projects?

After the policy analysis and the answer of the first sub question, the roles and incentives of the important stakeholders are analysed. Paragraph 3.1.1. shows a simplified version of the stakeholder composition and their roles. This thesis only elaborates the key players. This concerns the energy supplier, the operator (including both operators on the centralised and distribution grid), governmental organisations and in addition the aggregator. The generators and technology/infrastructure are not described individually. The choice is made as result of the data derived from the interviews and the policy analysis. Paragraph 4.1.1. describes the role development of specifically; suppliers, operators and governments. In most cases, described in paragraph 3.3., technology developers are new entrants. Confessional infrastructure developers are also excluded because infrastructural changes are not the crux in smart grid development and therefore not inside the scope of this study.

In the second section, the framework of paragraph 2.4. will be used to find the factors of success and failure. Because the existence of differences between smart grid subgroups and types of upscaling, the results are categorised per case. Table 3.1.3. shows how the cases relate to a specific type of upscaling. M4H refers to a rollout, Jouw energie moment relates to replication (the most) and Powermatching city can be considered as an expansion project. Diffusion is excluded.

In the end, the framework will be completed and used to answer the research question.

### 5.1. Smart energy policy discourse in the Netherlands

When talking about smart energy policy in the Netherlands, it is not possible to exclude the influence of stakeholder compositions and even the broad governance concept. As stated in paragraph 2.3.1., the implementation of social innovation conducts both the regime actors on the regulatory side and the new entrants on the innovations side. Geels (2004), also mentioned this fact in his paper where he introduces a system innovation framework which divides landscape, regime and innovation. The interesting point is that landscape also includes climate change. Geels (2004) elaborates that energy innovation develops beyond the control of regime actors. System change is inevitable because of the energy transition. Because of this system change not only the governance system changes but also policy perspectives. This paragraph elaborates on this discourse. Both the energy targets, regulation in the energy network and smart grid opportunities are combined in this overview.

#### 5.1.1. The transition towards 100% use of renewable energy sources

Beginning at the top, the EU began with developing targets according to the goals set in the climate agreement of Kyoto and after that Paris. The strategy aims for three deadlines; 2020, 2030 and 2050.

In 2050, the energy supply should exist between the 80% and 95% of sustainable energy sources. The Dutch Government copies this European strategy. The same targets were set and to get there the government is willing to change their legislative framework to reduce gas consumption and stimulate the development of sustainable energy generation (EU, 2016).

Mentioned several times in this thesis, the pressure on the growth of using renewable energy resources is substantial. In the Netherlands, only 5,9% (CBS, 2017) of the energy supply consists of sustainable energy. Keeping in mind that in 2020 the target is set at 15%, major leaps in the energy transition must be made. With regulation at one side and stimulation on the other, the government wants to speed up the transition together with the Market (RVO, 2016).

This same hurry is also noticed in the legislative and policy framework for smart grid implementation. Paragraph 3.2. describes how the policy framework lacks direction, as well smart grids are at the start of widespread implementation. The opportunities of smart grids have been researched but a good systemic overview of the policy around smart grid implementation has never been provided. This section is divided into four subsections: privacy and regulation, reliability and regulation, governance and regulation and the regulation on the integration of renewable energy resources.

#### *Privacy and regulation*

The implementation of smart grids affects the tension between the interest of the citizen in privacy and the benefit of collectives (Market and government) in free access to data. On the one hand, when implementing smart grids, data about the behaviour on energy use gets included in a database, and the danger exists that this data is used for different purposes. Behavioural data is sensitive data, and the privacy of citizens must be ensured according to the European law on privacy. On the other hand, to reach the full potential of smart grid implementation open access of data is essential. Especially, from a governance perspective, many stakeholders: operators, software developers, energy suppliers, energy producers and other consumers are dependent on the data they get (Wisman & Lodder, 2013 p. 94). A barrier one could identify, is the European policy, which is superior on the Dutch legislative framework. In short, to change the law on energy innovation, the European commission should adjust it. The national governance does the acquittal of the European law on privacy in the energy discourse. According to the guidelines on privacy for legal persons regarding the free movement of personal data on energy use, article 8 of the EVRM provide this legislative framework. This article, for example, describes the common functional requirements of smart metering. However, Wisman & Lodder (2013), mention the indistinctiveness of these guidelines as well.

A problem what often get mentioned is the dynamic way smart grids develop and policy often is very reactive instead of preventive. The question who and how personal data should be gathered is not answered. As well is it unclear how many data should be available to implement smart grids successfully. In addition to these uncertainties, the Dutch policy could be conceived as even more protective on privacy issues than the formal EU-law on privacy initiates. According to Liu & Xiao (2012), the free movement of data should not be a problem when formal agreements are made on how to use data and which parties are responsible for the utilisation of this data. Furthermore, cyber security should be the subject of interest instead of the use of data for the benefit of smart grids. Summing these perspectives up, Wisman & Lodder (2013) and Liu & Xiao plead both for clarifying the role of different stakeholders according to possession of personal data. Also, responsibility for the use of personal data should be assigned to specific stakeholders. At last, both articles plead for better understanding how much data and which data is needed to get the smart grid working.

Free access, responsibility, possession, proactive management, role clarification, etc. to make the regulation on smart grids regarding privacy issues less strict, a substantial amount of

recommendations are developed. Khurana, Hadley & Frincke (2011) also made an overview of privacy issues at smart grid implementation. In this article, they state that policy making on this subject is complex, especially because of the variety of technological solutions. Besides that, considering the upscaling feature, monitoring data attached to more than a thousand devices can experience as hard and complex. Also, the implementation of bigger smart grid projects has not been done so far.

In short, the Dutch regulatory system in the smart energy discourse must be more flexible to create a better climate for integrating and expanding smart grid implementation. To get to that point a couple of recommendations are made according to regulation and privacy:

- *Responsibility for data and cyber security should be assigned to certain stakeholders*
- *A better understanding of the role of interested parties according to the possession of personal data*
- *The amount and the sort of data what is needed for successful implementation of smart grids must be clear.*

However, regulation on privacy, according to Wisman & Lodder (2013), can also be considered as a cultural feature within governmental organisations. Within a private-public collaborative system, the government feels the urge to protect citizens. This also relates to reliability, what will be the subject in the following section.

#### *Reliability and regulation*

The energy system, according to Netbeheer Nederland ( the national consortium for operators) (2017), is one of the best in the world. In the energy network, governments stepped aside, now infrastructure developers and energy network operators are the actors who must assure that the consumer always has access to energy. Shutdowns, “blackouts” – these faults in load control, infrastructure and, in the case of smart grids, ICT-system, are the responsibility of network operators. The quality and reach of the energy network are important. This perspective belongs to the reliability of the energy network. With the interference of smart grid technologies, major investments in the quality of infrastructure are not needed anymore. Moreover, smart grid technologies can even help with reducing blackouts in the energy network. As spoken of in the theoretical section about grid automatization (see paragraph 2.1.1.), the self-healing capacity and the implementation of preventive software can help with the improvement in reliability (Friedl et al., 2009).

In short, reliability is one the essences of the energy law in the Netherlands. In 1998, the energy law was implemented under the supervision of the ministry of economic affairs. As well, according to the European law adopted in 1996 on electricity. In this law, reliability and sustainability became the main topics. Especially when focussing on sustainable energy resources, the tension increases again on the reliability of the power generation, but also the integrating of renewables on the distribution grid causes concerns because of the reliability of the distribution grid. Because both transitions are dependent on the influence of nature, which is unpredictable (EZ, 2016).

When focussing solely on the energy storage, laws and taxes are not adapted yet to the innovations in this area. According to the electricity law, every actor in both the transmission and distribution is rightful to integrate storage solutions. Only, operators are excluded. Because the operators are assigned to the ones, who are in control of the reliability of the energy network. According to the government, storage is intrinsically connected to the import and export of energy; this feature is too closely related to market mechanisms. When providing storage solutions for public interest and putting different stakeholders in charge, the law is not clear on this point. Thus, operators are strictly regulated by law relating to energy storage. Another regulatory fact of energy storage solution is net



metering. Net metering is a system that enables “prosumers” to transport own generated energy, intentionally solar-, wind energy, towards the distribution grid. The prosumer is then capable of using this energy at a later time and does not have to pay for it. This system stimulates the integration of renewable energies by households but also limits the potential of energy storage (TNO, 2013).

Grid automatization though is one of the systems which helps operators to control the energy flows on their grid in an efficient way but also with a high reliability. As the law shows, there does not exist any real regulatory measures on these technical solutions. Even, the EU developed a policy wherein it is mandatory for national governments to provide smart meters for every consumer in their country. The regulatory system is flexible for the integration of the energy flow in front and behind the meter (from grid towards smart buildings) (TNO, 2013; EU, 2015). However, the transition of energy infrastructure from a top-down, centralised system towards a system with small integrated producers was a smart grid steers especially decentralised areas is in overall perception substantially restricted. The projects as Jouw Energie Moment, M4H and Powermatching City are assigned as experimentation areas where a vast number of restrictions are excluded. Thus, for implementing smart grids without the assignment of an area of experimentation, it gets more complex to implement (TNO, 2013).

Summing up, the revised energy law initiates more attention towards sustainable power generation. However, because reliability is an important feature as well, not the whole smart grid is supported by the regulatory system of the EU and the Dutch government. Especially energy storage is restricted in many ways: net metering, taxes and restrictions for operators. At the other hand, smart grids help with balancing and control the energy grids, and therefore policy restrictions are minimal for grid automatization until reaching smart buildings. The regulation behind the meter will be explained further on. At last, the testing has been done in the so called “experimentation areas”. Where a vast number of restrictions are not included. In short, when focussing on upscaling procedures, commercialised smart grid implementation in non-experimentation areas must tackle even more regulatory measures.

#### *Governance and regulation*

Although the liberalisation process in the nineties, which divided the energy network from public parties, the influence of governments is still substantial. Several roles can be described in national and regional energy networks as well (see figure 3.1.1.). According to the study of Steenhuisen & de Bruijne (2015), ministers are responsible for defining roles on the national level and in lesser extent on the regional scale. Even though national-, regional and local governments are shareholders of network companies, these governments do not make decisions about details. To conclude, governments, until this moment, are always involved in energy system transitions. Still, the specific execution of transitions is not supervised by governmental institutions but by network companies (Electricity law, article 16). Because the network companies (operators etc.) are assigned in rule and law by governments, policy on how to govern energy networks is considerably strict (Loorbach, Van der Brugge & Taanman, 2008).

Governments thus assign the role of operators in law and policy. However, with the implementation of smart grids, development has started, and therefore new thinking is needed about energy network actors. The article of Steenhuisen & de Bruijne (2015) states:

“The legal perspective provides even less clarity when dynamics and more innovative developments are discussed. Legislation, rules and regulations are primarily descriptive and oftentimes too static to keep up with current developments (Steenhuisen & de Bruijne, 2015 p. 4).”

In the case of smart grid implementation, as described in the privacy part of this chapter, different factors will play a role. Responsibilities about these new factors must be assigned to an actor in the energy network. Steenhuisen & de Bruijne (2015) describe that it will take too long until the legal role of network companies is adjusted to innovations like smart grids. Market developments may overtake the role of network companies that can cause a lack of public mandate. According to European regulations, energy suppliers cannot merge with operators (network companies). Thus, close cooperation, to implement innovations like smart grids, is key.

In other words, changing regulatory measures takes relatively a substantial amount of time. Another route is the Minister who can change laws and so also the role of regulators. However, both changing regulatory measures and changing the law is a time-consuming process which is undesirable when implementing innovations like smart grids (Stout, 2010). Although both processes are time-consuming, on the 20th of May 2016, a letter was sent to the congress, in this letter the urge of good thinking about the regulation on smart grid implementation was brought forward. According to the minister of economic affairs, the energy transition must get more space in the Dutch legislative framework to get stimulated actually.

#### *Regulation on the integration of renewable energy*

Integrating renewable energy sources in the energy system will be a major challenge to the operation and governance of the energy network. In this thesis, as mentioned before, integrating renewable energy sources refers to the involvement of decentralised energy generation (Phuangpornpitak & Tia, 2013). The previous section elaborates on the static character of the regulation relating to the energy transition. Since 2013, the electricity law has been revised, and the flexibility towards decentralised integration of renewable sources has grown.

As mentioned before, net metering is a function which influences energy storage solutions. Besides that, according to the electricity law, are “prosumers” legally obliged to pay VAT over their own produced electricity when delivering it to the public energy network. They are also obliged to sign themselves in as freelancer formally. Small producers also have to pay VAT on their investment in, for example, solar panels. Besides that, energy taxes must be paid, and the difference between the use of energy supplier is relatively big. Thus, a couple of taxes must be paid, and the regulatory system is complex. Because of this regulatory regime, quite some disincentives are created (RVO, 2012).

#### *5.1.2. Stimulation of smart grid implementation*

February the 17th, 2009. Former president of the USA, Barack Obama, signed into law. Especially, in the world of smart grids, this was a major one. It was named: the American recovery and reinvestment Act of 2009. In this program, 4,5 billion dollars were provided to modernise the electric power grid. Focussing on smart grid implementation processes, utilities and other organisation was not just capable of improving the energy network by replacing infrastructure, they also could think about other solutions which were more related to the energy transition and more sustainable. Smart grid implementation has grown exponentially from that point on (Office of electricity delivery and energy reliability, 2009).

The smart grid stimulation system in the USA is seen successful by many. The international trade administration (2016) defines the role of United States as a world leader in not only investing but also the export has grown, and the economic stability of smart energy solution has become strong. In Europe and especially the EU-member states, this top-down investment was only 1,8 billion euro and besides that: the EC (EU commission) only funded 35% of these “catalogue” investments. These are

numbers until 2011, which is already later than the formalised recovery act of 2009 in the United States.

In short, the situation in Europe is relatively different from the situation in the USA. Considering the funding system in the USA as a successful one, the EC funding system still lacks potential. The national stimulation systems though, differ among nations. As well, focus on the Netherlands, a part of subsidies is deriving from EC- funding (Giordano et al., 2011). However, the rest of financial stimulation and another kind of stimulatory measures is organised on a multilevel actor playground.

#### *Financial stimulation*

In 2015, TKI Urban Energy was assigned to take charge over the received 103 million euros from the RVO/ Ministry of economic affairs to stimulate the innovation for energy transition purposes. The subsidies are mainly reserved for demonstration projects and divided among subsections. For instance, within the policy frames of the national government, the urge for flex energy networks is described. TKI Urban Energy provides a tender for a subsidy which is in total 2.78 million euros. Here every tender has a deadline. For this flex energy system subsidy, it is until the 12th of September this year. Moreover, every section of financial stimulation is related to the policy frames developed by the national government (RVO, 2017).

#### *Stimulation by flexibility*

Municipalities over the whole of Netherlands develop ambitions and visions about climate mitigation goals. Still, in the case of smart grids, the innovative nature of these technologies, etc. is hard to initiate by municipalities. In many cases, they expect that market parties initiate smart grid solutions. The role of the municipalities then is to facilitate this project. One of the facilities they have in areas, but most of the time areas are subject to regulations. For example, a zoning plan can cause many restrictions to the implementation of smart grid technologies. Many municipalities provide areas for experimenting, in this case, no restrictions caused by zoning plans obstruct the implementation. With the arrival of “de Omgevingswet” (new law for land-use planning), this will change, and therefore land-use will be more flexible.

Next, to financial support and flexibility measures, stakeholders should initiate forms for themselves. Focussing on stimulation of large-scale smart grid implementation from a governance perspective it is hard to find any related literature. Thus, the empirical part elaborates what the key-factors are regarding stimulation.

#### *5.1.3. Concluding remarks*

This section is included because the empirical results should be placed in a context. Without a description about the policy discourse among smart grid implementation and the elaboration of the researched projects in this research, it is impossible to get a conclusion out of the results.

Targets are set, deadlines are made and now it is not only governments but all parties (Civil society, governmental and non-governmental parties) that should change their behaviour in use, production and transport of energy. Ambitions and perceptions are described, but with the fast-growing innovation in the energy discourse, the policy on electricity use, transport and productions lack behind.

Regulation is often seen as one of the barriers at the upscaling of smart grid implementation. When analysing the legislative framework on electricity, the problem is that law on electricity is integrating climate mitigation ambition but is also relatively strict. Privacy is an issue which is highly related to governance processes. Data of consumers has to be used by, smart applications of the operator, generator and aggregator and vice versa. The regulation on privacy of behavioural data is strict in the Netherlands and is not conform with the law on privacy of the EU (which is not as strict). This means that there exists less flexibility towards the transport of data, data storage and innovation in applications which use this behavioural data. Although the restrictions on using behavioural data are substantial, many questions are not answered:

*Who is responsible for the cyber security? Who gets access to data, which and how much data do they need?*

Reliability and the decentralised integration of renewable energy is also regulated to a certain degree. The operator should invest in this reliability, but with the integration of renewables the supply will get more uncertain. Smart grids could help to invest in both interests. Still, the operator is not allowed to execute some new roles which are created during the implementation of smart energy systems. Also, tax-systems like the VAT and energy producing taxes are still not adjusted to innovations. This is also hindering the development of smart grid implementation. Because of the demonstration phase, a vast number subsidies, flexibility in zoning, etc. are provided. However, when scaling-up smart grid implementation. The stimulatory measures will get more complex. Consortia break up, new alliances will get formed, and subsidies will get less. Also, the full regulatory system will apply again, and therefore smart grid implementation processes get more complex.

The differences between projects are important to acknowledge:

- Different composition of citizens and buildings
- The municipalities
- Stakeholder composition per project
- Type of upscaling/ ambitions

## 5.2. Overview of stakeholders

This paragraph shows the actors who are involved in the upscaling process. The actors showed in the tables are those who are part of agreements or consortia, so, actors who are involved but not part of agreements or consortia are not included. This paragraph answers the sub question:

*Which actor(s) was/were included in the upscaling process?*

<b>Stakeholder upscaling PMC to PMC II</b>
<i>Enexis (Operator)</i>
<i>Essent (supplier)</i>
<i>Gasunie</i>
<i>ICT Automatisering</i>
<i>DNV GL (Initiator)</i>
<i>TNO</i>
<i>Hanzehogeschool</i>
<i>TU Delft</i>
<i>TU Eindhoven</i>

Figure 5.1.1. Stakeholders upscaling PMC to PMC II. Source: RVO, 2015.

<b>Stakeholder upscaling JEM to JEM 2.0.</b>
<i>Senfal (Initiator) (Aggregator) (supplier)</i>
<i>Shift</i>
<i>Technolution</i>
<i>TNO</i>
<i>Enexis (operator)</i>
<i>Enpuls</i>
<i>CGI</i>
<i>TU Eindhoven</i>
<i>Flexicontrol</i>

Figure 5.1.2. Stakeholders upscaling JEM to JEM 2.0. Source: Jouwenergiemoment, 2017/ RVO, 2015.

<b>Stakeholder upscaling M4H</b>
<i>Siemens (Initiator)</i>
<i>Stedin (operator)</i>
<i>Omnetric</i>
<i>Lyv smart living (aggregator)</i>
<i>Municipality of Rotterdam</i>

Figure 5.1.3. Stakeholders upscaling M4H. Source: Stadshavens Rotterdam, 2017

In the figures is shown which actors are involved, but also who the initiator, operator and supplier are. Paragraph 3.2.2. already elaborates on the involved respondent which are the initiators, context-related actors and experts. Suppliers and operators are interesting to research. However, the choice is only to involve experts and not involved actors per se.

### 5.3. From an overview towards their role

As mentioned in the previous paragraph, the research does not include all stakeholders but elaborates on the supplier, operator, governmental organisations and the aggregator role. This paragraph divides the three cases. It is essential to see the differences and comparisons between the three cases. It is then possible to give respond to the sub question:

*What are/were their incentives and what role did they have?*

#### 5.3.1. Powermatching City

PMC is the first two-way smart grid pilot and is interesting to see how the stakeholders behave in the beginning of the smart grid demonstration phase.

##### *Municipality of Groningen*

With ambitions (gemeente Groningen, 2015) such as:

- Being energy neutral in 2035
- Groningen as “energy city” (leader in the field of energy and innovation)
- Being a sustainable city

Groningen has major incentives in the smart grid development within the municipality.

The municipality of Groningen, according to Paul Korzaan, was not involved in the project itself. He stated:

“In general, municipalities have and should be the facilitator and should not intervene in smart grid implementation, both energy networks and developing smart technologies are assigned to the market (private and semi-private parties), watching from the side lines is what a municipality should do.”

In this sense facilitating means: communicating with citizens, organising an area to experiment and providing financial support. Considering financial assistance, also phase III was planned, but the municipality stopped with supporting this pilot financially, although many experts mentioned that it was a successful project.

##### *Enexis*

Because this project was the first two-way smart grid pilot in the Netherlands, Enexis (Enexis Innovatie, 2015) set out a couple of goals to get more information about:

- The feasibility of this flexibility system
- The behaviour of participants
- What is the advantage for the use of electricity infrastructure in the future

Because this was the first pilot in the Netherlands with a two-way smart grid, gaining more knowledge was a major incentive to involve in the upscaling of PMC.

In PMC, Enexis as operator installed smart meters in every household connected to the program. Besides that, also the energy transformer station has been equipped with a smart meter. Thus, this could be a stimulatory measure to attract consumers to connect with the smart grid. Further on, the integration of decentralised renewable energy resources was one of the aims in this pilot. The

operator role in this project concerned matching the energy supply (decentralised level) with the demand in an intelligent way. In this project, no aggregator was added.

#### *DNV-GL, former KEMA*

*“Driven by our purpose of safeguarding life, property and the environment, DNV-GL enables organisations to advance the safety and sustainability of their business. We provide classification, technical assurance, software and independent expert advisory services to energy industries (and others).”*

As being the leader of the consortium which organises and executes the PMC pilot, DNV-GL is not only interested in the results of the project but also in the process.

During the pilot, DNV GL brought all stakeholders together. In this second phase of the pilot, DNV-GL, together with Enexis, helped with the end-user billing and with monitoring the consequences for the energy market. Moreover, they developed several helpful applications such as energy monitor which stimulated awareness about energy consumption and production of prosumers (DNV-GL, 2016).

#### *Essent*

The interest of an energy supplier in this project is evident. The existence of a vast number of trade-offs between supplier and customer will increase when consumer get the change to supply own generated energy as well.

In this project, Essent had the role of developing real-life propositions for their customers and starting off with including prosumers in the process of trading on the energy market.

#### *5.3.2. Jouw energie moment*

Because this project is considered as an expansion pilot, only the municipality of Breda is described. Although Etten-Leur and Zwolle took part on this project as well, the municipality of Breda has been involved during the whole pilot development.

#### *The municipality of Breda*

In comparison with Paul Korzaan, Paul Paree emphasised the role of the municipality in the pilot a little more. The same as other municipalities, the municipality of Breda took the role as facilitator. Enexis, at first, actively approached the municipality of Breda. According to Paul Paree, the municipality has some ambitions described in their sustainability program. These ambitions are translated into a strategy with deadlines attached to it. As a result of this strategy, a framework is developed with requirements concerning projects. When projects suit within the framework, they get access to financial support.

Also, the communication with citizens and the communication with other organisations was a role which the municipality took.

*“Breda is full of innovative companies; start-ups and bigger companies, so we do not have to initiate certain projects. Still, we aim for our chosen strategy and want these new initiatives to adjust to this strategy, only then we think we can achieve our targets.”*

*“We were involved in this project as an actor who does only learns from this kind of project.”*

In short, the municipality has a strategy which contains strict targets. Only with using a framework pilots can provide incentives to the municipality to invest in it. Also, according to Paul Paree, communication is important.



### Enexis

Instead of integrating heat pumps, smart washing machines were integrated. Together with integrating renewable energy resources, consumers could use the intelligent system to get more aware of their energy consumption but also work with price incentives. This dynamic pricing system is a different one than the one used in PMC. The main incentive for Enexis was to integrate these smart grid solutions in various contexts. Because this project is a form of replication, especially the behaviour of consumers has been interesting to test. Enexis had as main incentive to get knowledge about the integration of dynamic price systems and the relation to context.

Here, the same as in PMC, Enexis provided smart meters, smart washing machines and sensors. As well, were they the initiator of the first phase of this pilot.

### Senfal

Senfal was the initiator of the second phase of this project which was integrated into Breda and Etten-Leur. Next, to the dynamic price system and smart devices, energy storage was added to this smart grid system. Senfal fulfilled the aggregator role.

As their business model, they built an online platform to communicate with consumers about the dynamic energy prices. Hubert Spruijt also told:

*“Next to this aggregator role, where communication is key. The product of Senfal introduces a combination of solutions, where prediction about fluctuations is made. However, also, we will fulfil the role as energy supplier.”*

### 5.3.3. M4H

Unfortunately, the precise role of Stedin is not clear. Because they are included in the letter of intent, financial support from this party is assured. An interview with a representative of Stedin was not possible either, so their role is missing in this paragraph.

### Municipality of Rotterdam

The difference with the other municipalities, the municipality of Rotterdam is part of the consortium (letter of intent). Financial support has been done as an investment rather than a subsidy.

Their incentive was based on:

*“We develop a sort of contest to create a new idea to promote and facilitate the M4H area. In this area, we try to attract tech- and innovative parties. Siemens told us that we should invest in a smart grid. After hearing, still not fully understanding though, what a smart grid is, we saw that it matched with our sustainability goals and the vision for this area...”*

The role of the municipality will be for most facilitating. As an addition to the meaning of facilitator as shown at other municipalities, also the use of networks with other companies/organisations, the municipality is also involved in actively searching for possible customers.

### Siemens

After the interview with Leo Freriks of Siemens, the founder of this initiative, the roles of the different stakeholders became apparent. Unfortunately, the role of Stedin, as already mentioned, remains unclear.

Thus, Siemens is the initiator of this project. They also provide the flexibility system and the sensors in this project. Developing the technology in the smart grid concerns the role of Siemens. Their business model is built on the use of this system (their incentive):

*“We do not want to force consumers only to connect Siemens devices to the smart network. We do not believe that this is the best way to implement an intelligent network. When one has a Philips television or a Bosch dishwasher, you still want to connect to the smart network. Thus, we think the business model gains more value when you provide your services until the meter.”*

In short, Siemens submit their services until the smart meter. They are responsible for the development of technologies within the smart grid but not within buildings.

#### *Lyv smart living*

This small company is responsible for the aggregator role. They have a system which gathers data from both the consumer and the operator. They are responsible for the input and output of data about behaviour and energy flows. Their role also concerns the communication with consumers and attracting potential customers. This aspect relates to the cooperation with the municipality of Rotterdam.

The same as Senfal, Lyv wants to test their product in this project. They almost provided all their assets according to Leo Freriks:

*“Lyv is taking substantial risks with putting most of their assets in this project.”*

#### 5.3.4. Conclusion

The projects have some differences in developments of roles for stakeholders. Whereas PMC did not have a predetermined aggregator role, the M4H-project has a smaller group of stakeholders, but the roles are strictly assigned to each stakeholder individually. When focussing on the M4H-project, it does not include any think tanks in the agreement. This might be the result of a different strategy. Leo Freriks told;

*“In the Netherlands, many pilots have been done. We want to implement this smart grid beyond the pilot structure. We seek feasibility, and this is only possible when getting more connections to the grid.”*

Thus, the strategy, according to Leo Freriks, is already a form of upscaling. Also, when comparing the JEM and PMC projects with each other differences exist on how stakeholders communicate with each other. Elke Klaassen explains:

*“The main difference between JEM and PMC was that PMC a lot more stakeholders were involved than at the JEM project. Therefore, the stakeholders of PMC were separated in different groups related to a certain subject, whereas JEM every stakeholder could communicate with each other easily.”*

In short, differences between projects already exists within the organisation of stakeholders. It could relate to the difference in upscaling or implementing. However, no indications can be found on this specific feature. Other indications though are provided in the next two paragraphs.

#### 5.4. Sub question 4

*What factors of governance are important for a success in upscaling smart grid projects?*

Paragraph 3.3.3. describes how the interviews are analysed. Using Nvivo to analyse what the factors of success are. Here coding trees are made for every project which relates to a certain form of

upscaling. Also, the different subgroups of technology are integrated (see figure 3.3.3.). At last, the governance frame is applied to this analysis. Thus, the factors of success are elaborated in a regulatory, stimulatory and collaboration perspective.

#### 5.3.1. M4H

*“Initiatives derive from innovative impulses most of the time. But I think we are making the last step towards creating commercial niches.”*

Frits Verheij stated that we are creating more commercial impulses. When relating this vision with the development of the M4H smart grid, we see how Leo Freriks confirms this statement. He does not see his initiative as an experiment; he seeks for the feasibility of the system. This indicates that this project is done with a commercial impulse instead of innovation. However, the implementation is developed, like the other two projects, as a pilot. The municipality assigned the area as space for experimentation, according to Roelof uit Beijerse. However, this could also, just avoid further restrictions in the development of the smart grid (see paragraph 4.1.). Anyhow, Leo Freriks explained the strategy behind the initiative. He explained that in the first phase a demand response system (D&R system) is integrated which connects customers with a two-way smart grid. The success of this project is difficult to explain because the project is not implemented yet. However, in the process, some success factors are already pointed out by several stakeholders.

##### *The success in regulation*

The rules and roles are clear. According to Roelof uit Beijerse, the letter of intent provides insurance about how the money is used and how the different stakeholders will perform. With this regulatory measure, the process behind the implementation of the first phase (implementation of the D&R system: grid automatization system) could develop more fluently. According to Rik van Berkel, this regulatory measure has been advantageous in many cases. Setting ground rules could help with developing a direction in how energy systems should look like (overall picture). However, on the other hand, when asked: “who should set these ground rules?” he answered:

*“I think that the national government should set these ground rules, or even on a higher level like the EU. There should be a stratification of guidelines about how the energy system for member states should look like. What is the role of governments, operators, suppliers and other stakeholders.? They have to provide ideas, and then the Dutch national has to develop an implementation policy. However, I do not think it is desirable to let local governments decide what the ground rules are”*

However, basic rules still haven’t been provided by higher governments.

Another factor which is highly related to regulation of insurance is standardisation. Leo Freriks sees that standardisation of roles is urgent. This is for most because the integration of smart technologies has an influence on the behaviour and role division of stakeholders within the energy system.

##### *The success in stimulation*

Siemens wants to install their D&R system until the smart meter. Leo Freriks explains:

*“We do not believe in a system where the consumer cannot choose. When one has a Philips television or a Bosch dishwasher, he or she wants these devices also being attached to the smart system. It is not desirable when only Siemens devices are connected to the smart system.”*

Siemens thinks when leaving room for consumers to connect all types of devices on the smart system, the use of the smart grid is stimulated. Providing room for consumers to choose how they want to use the smart energy system is according to Leo Freriks an excellent stimulatory measure. Also, other experts confirm this form of stimulation. Nicole de Koning states:

*“It is not only needs, but one should also focus on different subgroups. It is possible that four different subgroups are interested in the use of innovation. However, the way these subgroups want to make use of the smart group can differ. In this case, it is important to supply different services for different groups. Unfortunately, on this feature, little attention is given.”*

When being flexible in the use of the smart energy system behind the meter, customers could be more stimulated to connect to this smart grid. Also, Annelies Huygen elaborates:

*“The consumer should form the basis of smart grid implementation, what do they want and on these needs, policy should adjust.”*

Thus, being flexible and adjustable towards the needs of the customer can be used in a stimulatory way. Besides that, both Roelof uit Beijerse and Leo Freriks explain how the D&R system in this way, is a stimulation for companies, organisations and people to settle in M4H. Providing materials like this D&R system is in this case also a stimulatory measure.

Smart grids, in general, already sound like a complex matter. Which helps is to provide a good visualisation of the implemented technique. Roelof uit Beijerse already mentioned the way how the municipality interpreted the smart grid after the first conversation.

At last, providing space for experimentation is also a form of stimulation by law. When using this measure, it is possible to experiment in a particular area where some laws do not count. In this case, the area is less bounded on regulation and makes it more flexible. This is often seen as more attractive for both private companies and consumers. Annelies Huygen describes that regulation should be looser, innovation should get more room. Making the legislative framework more flexible helps with a more successful implementation of smart grids.

#### *The success of collaboration*

*“My telephone is ringing surprisingly often because of many innovative parties who call me: they ask if it is meaningful to integrate their, for example, windmills. This is what I like; we aim to get as many initiatives on board.”*

The letter of intent is a formal agreement with stakeholders who decide on the strategic level of the project: a typical form of a rollout. However, in agreement, flexibility towards new partners with good ideas seems to affect. Rik van Berkel also elaborates on the incumbent of new ideas. He regards it as the arrival of new entrants, or in his words: start-ups. Out of the box-thinking is important. Smaller companies often have interesting and new ideas about how to implement a smart grid.

Secondly, communication towards landowners and customers is necessary according to Arnold Vis. Landowners (original and potential) were interested in concrete plans on how and where these smart grid solutions are implemented. Concretely communicating this could be of help in the collaboration.

In another conversation with Hubert Spruijt, the importance of the involvement of major stakeholders in a smart grid project can help with a technology push. Leo Freriks also explains:

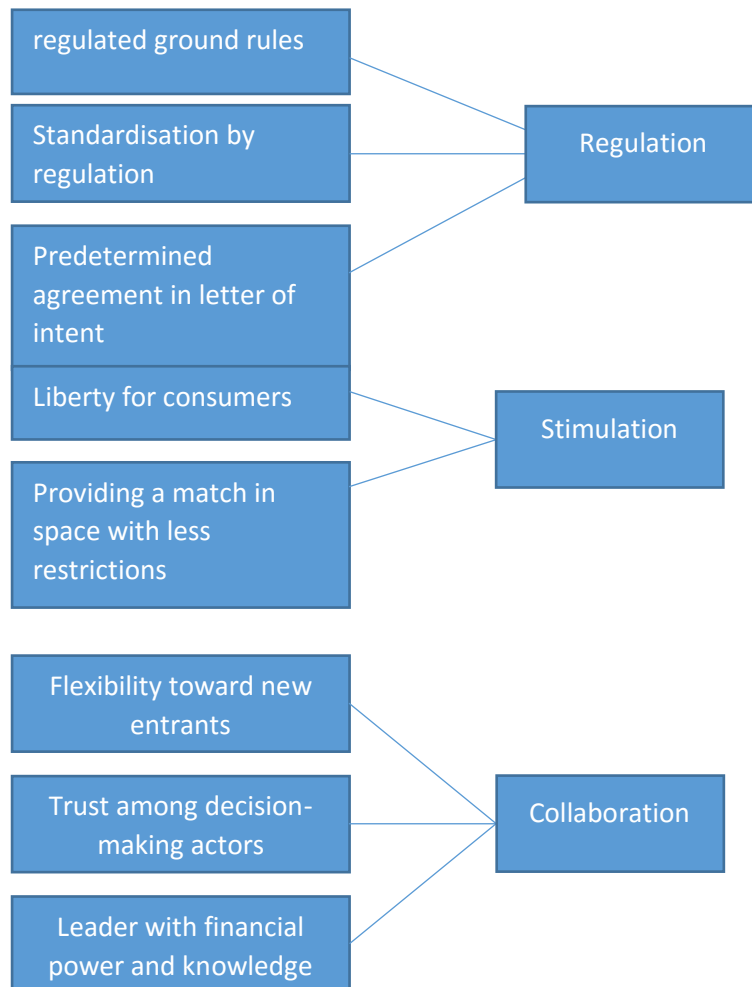
*“Siemens, as being a big organisation, can take the risk.”*

The extent of taking a risk and getting through failure could be successful in a collaborative way. Siemens can take risks away from other parties like Lyv smart living which put almost all their assets in this project.

A letter of intent can help with providing insurance, but what also seems to be a factor of success is trust. Trust/accountability between the organisations, either when parties differ in culture and interest. Roelof mentioned the belief (could also mean trust) in the capacity of Siemens to lead this project. Siemens as a major technology company, see figure 2.1., could be a champion. If it is about leadership, Roelof thinks that the municipality should listen to the expertise of Siemens.

At last, because the Alderman took a risk to invest in this project, together they should speed up the process of smart grid implementation. Because when the Alderman cannot prove the progression which is made, it can cause a lack of public support which is not beneficial for the project at all.

#### *M4H factors of success*



#### 5.3.2. Jouw energie moment

“Jouw energie moment was a success; the participants were willing to reschedule their laundry. However, focussing on business models, heat pumps and e-mobility have a higher value.”

Elke Klaassen, involved in both PMC and JEM, elaborated how the results of JEM should be interpreted. It was a success; participants were willing to use the D&R system and the smart devices in their homes. However, Hubert Spruijt already mentioned that it was hard to find citizens who were

ready to participate. With energy storage installed and new applications are added to the project new results could be more positive.

#### *The success in Regulation*

In JEM, a framework is developed where pilots can be tested on. When testing positive, the municipality of Breda is willing to give extra financial support. However, the pilots should conform to the strategy and targets set by the municipality. Paul Paree elaborated that Breda has a vast number of innovation within the city borders. He does not think that these administrative boundaries (keeping in mind that this is about subsidies not about rules) are not a problem for the development of projects. It is just that the project contributes to the direction which the municipality wants to go.

#### *The success in Stimulation*

Providing extra compensation for people when the flexibility of the energy pricing mechanism pushes the price higher than the normal energy costs, is one of the stimulatory measures. Because it is a pilot, this could be a good way to give consumers extra incentives. Enexis provided the compensation. However, the possibility to compensate when scaling up is insecure.

The simplicity of the smart meter was an interesting feature in this project. Because Nicole de Koning already told: most often, smart meters are not easy to understand. In JEM, the smart meter was provided, the same as the smart devices, etc. The applications were simple and easy to comprehend. Thus, consumers had to put less effort in the participation of this project. This simplicity feature indicates something important: the effort consumers must put in. Logically but of great significance according to both Nicole de Koning and Hubert Spruijt.

#### *The success in collaboration*

Bottom-up is a word which is necessary for the municipality of Breda. As mentioned before, much innovation is going on in the city. According to Paul Paree, it is important to accommodate these innovations with the right financial support, the right space and communication with the citizens. Still, the municipality uses a strategy to test these innovations first.

*“On a regional level, we communicate our innovations with other municipalities, the communication with municipalities outside this region is less.”*

Also, the market parties should be the leaders of these projects. According to Hubert Spruijt and Annelies Huygen, this is according to them the best way to upscale smart grid implementation. The capacity and the drive is greater at private parties than at local governments.

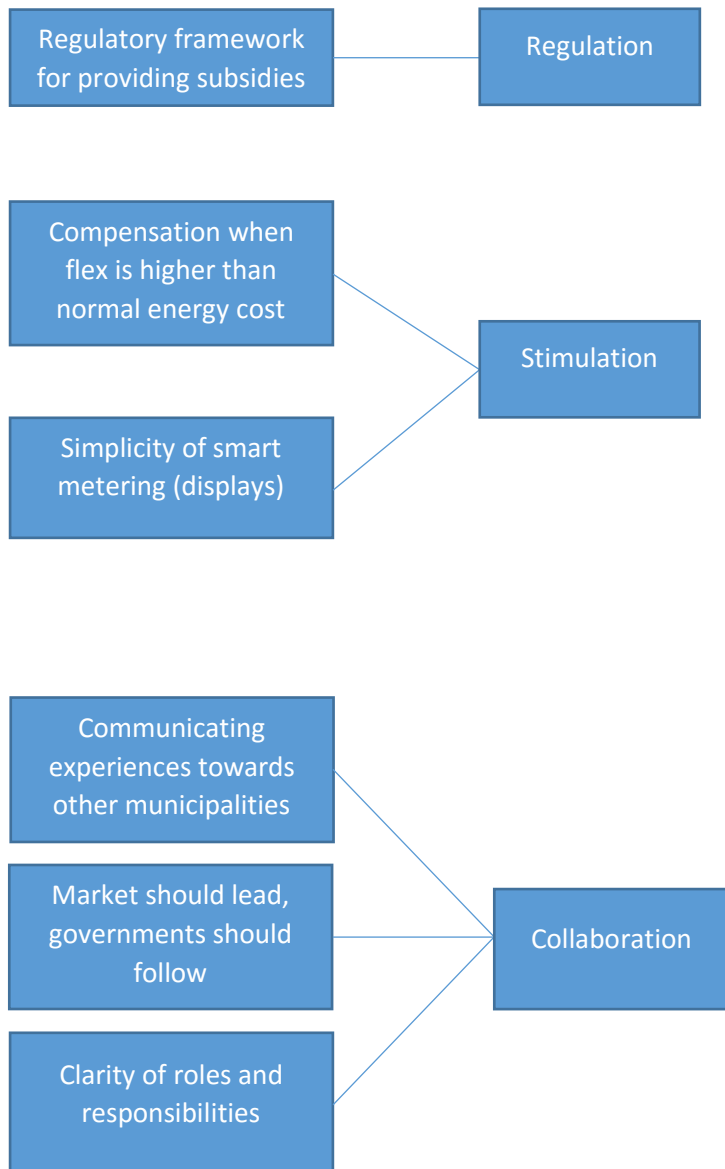
Rather on a regional level than on a national level communication is conceived as important according to Paul Paree. With sharing knowledge, innovations and funds, more possibilities are available.

According to Elke Klaassen, JEM gave a good insight of how standardisation of roles could help to stimulate smart grid implementation. At flexibility systems, this is interesting because of the existence of the aggregator role. In this project, because it was in approximately the same stakeholder composition, different contexts had a sort of standardisation of functions.

*“It is important that everybody take their responsibility, but the trust was there.”*

Hubert Spruijt elaborated on the cooperation within the project process. The roles were clear, and there was enough room to communicate with each other. This helps with creating trust and contributes to getting this project towards success.

#### *Jouw energie moment factors of success*



### 5.3.3. Powermatching city

In comparison with JEM and M4H, PMC is integrated on a much smaller scale. However, some stakeholders are involved, but also the attention towards this project is the same or even more than at other smart grid projects in the Netherlands.

#### *The success in regulation*

Upscaling is the focus of this research, but experimentation can influence the perception of the society. Nicole de Koning mentions how social media, or media in general, can blur the positive side of smart grid technologies. Paul Korzaan told that the municipality, although they have a minor role in the smart grid implementation, consumers must not become a victim of experimentation. Reliability should be one of the pillars of an experimentation project, and the municipality should also be aware of this. Of course, the role of the operator is to assure reliability of the energy supply, but the municipality should, in all cases, help the consumers. Thus, in certain forms, regulation is essential: for example, surveillance.



### *The success in stimulation*

The same as in other projects, providing materials like HR-e boiler, Hybrid heat pump, smart washing machines, smart meters, sensors, etc. is always an incentive for potential participants. However, the question could be if it is a useful stimulatory instrument as well when scaling projects up.

### *The success in collaboration*

To organise this project better because of the vast number of stakeholders, different groups are developed. Each attached to certain subjects.

*“In the PMC-project, I only had contact with the people attached to my subgroup of stakeholders.”*

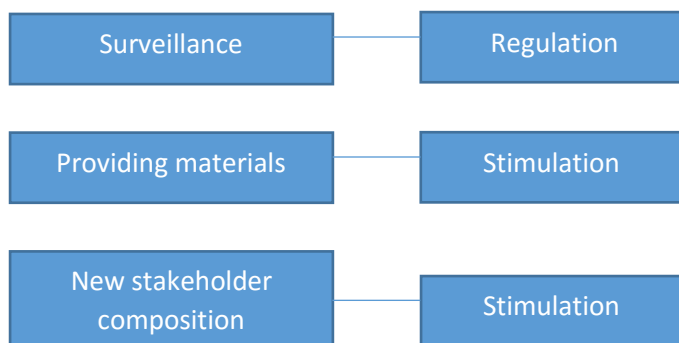
This could make the process of collaboration more efficient, and responsibility is easier to develop.

In a brownfield area Zuidoost Groningen a couple of the same stakeholders started a new smart grid project which focusses more on the integration of renewable energy (locally generated).

*“This project is created partly because of PMC. (Energie business, 2016)”*

In this project, a couple of the stakeholders are involved such as Enexis, the municipality of Groningen and Energy Valley. When being a success, this project replicates in different brownfield areas. In here, flexibility systems will be used to avoid power peak taxing.

### *Powermatching city factors of success*



### *5.3.4. In general*

Governance processes are growing in the intelligent grid discourse in the Netherlands. Coalitions are created, major players (Siemens, Tesla, etc.) getting involved, and according to Frits Verheij, the last step is made towards the first commercial niches. This is not only because the technologies create new business models, and pilots get scaled-up in bigger or different projects. Pilots are now in the phase of large scale demonstration, and this could be a result of success in the means of governance. Many experts gathered knowledge out of the former pilots and perceptions on the success in governance getting developed. This part links the general knowledge with the results deriving from the three cases.

### *Success in regulation*

Standardisation is a word which is often said during the interviews. Some experts question if standardisation should be done by regulation because the market can also standardise innovation. Rik van Berkel, however, sees the advantage when standardising by regulation:

“because of the smart grid discourse, the whole stakeholder system will change. New roles are required, and this causes insecurity. Furthermore, the energy network getting more decentralised.”

The system is changing, and with the ambitions of local governments, national governments and even higher, fast choices should be made. Developing regulatory frames to steer the transition in the same direction could help with scaling-up smart grids.

“Besides these frameworks, consumers could always be helped by providing specific contracts.”

Another important regulatory measure to initiate upscaling processes is the assignment of responsibility. Especially privacy is a big issue. Accountability and trust seem to contribute substantially in the upscaling according to many experts. At one hand this can be solved with collaborative tactics. However, regulatory measures could include a factor of success as well:

*“Why should stakeholders have access to this behavioural data? The data could also just stay at the consumer?” (Annelies Huygen)*

“The consumer has no idea what happens with their data, where it goes and what is used” (Nicole de Koning)

Regulation could help with assigning responsibility for the use of data and therefore a better incentive for consumers to participate.

#### *Success in stimulation*

Nicole de Koning, Annelies Huygen and Leo Freriks; many experts believe that stimulation should be done mostly towards consumers. Providing materials, financial support, space to innovate/ - experiment, creating platforms, making legislative frames more flexible, etc., does not only apply to technology companies, operators, suppliers, etc. but also applies to consumers.

Nicole de Koning elaborates:

*“There has been done much research on various forms of feedback which can help customers to stimulate. For example, comparative feedback: comparing yourself with others. Thus, providing data not only of your energy consumption but also of others...”*

Thus, there exist different kinds of stimulatory measures, but instead of stimulating companies or other stakeholders, the consumer should be the focus, according to the experts.

Finally, stimulation not in smart technologies per se, but in sustainability is also important according to Elke Klaassen. Consumers with for example PV-systems are more likely to participate in flexibility systems or energy storage than without.

#### *Success in collaboration*

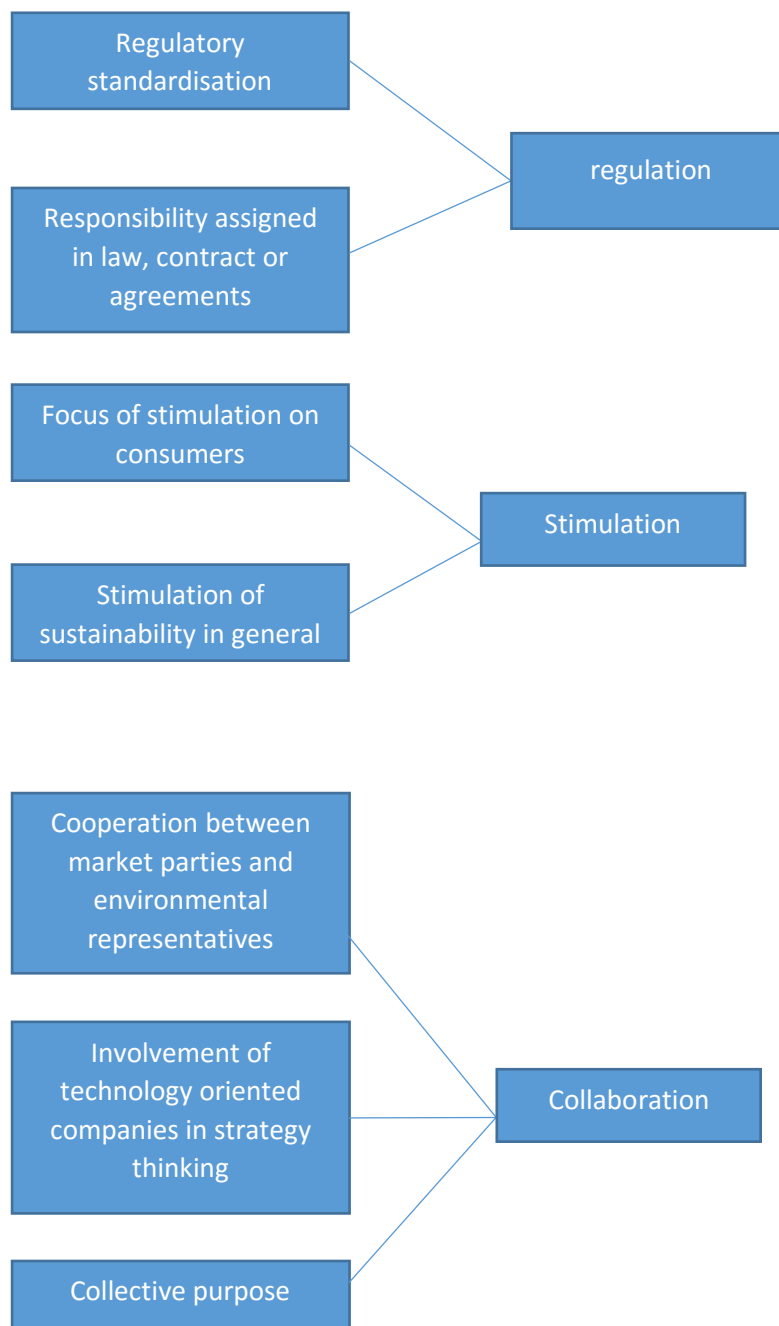
Conflict of interests is difficult to avoid. Governmental organisations might have problems with the ideas of market parties. Particularly on this theme, where the public interest is highly relevant. Rik van Berkel insinuated on the idea that market parties should involve environmental representatives in their cooperation. This could help with the attitude towards public parties. Because public parties are more likely to trust these market parties when also environmental representatives are involved.

Technology oriented companies, in general, have less power in the energy system than the confessional energy actors like operators, suppliers and generators. Most of the time they deliver services to these confessionals actors and the dynamic in the actor system does not change. With the introduction of smart grids on a larger scale these voices should be heard as well, they will gain more power when the energy system is getting digitalised (Rik van Berkel).

Nicole de Koning questioned the way how municipalities coordinate. There are ambitions but how do we get it to a real project. The way what is often done (see other cases); the market party should initiate and lead the project, and the municipality will facilitate. A direction could help so that a good strategy would be a solution:

*“A solution for a collective purpose could also bring social exclusion, and these questions are complex. The question arises; who should take the role to tackle these challenges?”*

#### *Factors of success in general*



#### 5.5. Sub question 5

*What factors of governance are not stimulating the upscaling of smart grid projects?*

This paragraph elaborates on the factors of failure. What does not support the upscaling of smart grid implementation?

#### 5.5.1. M4H

Because this project is not implemented yet, it is hard to find factors of failure because it is not tested yet. Still, with the information provided by experts, some aspects show challenges in the process.

##### *Failure in regulation*

*"My phone is ringing more often since this project started. Phone calls from people asking if they can contribute to this project. Still, I cannot predict the future. Thus, framing policy on innovation is hard."*

Although Rik van Berkel, Annelies Huygen and Hubert Spruijt, question the involvement of municipalities in developing ground rules, the reactive policy can be challengeable. Especially when referring to protecting the public interest. Still, Annelies Huygen also argued:

*"Protecting consumers can also mean: taking their freedom away. For example, with energy suppliers, contracts are made, etc. However, why can't the consumer choose their energy supplier on the moment this supplier is the best choice so that multiple suppliers will supply to one consumer?"*

We could question if the reactive policy works. Rik van Berkel describes:

*"I think that innovation will be done more often on the edges of policy and legislative frameworks and this can be successful. Then a governmental organisation has to think: should we adapt our framework because this innovation is successful? However, it could also be the case that these innovations are successful because it is done on the edges of the administrative borders. Examples are Uber and Air B&B."*

Is it a good idea to decide how the frames should be after innovations are implemented because there is a change that innovation changes rapidly and policy should be adapted every time. Instead of developing frames, guidelines might help. Still, this challenge is one of the main factors of success and failure.

##### *Failure in stimulation*

One could also question assigning an area as experiment phase. Because of this, restrictions are avoided. However, when focussing on upscaling this is not possible when wanting to roll-out over the whole city. When scaling-up either restrictions should change, or innovation should adjust to the regulatory framework.

##### *Failure in collaboration*

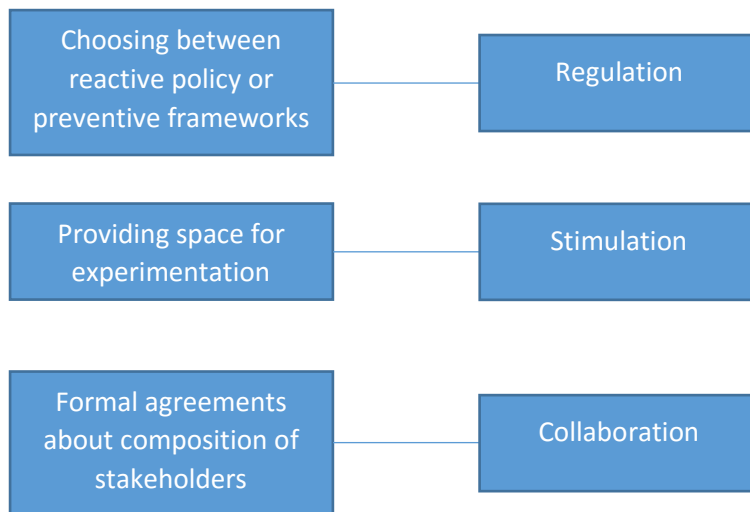
In this project, a letter of intent is developed. This is a sort of contract, where stakeholders get responsibilities and agreements are made about the choice of technology, place, steps, etc. In this letter of intent, only five stakeholders are included.

Arnold Vis already stated:

*"We also hope that the port of Rotterdam will be incorporated in the letter of intent."*

The flexibility of involvement of stakeholders in strategy development and decision-making decreases. Focussing on upscaling: this could develop barriers.

### Factors of failure M4H



#### 5.5.2. Jouw energie moment

The same as with PMC, the initiators of JEM had difficulties with finding consumers. Although researchers stated that JEM was a successful pilot, also lessons can be learned regarding the governance question.

##### *Failure in regulation*

Ambitions on the local level are involved in the JEM-project. However, still, national governmental organisations control the execution of smart grid projects. According to Paul Paree, projects have to be tested within the framework of TKI Urban energy when applying for funds (Frits Verheij). Still, the RVO and ministry of economic affairs are involved in this process.

*“During a meeting of the parliament. I was there for advice. They were talking about how to change the regulation regarding smart grid implementation. Unfortunately, they did not mention the consumer. Only in the end, when discussing the question: who has to pay, the consumer was mentioned (Annelies Huygen)”*

Thus, context related issues like consumers and citizen involvement are not integrated into the regulation on the national level.

##### *Failure in stimulation*

Elke Klaassen told:

*“In this project, the consumer was in between the flex and action; this resulted in a different pattern than at PMC.”*

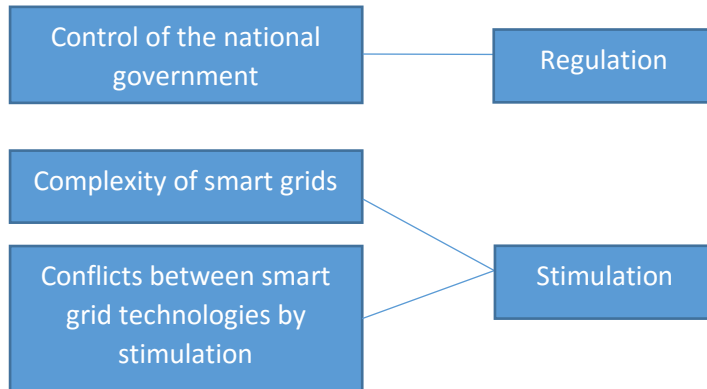
According to Elke, the liberty of consumers to stand in between the flexibility and action has not led to success per se. Some didn't bother when energy prices were higher, or they could use their own produced energy because they just wanted to do their laundry.

Thus, this could indicate that providing more liberty to the consumers does not result in a better use of the smart grid per se. This could assume that complexity arises when demanding consumers to react on the price or sustainability incentives.

Nicole de Koning, as mentioned before (see 5.3.2.), stated that simplicity of displays is essential for consumers to accept an innovation.

As well, stimulation on one feature can conflict with incentives of another technology. For example with laundry, net metering is stimulating the use of PV-installation. However, it is not stimulating using own energy supplies for people's smart applications.

#### *Factors of failure Jouw energie moment*



#### 5.5.3. Powermatching city

In comparison with the other projects this pilot program faded out. Paul Korzaan told me that there was a lack of incentives to invest money in a third phase. The reason why is still unclear.

#### *Failure in stimulation*

The system used in this project is more advanced than for example JEM. This means that these type of system needs more effort to implement than other technologies. To scale up, this means that different kinds adjustments are required. According to Elke Klaassen;

*“At PMC, you need an advanced system because people do not want to charge their electric cars for the night (actively)”*

Thus, more investments have to be made in this case.

#### *Failure in collaboration*

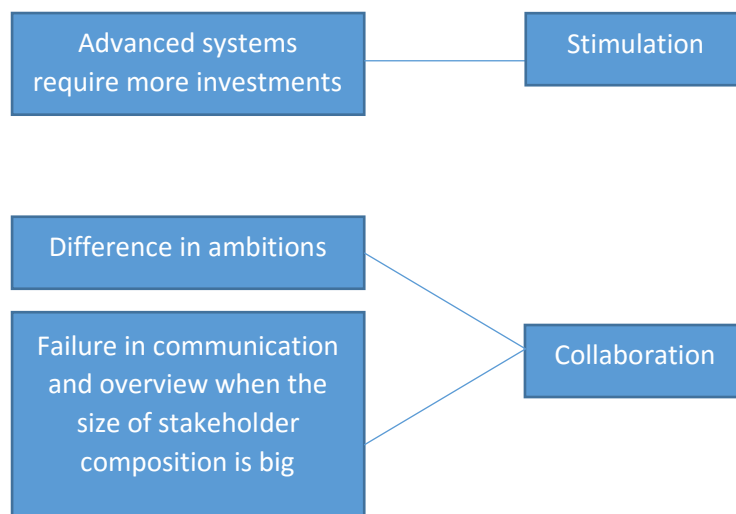
The introduction of this paragraph describes the fading out of this pilot program. The reason why is unclear but when listening to experts, some problems can occur in ambitions. Namely, pilots could be used for different ambitions by various stakeholders. For example, a municipality can also use these pilots as show cases, whereas an operator wants to use this pilot for extracting knowledge. This could cause conflicts.

Because the vast number of stakeholders involved, this could also interrupt the cooperation within the project. Elke Klaassen told:

*“the organisation at PMC was vast so that I could not communicate with all stakeholders.”*

This could be an indication that size of organisations can influence the cooperation within the project. This could hurt the larger scale smart grid implementation. Frits Verheij told: everybody should have the same focus. Communication is essential.

#### *Factors of failure Power matching city*



#### 5.5.4. In general

Stakeholder management seems to be important when talking to municipalities and initiators. Bottom-up innovation, the arrival of new entrants and the dynamics in smart grid technology development. Whom and what should we include and exclude in our upscaling? At the other hand, acceptance seems to be an issue. Experts explain this.

#### *Failure in regulation*

Annelies Huygen does not think that standardisation should be initiated by regulation.

“One should making the regulatory system more flexible; then all parties are in a better position to innovate.”

She plait for a decrease in restrictions. According to her:

“Standardisation occurs naturally when innovations get accepted by the society. No guidelines are required. Technologies scale-up when having success and technologies fade out when lacking acceptance.”

She thinks that regulation went out of hand. Whereas regulation is developed to protect the consumers, she thinks that it limits the consumers to choose which technology they want to accept.

#### *Failure in stimulation*

Aesthetic value, sustainability incentives, reliability incentives, financial incentives. Nicole de Koning explains that before scaling-up toward niches, acceptance at a larger number of consumers is critical. Until now there is a lack of integration of the will of consumers. Most of the time, technologies are developed without relating their technologies to the will of consumers. It is happening too often that the actions of consumers are integrated late in the process. Thus, no major adjustments are possible anymore.

With the endorsement of financial support, technology can still develop even though business cases are not sufficient.



Also, Sander Berkhout mentioned these problems. Sometimes the majority of consumers are not interested in the best solution but in the solution which has the most aesthetic value. Especially when focussing on the upscaling element. Stimulation of technology should not go according to the vision of governments but according to people's minds.

#### *Failure in collaboration*

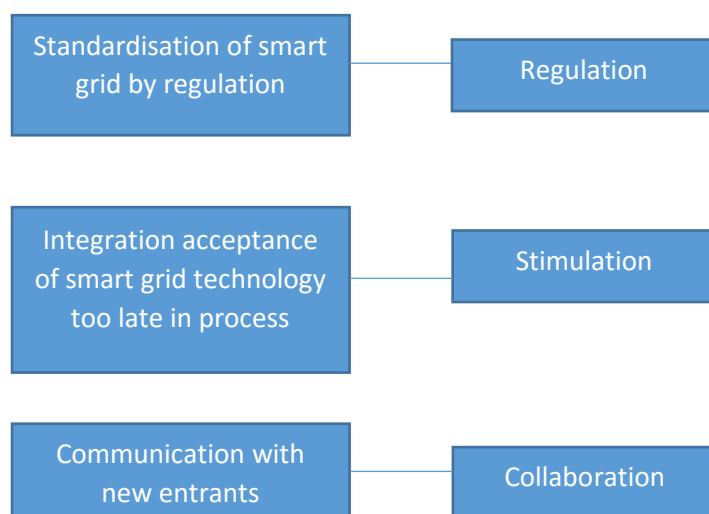
The arrival of new entrants causes challenges in collaboration. Rik van Berkel explains:

"The difference between an operator, big technology corporate and a start-up when integrating them in the field of energy is significant. These different organisations have their background, culture, thinking, interests, etc. This can cause misunderstandings or even less communication among each other."

It is not only integrating of organisations, but it is also about the communication with each other, getting the startups to draw up to the table.

The relationships among these stakeholders can also challenge collaboration. In the stakeholder network, everybody is a supplier or a consumer of one of another. This customer-supplier relationship can barrier the way to cooperation and a collective vision. Stakeholders should, therefore, communicate with each other about what should be the common direction we go.

#### *Factors of failure in general*



# Conclusion

An isometric illustration of a smart city layout. At the center is a circular base containing a blue communication tower with a signal antenna. Surrounding this base are three concentric, semi-circular zones. The innermost zone contains small blue houses and green trees. The middle zone contains larger blue office buildings and green trees. The outermost zone contains industrial buildings with smokestacks and wind turbines. The entire scene is set against a dark blue background.

*Answering the research question*  
*Discussing the thesis*  
*Providing recommendations*

## 6. Conclusion & Discussion

After investigating complexities within smart grids, governance and upscaling, three frameworks were developed. Smart grids are a bundle of technologies. These technologies differ in development on various aspects. Thus, to get a good understanding of smart grids, it is desirable to consider the concept of smart grids by dividing different sub groups. Also, governance is a rather fuzzy and broad definition, and in relation with the upscaling of smart grids, the means of governance are an important section of governance for finding key factors in the upscaling of smart grid implementation. At last, upscaling has been divided into different types, because organisations of actors relating to the smart grid implementation develop differently between these different kinds of upscaling.

Within the frames, all sub questions have been answered, and now at the end, it is time to combine the information of these answers and respond to the main research question in this thesis:

*Which factors of success and failure, considering a governance perspective, could be defined at the upscaling process from smart grid pilots towards large scale smart grid implementation in the Netherlands?*

At first, this thesis started off with describing the context where the energy discourse is in now. Upscaling is a transition, and the policy now shows the starting point. Investing in renewable integration on both central and decentralised level together with maintaining the energy network to be reliable has been the prior goals since the law on electricity in 1997 was published. Although revised during the last twenty years, according to some authors, this law is considered as rather strict.

Particularly with the implementation of smart grids, conflicts are inevitable. During the liberalisation of the energy network in the Netherlands, roles are assigned in the law. From generator until the consumer, regulation regarding all stakeholders is designed to protect the consumer. The use of data and other kinds of IT possibilities is not integrated within the borders of this regulation. As well, privacy issues arrive rather fast. Interestingly, the law on privacy in the Netherlands is even more strict than the law designed by the EU, which is the central organisation in the energy policy discourse. The integration of renewables on decentralised grids by the so called “prosumers” create challenges as well. Extra taxes (VAT) for “prosumers” when wanting to supply energy back to the grid and inefficient power management by grid operators could develop disincentives. Besides that, stimulation for one subgroup of smart grid solutions can conflict with another subgroup as we can see with net metering. Net metering provides chances for PV-installation and other forms of renewable energy integration, on the hand, energy storage loses a major part of its business case. However, investment in smart grid implementation is rising, as well are the areas provided for smart grid pilots.

The demonstration phase is making its last step towards creating commercial niches. However, there are still some challenges the overcome regarding the means of governance (among other things). In this thesis, different paths to create upscaling has been shown: rollout, expansion and replication. There exist differences in the composition of stakeholders among the projects PMC, JEM and M4H. Whereas PMC has a vast number of stakeholders involved in the pilot, JEM did not change a lot in the stakeholder composition but had still a substantial number of stakeholders involved. M4H, however, has a formal letter of intent with five stakeholders. Also, the ambitions differ, whereas in PMC and JEM, gathering knowledge and testing several subgroups of smart grid solutions was the prior goal, M4H is a project which will already be implemented to commercialise. At last, the geographical context and size vary substantially. This also indicates differences in behaviour of consumers.

## 6.1. The factors of success and failure

In the empirical part, a variety of factors are described. The key factors derive from this variety of factors. As explained throughout the thesis, there exist differences among types of upscaling and subgroups of smart grid technologies. In this paragraph, the different types of upscaling are divided and a distinction is made between smart grid technology subgroups.

### 6.1.1. Roll-out

Roll-out is described as scaling-up within the same context and not adding stakeholders in the formal organisation. Moreover, as already shown in several outcomes the definition of a roll-out is arbitrary, because what can be defined as the same context and what not. Also, the organisation is likely to differ when incubating different areas. However, M4H is the representing case study for a roll-out of smart grid implementation. With the letter of intent, five stakeholders are formally assigned to be involved in the strategy- and decision-making process.

This letter of intent creates insurance among the stakeholders. As well, standardisation is mentioned as important. In this case, it is done in a regulatory way. Roles are set and will proceed through the upscaling process. Thus, structured guidelines for roles among the stakeholders is perceived as necessary, for a roll-out because here the stakeholder composition will not change substantially. Referring to experts in smart grid innovation; innovation succeeds when involving consumers with ideas in strategies. These consumers, in the M4H-project, are mostly innovative companies/people. Thus, structured guidelines (predetermined strategy) developed by the five stakeholders is perceived as necessary for insurance and standardisation. However, the balance between a fully predetermined strategy and involving ideas throughout the upscaling process from bottom-up is indicated as a key factor.

Another success factor of stimulation regards to the acceptance of innovation. In this project, grid automatization will be implemented in the distribution grid. However, this system is connecting the distribution grid with the consumers. Furthermore, the project leaders try to conserve the liberty of consumers through not integrate the system “behind the meter”. Consumers can, therefore, make their own choices which smart building applications they want to connect with the automatization system. This liberty is necessary according to experts in the acceptance process. However, to avoid social exclusion, actors should be aware of the difference between the pace of consumers considering innovation. Some consumers could be ahead of the transition while others lack behind.

Collaboration in this project pointed out two key factors of success: trust and the involvement of a major player in both technological capabilities and financial power. Trust has been showed throughout the process so far. Everybody has their incentives, but his or her incentives can be successfully combined with one vision. The initiator, Siemens, is a major player with innovative and financial power. However, it is important that these stakeholders not conceptualise far ahead. The pace of the large innovative organisations can be too fast, while the acceptance of consumers could take time.

### 6.1.2. Expansion

In comparison with a roll-out, expansion is a type of upscaling where stakeholders are added during the scaling-up process. The context remains the same. PMC is considered as an expansion project, specifically, when focussing on the part when the pilot program ended. Another smart grid project started in Groningen as well, only with different partners together with stakeholders from the PMC-project.

Because the project was substantially smaller than the other two projects, the regulation in this project was minor. However, because the stakeholder composition changes during the upscaling, reliability is an important issue. The municipality therefore pleaded for surveillance. Surveillance that citizens will not be the victim of changes in stakeholders. The operator should perform the role assigned by the law, and the municipality should communicate with the consumers to maintain reliability. Experimentation and changing visions of stakeholders could affect consumers.

In this case providing materials had a favourable effect, according to Elke Klaassen this was also due to the successfully implemented technology. It was mostly focussed on smart applications. The consumer could not come between the smart application (heat pump) and the smart meter. Thus, the complexity of these applications decreased. At the other hand, advanced technologies were integrated, so this takes more investment and effort to get implemented. As well, as being an experiment, this could require more risk taking.

Visions could differ and change because the number of stakeholders is vast and the composition is dynamic. Communication is key to tackle challenges deriving from these changes and size. However, a couple of experts also mentioned that the vision of stakeholders could be too far from each other. For example, municipalities could not want to scale up on forehand because they see it more as a showcase.

#### 6.1.3. Replication

At replication, the focus is not per se on the stakeholder within the organisation, but the implementation of the same technologies is done in different contexts. JEM is a project which has been implemented in four different contexts.

The municipality created their regulatory framework. All innovations are welcome, but when being successfully tested within the framework, extra financial support is given by the municipality. Also, this could also be a stimulatory measure. This could help, but still, innovation is context related and does not always align with the ambitions of municipalities. Still, these innovations could initiate the upscaling of smart grids.

Stimulatory measures used in this project are for most only feasible on experimentation level. Communication with consumers though is key. This could be a stimulation in accepting the smart grid technologies.

This project shows that smart applications, grid automatization and energy storage now, cannot be implemented in every project. In Zwolle this pilot stopped, in Breda, it continued. Thus, context is considered as an important issue. Another statement what has been made is about the reactivity of policy. The municipality of Breda thinks that the municipality has not the capability to conceptualise smart grid innovation because there is a lack of knowledge. Thus, municipalities follow the market in its development of smart grid technologies.

In general

Besides these specific types of upscaling, also general key elements are applicable for all upscaling processes.

When examining all key factors, it shows on one hand that the private sector is full of innovative power and on the contrary that the pace of consumers is much slower in accepting the innovation. Because the targets of governmental organisations are ambitious, stimulation seems to go to innovation more often than the citizens to accept innovations. Sustainability targets cause pressure on energy network

transitions. However, acceptance of innovation is often difficult, in particular with the focus on upscaling.

Another feature is the regulatory system. On a national level, these restrictions must change according to experts. Flexibility is necessary. Still, agreements on how roles of energy actors should be constructed are difficult to make. Where one adjusts to the law with introducing an aggregator which involves in the communication process with the consumer. The other pleads for discontinuing of regulation about the role of operators and suppliers. In this way, operators and suppliers could take the role in data management and the consumer has more liberty in choosing.

All these key factors are an indication of which factors are key in the upscaling process of smart grid considering the means of governance. Still, all experts question the direction we should take. In short, the last step towards creating commercial niches is there, however, perceiving this final step as a small step or a giant leap differs among experts.

## 6.2. Discussion

This research creates a new framework of key factors for upscaling processes at smart grid implementation in the Netherlands regarding a governance perspective. Although much information is gathered and various visions of experts are included in this research, choices have to be made, and the reader should be aware of this.

### 6.2.1. Frameworks

When working with three concepts; smart grids, governance and upscaling, choices should be made from which theoretical perspective these concepts will be analysed. Smart grids are a bundle of technologies, so, to create a definition and make it researchable some interesting features had to be excluded. The real smart grid according to the definitions provided by many academic experts in this field is not implemented yet. In pilot phases, mostly a couple of technologies are implemented to experiment. At the other hand, it is impossible to analyse all technologies separately because there exist influences among these techniques. Subgroups tackle the broadness of the definition of smart grids and integrate influences among technologies.

Governance is a fuzzy concept; this means that this definition is not researchable without a scope. From a theoretical perspective, the means of governance seems to have a major effect on upscaling of smart grid technologies. Still, several aspects of the governance concept could be interesting to research as well.

Upscaling is a transition, and with many transitions in the field of innovations, upscaling will not develop in the same direction. Different strategies and forms can be divided. In this research, the choice for these three (four when integrating diffusion) was based on the integration of governance. With the arrival of new entrants and new stakeholder systems, this perspective on upscaling is interesting to use. Many other visions could also be included.

### 6.2.2. The choice for experts

When working with three concepts; smart grids, governance and upscaling, choices should be made from which theoretical perspective these concepts will be analysed. Smart grids are a bundle of technologies, so, to create a definition and make it researchable some interesting features had to be excluded. The real smart grid according to the definitions provided by many academic experts in this field is not implemented yet. In pilot phases, mostly a couple of technologies are implemented to experiment. At the other hand, it is impossible to analyse all technologies separately because there exist influences among these techniques. Subgroups tackle the broadness of the definition of smart grids and integrate influences among technologies.

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#### 6.2.3. Explanation of factors of success and failure

Success and failure are subjective, as well is upscaling. In this thesis success and failure is focussed on the potential to scale-up. Upscaling in this thesis is the line between demonstration projects and the existence of niche development with commercial impulses.

#### 6.2.4. Choice of context

The choice for context is complex. In this research, the three cases were chosen because they covered all types of upscaling and subgroups of smart grid technologies. However, there are a variety of different smart grid projects with their characteristics and outcomes; it would also be interesting to investigate these contexts. Furthermore, smart grid systems are not only implemented on the distribution grid but also on the transmission networks and centralised generation. The scope of this research in this research exclude the transmission networks.

## 7. Recommendations

Societal-, academic- and organisational motives for upscaling of smart grids are elaborated throughout the story, what remains is the question:

*What could we recommend according to this thesis?*

### *Academic recommendation*

This research is based on choices in theoretical perspectives and perspectives of experts. In further research both different theoretical perspectives on smart grids, governance and upscaling and different points of view of experts could be interesting to integrate. New findings could evolve, and the discussion on this topic would be more elaborated. Also, investigating other projects would create more value: what are the results in these projects? Do differences exist between other cases and the cases included in this research?

Involving the perception of consumers could also help with a better understanding of acceptance and upscaling. At the other hand, innovation in smart grid technologies from a bottom-up perspective is interesting to research as well.

Furthermore, representative data is relevant to research on the statistical basis. Causal relations can only be researched, in a quantitative way. These key factors could give a direction to further research.

### *Recommendation for strategy developers (Public- and private organisations)*

Upscaling is possible in different ways. It is important for strategy developers to find the balance between the pace of innovation and the speed of acceptance. The role of the governmental organisation is important in a sense that they could integrate both paces in a strategy. Too much attention towards innovative parties could result in conflicts with the public opinion, too much attention towards the majority of citizens could lead to the exclusion of potential good innovation. Thus, helping with redeveloping roles of governments, local, regional and national, is crucial.

Also, the balance between regulation and flexibility is important to keep in mind. Regulation could help with keeping all stakeholders in the same direction of intention, which is desirable when upscaling smart grids. Developing business cases and intention individually could insinuate conflict of interests and barriers in the collaboration. At the other hand, flexibility is necessary to create a healthy context for innovation. Stakeholder management is key. A platform where communication among innovative individuals and companies could help to get the right perspective, also communicating. This together with the aim for consensus in what form the smart grid should be developed is important.

Strategies for smart grid implementation should not be static. Strategies being more flexible towards additional technologies and the involvement of “new entrants” is important. Although it has benefits to create consortia based on formal agreements and with a clear assignment of roles, there should also be space for new entrants to involve.

At the end complexities in the energy discourse is vast. This major transition cannot be solved locally, not even on a national level, but should have an international focus. Privacy issues, social conflicts, changing roles of the current actors involved in the energy discourse, the arrival of new entrants, a variety of implemented strategies and perceptions, the energy transition, privacy issues, deadlines and targets, digitalisation; the change in the governance of energy network is a challenge which reaches much further than the border of nation states. New ground rules and standardisation are necessary before scaling up the smart grid implementation.

For the last step towards commercialised niches of smart grid implementation, acceptance of technologies should be increased in importance.

## Appendix I: Topic list for municipalities

Topics	Possible questions
<b>Ambitions and vision</b>	<ul style="list-style-type: none"> <li>- <i>How did the project developed in your city?</i></li> <li>- <i>How does this relate to your ambitions?</i></li> <li>- <i>Want are your incentives to involve in the smart grid?</i></li> </ul>
<b>Role and collaboration</b>	<ul style="list-style-type: none"> <li>- <i>What is your role in the process?</i></li> <li>- <i>Which tasks are you responsible for?</i></li> <li>- <i>With whom do you work with?</i></li> <li>- <i>How are the roles divided?</i></li> </ul>
<b>Policy and strategy</b>	<ul style="list-style-type: none"> <li>- <i>In what way do you facilitate the smart grid project?</i></li> <li>- <i>What strategy did you choose (process)?</i></li> <li>- <i>Regulation and stimulatory measures?</i></li> </ul>
<b>Barriers and success</b>	<ul style="list-style-type: none"> <li>- <i>What did you perceive as difficult or complex during the process?</i></li> <li>- <i>Do you think it is successful and why do you think it is successful?</i></li> <li>- <i>What do you think is still needed in policy and acceptance for smart grid implementation?</i></li> <li>- <i>Which lessons did you learn?</i></li> </ul>

## Appendix II topic lists experts

*Elke Klaassen*

Topics	Possible questions
<b>Role and experience</b>	<ul style="list-style-type: none"> <li>- <i>What was your role in both PMC and JEM?</i></li> <li>- <i>What did you experience in the collaboration between stakeholders in both projects?</i></li> </ul>
<b>Technique</b>	<ul style="list-style-type: none"> <li>- <i>Did you experience barriers at the implementation of technological solutions?</i> <ul style="list-style-type: none"> <li>➔ <i>Regulation</i></li> <li>➔ <i>Acceptance</i></li> <li>➔ <i>Feasibility</i></li> <li>➔ <i>Technological development</i></li> </ul> </li> </ul>
<b>Potential upscaling</b>	<ul style="list-style-type: none"> <li>- <i>What can you tell me about the upscale potential of these techniques?</i></li> <li>- <i>What did you think of the strategies for these projects?</i></li> </ul>
<b>Consumers</b>	<ul style="list-style-type: none"> <li>- <i>How did the consumers react?</i></li> <li>- <i>What is the best tactic?</i></li> </ul>

*Rik van Berkel*

Topics	Possible questions
<b>Initiative</b>	<ul style="list-style-type: none"> <li>- <i>What is your role regarding energy technologies?</i></li> <li>- <i>What are your experiences regarding the innovation in the smart grid discourse?</i></li> </ul>
<b>Collaboration, stimulation and regulation</b>	<ul style="list-style-type: none"> <li>- <i>How free should stakeholders be?</i></li> <li>- <i>How strict should regulation be?</i></li> <li>- <i>What should be the role of governments?</i></li> </ul>

	<ul style="list-style-type: none"> <li>- <i>What are good ways to innovate and what are the wrong ways within a governance process.</i></li> </ul>
<b>New entrants</b>	<ul style="list-style-type: none"> <li>- <i>What can you tell me about the melt between confessional actor within the energy network and new players in the field?</i></li> <li>- <i>What measures could one take to make the collaboration between the confessional actors and new entrants a success?</i></li> </ul>
<b>Potential upscaling</b>	<ul style="list-style-type: none"> <li>- <i>What should we do to stimulate larger scale smart grid implementation?</i></li> <li>- <i>Are there any tactics to successfully collaborate?</i></li> </ul>

Leo Freriks

Topics	Possible questions
<b>The initiative</b>	<ul style="list-style-type: none"> <li>- <i>What is your strategy behind the upscaling of this project?</i></li> <li>- <i>Which technologies are implemented?</i></li> <li>- <i>How are the roles assigned among stakeholders?</i></li> </ul>
<b>Consumers</b>	<ul style="list-style-type: none"> <li>- <i>Do you also involve consumers in the collaborative process?</i></li> <li>- <i>Are you flexible towards new ideas and visions on smart grid technology and collaboration?</i></li> </ul>
<b>Flexibility</b>	<ul style="list-style-type: none"> <li>- <i>How strict do you want to execute your strategy?</i></li> <li>- <i>Is there room for changes in plan?</i></li> </ul>

Topics	Possible questions
<b>Role and experience</b>	<ul style="list-style-type: none"> <li>- <i>What was your role in JEM?</i></li> <li>- <i>What did you experience in the collaboration between stakeholders in both projects?</i></li> </ul>
<b>Technique</b>	<ul style="list-style-type: none"> <li>- <i>Did you experience barriers at the implementation of technological solutions?</i> <ul style="list-style-type: none"> <li>➔ <i>Regulation</i></li> <li>➔ <i>Acceptance</i></li> <li>➔ <i>Feasibility</i></li> <li>➔ <i>Technological development</i></li> </ul> </li> </ul>
<b>Potential upscaling</b>	<ul style="list-style-type: none"> <li>- <i>What can you tell me about the upscale potential of these techniques?</i></li> <li>- <i>What do you think has to improve first?</i></li> </ul>
<b>Consumers</b>	<ul style="list-style-type: none"> <li>- <i>How did the consumers react?</i></li> <li>- <i>What is the best tactic to involve consumers?</i></li> </ul>

Topics	Possible questions
<b>Role and experience</b>	<ul style="list-style-type: none"> <li>- <i>What was your role in both PMC and JEM?</i></li> <li>- <i>What could you tell me about these projects regarding regulation/</i></li> </ul>
<b>Governmental involvement</b>	<ul style="list-style-type: none"> <li>- <i>Who should make the rules around smart grid innovation?</i></li> <li>- <i>What do you think of regulation by local governments to better implement their smart grid implementation strategy?</i></li> </ul>



<b>New roles for whom</b>	<ul style="list-style-type: none"> <li>- <i>Do you think the aggregator role is an addition to smart grid implementation?</i></li> <li>- <i>Should there be a change in the system or in the roles of stakeholders?</i></li> </ul>
<b>Consumers</b>	<ul style="list-style-type: none"> <li>- <i>How should consumers be protected?</i></li> <li>- <i>How flexible should regulation be?</i></li> <li>- <i>Regarding upscaling, standardisation of smart grids by regulation?</i></li> </ul>

*Nicole de Koning*

<b>Topics</b>	<b>Possible questions</b>
<b>Role and experience</b>	<ul style="list-style-type: none"> <li>- <i>What was your role in both PMC and JEM?</i></li> <li>- <i>What did you experience in the collaboration between stakeholders in both projects?</i></li> </ul>
<b>Collaboration</b>	<ul style="list-style-type: none"> <li>- <i>Top-down or bottom-up?</i></li> <li>- <i>How could the different stakeholders stimulate acceptance of smart grid technologies?</i></li> </ul>
<b>Consumers</b>	<ul style="list-style-type: none"> <li>- <i>Why do you think it is hard to get citizens to participate in smart grid pilots?</i></li> <li>- <i>What do you think are the main barriers in the acceptance of innovations?</i></li> </ul>
<b>Potential upscaling</b>	<ul style="list-style-type: none"> <li>- <i>Who do you think should focus on the acceptance of innovation within the smart grid?</i></li> <li>- <i>When do you think, a smart grid can be scaled-up?</i></li> </ul>

## Appendix III Coding scheme

Code	Explanation
<b>Collaboration</b>	
Arrival_new entrants	The reaction on the arrival of new entrants
Awareness_consumers	Being aware and willing to involve the perception of consumers
Bottom-up innovation	The occurrence of smart grid innovation from bottom-up
Collaborative tactics	Tactics to succeed in collaboration
Communication	The communication among stakeholders
Conflict_OI	Conflict of interests between public and private parties
Dertermine_newroles	The assignment of new roles to the stakeholders
Dev_stakehcomp	The development of the stakeholder composition
Dif_speed_priv/pub	The difference in speed between private and public actors
Domi_stake	The dominance of stakeholders
Involvement_majplay	The involvement of powerful players (Siemens, tesla etc.)
Landowner_involvement	The involvement of landowners in the collaborative process
Steering_by_mark	Steering by the market
System_change	The change in systems considering collaboration
Trust	The trust between stakeholders
<b>Stimulation</b>	
Financial_stim	Financial stimulation
Incentive_develop	The development of incentives
Simplicity	The simplicity of techniques
Stim_by_law	Stimulation by law; space to experiment for example
Stim_by_mat	Stimulation by providing materials
Providing_net	Stimulation by providing networks (potential customers) for another stakeholder to use
Visualising_smart grid	Visualisation of how a smart grid will look like and what it can do for someone
<b>Regulation</b>	
Flex_innovation	Flexibility of regulation regarding innovation
Flex_law	Flexibility of law regarding the implementation of smart grids
Regulated_agreements	Predetermined agreements between stakeholders; letter of intent for example
Protection_privacy	The protection of privacy

Regulation_collaboration	Regulation on collaboration
Regulation_innovation	Regulation on innovation
Regulation_nat_gov	Regulation national government
Regulation_oper	Regulation on role operator and supplier
Standardisation	Regulatory measure to standardise roles and techniques within the smart grid discourse
Extra	
Strategy development	The development of smart grid upscaling strategies
Business case development	The development of business cases for stakeholders
Acceptation society	The acceptance of techniques by the society

## Appendix IV NVIVO

### Examples of integrated nvivo outputs.

Name	Sources	References	Created On	Created By	Modified On	Modified By	Color
niche development	5	7	17 Jul 2017, 10:05	NE	17 Jul 2017, 15:42	NE	
regulation	0	0	18 Jul 2017, 10:00	NE	18 Jul 2017, 10:27	NE	
Control_national government	1	1	17 Jul 2017, 10:08	NE	17 Jul 2017, 10:43	NE	
Flex_innovation	5	9	15 Jul 2017, 21:04	NE	18 Jul 2017, 10:29	NE	
Flex_law	4	6	15 Jul 2017, 21:01	NE	17 Jul 2017, 17:05	NE	
Predetermined_agreements collab...	3	5	17 Jul 2017, 09:41	NE	17 Jul 2017, 17:09	NE	
Protection_privacy	2	2	15 Jul 2017, 21:08	NE	18 Jul 2017, 10:06	NE	
regulation_collaborative forms	1	1	18 Jul 2017, 10:15	NE	18 Jul 2017, 10:16	NE	
Regulation_context and consumers	1	1	17 Jul 2017, 11:28	NE	17 Jul 2017, 11:31	NE	
regulation_innovation_to_policy	1	3	18 Jul 2017, 10:13	NE	18 Jul 2017, 16:15	NE	
Regulation_national government	2	4	17 Jul 2017, 16:04	NE	18 Jul 2017, 16:15	NE	
regulation_policy innovation	4	4	17 Jul 2017, 16:04	NE	18 Jul 2017, 16:15	NE	

**Arrival\_new entrants**

**Summary** **Reference**

**Internals\Interview Frits Verbeij (TKI Urban energy)**  
1 reference coded, 3.32% coverage

Reference 1: 3.32% coverage

Wat je wel ziet is dat steeds meer verschillende spelers zich gaan mengen in het verhaal van de smart grid.

**Internals\Interview Leo Frenks (Siemens)**  
1 reference coded, 2.59% coverage

Reference 1: 2.59% coverage

We zullen ook moet afwachten welke innovaties er ontstaan tijdens het project. Hierbij kunnen verschillende partners ontstaan.

Name	Sources	References	Created On	Created By	Modified On	Modified By	Color
Acceptation_society	1	4	17 Jul 2017, 13:49	NE	17 Jul 2017, 14:55	NE	
Collaboration	0	0	18 Jul 2017, 10:21	NE	18 Jul 2017, 10:34	NE	
Arrival_new entrants	4	6	17 Jul 2017, 10:33	NE	17 Jul 2017, 17:05	NE	
Awareness_consumers	2	2	17 Jul 2017, 08:27	NE	17 Jul 2017, 13:02	NE	
Bottom-up innovation	1	1	17 Jul 2017, 15:49	NE	17 Jul 2017, 15:50	NE	
Collaborative_tactics	1	3	17 Jul 2017, 16:27	NE	18 Jul 2017, 10:23	NE	
Communication	5	6	17 Jul 2017, 11:10	NE	18 Jul 2017, 16:15	NE	
Conflict_of_interests_private-public	1	1	17 Jul 2017, 16:22	NE	17 Jul 2017, 16:23	NE	
Consumers_and_context	3	3	17 Jul 2017, 09:59	NE	17 Jul 2017, 16:48	NE	
Determine new roles	3	4	17 Jul 2017, 09:26	NE	17 Jul 2017, 16:45	NE	
Development_stakeholdercomposi...	2	2	17 Jul 2017, 08:37	NE	18 Jul 2017, 16:15	NE	

**Arrival\_new entrants**

**Summary** **Reference**

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