Rules for Watt?

Designing Appropriate Governance Arrangements for the Introduction of Smart Grids

Imke Lammers

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for the Introduction of Smart Grids

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RULES FOR WATT?

DESIGNING APPROPRIATE GOVERNANCE ARRANGEMENTS FOR THE INTRODUCTION OF SMART GRIDS

DISSERTATION

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the degree of doctor at the University of Twente,
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by

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Chapter 1

Introduction

Abstract

‘Without serious upgrading of existing [electricity] grids and metering, renewable energy generation will be put on hold, security of the networks will be compromised, opportunities for energy saving and energy efficiency will be missed, and the internal energy market will develop at a much slower pace’
(European Commission, 2011, p. 2).

Smart grids are considered a solution to upgrading the electricity network and to help overcome the challenges mentioned in the above statement. This PhD thesis is meant to contribute to the improvement of smart grid introduction in practice. I focus on the ‘rules of the game’ of local energy planning, and more specifically on advancing decision-making processes on the introduction of smart grids in the Netherlands. The choice for this country is related to the increasing need for smart grids in the Netherlands, as well as to prevailing rather slow decision-making in energy planning. This rather slow introduction of smart grids is problematic because it hinders the Dutch ambition towards a sustainable energy system. Therefore, in this dissertation I address the main research question *‘How can local governance on the introduction of smart grids be improved?’* To answer this question I empirically investigate current governance practices on smart grid introduction in the Netherlands, as well as use the empirical insights that derive from this to develop heuristics to facilitate the introduction of smart grids in Dutch local settings.

Section 1.1 outlines the need for a smart grids by providing background information on the energy transition, its consequences for the electricity distribution grid, and the role of smart grids and more generally of smart energy systems in overcoming these challenges. In Section 1.2 the research background and research problem of this PhD thesis are outlined. This research problem is translated into research objectives and questions in Section 1.3. Section 1.4 describes the theoretical underpinnings that guide the research conducted in this dissertation. The final Section 1.5 provides an outline of the PhD thesis by summarizing the focus of each thesis chapter.

1.1. The Need for Smart Grids

This section provides an overview of the energy transition challenges and of the developments towards a sustainable energy system. The focus of this dissertation in particular is on the arising implications for the electricity grid.

1.1.1. The energy transition

Our energy system is in transition, involving, among others, a shift from fossil fuels to renewable resources, as well as from centralized to decentralized electricity production. The need for an energy transition followed the urgency of combatting climate change and its translation into policy targets at different governmental levels.

At a global scale, in the Paris Agreement of the Framework Convention on Climate Change (UNFCCC) the United Nations (UN) specifies to hold the increase in the global average temperature to below 2°C above pre-industrial levels (United Nations, 2015a). At the European Union (EU) level, the previous ‘20-20-20 targets’ have been updated through the ‘2030 Framework for climate and energy’. The current targets are: 40% greenhouse gas emissions reduction as compared to 1990 levels, at least 27% renewable energy in the final energy consumption, and at least 27% energy savings as compared to the business-as-usual scenario in the EU by 2030 (European Commission, 2014).

At the national level, the Dutch government aims at an almost completely renewable-based energy provision by 2050 (Rijksoverheid, 2017b). In 2013, the Dutch government, market players and societal organisations signed the ‘Agreement on Energy for Sustainable Growth’, in short ‘Energy Agreement’ (in Dutch: *Energieakkoord*). By signing all signatories agreed on renewable energy ambitions for the Netherlands, and also recognized the need for smart grids and demand-side management to facilitate the transition to renewable resources (SER, 2013). The Energy Agreement outlines targets for energy saving (100PJ by 2020), clean technology and climate policy and has set a goal of 14% renewable energy in final energy consumption in 2020 and 16% in 2023 respectively (SER, 2013).

Due to Dutch reserves, natural gas dominates as energy resource in Dutch heat supply. One of the implications is to develop heating alternatives for natural gas in residential heating (Rijksoverheid, 2015). In electricity production onshore and offshore wind parks are a focal point of Dutch renewable energy policy. The ambition is to have an onshore wind capacity in 2020 of 6,000 MW and an offshore wind production of 4,450 MW in 2023 in the Dutch part of the continental shelf (SER, 2013). Furthermore, it is expected that most renewable-based electricity will be produced distributed in decentralized local settings, predominantly by small-scale

wind parks, photovoltaic (PV) panels and renewable-based combined heat and power (CHP) (ECN, 2016; SER, 2013).

In the Netherlands, the need for smart grids is clearly recognised to facilitate the effective and efficient integration of (intermittent) renewable-based electricity generation into the electricity grid. Yet, while the Netherlands is one of the countries with most funding for smart grid demonstration projects in the European Union (EU), the deployment of smart grids does not scale up and even has decreased after 2012 (Gangale, Vasiljevska, Covrig, Mengolini, & Fulli, 2017). The next subsections explain in more detail why smart grids are needed.

1.1.2. The challenged distribution grid

The increase in intermittent renewable-based electricity generation in combination with changing local load patterns challenges the operation and management of in particular the distribution grid; that is the middle and low voltage parts of the electricity grid that connect households (and other small entities) to the main electricity grid. This challenge can best be explained with a brief description of the operation and management of the current electricity grid.

The electricity system set-up in the Netherlands is guided by the principles of affordability, reliability and sustainability of supply¹. In the electricity system as we know it for long, electricity is generated in large-scale power stations and by high voltage lines, medium and low voltage lines distributed to end consumers (residential or industrial). In this set-up, the electrons flow in one direction – from the production unit to the consumer – and since electricity cannot be stored on a large scale, production and consumption need to be balanced real time. To explain, the cables and power convertors of the electricity grid have a fixed maximum capacity and consequently ‘system security requires production and consumption to constantly match, power flows not to violate any network constraints, and sufficient spare transmission and generation capacity to be available in order to avoid service interruptions in the event of outages or unexpected surges in demand’ (Ranci & Cervigni, 2013, p. 7). The operation and management of the grid, therefore, needs careful longer-term and short-term planning.

Since the liberalization of the electricity market, the planning of the physical flows of electricity through the grid is facilitated by different market formats, reflecting the economic transactions underlying the physical flow of electrons through the grid. Long-term contracts and the day ahead market form the economic core of the

¹ This principle is also reflected in the UN’s sustainable development goal number seven: ‘Ensure access to affordable, reliable, sustainable and modern energy for all’ (United Nations, 2015b).

electricity planning, making it is possible to plan the operation and management of the grid every day for the next day. In addition, the system operator accounts for uncertainties in the real time balance of the grid and anticipates by backup transactions in the form of loads (MWs) which can be (dis)connected to the grid in a very flexible way (Cervigni & Perekhodtsev, 2013). For instance, to dispatch or to reduce power generation, gas turbines are often used as these devices can be switched on and off quickly (Appelrath, Kagermann, & Mayer, 2012; PBL, 2009). On average twenty percent of generation capacity solely exists to meet peak demand, while these generators produce electricity only five percent of the time (Farhangi, 2010).

Wind speed and sunshine, which determine the production of electricity by wind turbines and PV panels, can only be forecasted with limited accuracy. This means that the contribution of these renewable resources to electricity supply always faces some uncertainties. In general these uncertainties are manageable but they tend to challenge the management of the distribution grid in particular. Notably the production of electricity from PV panels during daytime can lead to mismatches with local demand, which is highest in the morning and evening, whereas the local electricity production of PV panels is highest during the hours in between. As a result, a large part of the electricity generated by rooftop PV panels is fed into the distribution grid. As the supply from PV panels fluctuates on a daily and seasonal basis, the load profiles of consumers become less predictable as the number of rooftop PV panels increases. The uncertainties of the real time feed-in by solar PV panels (or wind turbines) requires flexibility in the distribution grid: this entails on the one hand to provide electricity when PV panels are under-producing and on the other hand to take electricity when the PV panels are overproducing.

A further challenge for electricity distribution grids is the increasing electrification on the demand side. Electric mobility is becoming more popular, partially due to tax incentives and the roll-out of charging points (Eising, Van Onna, & Alkemade, 2014). The charging of these electric vehicles can lead to higher and more concentrated loads when for example vehicles are charged in the evening (between 6 and 9 pm) when household load is highest (Clement-Nyns, Haesen, & Driesen, 2010; Moslehi & Kumar, 2010). Next to the electrification of mobility, electrification of space heating and cooling by heat pumps also challenges the medium and low voltage parts of the electricity grid (Grond, Schepers, Veldman, Slootweg, & Gibescu, 2011; Verbong, Beemsterboer, & Sengers, 2013). An example of what the implications of unexpected extreme peak demand can be was provided by a simulation in 2015 in the Dutch municipality of Lochem. Residents of three streets simulated a 'typical' Dutch situation regarding electricity demand in 2025: they charged 20 electric vehicles and baked off 20 pizzas in electric ovens at the same time; the resulting peak caused a complete blackout (Hoogsteen et al., 2017).

These outlined developments in supply and demand of electricity imply that energy management which ensures the balancing of consumption and production becomes more important in the low and medium voltage part of the distribution grid (IEA, 2011; Siano, 2014). Thus, with the emergence of distributed generation (DG) of electricity from renewable energy sources, the distribution grid needs to facilitate a bidirectional flow of electrons: from the grid to the consumer and from the consumer (prosumer) to the grid. This two-way flow of electrons is new and requires adjustments to electricity distribution grids.

1.1.3. Smart grids as solution for the challenged distribution grid

To allow for the integration of a large amount of intermittent renewable energy sources and accommodate more fluctuating demand patterns, imbalances between supply and demand have to be alleviated in order to prevent a congestion of the electricity grid. Presently three technical options are discussed to handle the increasing imbalances in electricity grids.

The first option is the strengthening of the electricity grid system both at the national and at the European level. This would entail strengthening the current large interconnected cross-border electricity transmission grid between EU member states. The expectation is that better connections among the electricity networks of countries would improve the absorption of unexpected shortages as well as allow to transfer electricity from places of abundance to places of scarcity in the European grid infrastructure (European Commission, 2017a). In addition to the strengthening of the high voltage lines across Europe, the middle and low voltage lines also would require significant investments to increase capacities. By means of higher-capacity transformers and cables imbalances at the local level could be accommodated. However strengthening the high, middle- and low-voltage grid across Europe, requires tremendous investments. For instance, under the German Federal Environment Ministry's scenario for 2020, an additional 380,000 kilometres of new cables are needed in Germany's electricity grid, including 650 km of new high voltage grid cables, which would amount to an investment of 21 to 27 billion euro (BDEW, 2011). In the Netherlands, two billion euro is already spent annually on the extension, replacement and maintenance of the Dutch electricity and gas grids (ECN, 2016).

A second option is the storage of electricity, particularly at the local or regional level to manage imbalances in the electricity distribution grid. Instead of feeding locally generated surplus electricity into the distribution grid, electricity could be stored and used when local generation is low/local demand is high. Electricity storage, however, is still relatively inefficient and expensive compared to other forms of energy storage such as thermal, gas and liquid fuel storage (Lund et al., 2016).

A third option is demand-side management. Demand-side management is aimed at reducing peak demand and is also referred to as ‘load management’, as its aim is to change load patterns instead of adjusting power generation (Karunanithi, Saravanan, Prabakar, Kannan, & Thangaraj, 2017). With the help of information and communication technologies (ICT), demand-side management can optimize the bi-directional flow of electricity and automate flexibility in demand. This ‘ICT layer’ includes technical components such as network sensors, substation automation and control technologies as well as smart meters (Blumsack & Fernandez, 2012). With the help of ICT methodologies such as the three-step control strategy ‘TRIANA’ forecasting, planning and real-time remote control of energy flows can be undertaken and the operation of (household) devices can be adjusted (Bakker, 2012; Bosman, 2012; Molderink, 2011). An example is the ‘charging of [electric] cars during night hours, spreading the electrical demand for heat pumps by buffering heat and having smart appliances² like smart washing machines running when demand is low’ (Veldman, Gibescu, Slootweg, & Kling, 2013, p. 246). In addition, home energy management systems (HEMS) can be installed to provide residents with insights into their energy consumption and production patterns via a wall display, mobile app or website. Demand-side management is complementary to storage and perceived as a cost effective alternative for grid strengthening investments (Van Leeuwen, De Wit, & Smit, 2017, pp. 944-945). This dissertation focusses on this energy-efficient option for handling balance challenges in local electricity distribution grids.

Electricity grids that are comprised of this advanced sensing, communication and control technologies are referred to as smart grids. ‘Smart grids enable increased demand response and energy efficiency, integration of variable renewable energy resources and electric vehicle recharging services, while reducing peak demand and stabilising the electricity system’ (IEA, 2011, p. 5). By monitoring and controlling the electricity grid intelligently, smart grids are considered to be more efficient, decentralized and resilient electricity grids that can reduce costs and environmental impacts and maximise reliability of supply as well as grid stability (DOE, 2009; IEA, 2011).

Smart (electricity) grids are regarded as one of several components of a smart energy system (Lund, Andersen, Østergaard, Mathiesen, & Connolly, 2012). In a smart energy system ‘smart electricity, thermal and gas grids are combined with storage technologies and coordinated to identify synergies between them in order to achieve an optimal solution for each individual sector as well as for the overall energy system’ (Lund, Østergaard, Connolly, & Mathiesen, 2017, p. 5). This holistic systems

² Smart appliances are (conventional) devices that are equipped with communication and steering interfaces – that is, have chips integrated into them – and can be switched on and off automatically (Wissner, 2011).

approach integrates the electricity, thermal (heating and cooling), and transport sectors with the objective of energy conversion and energy efficiency improvements. Smart energy systems are hence not only based on the renewable energy sources of wind and solar energy, but can, e.g., via smart heating grids, also integrate geothermal energy as well as residual resources such as biomass or industrial surplus heat (Lund et al., 2014). This cross-sectoral smart energy systems approach is considered particularly suitable for the transition to an energy system based on 100% renewable energy supply (Lund et al., 2017).

This dissertation mainly focusses on smart grid types of developments in relation to the electricity grid as this is where the current focus of research and practice lies when it comes to developments towards sustainable energy systems. In addition, in Chapter 4 two cases where stakeholders seek to upgrade the local heating grid infrastructure are analysed to identify whether local energy planning practices differ depending on the type of energy infrastructure in question. To explain, at the European Union level the Electricity Directive (2009/72/EC)³ for instance places emphasis on smart grids: ‘Member States should encourage the modernisation of distribution networks, such as through the introduction of Smart Grids, which should be built in a way that encourages decentralised generation and energy efficiency’ (Eur-lex, 2009b, p. 58). In 2017, the EU’s Joint Research Centre (JRC) identified 950 smart grid projects in the EU member states, Switzerland and Norway, amounting to €5 billion in investments (Gangale et al., 2017). In that regard it should be noted that the Netherlands is one of the countries with most funding for smart grid demonstration projects in the European Union (EU) (Gangale et al., 2017). Examples of realized demonstration projects are the twelve Dutch pilots of the ‘Innovation programme for smart grids’ (short IPIN) that took place between 2011 and 2016 (RVO, 2016b). These twelve projects received a total of €16 million euros in subsidies. Furthermore, system integration through smart grids is one of the priority areas of the Dutch Top Sector program on energy⁴. In this context, in 2012, two ‘Switch2SmartGrids’(S2SGs) tenders were opened that resulted in governmental co-financing of seventeen smart grid projects for a period of maximum four years (Agentschap NL, 2013). A few of these IPIN and S2SGs projects are analysed in Chapters 3 and 4 of this dissertation.

³ Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, published in OJ L 211, 14.8.2009, p. 55–93.

⁴ The Dutch Top Sector program is a policy initiated by the First Rutte cabinet to (financially) support and strengthen nine important sectors of the Dutch economy, of which energy is one. For each of the nine Top Sectors an innovation contract has been created, which includes measures, plans and agreements made by entrepreneurs, researchers and the government (Rijksoverheid, s.a.). Furthermore, for each Top Sector so-called ‘Top Consortia’ (Topconsortia voor Kennis en Innovatie, short TKI) have been created and subsidies are provided to private companies that invest in R&D of research institutes (RVO, 2014).

Overall, the deployment of smart grids, however, does not occur on a large scale yet and has even decreased after 2012 (Gangale et al., 2017). The slow progress with regard to the introduction of smart grids is problematic for moving forward with the energy transition. As explained, the energy transition entails the generation of electricity from intermitted renewable energy sources as well as more fluctuating demand patterns. Smart grids can facilitate the energy-efficient accommodation of these changes in the electricity grid.

To conclude, although the technical components of smart grids are well-developed, their implementation in the electricity infrastructure is slow and therefore needs specific attention. The research conducted in this dissertation is meant to contribute to the improvement of smart grid introduction in practice, in particular by focussing on the institutional side of decision-making practices of smart grid implementation. The technical dimension of smart grids is no separate focal point in this research; it is only covered when it is subject in decision-making processes that I analyse in my research. The research background and research problem in regard to this introduction of (components of) smart grids by stakeholders during local energy planning are outlined in the next section.

1.2. Research Background and Research Problem

This section introduces the emergence of a multi-actor setting in the electricity sector (Subsection 1.2.1), and its consequences for local energy planning, in particular with respect to the design and implementation of smart grids (Subsection 1.2.2). In this PhD thesis these two activities of ‘design’ and ‘implementation’ are jointly referred to as the introduction of smart grids.

1.2.1. An increasing multi-actor setting in the electricity sector

Before the liberalization process opened up the EU Member States’ electricity and gas markets to competition in the late 1990s, electricity generation and distribution were largely public tasks, organized in publicly-owned monopolies (Arentsen & Künneke, 1996). This came with ‘clearly defined positions and legally authorized tasks reflecting the public utility character of electricity supply and the company’s public service obligations’ (Arentsen, Fabius, & Künneke, 2001, pp. 152-153). Under this system, the integrated energy company was in charge of rolling out the energy infrastructure in residential areas. The options were rather straightforward: electricity and natural gas grid connections (only from the mid-1990s on heat distribution was increasingly considered as well). In the Netherlands, this situation changed in 2006 with the adoption of the Act on Independent Network Management Administration (in Dutch: *Wet Onafhankelijk Netbeheer*). Following this Act, companies which dealt

with distribution/transmission as well as generation/supply of electricity had to unbundle both types of activities into two completely separated and independent organisations before 2011 (Kist et al., 2008). Due to these liberalisation and unbundling requirements, the physical supply of electricity became the responsibility of a distribution system operator (DSO, responsible for the medium and low voltage part of the grid) and a transmission system operator (TSO, responsible for the high voltage part of the grid), whereas the contractual and financial part of the supply became the responsibility of electricity supply companies. After this liberalisation many new supply companies entered the Dutch energy market, offering consumers electricity (and gas) in a wide variety of contractual formats.

Another development that led to an increased number of stakeholders in the electricity sector was the changing structure of electricity production. Instead of the centralized production by large-scale production companies, electricity, especially renewable-based electricity, got generated more distributed near the places where it directly could be used. Examples are the installation of wind turbines, solar PV panels, cogeneration/combined heat and power (CHP), hydro power plants, or biogas production in anaerobic digestion plants. These new, distributed small-scale technologies not only increased the diversity of power generating technologies but also the number and diversity of actors with a stake in electricity production and supply.

Notably, the emerging distributed production of electricity by means of renewable resources was accompanied by an increasing trend of what is called prosumption: private individuals or collectives of individuals producing and consuming their own electricity (Bellekom, Arentsen, & Van Gorkum, 2016). Prosumption has become a trend in the Netherlands and is initiated and organized more and more by so-called local community energy initiatives⁵. In the Netherlands, the number of community energy initiatives has grown from 40 prior to 2009 up to 360 initiatives by 2016 (Oteman, Kooij, & Wiering, 2017).

In line with this development, end users of electricity are no longer perceived as merely passive consumers. They are assumed to become active participants who engage in sustainable production and consumption of electricity and other types of energy. Private consumers are assumed to participate by means of, for instance, the installation of renewable energy technologies, demand shift to off-peak moments and flexible contracting. Such behaviour change can be incentivized through dynamic energy tariff structures (Blumsack & Fernandez, 2012; Naus, Spaargaren, Van Vliet, & Van Der Horst, 2014). A Dutch Experimentation Decree for Decentralized

⁵ Community energy initiatives are *inter alia* also referred to local renewable energy initiatives, renewable energy cooperatives (short REScoops) or grassroots initiatives for renewable energy. In this dissertation the term ‘community energy initiative’ is predominantly used.

Renewable Electricity Generation from 2015 even allows residential end users to engage in collective generation, peer-to-peer electricity supply and system operation, as will be explained in more detail in Chapter 5.

With the shift to the market model in the electricity sector and the distributed generation of renewable energy, the number of stakeholders proliferating themselves in the transitioning energy system is continuously increasing. In addition to the already introduced energy supply companies, DSOs, prosumers and community energy initiatives, such stakeholders include for example ICT companies, technology manufacturers, local governments (e.g., through municipal energy companies), housing associations, data processing companies, investors, research centres, energy storage providers, energy service companies (ESCOs), as well as aggregators that manage the flexibility of electricity loads of various entities (Goldthau, 2014; Muench, Thuss, & Guenther, 2014; Wüstenhagen, Wolsink, & Bürer, 2007).

In consequence, many more people, groups and organizations consider a potential involvement and stake in local energy planning. In this dissertation, local energy planning is defined as the decision-making process on the design of new and changes in existing local energy grid infrastructures, which includes the introduction of smart grids. Sataøen, Brekke, Batel, and Albrecht (2015, p. 185) emphasize that ‘grid projects must involve all interested actors, and these actors must be given an opportunity to participate substantially in the decision-making process’. When changes to the local electricity grid infrastructure are discussed, decision-making often takes place in relation to the renovation or refurbishment of houses in urban renewal projects, as opposed to individual buildings (Elle et al., 2002; Van Der Waals, Vermeulen, & Glasbergen, 2003). Due to the increasing number and diversity of actors involved in local energy planning the local decision-making arena can be described as polycentric, as elaborated on in Chapter 3.

The joint decision-making of stakeholders is particularly relevant for the transition towards smart grids. Due to the unbundling requirements in the electricity system, different as well as more stakeholders have become responsible for distinctive parts of the electricity supply chain as well as for the technical and economic coordination needed for the well-functioning of the system (Goldthau, 2014; Künneke & Finger, 2009). More specifically in regard to smart grids, in its ‘Technology Roadmap Smart Grids’ the International Energy Agency (IEA) states that ‘the physical and institutional complexity of electricity systems makes it unlikely that the market alone will implement smart grids on the scale that is needed’ (IEA, 2011, p. 5). In consequence, the IEA considers the involvement of and collaboration among a wide variety of stakeholders necessary for the roll-out of smart grids, including governments, the private sector and consumers among many others (IEA, 2011).

In sum, many stakeholders now potentially play a role in local energy planning. The emergence of this multi-stakeholder setting has several consequences for energy

planning on the introduction of smart grids. This will be explained in the next subsection (1.2.2).

1.2.2. Consequences of the multi-actor setting for energy planning

The emerging multi-stakeholder setting is particularly challenging for decision-making on energy projects in the Netherlands. Under the Dutch ‘polder model’ of consensus decision-making all interests are heard (Coenen, Van De Peppel, & Woltjer, 2001). For Dutch energy infrastructure projects, the consensus-seeking by actors often slows down progress and high sustainability ambitions are watered down by what the consensus-based decision-making process generates as feasible outcome (Commissie Elverding, 2008; Ministerie van Economische Zaken, 2016). As will be explained in Chapter 7, decision-making on local energy planning basically has become a slow process of localised ‘muddling through’ with undefined, unpredictable outcomes.

The ‘muddling through’ in energy planning projects is related to the fact that not all roles and responsibilities of stakeholders in the energy system are clearly described and formally anchored in legislation anymore. The liberalization of the EU’s energy markets already led to an ‘unbundled value chain with hybrid modes of organization and diffuse property rights structures’ (Künneke & Finger, 2009, p. 7). This situation is especially problematic for the introduction of smart grids. Verbong et al. (2013, p. 121) explain that ‘disagreement exists on the practicalities of designing a smart grid: i.e., who should be the dominant actor, how should costs and benefits be allocated, who bears which responsibilities, etc.’ These aspects are influenced by ‘rules of the game’ (North, 1990; E. Ostrom, 2005), which structure the collaboration between actors and define roles and responsibilities in local energy planning (these ‘rules of the game’ are also referred to as institutions, as will be explained in Subsection 1.4.1). However, appropriate ‘rules of the game’ are considered to be lacking in the transitioning electricity system, and for the introduction of smart grids in particular. Wolsink (2012) expects that ‘most existing institutions, which are designed to support the centralised power supply system, will prove to be unfit for creating, operating, and managing microgrids within an integrated smart grid’ (p. 832).

In sum, the number and diversity of actors in the transitioning energy system has increased and the roles and responsibilities of stakeholders in local energy planning have blurred. Due to the fact that appropriate ‘rules of the game’ are lacking for decision-making in local energy planning processes, creating appropriate ‘rules of the game’ is essential for advancing the introduction of smart grids. This is particularly relevant for the Netherlands because smart grids are important for advancing the Dutch energy transition, but decision-making in energy projects is slow and sustainability outcomes are often watered down. For this reason, this dissertation is

concerned with making improvements to the ‘rules of the game’ which govern the introduction of smart grids in the Netherlands.

1.3. Research Objectives and Questions

In order to make progress on the introduction of smart grids, the previous Section 1.2 outlined the need for improvements to the ‘rules of the game’ that govern the multi-stakeholder local energy planning process. Based on this observation, the overarching research question of this thesis is:

How can local governance on the introduction of smart grids be improved?

This main research question can be translated into two research objectives that specify the research activities that will be undertaken in this dissertation to address the main research question:

- A. To obtain empirical insights into the governance arrangements inherent to decision-making on the introduction of smart grids in local settings.
- B. To use the empirically-obtained insights to develop heuristics that can facilitate the introduction of smart grids in local settings.

The research conducted in this dissertation focusses on the Dutch context because smart grids are considered important for the Dutch energy transition, and in particular for local settings where end users are connected to the low-and medium-voltage parts of the electricity grid. Yet, as outlined in the previous subsection, the introduction of smart grids in the Netherlands is rather slow and improvements need to be made to the ‘rules of the game’ that govern local energy planning processes. Therefore, researching how local governance practices on the introduction of smart grids can be improved is of particular relevance for the Dutch context.

To be able make suggestions for the improvement of governance practices pertaining to the introduction of smart grids, first an understanding of current practices is needed. Therefore, research objective A focuses on the empirical analysis of current governance practices. To guide this empirical analysis, three research sub-questions have been developed in relation to research objective A.

- A1: Which consequences can a polycentric local decision-making arena have for the realization of a renewable energy transition, in particular for the introduction of smart grids?

- A2: Which institutional conditions enable or disable decision-making processes regarding the introduction of smart electricity and heating grids in selected city district development projects in the Netherlands?
- A3: Which lessons can be learned from legal experiments with alternative governance arrangements for decentralized electricity systems?

After having obtained an empirical understanding of current governance practices, research objective B will be pursued. This research objective builds on the empirical findings, as well as on theoretical insights to develop heuristics that can facilitate and ideally accelerate decision-making on the introduction of smart grids. To this end, two research sub-questions have been created in connection to research objective B.

- B1: How can institutional arrangements for the introduction of smart grids be designed to be lawfully consistent?
- B2: How can decision-making on the design and implementation of smart grids be accelerated?

In response to these two sub-questions, heuristics in the form of two architectures will be developed: an institutional architecture and a process architecture. Moreover, whereas these two research sub-questions B1 and B2 are concerned with improving the governance on the introduction of smart grids in the Netherlands, the heuristics that will be developed later on in this dissertation are also suitable for the introduction of additional smart energy infrastructures (e.g., smart heating grids) and integrated smart energy systems in different contexts.

1.4. Theoretical Underpinnings

This section addresses the key theoretical underpinnings and concepts that are applied in this dissertation. The research background has shown the need for creating appropriate ‘rules of the game’, more specifically referred to as institutions, to improve the local governance on smart grid introduction.

In this PhD thesis, governance is defined as ‘all processes of governing, whether undertaken by a government, market, or network; whether over a family, tribe, corporation, or territory; and whether by laws, norms, power, or language’ (Bevir, 2013, p. 2). These processes of governing entail the collective decision-making by individuals to realize collective goals, for instance, the introduction of a smart grid. During decision-making, different governance arrangements can exist, for example in terms of the monocentric-polycentric continuum or based on the nature of governance (e.g., being of formal or informal nature) (Tollefson, Zito, & Gale, 2012). In this

dissertation I focus on the structural dimension of governance, that is on ‘the institutional ‘rules of the game’ that shape the interactions of actors’ (Lange et al., 2013, p. 409). More specifically, I study the influence of rules (i.e., institutions) on the decision-making processes undertaken by individuals to realize smart grids.

1.4.1. Defining institutions

I follow North (1990) who defines institutions as ‘the rules of the game in a society, or more formally, [...] the humanly devised constraints that shape human interaction’ (p. 3). These humanly devised constraints are prescriptions (rules) that structure the interactions between individuals (E. Ostrom, 2005). To elaborate, ‘institutions define and limit the set of choice of individuals’ (North, 1990, p. 4) and thereby the opportunities and constraints that are available to actors (E. Ostrom, 2005). In other words, individuals choose among rule-defined behavioural alternatives. Accordingly, in this PhD thesis institutional arrangements (that is the combinations of several individual rules⁶) are considered to define the behavioural options for individuals involved in a decision-making process; during the actual decision-making individuals in turn choose among the available options and display a certain behaviour (and define further rules). According to E. Ostrom (1990, 2005), institutions either derive from formal legal procedures (called rules-in-form) or from informal, unwritten agreements (called rules-in-use). Researching these rules is important as institutions ‘reduce the uncertainties involved in human interaction’ (North, 1990, p. 25) and ‘can prescribe and proscribe, speed up and delay change’ (March & Olsen, 2011, p. 8).

I recognize that the functioning of institutions depends inter alia on the strategies of actors (North, 1990). Yet, as North (1990) further explains, to be able to analyse institutions, it is important to separate rules from the strategies of the actors (players). I therefore focus on how rules define and limit the choices that individuals are faced with in a decision-making process. This set of choices available to individuals not only influences what these individuals are able to do, but also their motivation to act (March & Olsen, 2011). Furthermore, the importance of individual actors lies with the fact that ‘institutions are a creation of human beings. They evolve and are altered by human beings [...]’ (North, 1990, p. 5). This applies to institutions that derive from formal legal procedures as well as to those specified through informal, unwritten agreements. For instance, individuals who are interacting with each other can themselves craft rules that apply to their collective decision-making process. Rules are thus both the input, as well as the output of individuals’ interactions; a duality that

⁶ In Chapter 4 these individual rules are referred to as institutional conditions in order to emphasize their individual influence on the decision-making process.

is central to Giddens' (1984) structuration theory that sees social structure as the medium and the outcome of social action.

In sum, the focus of my research is on the influence of rules on decision-making processes on the introduction of smart grids. As explained in the next Subsection 1.4.2, I will both analyse, as well as design such rules (institutional arrangements).

1.4.2. Analysis and design of institutions

The goal of this PhD research is the analysis as well as the design of institutional arrangements regarding decision-making on the introduction of smart grids, as explained in Section 1.3. For these two research goals, the Institutional Analysis and Development (IAD) framework (E. Ostrom, 2005) is considered to be a suitable framework and is consequently applied in several chapters of this dissertation. Traditionally, the IAD framework has been mainly used for the study of common pool resource problems, e.g., in relation to fisheries, forests or water systems. More recently the value of this framework has also been recognized for the study of renewable energy projects (Koster & Anderies, 2013; Newell, Sandström, & Söderholm, 2017).

In brief, the IAD framework is a 'conceptual tool for inquiry about how rules affect a given situation' (E. Ostrom, Gardner, & Walker, 1994, p. 43). In this PhD thesis the specific situation (referred to as 'action situation' in the IAD framework) is the decision-making process on the introduction of smart grids in Dutch local settings. E. Ostrom distinguishes seven different rules-in-use⁷ that structure an action situation. As regards the actors inside the action situation, the IAD framework is based on the concept of bounded rationality (Simon, 1947), stipulating that in decision-making actors are not perfectly informed and have limited analytic abilities (e.g., to analyse all future moves) (E. Ostrom et al., 1994).

Tarko (2012, p. 53) explains that the IAD framework 'allows one to engage in both purely *descriptive research* (i.e., simply trying to understand from an outside vantage point the forces involved in the process of social change and to understand what kinds of outcomes different types of social arrangements tend to generate; E. Ostrom (2008)) and in *normative analysis* (in which one argues from a particular normative perspective in favour of the adoption of a specific change of institutions and rules)' [emphasis added]. The next two paragraphs introduce the descriptive as well as prescriptive value of the IAD framework. More details on the concepts of IAD framework and on its specific applications are provided in each chapter of this PhD thesis where the IAD framework is used.

⁷ These seven rules-in-use are boundary rules, position rules, choice rules, information rules, aggregation rules, payoff rules and scope rules (E. Ostrom, 2005).

The descriptive value of the IAD framework lies in the opportunity to decompose socio-technical systems into sub-parts, that is into individual action situations (Iychettira, Hakvoort, & Linares, 2017). Aligica and Boettke (2011) specify that the IAD framework especially facilitates the analysis of complex polycentric institutional arrangements. The analysis in Chapter 3 of this PhD thesis shows that local decision-making arenas for the introduction of smart electricity grids are such polycentric arrangements. In Chapter 4 then the IAD framework is used in an empirical research setting to explore which institutional conditions enable and disable decision-making processes on the introduction of smart electricity and heating grids in Dutch city districts.

As Tarko (2012) explains, in addition to the descriptive analysis of institutional arrangements, the IAD framework has prescriptive value for arguing in favour of specific rule change, particularly of the rules-in-use. To enhance the prescriptive value of the IAD Framework and to add a focus on (legal) rules-in-form, the IAD framework is synthesized with a normative dimension in the form of institutional legal theory (ILT) in Chapter 6. The resulting ILTIAD framework facilitates the analytical description and *ex ante* prescriptive design of institutional arrangements, and inter alia ensures the lawful consistency of legal rules inside action situations and across institutional levels.

1.5. Thesis Outline

This PhD thesis is guided by the main research question and structured around the two research objectives A and B as outlined in Section 1.3. Including this first introductory chapter, this PhD thesis is made up of eight chapters. Figure 1.1 presents a graphical overview of the structure of this PhD thesis, including a depiction of two main parts of this dissertation, part A and part B.

In **Chapter 2** a systematic literature review is conducted to gain an overview of local energy planning practices in the EU's post-liberalization era⁸. This review focusses on academic journal articles that report empirical research on governance practices on the roll-out of (small-scale) renewable energy technologies. This overview presents relevant background information for this dissertation because smart grid technologies will eventually have to be considered in local energy planning processes. Chapter 2 thus serves as a background section for the research conducted in part A of this dissertation (Chapters 3, 4 and 5) and confirms the need for empirical

⁸ The research question addressed in Chapter 2 is 'which institutional settings of local renewable energy planning in the EU's post-liberalization era has prior empirical research identified?' (Lammers & Hoppe, 2018). This question is not one of the central research question of this dissertation, but serves the purpose of guiding the literature review.

research on energy planning practices on the introduction of smart grids, as well as that the IAD Framework is very suitable to analyse such practices.

Figure 1.1: Chapter overview

Part A of this dissertation consists of Chapters 3, 4 and 5 which all provide empirical insights into the governance arrangements inherent to decision-making on the introduction of smart grids (research objective A).

Chapter 3 investigates the consequences of emerging multi-stakeholder decision-making arenas for the introduction of smart grids. The chapter revolves around the concept of polycentricity, referring to multiple centres of decision-making in local energy planning. To explore the effects of this polycentric setting for the introduction of smart grids, two case studies are analysed in this third chapter. With the help of semi-structured interviews and secondary data sources the two cases are positioned on the four criteria of polycentricity: control, efficiency, political representation and self-determination.

Chapter 4 empirically explores which ‘rules of the game’ (institutional conditions) enable and disable decision-making processes on the introduction of smart electricity and heating grids in Dutch city districts. For this purpose, in-depth interviews are conducted and secondary data is collected for four case studies in the Netherlands. The case data are analysed and compared with the help of the IAD

framework and causal process tracing. The seven rules-in-use of the IAD framework's 'action situation' (the decision-making process on the introduction of smart electricity – and heating – grids in Dutch local settings) are central to the analysis. Through casual process tracing, key moments are identified for each decision-making process to single out the most relevant sequentially linked action situations for analysis. Based on this analysis, I identify which of the rules-in-use that are at play in an action situation enable or disable the cases' decision-making processes at specific moments in time.

Chapter 5 analyses a legal experiment that was established to allow for alternative governance arrangements for (smart) local electricity grid projects: the Dutch Experimentation Decree for Decentralized Renewable Electricity Generation⁹. Projects that are granted experimental status based on this Decree can deviate from the current legal setting; that is, associations (owners' associations and energy associations) can carry out all tasks in the local electricity supply chain. In 2015 and 2016 this exemption was granted to nine projects in total. To analyse which effect the Experimentation Decree has on the governance arrangements adopted in these nine projects, empirical legal research is conducted. Based on document analysis, Chapter 5 identifies which lessons can be learned from these nine experimental projects with alternative governance arrangements for decentralized (smart) electricity grid projects outside of experimental settings.

After a synthesis of the findings of part A of this dissertation, the chapters of *part B*, Chapters 6 and 7, set out to address research objective B. These two chapters build on the empirical knowledge generated in the Chapters 3, 4 and 5 to develop heuristics that facilitate the governance on smart grid introduction. In particular, Chapters 6 and 7 focus on two different needs that were identified when addressing research objective A, being the creation of an appropriate institutional architecture (Chapter 6) and the development of an appropriate process architecture for the introduction of smart grids (Chapter 7). As explained in Subsection 1.3, these two heuristics will also be suitable for the introduction of additional smart energy infrastructures (e.g., smart heating grids) as well as for integrated smart energy systems.

Chapter 6 presents the institutional architecture that facilitates the analysis and design of institutional arrangements for the introduction of smart grids. Through synthesizing the previously applied IAD framework with a normative dimension reflected by institutional legal theory (ILT), a theoretical framework for analytical description and prescriptive design of institutional arrangements is developed: the ILTIAD framework. This framework is *inter alia* concerned with ensuring the lawful consistency of rules and facilitates a reflection on the energy justice concerns of

⁹ In Dutch: 'Besluit van 28 februari 2015, houdende het bij wege van experiment afwijken van de Elektriciteitswet 1998 voor decentrale opwekking van duurzame elektriciteit'.

democratization versus expansion. The theoretical explanation of the ILTIAD framework is followed by its application to two examples: first, to the envisioned smart grid design of one of the case studies addressed in Chapters 3 and 4, and second, to the Dutch Experimentation Decree for Decentralized Renewable Energy, as discussed in Chapter 5.

In **Chapter 7** the process architecture is developed that is concerned with the fact that the decision-making process as a whole has to be structured properly in order to facilitate the acceleration of the introduction of smart grids. Along these lines, emphasis lies on re-balancing self-determination and efficient decision-making. Therefore, based on engineering design thinking and two workshop sessions, a (qualitative) decision-making approach is developed. This approach defines several different phases of decision-making and identifies roles and positions of stakeholders in local energy planning based on the functionality of participation and the efficient and effective realization of results.

Chapter 8 concludes the PhD thesis by synthesising and discussing all findings. Answers are provided to the research questions on how the governance pertaining to the introduction of smart grids can be improved. Furthermore, the findings of this dissertation are discussed by reflecting on their implications for academic research as well as for policy-making. The chapter ends with a range of recommendations for the introduction of smart grids.

Chapter 2

Institutional Settings of Local Renewable Energy Planning: A Systematic Literature Review

Abstract

As introduced in the Chapter 1, due to the liberalization of the European Union's electricity sector, stakeholders' roles and responsibilities in local energy planning are not well-defined in legislation anymore. This lack of clarity is particularly problematic for decision-making on the introduction of smart grids. In this chapter, I conduct a systematic literature review to investigate what local energy planning processes – the processes in which the introduction of smart grids will need to be considered – look like in the post-liberalization era. I address the question '*which institutional settings of local renewable energy planning in the EU's post-liberalization era has prior empirical research identified?*' For this systematic analysis I conceptualized the analytic concept 'action situation' (as developed by Elinor Ostrom) from an energy governance and energy policy perspective. The literature review was conducted in two cycles: a systematic database search and snowballing. Four clusters of search terms were used to search two databases (Scopus and Web of Science), and additionally three selection criteria were applied. The selected articles were coded using Atlas.ti. Based on this coding, an in-depth qualitative analysis in the form of a narrative review was undertaken, and supplemented by a range of descriptive statistics. The research revealed that local energy planning is undertaken in a diversity of ways after the liberalization of the EU's energy markets. The institutional arrangements used in the reported local energy planning processes were found to not be ideal for the introduction of renewable energy technologies. No type of actor group seems to be actively supporting the realization of renewable energy projects and a high dependence on financial subsidies was found. These results are useful for practitioners and policy-makers as they show which possibilities and limitations exist for stakeholders in the changed level playing field of local energy planning, and ultimately for the introduction of smart grids. At the same time the findings show the relevance of further in-depth empirical research on the governance of smart grid introduction. As explained at the end of this second chapter, such research will be conducted in part A of this dissertation, being Chapters 3, 4 and 5.

This chapter is based on Lammers, I., & Hoppe, T. (2018). Analysing the Institutional Setting of Local Renewable Energy Planning and Implementation in the EU: A Systematic Literature Review. *Sustainability*, 10(9), 3212. doi: 10.3390/su10093212.

2.1. Introduction

The technical and organisational set-up of the electricity sector has changed notably, which impacts on both the need for as well as on the process of establishing smart grids.

Electricity production increasingly entails small-scale renewable energy technologies such as rooftop solar PV panels. The supply of electricity from intermittent renewable energy sources (RES) leads to difficulties in forecasting power generation and makes load profiles less predictable. On the one hand, the supply and feed-in of electricity from RES can fluctuate strongly on a daily and seasonal basis. On the other hand, consumers who possess rooftop solar PV panels still need to be fully supplied by the electricity grid when solar energy is unavailable (Moslehi & Kumar, 2010; Veldman et al., 2013). In addition, demand for electricity is rising, caused for example by the electrification of transport and heating (Eising et al., 2014). Smart grids can help to accommodate these developments in electricity grids. ‘Smart grids enable increased demand response and energy efficiency, integration of variable renewable energy resources and electric vehicle recharging services, while reducing peak demand and stabilising the electricity system’ (IEA, 2011). The introduction of smart grids takes place in a changed organisational set-up of the electricity sector.

The European Union’s energy market reforms in the 1990s changed the organizational set-up of the European electricity sector through liberalization of, and privatisation in electricity markets. To give an example from the Netherlands, until 1989 electricity generation and distribution were largely organized in public monopolies ‘with clearly defined positions and legally authorized tasks [...]’ (Arentsen et al., 2001, pp. 152-153). Following liberalization, the monopolized position of Dutch municipalities ceased to exist (Arentsen et al., 2001; De Jong, 2006): municipalities became shareholders in profit-oriented energy companies (Menkveld, Burger, Kaal, & Coenen, 2001)¹⁰ and when DSOs became separate entities many municipalities sold their stocks in their production and supply companies (Kist et al., 2008). Additionally, with the increased production of renewable-based electricity, new actors started to emerge in the electricity sector, for instance individuals (e.g.,

¹⁰ Municipalities became shareholders in profit-oriented energy companies, which changed their role in a threefold way. First, municipalities have to keep the energy companies’ need for profit in mind when trying to influence the companies’ decisions. Second, through mergers and increases in scale, energy companies are increasing in size, which decreases the relative control of municipalities. Third, due to a less intensive cooperation, municipalities lost their good access to energy consumers, as well as expertise in the area of consumer information provision (Menkveld et al., 2001).

prosumers), community energy initiatives, ICT companies, technology providers, energy service companies, aggregators and research centres.

In consequence, as introduced in Chapter 1, whereas electricity provision and planning used to be the task of formally legitimated organizations with clear roles and responsibilities, after the liberalization of the EU's electricity market, stakeholders' roles and responsibilities were not well-defined anymore. This lack of clarity on roles and responsibilities is considered problematic for decision-making on the introduction of renewable energy technologies at the local level, and for that of smart grids in particular. On the one hand, disagreements are likely to emerge on the distribution of roles and responsibilities in smart grids (Verbong et al., 2013), and in addition, on the other hand, the increase in the number of potentially involved actors makes local energy planning more complex (Elle et al., 2002, p. 54). Moreover, as introduced in Chapter 1, especially in the Netherlands decision-making in energy planning is rather slow and advancements on the introduction of renewable energy technologies and of smart grids are needed (European Commission, 2017b; Ministerie van Economische Zaken, 2016).

In sum, with the roll-out of small-scale renewable energy generation technologies the need for smart grids is increasing, but roles and responsibilities in regard to their introduction are unclear. The question therefore arises which local energy planning practices are being used when it comes to the introduction of smart grids in the post-liberalization era. So far, it remains under-researched what local energy planning practices exactly look like after the liberalization of the EU's electricity markets. Bulkeley and Kern (2006) distinguish four modes of governing climate protection, but do so only from the perspective of local governments. Similarly, Walker and Cass (2007) identify five different modes of renewable energy implementation in the United Kingdom (UK), yet mainly focus on the role of 'the public'. No overview exists of the institutional settings and corresponding roles and responsibilities that are prevalent in multi-stakeholder decision-making processes on the introduction of renewable energy technologies, and neither for the introduction of smart grids. Hoppe and Van Bueren (2015) point out this lack of research on institutional settings in regard to low carbon energy transitions in cities and propose a research agenda that, *inter alia*, addresses 'institutional conditions in multi-stakeholder configurations, looking into positions, ownership, institutional rules and policies' (p. 8). In this chapter I follow upon this suggestion by conducting a systematic review of literature that reports empirical research on governance practices related to the introduction of renewable energy technologies. Two reasons exist for this broader focus on renewable energy technologies. First, empirical research on smart grid governance is scarce; instead of addressing collective decision-making processes scholars mainly focus on individual aspects such as end user involvement (Nachreiner, Mack, Matthies, & Tampe-Mai, 2015; Verbong et al., 2013), domestic energy practices (Naus et al.,

2014; Smale, Van Vliet, & Spaargaren, 2017), and public acceptance (Fell, Shipworth, Huebner, & Elwell, 2015; Wolsink, 2012). Second, the introduction of smart grids will have to be considered in the context of these decision-making practices on installing renewable energy technologies. Therefore, this chapters addresses the question *‘Which institutional settings of local renewable energy planning in the EU’s post-liberalization era has prior empirical research identified?’* As mentioned in Chapter 1.5, this question is not one of the main research questions of this dissertation, but meant to guide the literature review, which provides background information for the research conducted in the following chapters.

A systematic, structured literature review will be conducted as this approach allows to identify and evaluate systematically in how far prior research has dealt with this research question, and to ‘[map] out areas of uncertainty, and [identify] where little or no relevant research has been done, but where new studies are needed’ (Petticrew & Roberts, 2006, p. 2). While a systematic literature review does not allow for an in-depth analysis of specific cases, it does make it possible to obtain a general interpretation of the institutional settings surrounding local decision-making processes. Next to this scientific purpose, the research is of relevance to practitioners and policy makers as it can help them to uncover which possibilities or limits exist in the changed level playing field of local energy planning, and specifically in regard to the introduction of (smart) renewable energy technologies. For this systematic analysis I apply the analytic concept ‘action situation’ of Elinor Ostrom’s Institutional Analysis and Development framework (E. Ostrom, 2011). As my analysis focuses on relevant literature related to local energy planning practices, I complement the seven elements of the ‘action situation’ with concepts used by scholars working on energy governance as well as energy policy studies.

This chapter is structured as follows. After this introduction, the next Section 2.2 describes the theoretical lens and the conceptual model that I developed for performing the systematic literature review. Section 2.3 depicts the method of the literature review in detail. The fourth Section 2.4 explains the results of the analysis, followed by the discussion and conclusion in Section 2.5.

2.2. The IAD Framework and the Action Situation

To identify and describe the institutional settings of local energy planning in the post-liberalization era, I draw on Elinor Ostrom’s Institutional Analysis and Development framework (E. Ostrom, 2011). The main reason for choosing the IAD framework over similar theoretical frameworks or theories is that it allows to decompose complex action situations into individual components (Iychettira et al., 2017; E. Ostrom, 2005) and, as a result, facilitates the analysis of institutional settings as well as making

comparisons between institutional settings. I therefore use the IAD's analytic concept of the 'action situation' (see Figure 2.1) for the research conducted in this chapter.

Figure 2.1: The action situation, including rules-in-use

Source: E. Ostrom (2011)

In the IAD framework, 'action situations are the social spaces where individuals interact, exchange goods and services, solve problems, dominate one another, or fight [...]' (E. Ostrom, 2011, p. 11). In the research presented in this chapter the action situation of interest is the local energy planning process where decisions about the introduction of renewable energy technologies (and smart grids) in local settings are taken. Figure 2.1 depicts all seven elements inside an action situation – actors, positions, actions, information, control, net costs and benefits, potential outcomes – and shows how these are influenced by seven 'rules-in-use'. Next to 'rules-in-use', the elements in the action situation are influenced by two other external factors: 'community attributes' and 'biophysical conditions'.

As this chapter is concerned with mapping the institutional setting (action situation) of local energy planning, I focus on the elements inside the action situation. The rules-in-use that led to the existence of these institutional settings (e.g., how actors became part of the decision-making process; boundary rules), will be addressed in later chapters of this dissertation; particularly in Chapters 4 and 6. In this chapter I map among other aspects which actors are part of this process, which positions they hold, and the actions that they can take.

Due to the fact that the data collection concentrates on literature related to local energy planning practices, I conceptualized the seven components of the action

situation based on literature by Elinor Ostrom (2007, 2011) as well as with concepts used in energy governance and policy studies (see Table 2.1).

Action Situation Elements	Conceptualization
Actors	Actors that participate in the decision-making process. E.g., from municipality, DSO, housing association, tenants, community energy initiative, project developer.
Positions	Positions that actors hold in the decision-making process. E.g., policy entrepreneur (Kingdon, 1984; Mintrom, 1997), Strategic Niche Management (Schot & Geels, 2008), Network Management (Kickert, Klijn, & Koppenjan, 1997; Meier & O'Toole, 2005).
Actions	Actions that can/have been taken. The (legal) possibilities that exist for collaboration. E.g., possible actions, laws and regulations, policy instruments.
Information	Information available to actors. Including information about technology, policies, meetings, websites, costs and benefits and the outcomes of one's own actions. E.g., framing (Hajer, 1995), boundary spanning (Bressers & Lulofs, 2010).
Control	Whether actors take actions on their own initiative, or whether they confer with others. E.g., individual action, collective action, coalitions (e.g., advocacy coalition, discourse coalition) (Hajer, 1995; Sabatier, 1988), co-creation (Nevens, Frantzeskaki, Gorissen, & Loorbach, 2013), co-production (Brandsen & Pestoff, 2006).
Net costs and benefits	The costs of various actions to each type of actor and the kinds of benefits to be achieved as a result of various group outcomes. E.g., costs of project, pay-back time, distribution of costs and benefits among actors.
(Potential) outcomes	The geographic regions and events in that region that are affected. The chain of events that links actions to outcomes. E.g., evaluation and implementation research (Bressers, 2004; DeLeon & DeLeon, 2002; Hill & Hupe, 2002).

Table 2.1: Conceptualization of the action situation

This conceptualization is required to enable me to identify what the concepts of the action situation mean in the discussion of energy planning processes. Energy governance is often discussed for the global level (Bazilian, Nakhoda, & Van De Graaf, 2014; Florini & Sovacool, 2009; Van De Graaf & Colgan, 2016); energy governance at the city district level is specifically referred to as urban energy governance. The notion of urban energy governance is 'used broadly to capture the multitude of ways in which urban actors engage with energy systems, flows and infrastructures in order to meet particular collective goals and needs, as framed or expressed in policymaking processes, but also in debates, contestations and conflicts over policy orientations, resources and outcomes' (Rutherford & Jaglin, 2015, p. 174). In line with this policy-making focus, I additionally draw inspiration from Hoppe, Coenen, and van den Berg's (2016) illustration of the use of concepts from the discipline of policy studies in energy research. The conceptualization in Table 2.1 is

the core for the coding scheme that was applied to the final selection of articles (see methods Section 2.3 for details).

2.3. Research Design and Methods

To address the research question that guides this chapter, I chose to conduct a literature review in two cycles: a systematic database search and snowballing. This section provides details on the selected method, including the case selection (Subsection 2.3.1), search cycles (Subsection 2.3.2.), and data preparation and analysis (Subsection 2.3.3).

2.3.1. Case selection and conceptualization

I only included countries in my search that were subject to the European Union's electricity market liberalization that started in the 1990s. This focus was chosen to have a long time frame because of an anticipated delay between the moment a project takes place, and the publication about such project in the scientific literature; i.e., a project that takes place from 1995 to 2000 might only be reported on in a peer-reviewed journal in 2001 or later. This led to the selection of the following fifteen countries that were a member of the European Union when the first and second liberalization directives were adopted in 1996/1998 and 2003 respectively: Germany, France, Belgium, Netherlands, Luxembourg, Italy, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland and Sweden.

To be able to develop clusters of search terms and selection criteria for the analysis, it is important to have a precise conceptualization of the unit of analysis. As mentioned previously, I want to investigate the institutional setting of local renewable energy planning. To be more precise, I am interested in decision-making processes that focus on the introduction of renewable energy technologies (and eventually that of smart grids) in local projects. Whether this goal was accomplished or not is not relevant for my analysis.

The spatial focus was local settings, and more precisely residential areas (city districts). Furthermore, as distributed renewable energy technologies are often implemented during large-scale housing renovation or construction projects in city districts, studies were likely to address these aspects.

2.3.2. Literature search and selection criteria

The literature review was conducted in two cycles, in which a different search strategy was used for each of the two cycles. Firstly, following Petticrew and Roberts (2006),

a systematic database search was undertaken, and, based on this, secondly, the snowballing method was applied.

2.3.2.1. Search strategy cycle 1: systematic database search

The first search cycle entailed a systematic database review, that is, a review that adheres ‘closely to a set of scientific methods that explicitly aim to limit systematic error (bias), mainly by attempting to identify, appraise and synthesize all relevant studies (of whatever design) in order to answer a particular question (or set of questions)’ (Petticrew & Roberts, 2006, p. 9). Using this method allows to systematically identify literature and as a result, to bridge the knowledge gap that currently exists in regard to information on the institutional settings of energy planning at the local level.

During the systematic database search, four clusters of search terms were used to screen titles, abstracts and in turn the full text of international, refereed journal articles (see Table 2.2). These clusters reflect the main research question and the concepts commonly used to study governance practices related to the introduction of renewable energy technologies. That is, the search terms in each cluster take into account the different synonyms used to describe the same concept, and were specified after test searches and the reading of sample papers. This resulted in the creation of the following four clusters of search terms for the identification of relevant peer-reviewed journal articles¹¹: (1) search terms related to energy; (2) search terms describing the planning process; (3) search terms focusing on an object of change; and (4) search terms indicating location/scale. Furthermore, all articles evidently had to report empirical case study findings.

Cluster		Search terms
#1	Energy	Empirical case study
		Renewable energy technologies, energy, electricity, energy efficiency, low carbon
#2	Planning process	spatial, planning, decision-making, policy, process, governance, stakeholders, management, climate policy, project
#3	Object of change	construction, implementation, renovation, buildings, infrastructure, utility, development
#4	Location/scale	Neighbor(u)rhood, residential, local, municipal/ity, urban, housing, district, city

Table 2.2: Clusters of search terms

The database search was performed in July and August 2016, as well as again in July 2018 to cover the period from September 2016 to July 2018. Two databases

¹¹ I decided not to include books or book chapters but focus on peer-reviewed journal articles.

relevant to the research field of interest were searched: Scopus and Web of Science¹². During this search the four clusters of search terms were connected with Boolean operators. A diagram of the literature search of cycle 1 and 2 can be found in Figure 2.2.

2.3.2.2. Search strategy cycle 2: snowballing

To identify additional relevant articles I applied the snowballing technique (Jalali & Wohlin, 2012).

Figure 2.2: Prisma Flow diagram literature search cycle 1 and 2

¹² The search in Scopus included title and abstract. In Web of Science abstracts cannot be searched and I therefore decided to search by topic. Due to the fact that the snowballing method is applied as well, this drawback is remedied to a large extent.

Both backward (from the reference list of the selected articles) and forward snowballing (identifying articles that cite the selected articles) were used. The four clusters of search terms were applied in a non-systematic way. During the snowballing I did not include references that led back to one of the original articles from the first search cycle.

2.3.2.3. Selection criteria

In combination with the clusters of search terms, the following three inclusion criteria were subsequently applied during both search cycles. First, the article focusses on an a case study of an empirical situation; hence methods such as life-cycle assessments, modelling and simulations were excluded. Second, articles were published between 1999¹³ and July 2018 and cover case studies that took place after 1999. Third, the content of the publication deals with (smart) renewable energy infrastructure in local settings, that is at the city district level. This selection criterion ‘local (renewable) energy infrastructure’ thus excludes energy sources like fossil fuels (i.e., non-renewable) and large-scale wind turbines (i.e., not installed in city districts). Additionally, during the search I did not include other types of infrastructures (e.g., road/traffic¹⁴, railroads), as well as excluded measures that only focus on energetic measures inside individual houses (e.g., thermal insulation). Systematic reviews and meta-analyses were also excluded in all search cycles.

Figure 2.2. shows that during the first cycle 531 articles were screened by title, in turn 171 by abstract and 65 by full text. Based on the selection criteria, articles were first of all excluded during the screening when they investigated a country that fell outside of my case selection. Remaining articles had to be eliminated as they focussed on a different technology (e.g., marine renewable energy installations, carbon capture and storage, light bulbs of traffic lights), a different unit of analysis (e.g., industrial parks, tall buildings, industrial economy in port cities, bicycling sustainable maps), a different (energy) source (fire, air quality, indoor thermal comfort, noise pollution), or entailed a different method (algorithms, GIS, micro-grid reliability assessment, building energy performance).

Topics such as energy-saving and refurbishment of buildings were initially not excluded as definitions and details on these measures can differ; only during the screening of full texts it could be evaluated whether these projects did or did not include renewable energy technologies, or e.g., merely the insulation of individual buildings.

¹³ The first liberalisation directive for electricity (96/92/EC) was adopted in 1996 and should be transposed into the legal systems of all EU Member States by 1998. Therefore, my literature review focussed on the period of 1998 and onwards (European Commission, 2012).

¹⁴ I did not exclude the search term ‘transport’, in order to not eliminate electric vehicles from my search.

The systematic search and application of selection criteria led to the identification of 24 relevant articles for analysis.

2.3.3. Data preparation and analysis

The 24 selected articles were coded using Atlas.ti, with the help of a coding scheme which is based on the seven elements of the action situation, as conceptualized in the theoretical section of this chapter. Furthermore, I added the two external variables ‘bio-physical conditions’ and ‘attributes of community’ of the IAD framework to my coding scheme. Additionally, during coding I was open to the emergence of new codes. The final coding scheme can be found Appendix A.

Based on this coding, an in-depth qualitative analysis in the form of a narrative review was undertaken. This approach is especially suitable for addressing this chapter’s research question on the institutional settings of decision-making processes, as these concepts can best be captured qualitatively. To introduce and supplement the qualitative analysis, a range of descriptive statistics will be presented in the beginning of the results section.

2.4. Results

This section starts with an overview of the selected articles in Subsection 2.4.1 (see Appendix B for the full list of selected articles), followed by the in-depth qualitative results of the analysis in Subsection 2.4.2.

2.4.1. Introducing the selected articles and cases

As reported, 24 articles were selected for analysis. This section briefly introduces these articles to provide background information for the analysis presented in Subsection 2.4.2.

2.4.1.1. Articles by year and journal

The analysis revealed that empirical research on institutional settings of local renewable energy planning is only recently emerging in the academic literature (see Figure 2.3).

In the period from 1998 to 2011 only four articles were published in different years (2002, 2003, 2008, 2010). From 2012 on attention seems to have risen, with five articles published in 2015; note that for the year 2018 data collection only covered the first six months.

The articles were published in a wide range of journals (see Appendix C). Only in five journals more than one article had been published, the most being four articles

in the journal of 'Energy, Sustainability and Society' (Local Environment, n=2; Journal of Cleaner Production, n=2; Energy Policy, n=2; Building Research and Information, n=2; Energy, Sustainability and Society, n=4).

Figure 2.3: Articles by year of publication

2.4.1.2. Countries and studied cases

In the selected articles, I retrieved cases being studied in seven of the fifteen countries whose electricity markets were liberalized in the 1990s and early 2000s (see Figure 2.4): The Netherlands (n=7), Germany (n=6), Sweden (n=6), Denmark (n=5), UK (n=3), Austria (n=2) and Norway (n=2).

Figure 2.4: Countries studied by frequency

This does not come as a surprise when taking into account that these countries are known for their progressive policy measures on renewable energy and mostly have a strong tradition of publishing in English. Thirteen of the articles concerned single case studies, while eleven analysed multiple case studies, ranging from two to twelve cases; making it a total of 65 empirical case studies.

As regards technologies, the main goals reported in the articles were the installation of solar PV panels, followed by solar thermal technologies, and to a lesser extent by heat pumps, small-scale CHP, and district heating (in combination with biomass). Mostly, the installation for these technologies was mentioned together with the goal of reducing energy demand – while reducing CO₂ emissions was barely mentioned explicitly. The increased roll-out of these technologies can present a challenge to electricity distribution grids (as well as heating grids), which makes the introduction of smart grid technologies relevant.

While all 65 projects' goals were stated, not all outcomes were reported (n= 16). In the majority of studied projects (n=35), the pre-established goals had been achieved, and only in a smaller number of projects (n=14) this was not the case. Information on these outcomes was however only present at general level, for instance, no data on installed generation capacity or CO₂ emissions reduction was provided. Secondary outcomes such as co-benefits on employment opportunities were not mentioned.

2.4.1.3. Bio-physical conditions

As regards location, in three cases projects took place on a (former) industrial terrain located outside the city centre; Gansmo (2012) discloses that the terrain was co-owned by public partners (state, county and regional hospital), in the empirical research conducted by Williams (2012) municipal ownership of the terrain was the case. Projects led by housing associations often focused on dwellings that were 'bleeding energy', e.g., poor isolation, bad ventilation and leaky facades (e.g., see Gustavsson and Elander, 2016; or Jensen and Maslesa, 2015). Bio-physical conditions were at times hindering projects; limited roof space (Muying, 2015) and suboptimal roof-orientation for solar PV panels (Hoppe, 2012; Schroepfer and Hee, 2008), inadequate existing infrastructure for the installation of solar thermal systems (Hoppe, 2012) and unsuitability of a rural area to be connected to a district heating grid (Smedby & Quitzau, 2016) were reported.

2.4.1.4. Attributes of Community

Attributes of Community were not always addressed in detail, but two aspects stand out. The first is socio-economic status. Evidently, in projects led by social housing associations residents have a low-socio economic status; for instance 'with a high percent of unemployment, and ridden by many related social problems' (Gustavsson

& Elander, 2016, p. 5). However, socio-economic status is not necessarily linked to the attitude of householders towards renewable energy; Williams (2012) analysed that residents in her German case had low, medium and high income levels and were all active 'energy citizens', whereas the project she studied in Sweden involved rich, but passive consumers. Second, the role of gender has been pointed out by Muyingo (2015): members of the boards of tenant-owner cooperatives were often older, wealthier, well-educated males; in total 'fifty-five percent of the inhabitants in tenant-owner cooperatives are women, 66 percent of the members of the executive boards and 80 percent of the chairpersons are men' (Muyingo, 2015, p. 3658).

2.4.2. Results of the qualitative analysis

Through the systematic literature review I was able to analyse which institutional settings of local renewable energy planning have been identified by prior empirical research. The results for each element of the action situation are explained in the following; overlaps between sections are self-evident due to the interrelation of elements¹⁵.

2.4.2.1. Actors

A multitude of different actors were participating in each described local energy planning process, as shown in Figure 2.5¹⁶. This subsection provides an overview of the most frequently involved stakeholders, as well as explains which stakeholders initiated projects. Mainly initiating actors were a coalition of stakeholders, and only in some cases individual entities. Important to add is that actors do not necessarily remain in the driving seat during the entire period a project takes place.

Local governments, namely municipalities, were most frequently reported to not only have been involved in the projects (n=28), but also to have initiated these (n=15). The problem with this was that municipalities often established climate policies, but mostly did not own possible project locations when it comes to the residential sector. Quitzau et. al (2012) explain that the local authority in Denmark had to purchase a whole building site in order to be able to impose legally binding energy efficiency

¹⁵ The element '(potential) outcome' is not discussed separately as the selected articles mostly did not address this aspect, and particularly not the reasons for the (non) achievement of certain outcomes.

¹⁶ In the 24 selected articles 65 case studies were analysed in total. The information provided on the participating stakeholders however has to be treated with caution, especially due to the following two reasons. First, it is not possible for me to validate whether all stakeholders have been reported for each case. Second, in a few articles (Dewine-Wright and Wiersma, 2013; Williams, 2010 and 2012) stakeholders were aggregated, e.g., only referred to as third sector or private sector actors. These aggregated actors have not been included in Figure 2.5.

requirements; this was considered an investment risk. This situation was also the case in the German project studied by Williams (2012, p. 136) where ‘municipal ownership of the site provided the city council with the leverage it needed to demand higher energy standards in buildings’.

Figure 2.5: Number of participants and project initiators

To achieve their ambitious targets, local governments are dependent on actors who do own project locations. In regard to this, it is easier for municipalities to address housing associations that can implement measures in a large number of houses, than to approach a multitude of home owners individually. The findings reveal that housing associations were very often involved in ($n=16$) and initiating ($n=9$) local energy projects. Stakeholders from the building and construction industry ($n=17$) and consultants from engineering companies ($n=16$) were involved in many projects as

well, which is explained by the expertise that they hold. Yet, these experts mainly joined projects that had already started instead of initiating these themselves.

In several cases ($n=12$, of which $n=7$ as initiators) unions of residents – which include tenants' associations and owners' associations – have been involved from the start of the projects. This is equal to the involvement of householders ($n=12$), while we have to bear in mind that the number of possible householders (residents) that can join is comparatively much higher than the possible number of unions of residents. Furthermore, householders were often only consulted in later stages of a project.

What stands out is that distribution system operators only participated in nine projects, and only were involved from the beginning on in one project; this one project did not concern the electricity grid, but the extension of a district heating grid (for details see Van Der Waals et al., 2003). Many projects considered the installation of distributed generation technologies – mainly in the form of solar PV panels – that are to be connected to the electricity grid. The feed-in from these PV panels, as well as changing electricity demand patterns could present a technical challenge to the distribution grid, and hence to the core responsibility of the DSO.

2.4.2.2. Positions

Positions is an element of the action situation that has not been addressed extensively by the selected articles, but three conclusions can be drawn. Firstly, while local governments participate in and initiate the largest amount of projects (see Subsection 2.4.2.1. above), eventually they often only hold the position of observer. This is explained by the fact that local governments mostly impose requirements for local energy projects, but expect other actors to realize such projects. Secondly, in the analysis a policy entrepreneur was only identified in three articles. In one case, this entrepreneur was considered to have had a general positive influence on the realization of renewable energy solutions (i.e., company Solarcomplex AG, in Fuchs and Hinderer, 2014), whereas in the other two cases he/she was campaigning for furthering his/her own interests (Moss et al., 2015) and was found to deliberately not involve certain actors out of fear of being held back by them (Gansmo, 2012). Thirdly, Network Management could be traced in five cases, often being undertaken by a company or project manager with experience in other projects and access to a network of experts (Gansmo, 2012; Gustavsson and Elander, 2016; Hoppe, 2012; Quitzau et al., 2012; Quitzau et al., 2013).

2.4.2.3. (Possible) Actions

While the actions that should and could have been taken are very specific for each individual actor and dependent on the project taking place, a synthesis of the findings is possible.

Laws and regulations discussed included legal permits, planning regulations, energy standards, legally binding covenants, and purchase agreements. These laws and regulations were mostly reported to be too strict/conservative or demand too many measures. For instance, a ‘housing association complained that the local authority insisted that expensive renewable energy measures be adopted’ (Hoppe, 2012, p. 797) and all costs be financed solely by the housing associations. In addition, laws and regulations were considered to have too time-consuming (and non-standardized) procedures, and a lack of information about laws and regulations was reported (e.g., in Williams, 2010). An exception to the negative view on laws and regulations is the Hyllie Environmental Programme (Parks, 2018) that states that renewable energy should be considered early on in spatial planning and building processes.

The policy instruments applicable in the studied cases were mainly governmental financial support measures. Financial support came from all levels of government (local, regional, national and EU), and mainly in the form of subsidies (mentioned in eight articles). These subsidies were reported to have a positive influence on pay-back time and related to this, on the one hand on considerations to embark on project, and on the other hand on the project’s success. However, uncertainties about conditions and information about policy instruments existed (e.g., reported by Van Doren et al., 2018), and especially local governments had limited financial means to provide (continuous) sufficient support.

Furthermore, ownership (see point 2.4.2.1. for details) often determined which actions were possible, for example as regards owner-occupants/ housing association-tenant dilemmas (and voting requirements), or where a building side was owned by one single actor (e.g., by local government, Williams, 2012).

2.4.2.4. Information

The element information has been discussed extensively in the articles that were analysed. First, it was considered a vulnerability when knowledge was in the hands of one specific actor, as this knowledge would be lost once this expert were to leave the project consortium (as was the case in Gansmo, 2012). Second, a lack of information was often reported, for instance (a) on policy instruments and rules and regulations; (b) on the technology itself, its installation and maintenance; and (c) on the costs of projects, albeit sometimes ‘this concern related to impressions of costs at face value, rather than any consideration of the actual costs and benefits’ (Van der Waals et al., 2003, p. 417). Third, information was found to be enabling projects when information meetings for participants were organised, when researchers were involved in a project, and when knowledge was shared about success stories (e.g., from pilot projects, or through the participation in international or regional networks) as well as inside organisations (e.g., municipality).

Framing and boundary spanning could only be traced in a few articles. Framing of the planning process was undertaken by several stakeholders in regard to (a) how positively or negatively they judged collaboration with other stakeholders; (b) the role of a consultant (Jensen and Masleser, 2015); (c) the goal of the overall project (Fuchs and Hinderer, 2014); and (d) to further the interests of a certain organisation, e.g., of an installation contractor (Hoppe, 2012). Boundary spanning was reported once by a task force which exchanged experiences among several local projects (Hoppe, 2012) and once by the media (Gansmo, 2012); in the latter case the municipality would have preferred to take on the role as boundary spanner itself, instead of leaving it to the media, but lack of financial means prevented this.

2.4.2.5. Control

In brief, control refers to individual compared to collective action. Individual action took place in a few projects, e.g., when the local government alone pushed for the direction of the project (Quitau et al., 2012 and Williams, 2012). Such individual actions were reported to be undesirable due to the exclusion of end-users and possible opponents from the decision-making process, being residents (Williams, 2012 and Gansmo, 2012), as well as powerful stakeholders such as incumbent network operators and city government (Moss et al. 2015). Often individual action turned at one point into collaboration.

Coalitions of all shapes and sizes existed. Coalitions involved actors at different levels (mainly local and regional) and included private, public, semi-public and civic actors. Collaboration was mostly formalized, e.g., via covenants, working and steering groups, or through public-private partnerships. Only in one case a problem was reported in regard to coalitions: severe project delays had a negative influence on the relationship between a local government and a housing corporation, due to which the municipality left the project and in consequence no renewable energy systems were implemented (Hoppe, 2012).

With co-creation (potential) residents, the community as a whole, developers and those delivering infrastructure were a few times involved in the planning process. The involvement of these actors and a continuous dialogue between all stakeholders were considered to be enabling factors in the project. However, two major drawbacks of co-creation were identified as well. First, lay-persons do not have professional knowledge which can lead to suboptimal decisions and higher costs (see Muyingo, 2015; Frances and Stevenson, 2018). Second, involving a large number of actors was reported to be resource intensive, as it slows down the project and increases overall costs (Williams, 2012).

Co-production was explicitly discussed in three articles and mainly refers to the role of utilities (Moss et al., 2015; Fuchs and Hinderer, 2014) and the private sector for delivering the infrastructure and technologies needed (Williams, 2010). This co-

production however was identified as an unwelcome dependency by Williams (2010), as actors in the private sector only undertook action once sufficient market demand was present.

2.4.2.6. *Net costs and benefits*

The costs of various actions as well as their benefits were not reported in all articles. Specific numbers on the distribution of costs – not of the benefits – were only mentioned in two articles (total investment cost reported by Gustavsson and Elander, 2016; total project costs and rent increases in Jensen and Masleser, 2015).

Considerations about the pay-back time of investments on the other hand were mentioned in most of the articles that I analysed. In seven articles the code ‘pay-back time’ co-occurred with the code ‘policy instruments’, as subsidies played a major role in facilitating projects (see Subsection 2.4.2.3 above). Where such subsidies were absent or considered insufficient, pay-back time was always seen as one of the main barriers to starting and/or succeeding with the project. These obstacles include the price of technology vis-à-vis economic returns, the investment risk caused by (unproven) new technologies, the length of the pay-back time, or the height of the investment incurred by one sole stakeholder. Moreover, it was reported that stakeholders felt that little specific information was available about pay-back times and that ‘the public were also deterred from installing individual systems by high transaction costs (connection, sourcing technologies, obtaining planning permission, finding companies to maintain systems) and low economic returns’ (Williams, 2010, p. 7610).

2.5. Discussion and Conclusion

After the liberalization of the EU’s electricity markets, stakeholders’ roles and responsibilities in local energy planning were not well-defined in legislation anymore. This lack of clarity is problematic for decision-making on the introduction of renewable energy technologies, and for that of smart grids in particular. Due to the fact that an overview is lacking of the local energy planning practices used in the post-liberalization era, I conducted a research synthesis of literature that reports empirical findings on governance practices used in local energy planning processes, seeing that the introduction of smart grids will have to be considered in these processes. Specifically, this chapter addressed the research question ‘*which institutional settings of local renewable energy planning in the EU’s post-liberalization era has prior empirical research identified?*’ To analyse as well as compare the institutional settings in the selected articles, I chose to conceptualize the seven elements of the ‘action situation’ (E. Ostrom, 2011) from an energy governance and energy policy perspective.

This study contributed to growing body of knowledge pertaining social science in energy issues and energy research (Sovacool, 2014). Within this field it is part of a similarly growing scholarly attention to the importance of institutions in emergent energy issues (Heldeweg, 2017; Hoppe, Butenko, & Heldeweg, 2018; Lammers & Heldeweg, 2016) like climate change mitigation (i.e., meeting the Paris Agreement targets), low carbon energy transition, emerging technologies like smart grids, and issues regarding energy justice. Yet, many of these publications present conceptualisations of institutions in energy settings, illustrate them or present new conceptual frameworks, as to date a systematic overview of action arenas and the institutional rules they entail in empirical studies was missing. With the results of the systematic literature study presented in this article I tried to show the importance of the use of these concepts in empirical research, and elicit the meaning of ‘action situation’ and ‘institutional rules’ in actual real-life empirical case studies. As such, not only do the results of the study contribute as another field of application to Ostrom’s IAD framework (Elinor Ostrom, 2009), showing how and in which ways institutional rules influence decision-making in action situations, but also does it contribute to research agendas that seek to highlight ‘institutional conditions in multi-stakeholder configurations, looking into positions, ownership, institutional rules and policies’ vis-à-vis transformation of energy systems (T. Hoppe & E. M. van Bueren, 2015, p. 8).

Based on the research conducted in this chapter I can conclude that the topic of institutional settings of local renewable energy planning in the post-liberalization era is a newly emerging topic in the academic literature, and focusses mainly on a few countries located in North-Western Europe (with the exception of Austria). Overall, no standard governance arrangements have emerged, but institutional settings vary between countries, as well as for cases within the same country. My research revealed that local energy planning is indeed highly complex, as Elle et al. (2002) stated, and undertaken in a diversity of ways after the liberalization of the EU’s electricity markets. The systematic literature review showed that four main characteristics are prominent in the reported institutional settings in the post-liberalization era. In the following paragraphs I summarize and discuss these characteristics.

Firstly, the analysis demonstrated that local governments (actors) are involved in the majority of projects as well as initiate many of these projects. The role that local governments take on in these projects, however, is only that of a passive observer (position). Local governments often establish ambitious climate policies and energy efficiency targets (possible actions: rules and regulations), but expect other actors to reach these. This is also related to the fact the local governments often do not own possible project locations in residential areas (possible actions: ownership). In consequence, actors besides local governments are needed for the realization of renewable energy projects.

Yet, secondly, whereas the institutional arrangements consisted of coalitions of all shapes and sizes in the cases that were studied (control: coalition), the absence of householders and DSOs (actors) in these coalitions stood out. When householders were actively involved in a project, this mostly involved their consultation in a later stage of the project. Due to the lack of participation of DSOs in most projects the consequences of the installation of renewable energy technologies for the electricity grid are likely to be underexposed in these projects.

Thirdly, the analysed articles reported that financial policy instruments in the form of governmental subsidies (possible actions: subsidies) have a positive influence on pay-back time (net costs and benefits: pay-back time) and as a result on starting and realizing projects. But, relying on public money limits the upscaling of projects; viable business cases need to be developed and costs and benefits need to be shared among stakeholders (actions/net costs and benefits).

Lastly, the analysis showed that the role of information (information), and more precisely the lack thereof, was prominent for all institutional arrangements. The lack of information applied to stakeholders across the board and concerned lacking information on policy instruments, on laws and regulations, on technology as well as on costs and benefits. Where knowledge on these aspects was available, it was at times in the hands of one specific actor only.

In sum, the institutional arrangements used in local energy planning on the introduction of renewable energy technologies after the liberalization of the EU's electricity markets are not ideal. Currently, the initiation of renewable energy projects is largely dependent on financial subsidies and on the influence of local governments who expect others actors to realize projects once they have been initiated. Yet, while other actors besides local governments need to take on an initiating and active role in projects, this is currently not the case (especially householders and DSOs are not involved) and the information needed to succeed in realizing project goals is lacking. Due to the fact that the considerations on the introduction of smart grids will occur in the context of the energy planning processes described in this chapter, the findings of this literature review allow to anticipate that decision-making on the introduction of smart grids will experience similar challenges. Overall, these findings are useful for practitioners and policy-makers because they show where room for improvement exists in the changed level playing field of local energy planning, and eventually for the introduction of smart grids. As regards further research, two relevant areas can be identified, as explained in the next subsection.

2.5.1. Link to part A of the dissertation

The findings of this chapter allow me to identify two areas for further research. The first concerns conducting empirical case studies of what local energy planning

practices look like in light of the renewable energy transition. Due to the relevance of smart grids for the energy transition, as well as their rather slow roll-out, empirical research on decision-making practices on the introduction of smart grids is of particular relevance. Whereas the systematic literature review showed the benefits of applying the energy governance and policy-oriented conceptualization of the ‘action situation’, it was based on secondary data which made it difficult to obtain in-depth insights. For example, only little information was reported over ‘positions’, ‘net costs-and benefits’, as well as ‘outcomes’. Collecting and analysing primary data on the governance in local energy projects allows to identify these (and additional) elements as well as to analyse them in detail.

Secondly, I recommend to analyse collected case study data with the help of the Institutional Analysis and Development framework. This chapter has shown that the IAD framework is very suitable for decomposing complex action situations into individual elements, as already emphasized by E. Ostrom (2005) and confirmed by scholars such as Aligica and Boettke (2011) and Iychettira et al. (2017). Decomposing actions situations into individual elements allows to analyse action situations in detail as well as to make comparisons between institutional settings. In addition to the analysis of the seven elements of an action situation, the IAD framework can be used to study which external variables, and in particular which rules-in-use, influence these elements.

In part A of this dissertation these two research avenues are followed in response to research objective A ‘to obtain empirical insights into the governance arrangements inherent to decision-making on the introduction of smart grids in local settings’. In Chapter 3 empirical case study data on local smart grid projects is collected to identify which consequences polycentric local decision-making areas have for the establishment of smart grids. In Chapter 4 of this PhD thesis empirical case studies are conducted and then analysed with the IAD framework to identify which rules-in-use (institutional conditions) enable and disable decision-making processes on the introduction of smart electricity and heating grids. The final chapter of part A, Chapter 5, explores which lessons can be learned from projects that entail legal experiments with alternative governance arrangements for decentralized electricity systems.

Part A

Polycentricity in Local Energy Planning: the Case of Smart Grids

Abstract

This chapter shows that the increase in the number and diversity of actors involved in energy planning has made local decision-making arenas on the introduction of smart grids polycentric. Against this background, I investigate sub-question A1 in this third chapter, being ‘*which consequences can a polycentric local decision-making area have for the realization of a renewable energy transition, in particular for the introduction of smart grids?*’. Polycentricity is characterized by configurations of units that are multi-level, multi-purpose, multi-sectoral and multi-functional. The functioning of these configurations can be assessed by using four criteria: control, efficiency, political representation and self-determination. I applied these criteria to analyse two cases. The analysis reveals tensions in polycentric configurations between on the one hand control and efficiency, and on the other hand self-determination and political representation. In other words, having control and working efficiently can lead to faster results; involving local communities and political representatives makes the process more democratic but also increases the likelihood that decision-making processes slow down. For this reason I call for the need for appropriate institutional arrangements to make improvements to the functioning of local polycentric configurations inherent to the introduction of smart grids.

This chapter is based on Lammers, I., & Arentsen, M. J. (2016). Polycentrisme in lokale besluitvorming over duurzame energie: de casus slimme netten. *Bestuurswetenschappen*, 70(3), 20-31.

3.1. Introduction

Chapters 1 and 2 have established that the number and diversity of actors involved in local energy planning have increased. The emergence of these multiple centres of decision-making have made local decision-making arenas polycentric. Four recent developments in the energy sector, and notably in the electricity sector, were of particular influence for this: liberalization, renewable energy sources, community energy initiatives, and smart grids. Liberalization is the process of gradually changing the organization of energy provision from a monopoly to a market setting (Arentsen & Künneke, 2001). Next to liberalization, ambitions regarding renewable energy have led to an increase in the amount of renewable energy sources and in the number of electricity suppliers on the Dutch electricity market. Furthermore, community energy initiatives have emerged to manage (renewable) energy supply locally. A fourth development of interest to this chapter is the advancement of smart grid technology in the electricity sector. This technology allows for the intelligent management of demand and supply of electricity by means of information and communication technology; a development in which an increasing number of stakeholders want to participate.

Due to these four developments the local arena in which decisions are made on local energy infrastructures is increasingly getting crowded. Some actors have to participate in discussions and decision-making on the basis of their legal responsibilities, other actors take part in the debate due to their knowledge and expertise, and additional actors want to join in as their interests are at stake. Accordingly, not only more actors are entering the local decision-making area, but also the diversity of actors is increasing. In brief, the local setting has become polycentric.

In this chapter I investigate polycentric governance arrangements in local decision-making arenas and their consequences for the introduction of smart grids. I consider the introduction of smart grid technology a part of the local energy transition: local decision-making on energy infrastructure projects is increasingly focussing on renewable energy, including using smart grid technology to efficiently integrate renewable energy sources into the electricity grid. Specifically, I therefore address sub-question A1 *‘which consequences can a polycentric local decision-making area have for the realization of a renewable energy transition, in particular for the introduction of smart grids?’* My interest especially lies in the consequences that the increased number and diversity of actors has on the process of local energy planning. I address the research sub-question theoretically as well as empirically with the help of two case studies in which components of smart grid technology are central. One

case concerns the testing of this technology, the other case aims at the implementation of technological smart grid components.

In the next Section 3.2 I shortly introduce the core idea of polycentricity as it has been established by Vincent and Elinor Ostrom. Section 3.3 presents the two cases and method based on which I analyse and compare both case studies in Section 3.4. I end this chapter with a number of conclusions and recommendations in Section 3.5.

3.2. Polycentricity

The concept of polycentricity is closely related to the work of Vincent and Elinor Ostrom. Both scholars conducted life-long research on so-called polycentric configurations which are characterized by a diversity of actors whose relation cannot be qualified as either hierarchy or market (Toonen, 2010). In the words of Vincent Ostrom, polycentricity involves ‘many centers of decision-making which are formally independent of each other’ (V. Ostrom, Tiebout, & Warren, 1961, p. 831). Hence, V. Ostrom *et al.* positioned polycentricity against monocentricity which characterizes a hierarchical order. In their early work, the Ostroms showed that the idea of monocentricity as one centre of decision-making cannot adequately explain situations such as for instance decision-making on the urban development in the United States.

With their life-long research Vincent and Elinor Ostrom established a research school, the Bloomington School, in whose context several scholars have contributed to the conceptual development and empirical grounding of polycentricity (Aligica & Tarko, 2012; McGinnis, 2011b; McGinnis & Ostrom, 2012; E. Ostrom, 2010a, 2010b; Toonen, 1988). At the same time, the Ostroms’ concept of polycentricity has been criticized in regard to a few aspects. According to McGinnis (2009/2011) who summarized these criticisms, polycentricity pays too little attention to the distribution of power and insufficiently considers whether rules have been made through democratic procedures. I therefore want to stress that self-governance does not automatically guarantee justice in procedures and outcomes, that it needs investment in terms of time and efforts, and that polycentricity should not be regarded a panacea (McGinnis, 2009/2011; E. Ostrom, 2010b).

McGinnis (2011a) provides a good overview of the characteristics that define the units of polycentric configurations: the units are multi-level, multi-purpose, multi-sectoral and multi-functional:

1. Multi-level: local, regional, provincial, national and global units of governance;
2. Multi-purpose: general purpose nested jurisdictions vs. specialized, cross-jurisdictional units;

3. Multi-sectoral: form of coordination, being public, private, voluntary, or community-based;
4. Multi-functional:¹⁷ a separation of the production and provision of (public) goods and services, special units can exist for financing, coordination, monitoring, sanctioning, and dispute resolution (McGinnis, 2011a).

According to V. Ostrom et al. (1961) during the production and provision of (public) goods four criteria have to be considered: (1) control; (2) efficiency; (3) political representation; and (4) self-determination. Control entails that actors have authority and jurisdiction over the geographical area in which their collaboration/project takes place. Efficiency relates to economies of scale of collaborating and to the effectiveness of control (for instance via joint management). Political representation occurs through ‘the inclusion of the appropriate political interests within the decision-making arrangements’ (V. Ostrom et al., 1961, p. 836). Local self-determination refers to the involvement and autonomy (decision-making power) of local communities (self-governance).

These four criteria emphasize the underlying idea of polycentricity: actors who have the ambition to solve a collective problem, or want to achieve a collective goal, need to be capable to determine themselves who is needed for realizing these ambitions (McGinnis, 2009/2011). The optimal arrangement – especially for the production and provision of goods and services – varies from task to task (Toonen, 1988). This can eventually lead to a diversity of formal and informal organizations, that is, to a configuration of existing public authorities, new institutions, and informal (local) arrangements.

These configurations are generally the result of (perhaps competitive) negotiations and agreements among all involved actors. Through interacting, the involved actors themselves define the ‘rules of the game’ and the way in which agreements and institutional mechanisms are created, maintained and changed. For creating well-functioning polycentric configurations it is important that actors have the opportunity to decide themselves on the rules that influence their situation, instead of having such rules imposed upon them by outsiders. For the demarcation of polycentric settings it is furthermore important that all actors accept the same system of rules and comply with these rules (Aligica & Tarko, 2012). Elinor Ostrom’s (2005, 2011) Institutional Analysis and Development Framework can help to develop such rules (see Section 3.5). Yet, it has to be taken into account that decision-making based on consensus can facilitate ‘the dominance of the powerful and vested interests of the few over the many’ [Fine, 2010 in McGinnis (2009/2011, p. 151)].

¹⁷ This characteristic is one of E. Ostrom’s (1993) eight ‘design principles’ for the sustainable management of common-pool resources, referred to as ‘nested enterprises’.

Overall, polycentricity has several advantages, among which are collaboration, self-governance, distribution of power, mutual control ('checks and balances'), possibilities for innovation and experimentation, as well as the emergence of learning and mutual trust. For these reasons, polycentricity can lead to better results and performances (E. Ostrom, 2010b). A disadvantage is the high demand that is placed on stakeholders in terms of deliberation and negotiation. Additionally, collaboration often does not emerge spontaneously; configurations have to be created. Once this has happened, innovative projects can be realized collectively. Therefore, polycentric configurations could have a supporting effect on advancing the energy transition and lead to innovative results. After all, polycentricity implies using the diversity of knowledge, experience and skills that are present in local settings. Provided that these elements are used productively, their diversity can lead to innovative solutions.

In the Netherlands numerous examples exist in which stakeholders have collectively created sustainable solutions for streets, neighbourhoods and villages by locally producing electricity from renewable sources (Chmutina, Wiersma, Goodier, & Devine-Wright, 2014; Geelen et al., 2013; Hoppe, Graf, Warbroek, Lammers, & Lepping, 2015; Warbroek & Hoppe, 2017). It is especially citizens who are increasingly initiating such projects. Working together with governmental organizations and companies is however indispensable. Electricity, gas and heat are sophisticated products that are offered by highly-specialized companies. The technical coordination of demand and supply of these products involves the use of sophisticated technical infrastructures. Being able to operate on these product 'markets' requires advanced technical expertise and skills. Community energy initiatives often do not possess such expertise and skills themselves, and therefore need to seek collaboration with distribution system operators (DSOs), energy companies and governmental entities. As a result, many local polycentric configurations have emerged in the Netherlands in which local citizen initiatives work together with professionals to make their surroundings more sustainable. One of several successful examples is LochemEnergie (Arentsen & Bellekom, 2014; Hoppe et al., 2015; Oteman, Wiering, & Helderman, 2014). Yet, such local polycentric configurations also emerge in relation to construction or renovation projects that are initiated through governmental subsidies.

3.3. Two Case Studies

From the perspective of the energy transition, it is relevant to investigate which consequences a polycentric local decision-making area can have for the introduction of smart grid technology in the Netherlands. The deployment of smart grids (and of smart energy systems) is important for the energy transition as it can optimize energy flows, integrate large amounts of renewable energy, and make the energy system at

large ‘future-proof’ with the help of information and communication technology. The introduction of smart grids does not take place on a large scale in the Netherlands, but there are several experimental projects in which the deployment of technological components is tested. To address the research question posed in this chapter I chose to analyse two cases that focus on introducing and testing technological smart grid components in a polycentric setting: ‘Jouw Energie Moment: Smart Grid met de consument’ (short: JEM Zwolle case) and ‘Bothoven-Noord: op weg naar een energieneutrale wijk’ (short: Bothoven-Noord case).

3.3.1. IPIN project JEM Zwolle

The first case is ‘Jouw Energie Moment: Smart Grid met de consument’¹⁸ in the municipality of Zwolle, the Netherlands. JEM Zwolle was part of the ‘Innovatieprogramma Intelligente Netten’ (Innovation Programme Smart Grids, short IPIN), a subsidy scheme through which the Dutch Ministry of Economic Affairs financially supported twelve smart grid projects from 2011 to 2016 (with a total project budget of € 16 million).

The JEM smart grid project took place between January 2012 and January 2015 in the newly constructed city district Muziekwijk in Zwolle. DSO ‘Enexis’ was the initiator of the project and, as specified in the subsidy provisions, had to look for project partners that had the (collective) goal to implement a smart grid in the Muziekwijk district, and were willing to invest in the project. Eventually, smart meters, energy displays (equipped with a home energy management system, short HEMS, via the companies ‘Flexicontrol’ and ‘CGI’), smart washing machines and solar PV panels were installed in 226 rental properties of ‘SWZ’ housing association (Kobus, Klaassen, Kohlmann, Knigge, & Boots, 2013). Accordingly, the residents could choose on their energy displays if they wanted their washing machine to automatically start at the point of time when electricity was cheapest, or at the point of time when renewable electricity was available¹⁹ (Klaassen, Frunt, & Slootweg, 2014). The polycentric configuration was institutionalized through the establishment of a consortium, consisting of ‘Enexis’, ‘SWZ’ housing association, energy supplier ‘Eneco’, ‘Flexicontrol’ and ‘CGI’. The residents of the Muziekwijk district and the national government (that invested a couple of million euros in the project) were not part of the consortium.

¹⁸ In English: ‘Your Energy Moment: Smart Grid with the consumer’.

¹⁹ Dynamic energy tariffs applied. The dynamic tariff consisted of a dynamic electricity tariff (via Eneco), and a dynamic network tariff (via Enexis). The energy tax and VAT that are part of the energy tariff were not dynamic.

3.3.2. Green Deal project Bothoven-Noord

The second case is ‘Bothoven-Noord: op weg naar een energieneutrale wijk’²⁰, in the Bothoven-Noord district in the municipality of Enschede, the Netherlands. This project is part of the ‘Green Deal Smart Energy Cities’, an agreement between the Dutch government and societal partners, with the goal of realizing a smarter, more renewable local energy in 100,000 buildings in the Netherlands by 2019 (greendeals.nl, 2013)²¹.

In November 2013, the municipality of Enschede signed the ‘Green Deal Smart Energy Cities’. To meet the goals of the Green Deal, the municipality had to nominate projects and look for project partners. The choice for a kick-start project was made quickly, as a project group called ‘Sustainability’ already existed for the district, and the three project group members (employees of ‘De Woonplaats’ housing association, ‘Domijn’ housing association and the City of Enschede) were enthusiastic about realizing a smart grid in the district. Besides these three stakeholders, DSOs ‘Cogas’ and ‘Enexis’ and ‘Pioneering’ building association became a member of the project group. From the start of the project in august 2014, until the beginning of 2016, no other components besides smart meters were installed in the city district.

3.3.3. Data collection and analysis

Data for the JEM Zwolle case was collected in February and March 2015 through semi-structured interviews with experts from DSO ‘Enexis’, and through document analysis. Data collection for the Bothoven-Noord case was performed in June and July 2015, and included semi-structured interviews and document analysis as well. Next to interviewing all six members of the project group of the Bothoven-Noord case, I participated in eleven monthly project group meetings that took place in 2015 and 2016.

The analysis that was conducted is based on the four criteria that V. Ostrom et al. (1961) identified for polycentricity: control, efficiency, political representation and self-determination. For the introduction of smart grids two of these four criteria are especially relevant: efficiency and self-determination. Efficiency is about how quickly and effectively a local configuration can realize solutions. Self-determination

²⁰ In English: ‘Bothoven-Noord: towards an energy neutral district’.

²¹ The Green Deal Smart Energy Cities has been signed by five Dutch municipalities (Amsterdam, Arnhem, Deventer, Eindhoven and Enschede), Netbeheer Nederland (the umbrella organization of Dutch DSOs), the Ministry of Economic Affairs and four TKIs, which are consortia of nine Dutch policy sector programs (Stichting TKI Switch2SmartGrids, Stichting TKI EnerGo, Stichting TKI Solar Energy, Stichting TKI Power2Gas, Stichting TKI ClickNL).

concerns the local autonomy during and over the process of introducing smart grid components. Such local self-determination can however come under pressure when non-local actors dominate the process or when central governmental subsidy schemes specify criteria that limit local self-determination. In sum, the criteria of efficiency and self-determination are important indicators for analysing the process of energy planning in local polycentric configurations.

3.4. Results

The main research question was addressed in two steps. First, I analysed the polycentric characteristics of the two cases (Subsection 3.4.1), and second, I positioned both cases on the four criteria of polycentricity (Subsection 3.4.2).

3.4.1. Polycentric characteristics of both cases

The local configuration in both cases can be described as polycentric, as summarized in Table 3.1.

	JEM Zwolle	Bothoven-Noord
Multiple levels	<i>Local:</i> SWZ, residents <i>Regional:</i> Enexis <i>National:</i> Eneco, Flexicontrol, national government <i>Global:</i> CGI	<i>Local:</i> housing associations, municipality <i>Regional:</i> Enexis, Cogas, Pioneering
Multi-purpose	<i>Territorial jurisdiction:</i> Enexis, SWZ, residents, national government <i>Non-territorial jurisdiction:</i> Eneco, CGI, Flexicontrol	<i>Territorial jurisdiction:</i> Enexis, Cogas, housing associations, municipality <i>Non-territorial jurisdiction:</i> Pioneering
Multi-sectoral	<i>Private:</i> residents, companies <i>Public:</i> national government <i>Semi-public:</i> Enexis, Eneco, SWZ	<i>Private:</i> Pioneering <i>Public:</i> municipality <i>Semi-public:</i> Enexis, housing associations, Cogas
Multi-functional	<i>Provision:</i> Enexis <i>Production:</i> Eneco, residents <i>Control/sanctions:</i> national government <i>Co-financing:</i> consortium members	<i>Provision:</i> Enexis (further unclear)

Table 3.1: Polycentric characteristics of both cases

In the decision-making arenas in both projects, actors are involved at *multiple levels*, from local housing associations, over regional DSOs, to the international company ‘CGI’ in the case of JEM Zwolle. *Multi-purpose* units are present, in which several actors possess territorial jurisdiction (DSOs ‘Enexis’/‘Cogas’, housing

associations, residents, national government/municipality), while other actors do not have territorial jurisdiction.

Both cases have *multi-sectoral* characteristics: semi-public authorities (DSOs ‘Enexis’/‘Cogas’, housing associations, ‘Eneco’), public authorities (national government and municipality), private companies and citizens are involved. The *multi-functional* characteristics are especially visible in the JEM project: ‘Eneco’ and residents are involved in the production of electricity, ‘Enexis’ is responsible for provision of electricity, all consortium members finance the project and the national government is responsible for control and dispute resolution.

3.4.2. The positioning of both cases on the four criteria of polycentricity

In Table 3.2 both cases are positioned on the four criteria of polycentricity. The higher the control, efficiency, political representation and local self-determination, the more successful the polycentric arrangement is according to theory (V. Ostrom et al., 1961). I analyse both cases from this perspective.

	JEM Zwolle	Bothoven-Noord
Control	Enexis and housing associations	Enexis & housing associations directly, municipality indirectly
Efficiency	Joint investments	<i>Stakeholders are searching, uncertainties exist</i>
Political representation	<i>No elected unit directly involved</i>	Local government involved
Local self-determination	<i>Residents indirectly involved (not in decision-making)</i>	<i>Residents not involved</i>

Table 3.2: Positioning of both cases on the four polycentric criteria

According to Vincent Ostrom, actors who have jurisdiction over the geographical area in which a project is taking place can exercise *control*. Following this definition, in both smart grid projects only ‘Enexis’ (operator of the electricity grid in the district) and the housing associations (owner of houses) have, based upon their legally-defined responsibilities, direct control in the projects. The control of ‘Enexis’ and the housing associations is however limited as they are semi-public organisations that have to adhere to conditions and limitations established by the national government. Especially as regards smart grid projects the Dutch Authority for Consumers and Markets (ACM) is increasingly paying attention to the fact that semi-public organisations are not allowed to undertake commercial activities (ACM, 2015). This limits the possibilities for semi-public organisations such as DSOs and housing associations to initiate local projects, an otherwise plausible activity for DSOs as they have the technical expertise to introduce renewable options at the local level. In the

Bothoven-Noord case, the local government is involved, but does not have direct jurisdiction over (parts of) the project.

In line with the polycentric literature, *efficiency* is present when collaboration leads to economies of scale and to faster and more effective results. In this regard, the JEM project seems to have been executed efficiently as joint investments and coordinated management took place. The Bothoven-Noord case appears to have experienced more problems in realizing economies of scale and in achieving results efficiently and effectively; uncertainties especially exist regarding tasks, responsibilities and the distribution of costs and benefits, resulting in the outcome that between August 2014 and March 2016 only smart meters have been installed. The JEM project was more efficient: between January 2012 and January 2015 not only smart meters, but also energy displays (HEMS), smart washing machines and solar PV panels have been installed and tested in 226 dwellings, resulting in residents behaving in a more environmentally-friendly way. The interviews showed that efficiency was increased due to the pilot-project character of the JEM case, and linked to the available governmental subsidy scheme and the (former) possibilities for semi-public organizations to invest in the project.

In both cases *political representation* was present because of the involvement of municipal city councils, however these councils remained distant from the projects and had little influence. Besides this, *local self-determination* was low in either case as residents did not have a say in the decision-making process; they were not involved at all in decision-making. The interviews did not provide sufficient explanation for the reasons behind the absence of residents, even though these end users are essential for the functioning of smart grid technologies.

I conclude that the JEM Zwolle and the Bothoven-Noord cases employed polycentric configurations with a range of specific characteristics that can be important to consider for the introduction of smart grids. In both projects one stakeholder was in charge (DSO 'Enexis' and the City of Enschede, respectively). Additionally, high commitment existed in both cases as all involved actors had the common goal to implement a smart grid. The collaboration in both projects had been institutionalized and in the JEM Zwolle case the stakeholders also jointly invested in the project; in the Bothoven-Noord case, however, finances were not discussed yet. Both cases show that local self-determination through the involvement of residents barely occurred. This is striking as it is especially residents who are considered to play an important role in the energy transition, are increasingly claiming more autonomy over the organization of their surroundings and are considered important for enabling demand-side management in smart grids, e.g., through allowing remote-control of household appliances and changing of energy demand patterns. However, local self-determination can come under pressure, for instance when the national government determines in one way or the other what decision-making should look like at the local

level. In both cases external intervention by the national government did indeed occur. In the JEM Zwolle case it happened by means of subsidy conditions, and in the Bothoven-Noord case the conditions of the Green Deal provoked stakeholders to collectively pursue the introduction of a smart grid.

In sum, both cases show characteristics of polycentric configurations, with diversity in terms of organizations and perspectives, and to a certain extent in terms of efficiency and involvement of democratic bodies. However, regarding the aspect of self-determination of residents both cases perform less well as residents were not part of the consortium that made and executed decisions.

What can we then learn from both cases about the influence of polycentric configurations on the energy transition in the Netherlands? Do such configurations facilitate the energy transition or do they hinder it? My limited analysis does not allow for far-reaching conclusions, but it does reveal that polycentric configurations show tensions between on the one hand control and efficiency, and on the other hand self-determination and political representation. Working in a structured and efficient way can lead to faster and more effective results and in consequence contribute to advancing with the energy transition. However, searching for a balance with self-determination and political representation can slow down the process; while this is not desirable from the perspective of moving forward with the energy transition, it is beneficial from a democratic point of view. In consequence, it is important to find a good balance between efficiency and democracy: to make progress by means of an open, democratic process. Finding this balance is challenging, but many community energy initiatives in the Netherlands and abroad have shown that it is possible to achieve this balance. A first important step for realizing local renewable energy infrastructures is to structure the local dynamics in a productive and open polycentric configuration; the next section provides several suggestions to address this aspect.

3.5. Conclusion

This chapter set out to analyse the consequences of polycentric local decision-making areas for the realization of the energy transition, in particular for the introduction of smart grids (sub-question A1). With the help of the four criteria of polycentricity (control, efficiency, political representation and local self-determination) two cases were analysed. This analysis revealed that the functioning of the existing polycentric configurations can be improved because tensions exist between on the one hand control and efficiency, and on the other hand self-determination and political representation. For local energy planning on the introduction of smart grids it is particularly important to find a good balance between efficiency and democracy: to make progress by means of an open, democratic process. Efficiency is important as the Netherlands needs to make advancements in regard to making its energy supply

more renewable. Self-determination can enhance local support for the establishment and functioning of smart grids.

Based on the findings of Chapters 2 and 3, I recommend that in order to structure the local dynamics in a productive and inclusive polycentric configuration, having appropriate institutional arrangements (rules), can help. For the creation of well-functioning polycentric configurations it is beneficial that individuals who are interacting with each other can themselves craft rules that apply to their collective decision-making process. As concluded in this chapter, such rules for decision-making on the introduction of smart grids should inter alia facilitate efficiency of decision-making as well as the involvement of local residents. With this in mind, in the next chapter I analyse which institutional conditions enable or disable decision-making processes regarding the introduction of smart grids in residential areas. Furthermore, in the fifth chapter I assess which lessons can be learned from legal experiments where associations are in charge of the local production and supply of renewable electricity, in other words, where local self-determination is central.

Chapter 4

Decision-Making on the Introduction of Smart Energy Infrastructures: The Influence of Institutional Conditions

Abstract

This paper analyzes ‘rules of the game’ that influence decision-making concerning the realization of smart grids. Smart grids are considered as a solution to optimize and make electricity systems ‘future-proof’. Their introduction, however, is challenged by a polycentric multi-stakeholder configuration with ‘rules of the game’ (institutional conditions) which are essential for the cooperation between stakeholders but perceived to be outdated. To address this problem, the central research question in this chapter is: ‘*which institutional conditions enable or disable decision-making processes regarding the introduction of smart electricity and heating grids in selected city district development projects?*’ (sub-question A2). I conducted in-depth interviews and collected secondary data for four case studies in the Netherlands, two electricity grid cases and two heating grid cases. Cases were selected with the aim to see whether differences in decision-making practices exist based on (a) the energy infrastructure components that are to be implemented, and (b) the type of energy infrastructure. For all four cases data were analysed, and cases were compared with the help of the Institutional Analysis and Development framework, and causal process tracing. The results reveal a connection between three disabling institutional conditions: position, choice and payoff rules. Only stakeholders in the position of project leader were actively pursuing project goals (position rules), legal barriers as well as path dependency of previous decisions limited the available choices (choice rules), and agreement was lacking on sharing costs and benefits (aggregation rules). Furthermore, end users were hardly involved in the projects, mainly because initiatives had a top-down character. Together, the disabling institutional conditions led to delays or even prevented the realization of pre-set project goals. As ‘rules of the game’ for decision-making continue to present a challenge for the introduction of smart electricity and heating grids, the chapter ends with the call for developing tailor-made institutional conditions.

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4.1. Introduction

Current electricity infrastructures were not designed for handling the increasing electrification of energy demand and the supply of electricity from distributed, intermittent renewable energy sources. The concept ‘smart grid’ is often presented as a promising solution to tackle the arising technical challenges in the electricity grid (Blumsack & Fernandez, 2012). In addition, smart heating grids are increasingly considered to play ‘an important role in the implementation of future sustainable energy systems’ (Lund et al., 2014, p. 2). The ‘smartening’ of these energy infrastructures occurs with the help of information and communication technology.

Although the technological components that make up smart electricity and heating grids are fairly well-developed, the introduction of smart energy infrastructures in real-life settings still faces many non-technical barriers (Mosannenzadeh, Di Nucci, & Vettorato, 2017). One factor is the increasingly complex multi-stakeholder setting. Sataøen, Brekke, Batel, and Albrecht (2015) emphasize that ‘grid projects must involve all interested actors, and these actors must be given an opportunity to participate substantially in the decision-making process’ (p. 185). Upgrading energy infrastructures increasingly entails collective action among a large variety of stakeholders, for instance policy-makers, technology providers, distribution system operators and different sorts of end users (Muench et al., 2014).

Thus far, scholars mainly focus on the introduction of smart grids from a legal context (Brown & Zhou, 2013; Clastres, 2011; Friedrichsen, Brandstätt, & Brunekreeft, 2014; Lammers & Diestelmeier, 2017) or address individual stakeholder perspectives. For example, smart grid research has been undertaken into the visions and expectations of actors (Skjølsvold & Lindkvist, 2015), the behaviour of end users (Fell et al., 2015; Nachreiner et al., 2015), and household practices (Goulden, Bedwell, Rennick-Egglestone, Rodden, & Spence, 2014; Naus, Van Vliet, & Hendriksen, 2015), but did not address on how stakeholders had established smart energy infrastructure projects.

Despite this body of research, there is thus a knowledge gap as regards the analysis of decision-making practices among stakeholders, and especially regarding the ‘rules of the game’ that hinder or facilitate decision-making in projects that aim at realizing smart energy infrastructures. Sovacool (2014) analysed 4444 energy research articles and concluded that only 3.3 percent of these articles deal with ‘how humans make decisions and form institutions that craft rules shaping individual behavior’ (p. 21). This finding is echoed by Von Bock und Polach, Kunze, Maaß, and Grundmann (2015) who state that ‘there are relatively few studies that scrutinise how rules and social relations influence the performance of technical systems’ (p. 129).

For these reasons, in this chapter I investigate in-depth the institutional rules ('rules of the game') that influence decision-making processes in multi-stakeholder settings. Specifically, I study the influence of institutional conditions over time on decision-making processes in local projects where stakeholders intend to introduce (components of) smart electricity grids and smart heating grids. Whereas the focus of this dissertation is on smart electricity grids, in this chapter additionally the institutional conditions in two heating grid cases are analysed to investigate whether differences in decision-making processes exist based on the type of infrastructure in question.

I focus on the Dutch context as the Netherlands is considered one of the countries which provides most funding to smart grid demonstration projects in the European Union (EU) (Gangale et al., 2017). Examples of realized demonstration projects are the twelve Dutch pilots of the 'innovation programme for smart grids' (short IPIN) that took place between 2011 and 2016 (RVO, 2016b). However, overall the deployment of smart grids does not occur on a large scale yet (Gangale et al., 2017) and Chapter 3 has identified the need for creating appropriate institutional arrangements for local energy planning on smart grid introduction in the Netherlands. It is therefore important to empirically investigate which institutional conditions enable or disable decision-making processes on the introduction of smart energy systems, and consequently influence the selection - or failure to select - of smart energy systems to be introduced in Dutch city districts.

To capture all relevant institutional factors, I reconstruct the decision-making processes in four Dutch smart energy infrastructure projects, and more specifically analyse the institutional conditions ('rules of the game') that structure these decision-making processes. The research question I address is '*which institutional conditions enable or disable decision-making processes regarding the introduction of smart electricity and heating grids in selected city district development projects in the Netherlands?*' (sub-question A1). As I analyse the influence of generally applicable institutional conditions, my findings from the Netherlands are relevant to advancing decision-making processes on introducing smarter energy infrastructures in a variety of contexts.

To address the research sub-question I first provide background information on the increased multi-actor complexity and the perceived lack of fitting 'rules of the game' to establish smart(er) energy infrastructures in Section 4.2. This is followed by a theoretical discussion of the institutional conditions for local energy planning regarding smart energy infrastructures in Section 4.3. Section 4.4 explains the research design and methods, which contains four case studies that are each analysed and compared. The case studies are presented in Section 4.5, followed by the case comparison in Section 4.6. After a discussion of these results in Section 4.7, the

chapter ends with a conclusion and presents recommendations for future research in Section 4.8.

4.2. ‘Rules of the Game’ for Smart Energy Infrastructure Governance

Several developments in the electricity sector have led to the emergence of a multi-actor complexity and ‘rules of the game’ that are considered outdated for the introduction of smart energy infrastructures.

After the liberalization of the EU’s electricity and gas markets in the late 1990s the ‘clearly defined position and legally authorized tasks’ (Arentsen et al., 2001, p. 152) of actors in the electricity sector diminished when the distribution as well as the production and supply of electricity had to be accommodated in separated companies. Goldthau (2014) argues that, ‘this push toward the market model in energy has not only increased the number of involved actors and the levels of regulation; it has also enhanced the need for coordination among and between them’ (p. 137). This multi-actor setting and need for coordination has grown even more with the increase of electricity production from renewable energy sources at the low- and medium- voltage grid level. In the Netherlands, it is especially electricity that is increasingly produced in a decentralized setting, notably through the use of solar PV panels, combined heat and power (CHP) or small-scale wind parks (ECN, 2016). This development turns consumers into ‘prosumers’ and multiplies the number of actors that is actively involved in the electricity sector. This trend is illustrated by a sharp rise in the number of community energy initiatives in the Netherlands, growing from 40 community energy initiatives prior to 2009 to 360 such initiatives by 2016 (Oteman et al., 2017).

Smart electricity grids and smart heating grids (also called smart thermal grids) both ‘focus on the integration and efficient use of potential future RES as well as the operation of a grid structure allowing for distributed generation which may involve interaction with consumers’ (Lund et al., 2014, p. 9). The ‘smart’ element of these energy systems refers to information and communication technologies that enable the forecasting, planning and real-time remote control of energy flows. Smart electricity grids focus on these aspects in relation to the reduction of peaks in electricity demand and supply, for instance concerning the integration of electricity generated from fluctuating renewable energy sources or the charging of electric vehicles (IEA, 2011). Smart heating grids concern developments in local heating and cooling grids and can intelligently control heat demand and supply, for instance produced by CHPs, solar thermal units, heat pumps, geothermal heat as well as by industrial surplus heat or waste incineration (Lund et al., 2014). The roll-out of smart electricity and smart heating grids is increasingly becoming important for Dutch residential areas because electricity grids were not designed for handling increasing peaks in electricity supply and demand, and heating grids are to replace gas grids in the Netherlands

(Rijksoverheid, 2015; SER, 2013). In this chapter smart electricity grids and smart heating grids are collectively referred to as smart energy infrastructures. I define a smart energy infrastructure to consist of an ‘ICT layer’, an infrastructure that includes local renewable energy sources, energy storage capacity, and allows for the integration of (multiple) renewable energy sources. I argue that the more of these components an energy infrastructure entails, the smarter the energy infrastructure.

The introduction of smart energy infrastructures takes place in the above outlined multi-actor setting in which stakeholders have to coordinate their actions. Yet, when Verbong et al. (2013) analysed the visions and expectations of stakeholders working on the topic of smart grids, they found that ‘disagreement exists on the practicalities of designing a smart grid: i.e., who should be the dominant actor, how should costs and benefits be allocated, who bears which responsibilities [in a smart grid]’ (p. 121). Appropriate ‘rules of the game’ can help clarify these disagreements and as a result reduce uncertainties in the collaboration between stakeholders during energy planning at the local level. Yet, there are only few studies that investigate how rules influence the decision-making processes on the introduction of technical systems in the energy sector (Sovacool, 2014; Von Bock und Polach et al., 2015). Wolsink (2012) expects a problematic situation as most existing ‘rules of the game’ are ‘designed to support the centralised power supply system, [and] will prove to be unfit for creating, operating, and managing microgrids within an integrated smart grid’ (p. 832). In this chapter I will address this aspect of (perceived) outdated ‘rules of the game’ in local energy planning projects empirically. Whereas research on governance in the energy sector mainly addresses smart electricity instead of smart heating grid projects, the need for appropriate ‘rules of the game’ supposedly likewise applies to smart heating grid projects because (a) these projects also take place in the context of local energy planning processes and (b) consequently are faced with similar multi-stakeholder complexities and a lack of clarity on roles and responsibilities.

4.3. Institutional Conditions for Local Planning on Smart Energy Infrastructures

To obtain an encompassing account on the institutional conditions that influence decision-making processes on the introduction of smart energy infrastructures in Dutch city districts I draw on the Institutional Analysis and Development framework (E. Ostrom, 1990, 2011). Following North (1990) and E. Ostrom (2005) I define institutions as the humanly devised prescriptions that are used to organize human interactions, referred to as institutional conditions or ‘rules of the game’.

While the IAD framework has conventionally been applied to the study of traditional common pool resource management, its value has more recently been recognized for research on energy transitions as well (Iychettira et al., 2017; Koster

& Anderies, 2013; Newell et al., 2017). Newell et al. (2017) point out that institutions and management strategies effect network processes in local renewable energy projects and draw on the seven rules that are part of the IAD framework (see below) to understand this effect. Iychettira et al. (2017) emphasize the importance of institutional context in energy policy design and praise the usefulness of the IAD framework in decomposing socio-technical systems into sub-parts. Additionally, Aligica and Boettke (2011) state that the IAD framework is useful for the analysis of complex polycentric institutional arrangements; decision-making arenas on the introduction of smart grids have such polycentric characteristics, as discussed in the previous third chapter (Lammers & Arentsen, 2016).

Overall, the IAD framework is suitable for addressing the main research question posed in this chapter as it is considered to be a ‘conceptual tool for inquiry about how rules affect a given situation’ (E. Ostrom et al., 1994, p. 43). These rules (institutional conditions) determine the possible interactions that stakeholders involved in city district energy planning can undertake. The IAD framework is thus not an explanatory theory that specifies (assumed causal) relations among variables, but a theoretical framework that allows researchers to analyse the institutional setting within which decision-making takes place. The IAD framework includes three external variables, an action situation, patterns of interactions, as well as outcomes and evaluative criteria, as shown in Figure 4.1.

Figure 4.1: The Institutional Analysis and Development Framework

Source: E. Ostrom (2011)

The ‘action situation’ refers ‘to an analytic concept that enables an analyst to isolate the immediate structure affecting a process of interest to the analyst for the purpose of explaining regularities in human actions and results, and potentially to reform them’ (E. Ostrom, 2011, p. 11). The ‘action situation’ studied in this chapter is the decision-making process on the introduction of smart energy infrastructures in Dutch city districts.

‘Action situations’, as portrayed in Figure 4.2, consist of seven clusters of elements with their respective rules-in-use. In this chapter I refer to these rules-in-use as institutional conditions because I am interested in their individual influence on the decision-making process. These rules-in-use are as follows (for a more detailed description please refer to the coding scheme in Annex VI):

- *Boundary rules*: specify the number of actors that participate in the local energy planning project, and how these actors join and leave the decision-making process;
- *Position rules*: specify the set of positions that actors hold in the decision-making process;
- *Choice rules*: specify the sets of actions that can, may be, or must not be taken at specific points in time;
- *Information rules*: specify the amount and type of information available to participants and how this information is used and shared;
- *Aggregation rules*: specify how decisions are made, e.g., by an individual actor, or in collaboration with others;
- *Payoff rules*: specify the costs and benefits that derive from particular actions and outcomes;
- *Scope rules*: specify the set of possible outcomes, as well as the jurisdiction and state of outcomes, e.g., whether they are final or not (E. Ostrom, 2011; Polski & Ostrom, 1999).

Figure 4.2: The ‘action situation’ and the respective rules-in-use

Source: E. Ostrom (2011)

As shown, the IAD framework is a useful theoretical framework to delineate the institutional conditions for a *static* ‘action situation’. Considering that decision-making on energy infrastructure planning is often a lengthy and complex process, its reconstruction calls for the analysis of several ‘action situations’ over time. Once a change occurs in the combination of institutional conditions, a new ‘action situation’ comes into existence. E. Ostrom et al. (1994) phrase it as follows: ‘while the concept of a ‘single’ [action situation] may include large numbers of participants and complex chains of action, most of social reality is composed of multiple [action situations] linked sequentially or simultaneously’ (p. 45). To map institutional settings over time, one needs to single out the most relevant sequentially linked ‘action situations’ for analysis. In order to do so I conduct causal process tracing (see Subsection 4.4.2) and inter alia identify key moments in each decision-making process that allow me to distinguish between ‘action situations’. With causal process tracing these key moments are referred to as ‘smoking guns’: central pieces of evidence that reveal critical moments in the causal process (Blatter & Haverland, 2012). I define a key moment as an instance in the decision-making process that effectively influenced the outcome of decision-making, that is, the introduction of a smart(er) energy infrastructure. Key moments can for example be important agreements or external events, all of which lead to a change in the existing combination of institutional conditions. For the purpose of analysis, I treat each key moment as a stable point in time during which a certain combination of institutional conditions prevailed.

Considering that all ‘action situations’ (decision-making processes) consist of the same conceptual elements and are affected by the same set of rules, ‘action situations’ in different contextual settings can be compared more systematically. Next to analysing decision-making practices in individual projects, I therefore am able to compare these projects in regard to the (combinations of) institutional conditions that influenced the decision-making processes, as explained in the next section.

4.4. Research Design and Methods

To reconstruct and analyse the institutional conditions at play during complex decision-making processes on the introduction of smart(er) energy infrastructures one needs to obtain in-depth, detailed information. An empirical, qualitative case study approach is most suited for this purpose as it allows for ‘analysing more complex action situations and their linkages’ [Yandle, 2001 in E. Ostrom (2005, p. 35)]. In this chapter I present the analysis of four case studies.

4.4.1. Case selection

To obtain cases that portray the full range of variation regarding decision-making processes on the introduction of smart energy infrastructures in Dutch city districts, I use a ‘diverse cases’ case selection approach. ‘Diverse cases are likely to be representative in the minimal sense of representing the full variation of the population (though they might not mirror the *distribution* of that variation in the population)’ (Gerring, 2006, p. 89). I am interested in decision-making processes that portray variation on two aspects. The first aspect is whether high or low smart energy infrastructure ambitions exist. I consider ambitions to be higher when more energy infrastructure components are to be implemented in a local project. As introduced Section 4.2 these components are the amount of local renewable energy sources, energy storage capacity, integration of (multiple) renewable energy sources, and data flows. Second, I seek variation regarding the type of energy infrastructure, being either the electricity or heat infrastructure in a Dutch city district. Energy conservation measures such as thermally insulating residential buildings are not of interest. This variation allows me to study cases that present the full variation of smart energy infrastructure projects in the Netherlands and makes it possible to investigate whether the influence of institutional conditions varied based on the energy infrastructure components that are to be implemented as well as the type of energy infrastructure in question, namely the electricity or heating grid.

Prior to selecting cases I looked at projects that were part of the following Dutch innovation programmes on renewable energy systems: the ‘IPIN’ programme, ‘Switch2SmartGrids’ (S2SGs), the ‘Green Deal Smart Energy Cities’ (Green Deal SEC), and the database ‘Energy efficient construction’ (in Dutch: ‘energiezuinig gebouwd’). To be able to address the research sub-question posed in this chapter, it was important to select cases that allow me to obtain in-depth information which are needed for the within-case analysis in the form of causal process tracing. The selection of each of the cases is discussed below.

4.4.1.1. Cases with high smart energy infrastructure ambitions

The projects with high smart energy infrastructure ambitions considered were among the Dutch pilot projects that received exceptional financial support under the ‘IPIN’ programme and the tender ‘Switch2SmartGrids’.

The IPIN programme is the Dutch innovation programme for smart grids under which the Dutch government financially supported twelve smart grid pilot projects in the period from 2011 to 2016 (RVO, 2016b). Four of these twelve pilot projects fit the two case selection criteria, and eventually the project ‘*Intelligent Net in Duurzaam Lochem*’ in the municipality of Lochem was selected. The reason for this was the local ambition to implement several smart grid components, combined with a multi-actor

setting that included a wide range of stakeholders, inter alia a community energy initiative. The project involved the installation of a smart electricity grid with multiple solar PV parks, electric vehicles (EVs) and sensors for monitoring electricity flows locally in transformers and homes.

The ‘Switch2SmartGrids’ programme entailed two tenders in 2012, which resulted in governmental co-financing of seventeen smart energy grid projects for a period of maximum four years (Agentschap NL, 2013). Of these seventeen projects only four focused on residential areas in city districts, and only one of these projects – ‘*Smart Grid MeppelEnergie*’ in Meppel – involved the implementation of technical solutions by stakeholders in practice, put differently, it entailed a decision-making process. In this project the installation of a smart district heating grid based on biogas, combined heat and power and heat pumps was foreseen for a city district that was to be newly constructed.

4.4.1.2. Cases with a lower degree of smart energy infrastructure ambitions

The projects with lower smart energy infrastructure ambitions, that is, with a smaller amount of smart energy infrastructure components, were selected from the ‘Green Deal Smart Energy Cities’ and the database ‘Energy efficient construction’.

The ‘Green Deal Smart Energy Cities’ was established for the period from 2014 to 2019 to stimulate public-private collaboration for the upscaling of smart energy concepts in 100,000 buildings in the Netherlands (greendeals.nl, 2013). This program included eleven ‘kick-start’ projects for whose implementation the project consortia could temporarily ask for the help of experts who would act as ‘innovation broker’ (finding innovative technologies for a local project) or ‘creative producer’ (creatively supporting the involvement of end users). The project that most strongly fit the case selection criteria was ‘*Bothoven-Noord: op weg naar een energieneutrale wijk*’ (in English: Bothoven-Noord: towards an energy neutral district) in the municipality of Enschede, a project that aimed at creating an energy neutral district by 2040 through installing solar PV panels and monitoring residential electricity flows.

The database ‘Energy efficient construction’ of the Netherlands Enterprise Agency ‘RVO’, includes innovative projects in the built environment (RVO, 2017). Due to the fact that of the three already selected cases two address electricity grids (‘Lochem’, ‘Bothoven-Noord’) and only one focuses on the district heating grid (‘MeppelEnergie’), I chose to search for an additional heating grid project. This led to nine innovative projects, three of which fit the case selection criteria, and of which the ‘*Hart van Zuid*’ project was the most interesting as the local government (the municipality of Hengelo) was leading the construction and operation of an envisioned open district heating grid in a cascade setting using industrial excess heat.

To summarize, the case selection resulted in two projects that had high smart energy infrastructure ambitions (embodying several smart energy infrastructure

components), and two projects that aimed at realizing an energy infrastructure with fewer smart energy infrastructure components, as shown in Table 4.1.

	High Smart Energy Infrastructure Ambitions			Lower Smart Energy Infrastructure Ambitions
Electricity Grid	Intelligent Lochem	Net	Duurzaam	Bothoven-Noord: op weg naar een energieneutrale wijk
Heating Grid	Smart Grid	MeppelEnergie		Hart van Zuid

Table 4.1: Selection of four cases

4.4.2. Data collection and analysis

To obtain in-depth insights into each decision-making process data collection involved both primary (interviews and moderate participation observation where possible) and secondary data (project text documents). The interviews were semi-structured and included as many stakeholders as needed to achieve data saturation for each decision-making process, resulting in a total number of 20 interviews (see Table 4.2 for details). The interview guide is included in Appendix D in Dutch, as well as translated to English in Appendix E.

Case	Number of interviews	Interviewees
Intelligent Net Duurzaam Lochem	N= 4	- member of citizen energy initiative (2x); - researcher working for a university; - DSO project manager.
Smart Grid MeppelEnergie	N= 5	- municipal civil servant; - DSO project manager (2x); - researcher working for a university of applied sciences; - consultant of a networking organization focussed on business and project development.
Bothoven-Noord: op weg naar een energieneutrale wijk	N= 6	- municipal civil servant; - asset manager at DSO; - employee of housing association (2x); - researcher working for a university of applied sciences; - director of a building association.
Hart van Zuid	N= 5	- municipal civil servant (3x); - DSO project manager; - project engineer at an energy supplier.

Table 4.2: Interviewees of semi-structured interviews per case study

The interview questions were mostly derived from the theoretical framework, as well as from the aspects linked to the technique of process tracing (see the paragraph

below). Additionally, pilot interviews were conducted based upon which several questions were revised, as it turned out that some questions could be merged, rewritten or deleted. All interviews were audio recorded with the permission of the interviewees and were transcribed afterwards. In turn, the interview transcripts and secondary data were coded with the qualitative data analysis and research software tool Atlas.ti (version 7.5.4.) by using a coding scheme that was based on the elements of the IAD framework, the core questions of the causal process tracing approach and on inductively derived codes (see Appendix F).

For the within-case analysis of all four cases causal process tracing was undertaken to reconstruct the decision-making processes and map the institutional conditions that influenced each decision-making process over time. Causal process tracing 'is geared toward identifying the causal chains, causal conjunctions, and causal mechanisms that make specific kinds of outcomes possible' (Blatter & Haverland, 2012, p. 142). This approach fits my research goal as it emphasises timing and temporal sequences. To specify, it involves three different types of observations: (a) comprehensive storylines, (b) the identification of key events in the decision-making process, and (c) the motivations and anticipations of actors (Blatter & Haverland, 2012). With this comprehensive, structured approach I was able to reconstruct the decision-making processes by using the key moments to divide the decision-making processes into sub-parts, that is, into individual 'action situations'. Based on this breakdown I could identify in a structured way the institutional conditions that influenced the decision-making processes during each key moment in the four selected cases.

Following the four within-case analyses, a comparative analysis was conducted to identify patterns of institutional conditions that influenced the decision-making processes in the four case studies. For this comparative analysis, the results of the individual case studies were compared with the help of conceptually clustered matrices (Miles & Huberman, 1994)²² which were based on the theoretical framework and on the empirical findings. The comparison identified whether the seven analysed institutional conditions had an enabling (+) or disabling (-) influence on the decision-making process on the smart energy infrastructure introduction. When an institutional condition was enabling at certain moments in the project, and disabling at other moments, the symbol (+/-) was used.

²² 'A conceptually clustered matrix has its rows and columns arranged to bring together items that 'belong together' [either conceptually or empirically in order to compare cases and generate findings more easily]' (Miles & Huberman, 1994, p. 127).

4.5. Case Analysis

This section presents the analysis regarding the institutional conditions that enabled or disabled the decision-making processes on the introduction of smart(er) energy infrastructures in the four studied cases. For each case analysis timelines with key moments as well as tables that summarize the influential institutional conditions at each key moment are added. The extended case narratives and detailed chronological explanations of the influence of each institutional condition can be found in Appendices G to J.

4.5.1. Intelligent Net Duurzaam Lochem

The reconstruction of the decision-making process in the ‘Intelligent Net Duurzaam Lochem’ (short: ‘Lochem’) case resulted in the identification of influential institutional conditions at seven key moments between December 2011 and April 2015, as shown in Figure 4.3, Table 4.3 and in Appendix G.

Figure 4.3: Timeline of the 'Intelligent Net Duurzaam Lochem' case

It was especially the *payoff rules* in the form of exceptional investments from the ‘de facto’ project leader DSO ‘Alliander’ – next to a subsidy of €1,493,957 from the central government – that enabled the introduction of a smart electricity grid in Lochem. Additional enabling institutional conditions were the adoption of clear collective decision-making rules (*aggregation rules*) and a project set-up with a steering group and project group. In the second half of the project householders were enabled to gain insight in their energy flows as well as to join information evenings and working groups (*information rule*), which ensured their active involvement in the

project (*position rule*: from passive to active role of householders). However, the strict rules for householders to join at the beginning of the project (*boundary rules*) led to the situation that fewer householders than expected joined the project (160 instead of 250).

	Key moment	Influential rules-in-use
1	December 2011: IPIN subsidy granted	<ul style="list-style-type: none"> • Boundary rule: Project initiators University of Twente and community energy initiative ‘LochemEnergie’ invite other actors to join the project, and apply for a governmental subsidy to run the project. • Payoff rule: The subsidy is granted, but it turns out to be less than expected. • Scope rule: The set of possible outcomes decreases because less subsidy is received than expected initially.
2	December 2012: Brainstorm session	<ul style="list-style-type: none"> • Position rule: DSO ‘Alliander’ becomes ‘de facto’ project leader. • Aggregation rule: All consortium members discuss the options for the project together.
3	January 2013: Trianel bankrupt	<ul style="list-style-type: none"> • Boundary rule: Exit energy supplier ‘Trianel’ due to bankruptcy; strict boundary rules for householders to join the project. • Scope rule: technical solutions are limited due to the exit of energy supplier ‘Trianel’.
4	April-June 2013: Smart meters and first collective solar PV park	<ul style="list-style-type: none"> • Position rule: Householders become active resource users. • Information rule: Householders gain insight in energy flows and can join information evenings and working groups. • Payoff rule: DSO ‘Alliander’ finances smart meters and a first solar PV park on roof of the city hall.
5	Beginning of 2014: Low-voltage sensors installed	<ul style="list-style-type: none"> • Aggregation rule: Project set-up in which the steering group decides and the project group implements.
6	March 2014: Test installation constructed	<ul style="list-style-type: none"> • Choice rule: A simulation shows which choices can be made regarding the technical set-up.
7	April 2015: Stress Test	<ul style="list-style-type: none"> • Payoff rule: DSO ‘Alliander’ finances electric vehicles.

Table 4.3: Influential rules-in-use in the decision-making process in the ‘Intelligent Net Duurzaam Lochem’ case

Furthermore, the scope of the project was adjusted over time; initially the set of possible outcomes was limited (*scope rules*) as less financial subsidy than expected was obtained (*payoff rule*) and later on the bankruptcy of energy supplier ‘Trianel’ (*boundary rule*) additionally limited the technical options that had been foreseen (*scope rule*). Eventually, it was the technical simulation of the city district’s electricity grid in a test lab that enhanced the stakeholders’ understanding of the choices that could be made regarding the technical set-up (*choice rule*). This simulation was

followed by the ‘stress test’ that provided valuable insights into the grid’s capacity and successfully ended the project. During this stress test residents of three streets simulated a ‘typical’ Dutch situation regarding supply and demand of electricity in 2025: they charged 20 electric vehicles and baked off 20 pizzas in electric ovens, resulting in a peak load that caused a blackout (Hoogsteen et al., 2017).

4.5.2. Smart Grid MeppelEnergie

My analysis established six key moments with their respective institutional conditions for the decision-making process in the ‘Smart Grid MeppelEnergie’ project for the period from spring 2010 to the May 2017, as summarized in Figure 4.4 and Table 4.4 and explained in detail in Appendix H.

The decision-making process regarding the introduction of a smart heating grid in a city district in Meppel was initially enabled as the local government had decided in the spring of 2010 (*choice rule*) that no conventional gas grid was permitted to be installed in the district (and had established its own energy company, ‘MeppelEnergie’).

Figure 4.4: Timeline of the ‘Smart Grid MeppelEnergie’ case

Although several stakeholders joined the municipality’s sustainability efforts (*boundary rule*) and a governmental subsidy of €567,439 was granted to the project in October 2012 (*payoff rule*), the decision by the consortium to initially install a natural gas-fed district heating grid and only replace it with a sustainable solution once 150 homes had been constructed (*choice rule*), led to path-dependency of the non-renewable gas-grid option as compared to the originally envisioned smart energy system (*scope rule*). This path dependency was influenced by the disabling *payoff rules*: due to the slow speed of construction the investments in the planned CHP unit

and biogas pipeline were considered too high by the consortium members (*payoff rule*) and the more expensive (semi-) detached homes with individual heat pumps were never built (*payoff rule*). At the same time, all consortium members – except for the DSO ‘Rendo’ – were passively observing the progress made (*position rule*).

In the fall of 2016, the sixth key moment, DSO ‘Rendo’ opened up a tender for local parties to come up with a sustainable solution for the local district heating grid, and in May of 2017 the DSO selected an engineering company to realize such heating grid. This decision of the DSO was due to legal provisions that mandate DSOs to stick to their core tasks of grid operation in future projects, and not act as an energy supplier anymore (*choice rule*). Yet, the energy system that will be realized by the engineering company will not be ‘smart’; in sum *choice*, *payoff* and *position rules* drastically disabled the decision-making process so that the originally envisioned smart heating grid could not be introduced.

Key moment		Influential rules-in-use
1	Spring 2010: Municipal ambition for sustainable city district	<ul style="list-style-type: none"> Choice rule: The local government determines that the city district will get a district heating grid instead of a conventional gas grid. Boundary rule: The municipality invites stakeholders having expertise, and establishes its own energy company ‘MeppelEnergie’.
2	October 2012: Subsidy granted	<ul style="list-style-type: none"> Boundary rule: networking agency ‘EnergyValley’ joins (invited by the municipality) and invites experts from its own professional network. Payoff rule: A governmental subsidy is granted.
3	Fall 2012: Consortium members experience problems	<ul style="list-style-type: none"> Position rule: DSO ‘Rendo’ and the water board exercise a less ambitious role; ‘EnergyValley’ becomes a passive advisor.
4	Fall 2014: First homes constructed	<ul style="list-style-type: none"> Position rule: All participants except ‘de facto’ project leader DSO ‘Rendo’ are passive project participants.
5	Spring 2015: Temporary, non-renewable energy system running	<ul style="list-style-type: none"> Choice rule: The renewable energy system will be installed once 150 homes have been constructed. Payoff rule: The renewable energy system with a CHP unit is not profitable for a small amount of homes constructed; the biogas pipeline is deemed to be too expensive. Scope rule: A temporary, non-renewable energy system is installed.
6	Fall 2016: Tender for sustainable district heating grid opened	<ul style="list-style-type: none"> Choice rule: The law mandates DSOs to stick to their core tasks for future projects, and not become energy supplier.

Table 4.4: Influential rules-in-use in the decision-making process in the ‘Smart Grid MeppelEnergie’ case

4.5.3. Bothoven-Noord: op weg naar een energieneutrale wijk

The decision-making process on the project ‘Bothoven-Noord: op weg naar een energieneutrale wijk’ contained six key moments with their respective institutional conditions in the period from September 2012 to August 2017, as shown in Figure 4.5 and Table 4.5 (for additional details see Appendix I).

Especially the lack of *payoff rules* had a disabling influence on the decision-making process in the project: no consortium member invested in the project, leading to a lock-in of the status-quo. This situation was related to the *position* and *choice rules*: all consortium members were eager to suggest ideas, but when it came to project implementation they were only passively observing the developments (*position rule*) and were not able to invest, inter alia due to legal restrictions (*choice rule*).

Figure 4.5: Timeline of the ‘Bothoven-Noord: op weg naar een energieneutrale wijk’ case

The broad *boundary rules* and *scope rules* under which several times additional consortium members were invited and the set of possible outcomes was broadened did not help in finding investors and never made it possible for residents to join the project. The lack of information sharing among consortium members (*information rule*) and the absence of a collective decision-making procedure (*aggregation rule*) further disabled the process.

In early 2016 a governmental subsidy of €983,894 was granted to a business developer for the roll-out of home energy management systems (HEMS) in 1,000 households, 500 of which were to be installed in the Bothoven-Noord district (*payoff rule*) and an external project manager was hired (*boundary rule*). However, in August 2017 the consortium ended the collaboration with the business developer as he was not openly communicating about the delay in the delivery of the HEMS (*information rule*).

	Key moments	Influential rules-in-use
1	September 2012: 'Working group sustainability' created	<ul style="list-style-type: none"> Boundary rule: The municipality and the housing associations form and join a 'sustainability' working group.
2	November 2013: Green Deal Smart Energy Cities signed	<ul style="list-style-type: none"> Boundary rule: Two DSOs and a networking platform join the consortium. Position rule: The municipality becomes the project leader. Information rule: The housing associations and the municipality have more information than other partners.
3	Sept/Oct 2015: Installation of smart meters in city district	<ul style="list-style-type: none"> Position rule: The DSOs install smart meters and thereafter take on take on a role as passive external advisors. Aggregation rule: Individual organisations decide on renewable energy options, not the consortium as a whole.
4	Early 2016: DEI subsidy granted	<ul style="list-style-type: none"> Boundary rule: Business developer 'Texel Development' is invited by the consortium and joins the project. Payoff rule: A governmental DEI subsidy is granted; however no stakeholder is making additional investments. Choice rule: The law mandates semi-public organisations to focus on their core tasks (which do not concern smart grids). Position rule: The municipality moves from being project leader to being a passive facilitator.
5	May 2016: External project manager hired	<ul style="list-style-type: none"> Boundary: An external consultant is invited to join the project as project manager. Position rule: The project manager is in charge of leading the project; 'Texel Development' only exerts a passive role. Scope rule: The scope rule is broadened and many ideas and potential technologies are suggested.
6	August 2017: Plans for installation HEMS cancelled	<ul style="list-style-type: none"> Information rule: 'Texel Development' does not communicate openly about progress (delay) in the development of the HEMS.

Table 4.5: Influential rules-in-use in the decision-making process in the 'Bothoven-Noord: op weg naar een energieneutrale wijk' case

While solar PV panels had been installed on the roof of an old factory building located in the district in July 2017, the 280,000 kWh of electricity that will be produced annually will either be used by companies located inside the building, or fed into the electricity grid; a local smart electricity grid did thus not come into existence.

4.5.4. Hart van Zuid

For the decision-making process in the ‘Hart van Zuid’ city district in Hengelo influential institutional conditions were identified for six key moments in the period between 2002 and January 2017 (see Figure 4.6, Table 4.6 and details in Appendix J).

In the ‘Hart van Zuid’ case it was mainly the combination of three institutional conditions that slowed down the introduction of an innovative district heating grid that was supposed to be fed with industrial excess heat: payoff rules, choice rules, and information rules. Due to unfavourable *payoff rules* (linked to strict *boundary rules* for companies to join), in the early 2000s the municipality could not find companies that could offer affordable solutions for the planned district heating grid. The municipality’s decision to realize a sustainable, ‘gas-free’ district was initially enabling for the project, but in December of 2007 this *choice rule* eventually forced the municipality to install several non-renewable (based on gas) district heating grids by itself – via the municipal department ‘Warmtenet Hengelo’ – as homes had been constructed and needed to be supplied with heat.

Once research in the fall of 2014 revealed that the information regarding the profitability of these heating grids had been incorrect (*information rule*), *payoff rules* shaped the remainder of the project. As stopping the project would be more expensive than installing a ‘backbone’ (a pipeline that delivers industrial excess heat to the heating grid in the city district) that could make the project’s business case profitable, the municipality decided to invest more money (*payoff rule* and *choice rule*).

Figure 4.6: Timeline of the ‘Hart van Zuid’ case

With the investments into the ‘backbone’ ensured (and eventually a large financial loss for the municipality), after more than ten years the municipality was able turn the project over to independent companies in January 2017; a process that

profited from clear position, payoff and aggregation rules. In November of 2017 then, DSO ‘Alliander’ and energy supplier ‘Ennatuurlijk’ had realized the envisioned renewable energy district heating grid in the ‘Hart van Zuid’ city district.

	Key moment	Influential rules-in-use
1	2002: Municipality chooses for sustainable district heating grid	<ul style="list-style-type: none"> Choice rule: The local government determines that the city district will get a district heating grid instead of a conventional gas grid. Boundary rule: Strict financial targets are set for companies to join the planned district heating grid project. Payoff rule: No company can offer an affordable solution.
2	Dec 2007: Municipality starts ‘Warmtenet Hengelo’	<ul style="list-style-type: none"> Choice rule: A heating grid must be installed as newly-constructed houses must be supplied with heat – the municipality starts the heating grid project alone.
3	Fall 2014: Research by ‘CE Delft’ published	<ul style="list-style-type: none"> Choice rule: The construction of the ‘backbone’ can happen once sufficient end users have committed to being connected to the heating grid, and make the ‘backbone’ profitable. Information rule: The municipal government is officially informed that the installed islanded natural gas-fed district heating grids are not profitable.
4	Jan 2015: Municipality decides to install ‘backbone’	<ul style="list-style-type: none"> Choice rule: The municipality has to install a ‘backbone’ in order not to make an even bigger financial loss. Payoff rule: Stopping the project would be more expensive for the municipality than installing the ‘backbone’.
5	May 2015: Tender for sale district heating grid	<ul style="list-style-type: none"> Boundary rule: DSO ‘Alliander’ and energy supplier ‘Ennatuurlijk’ join the project via a tender. Aggregation rule: Transparency during negotiations. Payoff rule: The municipality sells its non-renewable islanded district heating grids for €1 – losing €8.5 million; unexpected costs to be shared by all partners.
6	Jan 2017: District heating grid handed over	<ul style="list-style-type: none"> Position rule: Two companies, ‘Alliander’ and ‘Ennatuurlijk’ have a large role; the municipality gets a small role. Aggregation rule: 95%/5% influence companies/municipality, monthly project group meetings.

Table 4.6: Influential rules-in-use in the decision-making process in the ‘Hart van Zuid’ case’

4.6. Case Comparison: Enabling and Disabling Institutional Conditions

In this section the results of the comparative analysis of the four cases is presented. However, first it is important to address whether the projects were successful in meeting the pre-set ambitions in terms of smart energy infrastructure installation, as summarized in Table 4.7.

	Project name	Time period analysed	Smart energy infrastructure goal	Smart energy infrastructure achievement
Cases with high smart energy infrastructure ambitions	Intelligent Net Duurzaam Lochem	2011 – spring 2015	Renewable energy generation (solar PV panels), ICT for monitoring and steering energy flows, end user involvement, EVs to store energy.	Goals achieved by April 2015 through stress test, but fewer end users involved than originally planned.
	Smart Grid Meppel-Energie	2010 – spring 2017	Biogas to feed district heating grid, individual heat pumps, ICT for monitoring and steering energy flows, end user involvement.	Goals not achieved (yet), by the end of 2018 renewable energy sources should be used for feeding the district heating grid.
Cases with lower smart energy infrastructure ambitions	Bothoven-Noord: op weg naar een energie-neutrale wijk	2012 – early 2017	ICT for monitoring households' energy flows, active end user involvement, installation of solar PV panels to make the city district energy neutral.	Goals not achieved, plans to install Home Energy Management System cancelled in 2017, solar PV panels installed but electricity not used in district.
	Hart van Zuid	2002 – early 2017	District heating grid that is fed with industrial excess heat.	Goals achieved, since November 2017 district heating grid is fed with industrial excess heat.

Table 4.7: Comparing goals and goal achievement in the four cases

The overview presented in Table 4.7 reveals that the differences in goal achievement between the four cases are not simply related to the amount of energy infrastructure components that stakeholders aimed at introducing, neither to the type of energy infrastructure: all goals were attained within four years in the ‘Intelligent Net Duurzaam Lochem’ project (electricity grid with high smart energy infrastructure ambitions), and in fifteen years the ‘Hart van Zuid’ project (heating grid with lower smart energy infrastructure ambitions), whereas the other two analysed projects have not (yet) achieved their goals. Neither can the governmental financial subsidies that were received in each project explain the success rates; the ‘MeppelEnergie’ project, for instance, was subsidized with more than half a million euros in the beginning of 2013, but the energy system was still based on non-renewable energy sources in the summer of 2017. Drawing conclusions on which factors enable or disable the decision-making process on the introduction of these smart energy infrastructures thus requires taking a deeper look at the institutional conditions that influenced the decision-making processes.

Before considering all seven institutional conditions individually, I want to clarify the influence of external events on the decision-making processes under analysis. In the ‘Lochem’ and in the ‘MeppelEnergie’ case external events were directly responsible for two key moments. In Lochem energy supplier ‘Trianel’ went bankrupt, had to leave the project and as a result partially limited the set of possible outcomes of the project. The legal problems that two consortium members experienced in the ‘MeppelEnergie’ case led these two stakeholders to take on less ambitious roles in the project. Additionally, the financial-economic crisis of 2008 was responsible for slowing down the construction of homes in the ‘MeppelEnergie’ and ‘Hart van Zuid’ cases, making it more difficult to find sufficient end users to make renewable energy options for the local district heating grids profitable.

Besides these three external events, all other key moments resulted from the institutional conditions that influenced the decision-making process between the consortium members (see Table 4.8). This finding makes it reasonable to assume that institutional conditions were responsible for enabling or disabling the decision-making processes in the four analysed cases.

	<i>High Smart Energy Infrastructure Ambitions</i>		<i>Lower Smart Energy Infrastructure Ambitions</i>	
	Intelligent Net Duurzaam Lochem	Smart Grid MeppelEnergie	Bothoven- Noord: op weg naar een energieneutrale wijk	Hart van Zuid
<i>Goal attainment</i>	<i>Yes</i>	<i>Not (yet)</i>	<i>Not (yet)</i>	<i>Yes</i>
Boundary rule	+/-	+/-	+/-	+/-
Position rule	+	-	-	+/-
Choice rule	+/-	+/-	-	+/-
Information rule	+	-	-	-
Aggregation rule	+	-	-	+
Payoff rule	+	-	-	-/+
Scope rule	-	-	-	-

Table 4.8: The influence of institutional conditions on the decision-making processes regarding the introduction of smart energy infrastructures in the four studied cases

In Table 4.8 I summarize the enabling (+) or disabling (-) influence of all seven institutional conditions (called rules-in-use by E. Ostrom) on the decision-making processes regarding the introduction of smart energy infrastructures in the four selected city district development projects. In the following Subsections the enabling and disabling influence of each institutional condition will be explained in detail. Remember that when an institutional condition was enabling at certain moments in the project, and disabling at other moments, the symbol (+/-) was used.

4.6.1. Boundary rules

The boundary rules in all four projects were enabling as well as disabling each decision-making process. It was enabling (+) that in all cases the project initiators invited experts from their own network to join the project. At the start of the projects in the ‘Lochem’ and ‘Hart van Zuid’ cases strict boundary rules (-) that specified the conditions for householders and companies to join the projects, however, made it increasingly difficult to find participants (thus the ‘+/-’ symbol in Table 4.8). In the ‘Lochem’ case householders had to make a fifteen year commitment by investing in solar PV panels, becoming a member of the community energy initiative ‘LochemEnergie’, and switch to a particular energy supplier. In the ‘Hart van Zuid’ case the local government had established strict financial targets that companies had to meet in order to be allowed to take on the development of the envisioned renewable district heating grid.

Looking at the stakeholders that joined in the end, it stands out that only in the ‘Lochem’ case householders were actively involved in the project, whereas this ambition was also set for the cases of ‘MeppelEnergie’ and ‘Bothoven-Noord’, but was not proactively pursued by the consortium partners (explaining the +/- symbol for these two cases in Table 4.8). In the ‘Lochem’ case householders not only invested in solar PV panels, but also gained access to their smart meter data, and participated in workshops to further energy saving and electric transport – aspects that enabled the successful introduction and a good functioning of the local smart electricity grid.

4.6.2. Position rules

Except for the position of project leader, the position rules were mostly not clearly communicated in the projects under analysis. I can however identify that some participants took on active roles in the process, while others were passive observers. Yet, these positions did not result from the collective creation of position rules, but were the decisions of individual members. Actually in all but one project, the ‘Intelligent Net Duurzaam Lochem’ project, the position rules were disabling (-) as all consortium members besides the project leader took on a passive observer role (see Table 4.9; in the ‘Bothoven-Noord’ and ‘Hart van Zuid’ case the project leaders changed during the course of the project). Only in the ‘Lochem’ project the position rules were enabling (+) and all consortium members actively worked together (under the lead of DSO ‘Alliander’), and two years after the start of the project householders were actively involved as well. In the ‘Hart van Zuid’ case it was only when the local government handed over the project in January 2017 to a DSO and energy supplier that the position rules were enabling; explaining the additional ‘+’ in Table 4.8.

Looking at the type of organisation the consortia members worked in does not provide a direct reasonable argument for their (non-) involvement in some projects. Whereas DSOs were in charge in the projects in the ‘Lochem’ and ‘MeppelEnergie’ cases, they did not want to actively contribute in the ‘Bothoven-Noord’ and ‘Hart van Zuid’ cases.

	Project leader	Active participants	Passive participants
Intelligent Net Duurzaam Lochem	DSO Alliander	DSO Alliander and all other consortium members (after two years also householders)	/
Smart Grid MeppelEnergie	DSO Rendo	DSO Rendo	universities, local government, companies, water board
Bothoven-Noord	Local government → consultant	Local government → consultant	DSOs, platform for construction companies, business developer
Hart van Zuid	Local government → DSO and energy supplier	Local government → DSO and energy supplier	<i>Not applicable</i>

Table 4.9: Positions of consortia members in the four studied cases

In the latter case of ‘Hart van Zuid’ the DSO only joined once the project was sure to be running well. This situation also applies to the involvement of the municipality; in two projects the municipality was initially actively involved – ‘Bothoven-Noord’ case, ‘Hart van Zuid’ case – while it was only involved in the background in the ‘MeppelEnergie’ and ‘Lochem’ cases. For example, the municipality of Meppel established the energy company ‘MeppelEnergie’ to run the smart heating grid project, and the municipality of Lochem permitted community energy initiative ‘LochemEnergie’ to install a collective solar PV park on the roof of the city hall (Hoppe et al., 2015).

4.6.3. Choice rules

The influence of choice rules on the decision-making processes both enabled and disabled the introduction of smart energy infrastructure components in all of the four projects. The decisions of two municipalities to have a district heating grid instead of a conventional natural gas grid installed in city districts can be seen as an initial catalyser for the projects in the ‘MeppelEnergie’ and ‘Hart van Zuid’ cases (+). In the ‘Lochem’ case the simulation of the district’s electricity grid in a test location clarified and in consequence changed the set of feasible technical options and activities (an

enabling choice rule, +) that could be taken, a stepping stone to the introduction of the smart energy infrastructure.

On the downside, in two projects choice rules adopted by the consortia members disabled (-) the adoption of smart energy infrastructure components as these rules led to a long period of path dependency of the installed conventional, non-renewable energy systems. In the 'Hart van Zuid' case the municipality had to start the project alone with a non-renewable solution as the construction of homes that needed to be connected to the district heating grid (a decision made five years earlier) had started. In the 'MeppelEnergie' case, the consortium's decision to only feed the district heating grid with renewable energy once 150 houses had been constructed as well led to the installation of a temporary natural gas-fed district heating grid.

The influence of choice rules was especially disabling (-) the decision-making process in the 'MeppelEnergie' and 'Bothoven-Noord' cases, as renewed emphasis on the regulations of the Dutch law that mandate DSOs and housing associations to merely focus on their core tasks (being energy system administration and the provision of social housing, respectively) severely limited the actions that these organisations could take in the smart energy infrastructure projects.

4.6.4. Information rules

In all projects except for the 'Lochem' case, information rules hindered (-) the decision-making process as information was not shared among all consortium partners, but was rather in the hands of a limited set of actors. In the 'MeppelEnergie' and 'Bothoven-Noord' cases this lack of information sharing was related to the position rules: information was mainly in the hands of the project leaders who were in charge of project planning and operation. In the 'Hart van Zuid' case the municipality was solely responsible for the project for many years, but was still suffering from inadequate internal information sharing regarding the profitability of the chosen natural gas-fed district heating grids.

Additionally, in all cases but the 'Lochem' case householders were not informed about the goals that had been established for upgrading the energy infrastructure in their city district. In Lochem on the contrary householders could participate in information evenings and workshops, and could gain insight into their energy flows (enabling information rule, +). This information sharing with householders helped to motivate them to be actively engaged in the project and enabled the successful introduction of the smart energy infrastructure.

4.6.5. Aggregation rules

A project set-up in which a steering group was in charge of strategic decision-making, and a project group was responsible for the execution of strategic decisions, was found to be an enabling aggregation rule (+) in the ‘Lochem’ project. Likewise, the occurrence of monthly meetings during which agreements were made collectively as well as transparency during negotiations (together with equal information rules) were found to be enabling factors (+) in the ‘Lochem’ and ‘Hart van Zuid’ cases. However, having collective monthly brainstorm meetings while in the end relying on individual consortium members to take decisions on the introduction of technical solutions can be regarded as disabling (-), as the ‘Bothoven-Noord’ case showed. In the ‘MeppelEnergie’ case the lack of collective aggregation rules was also disabling (-) the decision-making process as the informal project leader DSO ‘Rendo’ took decisions on its own during the implementation phase and did not consult with others.

4.6.6. Payoff rules

In the cases studied payoff rules strongly influenced the decision-making processes on the introduction of smart energy infrastructure. Whereas subsidies can facilitate the realization of projects, the mere granting of a subsidy is not necessarily sufficient to achieve the established project goals, as the ‘MeppelEnergie’ case and the ‘Bothoven-Noord’ case demonstrate. Studying the successful ‘Lochem’ case revealed that the decision-making process benefits from clear rules on the sharing of costs and benefits (+): all consortium members discussed and agreed upon how costs were to be shared and in the end it was especially DSO ‘Alliander’ that made significant investments (an option that after the project ended does not exist anymore as current rules of law mandate DSOs to merely focus on energy system administration).

In the ‘Hart van Zuid’ case the path dependency of choices (a heating grid is needed for houses that started to be constructed) led the local government to take on the investments in non-renewable heating grids by itself as no company was able to invest (the latter being a disabling payoff rule, -). Seven years later, the payoff rules – again the local government decided to carry the costs of a ‘backbone’ installation – turned out to be enabling the decision-making process for the ‘Hart van Zuid’ project (+); following this decision two organizations decided to realize a district heating grid fed with industrial excess heat.

In the other two projects – the ‘MeppelEnergie’ and ‘Bothoven-Noord’ cases – the consortium members were unable to invest (disabling pay-off rule, -), partially due to legal restrictions for semi-public authorities (see Subsection 4.6.3 on choice rules). Additionally, the experiences from the ‘MeppelEnergie’ and ‘Hart van Zuid’ cases reveal that it is essential to investigate the exact project costs, including the

distribution of costs and benefits, when the project's goals are established in order to prevent that options get chosen that are too expensive to ever be realized by the consortium.

4.6.7. Scope rules

The sites (city districts) where each of the smart energy infrastructure projects was to take place were identified at the start of all studied projects, but the exact range of possible outcomes regarding the envisioned smart energy infrastructure was either narrowed down compared to the original project goals, or unclear. In three of the analysed projects the range of possible outcomes turned out to be much smaller when compared to the initial project ambitions (-), while in one project (the 'Bothoven-Noord' case), the scope rules never became evident (-). The analysis reveals that the restricted scope of possible outcomes was not a direct consequence of deliberately adopted scope rules, but was caused by the disabling influence of other institutional conditions. Examples are projects in which less financial subsidy than expected was granted (payoff rule in the 'Lochem' case), or where past decisions led to the installation of non-renewable energy grids (choice rule, 'MeppelEnergie' and 'Hart van Zuid' case).

4.7. Discussion

This study sheds light on the institutional conditions that were responsible for enabling or disabling the decision-making processes in four smart energy infrastructure cases. As Verbong et al. (2013) and Wolsink (2012) anticipated, my analysis confirmed empirically that currently existing 'rules of the game' are not all appropriate for smart energy infrastructure developments.

My findings showed that decision-making processes on the introduction of smart energy infrastructures involve a multi-actor setting, a trend that was already foreseen by Künneke and Finger (2009) and Goldthau (2014) after the liberalization of the European energy markets. However, no specific type of organization played a central role in smart energy infrastructure projects in Dutch city districts, and in all but in one of the analysed projects householders were not aware of the energy infrastructure developments that were planned for their city district. Whereas end users are perceived as a potential barrier to the development and implementation of smart grids due to concerns for privacy, lack of time and needed behaviour change (Verbong et al., 2013), my research suggests that a preceding barrier for householders consists in the option to be engaged, e.g., invited, in the project at all.

By studying seven institutional conditions that influence decision-making I was able to identify not only which institutional conditions enable and disable the

decision-making processes, but also how these conditions are interrelated. This finding can help overcome the existing ‘lack of good cooperation and acceptance among project partners’, a key barrier for the introduction of smart energy projects (Mosannenzadeh et al., 2017, p. 191). My research especially revealed a connection between three disabling institutional conditions: position, choice and payoff rules.

Position rules were often not clearly communicated in the projects under analysis and mostly all consortium members besides the project leader took a passive observer role (with the exception of the ‘Lochem’ case). Based on the research conducted in this chapter I can conclude that the passive role of stakeholders in the process is partially influenced by choice rules in the form of legal barriers for DSOs and housing associations to invest in smart energy infrastructure projects (payoff rule). Legal barriers have previously been identified to strongly disable the roll-out of smart renewable energy technologies (Luthra, Kumar, Kharb, Ansari, & Shimmi, 2014; Muench et al., 2014). In addition, I can conclude that decisions to initially install temporary non-renewable energy systems (choice rule) have led to a lock-in of non-renewable energy systems and delayed the installation of smart energy infrastructures.

In combination, the limitations created by choice rules and the passive positions of consortium members led to a lack of appropriate agreements on the sharing of costs and benefits (payoff rules), a clearly disabling institutional condition. While the provision of subsidies has been identified as an important condition that can facilitate the roll-out of renewable energy technologies (Hoppe, 2012; Mosannenzadeh et al., 2017), my research has shown that subsidies alone are not enough, but appropriate agreements (payoff rules) are needed on the sharing of costs and benefits among consortium members.

Due to the disabling influence of several institutional conditions on the decision-making process, my research demonstrates that the established project goals were over-ambitious, a factor that was also found by Hoppe (2012) regarding the implementation of innovative energy systems in social housing projects.

4.8. Conclusion

Against the background of a multi-actor setting and perceived outdated ‘rules of the game’ for smart energy infrastructure introduction, this chapter set out to address sub-question A2 ‘*which institutional conditions enable or disable decision-making processes regarding the introduction of smart electricity and heating grids in selected city district development projects in the Netherlands?*’ To answer this question I analysed decision-making processes in four projects in which different ambitions existed as regards smartening the energy infrastructures for the local electricity grid or heating grid.

Considering that institutions are often studied as static concepts, I combined the Institutional Analysis and Development framework with causal process tracing in this chapter. Doing so allowed me to conduct a dynamic analysis over time; I was able to decompose the complex multi-stakeholder decision-making processes into sub-parts and to analyse the institutional conditions at play during different moments in time. I recommend this dynamic focus especially for the study of institutional conditions in decision-making process on (smart) energy infrastructure development, as these processes are often lengthy and complex. My findings demonstrate that such research is particularly relevant because institutional conditions are foremost responsible for enabling or disabling decision-making processes on smart energy infrastructure introduction (external events, generally speaking, had less influence on the analysed decision-making processes). Furthermore, differences in decision-making practices and more particularly in goal achievement were found to neither be related to the amount of smart energy infrastructure components that stakeholders aimed at introducing, nor to the type of energy infrastructure in question. Due to the general applicability of the analysed institutional conditions to diverse contexts, my research from the Dutch context can also help to analyse decision-making processes on smart energy infrastructure introduction in other countries, and if needed, aid in pinpointing the institutional conditions that need to be improved.

All findings considered, three overarching conclusions can be drawn from the research conducted in this chapter. First, institutional conditions disabled decision-making in the analysed cases. As explained in the discussion Section 4.7 above, it was especially the combination of position, choice and payoff rules that caused this disabling effect: choice rules in the form of legal barriers (rules-in-form) prevented DSOs and housing associations to invest in smart energy infrastructure projects (payoff rule) and partially led these stakeholders to take on a passive role in the decision-making process (position rule). Although the provision of governmental subsidies can support the development and operation of projects, it is especially agreements about the sharing of costs and benefits (payoff rule) among consortium members that helps to attain pre-set project goals.

Second, in each analysed case the constellation of the project consortia (boundary rule) was partially disabling the decision-making process as well. Consortia were formed ad hoc, mostly through inviting experts from the initiators' own professional networks. End users were hardly involved in the development of smart energy infrastructures, as already identified in Chapters 2 and 3 of this dissertation. The analysis in this chapter revealed that to a large extent this was related to the fact that initiatives had a top-down character, often being initiated by local governments or distribution system operators. However, overall, no single stakeholder emerged as a dominant player in grid development. Related to this finding, in Chapter 5 I analyse

experimental governance settings in which associations are responsible for local electricity grid projects.

Third, the progress of achieving the pre-set goals varied strongly for the analysed cases, ranging from four years ('Intelligent Net Duurzaam Lochem'), over fifteen years ('Hart van Zuid'), to not having been achieved at all ('Bothoven-Noord: op weg naar een energieneutrale wijk'; 'Smart Grid MeppelEnergie'). Where Chapter 3 only showed that efficiency is in conflict with local stakeholder participation, the results of this fourth chapter reveal that the observed lack in progress in the four cases was found to be influenced predominantly by position, choice and payoff rules. These three rules disabled decision-making processes in such a way that progress was not only slowed down, but also that the achievement of goals was prevented.

To conclude, existing 'rules of the game' are not all appropriate for decision-making on the introduction of smart electricity grids and smart heating grids in Dutch city districts. Therefore, it can be derived from my findings that further research on the creation of appropriate 'rules of the game' for the introduction of local smart energy infrastructures is needed. The remainder of this dissertation is concerned with this.

Chapter 5

Experimenting with Law and Governance for Decentralized Electricity Systems: Adjusting Regulation to Reality?

Abstract

Moving towards a low-carbon society calls not only for technological innovation, but also for governance arrangements that facilitate this innovation. However, reflecting on the findings of the previous empirical chapters of this dissertation shows that the current legal framework of the electricity sector, and the governance arrangements that it fosters, are not ideal for the introduction of local renewable electricity infrastructures in the form of smart grids. To obtain insights into how the legal framework can be adjusted in light of ongoing innovations in the electricity sector, in 2015 the Dutch government adopted a Crown Decree for experiments with decentralized renewable electricity generation (Experimentation Decree). This chapter investigates which effect this Experimentation Decree has on adopted governance arrangements, and specifically addresses sub-question A3 ‘*which lessons can be learned from legal experiments with alternative governance arrangements for decentralized electricity systems?*’ To address this question, I follow the perspective of empirical legal studies and conduct document analysis to compare the governance arrangements established in the Dutch Electricity Act, those created through the Experimentation Decree, as well as those adopted in nine experimental projects. The analysis reveals that although the Experimentation Decree specifies that associations have to be responsible for local grid projects, other actors took the lead in the projects, and active consumer involvement was limited. Furthermore a re-bundling of activities in local electricity grids occurred and the involvement of additional actors and room for emerging activities was found to be restricted. Consequently, this chapter concludes that in their current form, the usefulness of the experimental governance arrangements for projects outside of experimental settings is limited.

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5.1. Introduction

The European Union aims at 27% final energy consumption from renewable sources by 2030 (European Commission, 2014, 2016). The shift towards a low-carbon economy not only implies a changing *source* of energy generation but also a changing *structure* of the energy system, and of the electricity system in particular. Whereas electricity generated from fossil or nuclear sources is mainly produced large scale at centralized locations, electricity from renewable energy sources is increasingly produced on small scales. Distributed generation from intermittent renewable energy sources for example is increasing rapidly. To integrate RES efficiently into the electricity system, smart grid technology is advancing (IEA, 2011; Tuballa & Abundo, 2016). Arguably, renewable energy sources and smart grid technologies will, and already are reshaping our current electricity system (Schleicher-Tappeser, 2012). However, while technologies for these developments already exist, many European countries experience problems with policies and regulations for innovative renewable energy systems such as smart grids (IEA, 2011; JRC, 2014).

EU-wide research by the Joint Research Centre (JRC) summarises that one of the main uncertainties for smart grid implementation concerns the roles and responsibilities of actors, the sharing of costs and benefits as well as the development of new business models (JRC, 2014). The developments in the electricity sector also bear a potential conflict between well-established and newly emerging actors, notably ‘while strong business dynamics pushing for an accelerated transition to renewables is good news for climate policy, powerful incumbents in the power business fear they may lose influence’ (Schleicher-Tappeser, 2012, p. 64). This shows that technological innovation alone is not sufficient for facilitating the energy transition, but equally requires novel governance arrangements. This chapter focuses on the search for alternative governance arrangements specifically in the electricity sector. Here, one of the main underlying problems is that the current legal framework of the electricity sector – which shapes the sector’s governance – impedes innovation in the electricity sector: it is tailored to the conventional electricity system and divides tasks between incumbent actors (Akerboom, Buist, Huygen, Ottow, & Pront-Van Bommel, 2011; Friedrichsen et al., 2014; IEA, 2011; JRC, 2014; Lavrijssen, 2016; Luthra et al., 2014; Muench et al., 2014). This problem has been confirmed in the previous empirical chapters of this dissertation as regards the introduction of local renewable electricity infrastructures in the form of smart electricity grids, as well as in relation to smart heating grids. For instance, Chapter 3 has shown that local self-determination of residents’ in decision-making practices on the introduction of smart grids clashes with efficiency. The analysis in Chapter 4 revealed that many initiatives had a top-down character, including incumbent actors but excluding end users, and that electricity

sector legislation (rules-in-form) are in conflict with the (desired) actions of stakeholders (rules-in-use).

For overcoming these obstacles, experimental legislation is considered a valuable option, as it entails the temporary testing of novel legal approaches (Ranchordás, 2014). Arguably, the role of the legislator should be to ‘allow and continually foster the development of flexible solutions and adapt the [legal] framework to the altered system that develops’ (Friedrichsen et al., 2014, p. 273). A relevant example of legal experimentation in the electricity sector is provided in the Netherlands. On 1 April 2015, the Dutch government allowed for experimental derogation from specific provisions of the Dutch Electricity Act: the Experimentation Decree (Crown Decree) for Decentralized Renewable Electricity Generation²³ (herein, Experimentation Decree) entered into effect. This Experimentation Decree aims at investigating in how far an alternative governance arrangement can contribute to increasing DG, foster the efficient use of the energy infrastructure, and improve consumer involvement (Minister van Economische Zaken, 2009). These goals are linked to the introduction of smart grids and ideally, outcomes of the experiments can contribute to adjusting the legal framework applicable to the Dutch electricity sector in light of ongoing innovations in the sector.

However, inherent to legal experiments is the characteristic that experimental circumstances differ from real-life settings. Upscaling such experiments and allowing projects with alternative governance arrangements to take place on a larger scale can help overcome current legal restrictions to innovation in the electricity sector. To evaluate which effect the Experimentation Decree has on local governance arrangements, the main research question of this chapter is *‘which lessons can be learned from legal experiments with alternative governance arrangements for decentralized electricity systems?’* (sub-question A3). This chapter sets out to address this question through conducting empirical legal research, which is based on document analysis. First, I identify which experimental governance arrangements are defined under the Dutch Experimentation Decree compared to those established by the current legal framework. Second, I analyse which governance arrangements are adopted in the experimental local grid projects. This is followed by a discussion of whether the experimental legislation fosters the adoption of alternative governance arrangements in decentralized electricity systems, and which lessons can be learned for a wider application of these arrangements outside of experimental settings.

This chapter is structured as follows: Section 5.2 introduces the relevance of experimentation, and the specific example of the Dutch Experimentation Decree.

²³ In Dutch: ‘Besluit van 28 februari 2015, houdende het bij wege van experiment afwijken van de Elektriciteitswet 1998 voor decentrale opwekking van duurzame elektriciteit’ (Besluit experimenten decentrale duurzame elektriciteitsopwekking, 2015).

Section 5.3 describes the empirical legal research conducted in this chapter, as well as the data collection method. In Section 5.4 I analyse which alternative governance arrangements are defined in the Experimentation Decree and which ones are adopted in the experimental projects. Section 5.5 discusses these findings and lessons learned, while Section 5.6 concludes.

5.2. Background: In Search for Novel Governance Arrangements in the Electricity Sector Transition

As a prerequisite for this chapter's main analysis this section outlines the current governance arrangements prevalent in the electricity sector, the quest for finding new governance forms which better incorporate the aim of integrating decentralized, renewable electricity, and finally the approach implemented in the Netherlands in the search for such novel governance arrangements.

5.2.1. Current governance arrangements in the electricity sector

To understand the quest for finding novel governance arrangements, this section briefly describes the prevalent governance arrangements in the electricity sector along with the general technical setting of the system and the market structures of the sector.

The electricity system consists of various components jointly assembling the electricity supply chain, from generation, to long-distance transmission, to distribution, and finally to the loads, meaning consumption. The governance of the electricity sector is strongly influenced by the technical setting of the electricity system. Centralized, large generation plants are connected to the high-voltage transmission grid which transports the electricity over long distances, via the low- and medium-voltage grid electricity is distributed to the final customers. Often, the technical set-up of the electricity system is referred to as 'top-down' system, capturing the general setting of large generation at the 'top' of the electricity supply chain, until consumption at the 'bottom' of that chain. The adopted governance arrangements correspond to this 'top-down' structure of the electricity system. This entails for instance that most of the grid operation- and planning responsibilities are located at transmission level with the transmission system operator (TSO), that the distribution system operator (DSO) is responsible for electricity distribution, and that consumers remain largely passive regarding conscious electricity consumption (Bouffard & Kirschen, 2008; Funcke & Bauknecht, 2016).

Electricity sector regulation aims to facilitate competition in activities that are not related to the grid infrastructure, namely, generation and supply of electricity (Tooraj & Pollitt, 2005). This involves a separation of generation and supply on the one hand and grid operation on the other hand, legally coined as 'unbundling'. The objective of

unbundling is to increase overall welfare by improving economic efficiency with a competitive market setting. Clearly, a liberal market for electricity generation and supply allowed many more actors to enter and participate in the sector as generators and suppliers of electricity. In consequence, the prevalent governance arrangements are established by legislation which strictly separates potential commercial activities (generation and supply) from grid operational tasks. For this reason, generators and suppliers of electricity are not permitted to exercise any control over grid operation, and vice versa, grid operators are not allowed to engage in generation and supply.

5.2.2. The quest for novel governance arrangements in the electricity sector: the example of the Netherlands

Next to the European and national policy objectives of facilitating secure and affordable electricity supply stands the objective to improve sustainable electricity generation by means of RES (Eur-lex, 2009a). Yet, the energy transition and particularly the increasing feed-in of electricity from distributed intermittent RES pose challenges to the technical and governance setting of the electricity system (Grond et al., 2011). Some examples illustrate this mismatch between technical developments and the governance setting with conventional governance arrangements. Firstly, private end users (householders) and small enterprises who engage in DG generally do not primarily strive for commercial activities in the electricity sector, but mainly generate for their own consumption. Secondly, these entities, referred to as ‘prosumers’, do not have a clear position yet in the electricity sector as they are neither a generator, nor a supplier, nor defined as something else yet (Parag & Sovacool, 2016). Thirdly, resulting bi-directional electricity flows from prosumers are causing challenges for the distribution grid system operation as DSOs are not assigned and equipped with the task of actively managing electricity flows (De Joode, Jansen, Van Der Welle, & Scheepers, 2009). This is even exacerbated by the intermittent character of RES. Flexibility in consumption could mitigate this problem and could, based on production, entail that various consumers, generators, and prosumers are pooled to jointly increase their flexibilities (Giordano & Fulli, 2012). The challenges mentioned are just a glimpse of how the electricity system and the electricity sector are changing. Certain, however, is that those developments do not fit with the current governance arrangements which correspond to a clear top-down setting of the electricity sector.

In the Netherlands, first efforts have been launched to experiment with novel governance arrangements which incorporate the above mentioned challenges. In the context of this chapter this section provides some further background on the developments leading up to the legislative experimentation approach chosen in the Netherlands in 2015. In 2009, the Dutch government established a ‘Taskforce

Intelligente Netten' ('Taskforce Smart Grids') to further investigate the emergence of smart grids in the context of achieving the transition towards affordable, secure, and clean energy supply (Minister van Economische Zaken, 2009). This resulted in twelve pilot projects, named IPIN²⁴ projects, which were launched around the beginning of 2012 for three or four years. The projects (RVO, 2015a) were mainly concerned with the implementation of technical innovations and aimed at investigate the integration of DG, storage, demand-response, and the development of new services and products. The projects did not specifically focus on the changing role of various actors in the pilot projects, albeit the fact that the 'Taskforce' considered a prominent role of DSOs undesirable due to the risk of creating a dominant position in various services that could also be undertaken by other parties (Ministerie van Economische Zaken, 2010). Nevertheless, in the majority of the projects (nine out of 12) the regional DSO became the leading actor in the project (Ministerie van Economische Zaken, 2011). In addition, a range of other governance obstacles appeared during the projects. For instance, the quest to deploy 'flexible system operation' (combining generation, transport, storage, and supply), essentially requesting the re-bundling of market and grid activities. Also, the current rules on electricity supply were perceived as an obstacle by the actors because current legislation requires a licence to supply electricity which makes peer-to-peer supply (P2P supply) of electricity impossible. Furthermore, static electricity prices and network tariffs were considered a limitation in several IPIN projects; whereas, technically, the demand side could actively participate through demand-response, the financial incentive of dynamic pricing was missing for consumers in most projects (RVO, 2015b).

Overall, several governance obstacles occurred in the IPIN projects, which were not anticipated until then. Therefore, the main conclusion of the IPIN projects in regard to governance was that new technical options enable, and even require novel governance arrangements. Especially the strict division between market- and grid-related tasks was perceived as an obstacle regarding newly emerging tasks as storage, peer-to-peer supply, operation of ICT infrastructure, aggregation of demand flexibility, and aggregation of small-scale generation.

5.2.3. Experimentation as tool for developing novel legislation

The electricity sector is in transition, but 'whether law really will support beneficial innovation depends mainly on its quality and its capacity to maintain the connection with technological innovation' (Dorbeck-Jung, 2013, p. 181). A conventional, 'one-size-fits-all' approach is considered to be outdated, while the new role of the legislator

²⁴ Long for 'Innovatie Program voor Intelligente Netten'; in English: 'Innovation Program for Smart Grids'.

should arguably be to adapt a legal framework that is suitable for the new, altered system (Friedrichsen et al., 2014). For developing novel regulation that is suited for and could foster technological innovation, experimental legislation is a valuable option.

Experimental legislation mostly entails ‘new temporary regulations (secondary legislation) with a circumscribed scope that, derogating from existing law or waiving the observance of a number of rules or standards, are designed to try out novel legal approaches or to regulate new products or services so as to gather more information about them’ (Ranchordás, 2014, p. 7). These temporary, small-scale new rules are, in turn, evaluated after a specified amount of time, and depending on the results, the legal framework is transformed in light of these findings (Ranchordás, 2013, 2014).

In the Dutch legal context ‘experiment’ is defined as an empirical, experimental determination of whether a specific instrument contributes to solving a societal problem (Ministerie van Justitie, 2000). The main aim of legal experimentation is thus to obtain information; ‘only a non-informative experiment is a failed experiment’ (Heldeweg, 2016, p. 3). In brief, these legal experiments allow to temporarily test a regulatory strategy and/or legislative quality and to learn about the advantages and disadvantages of potentially radical changes (Heldeweg, 2015, 2016).

5.2.4. Experimentation Decree for Decentralized Renewable Electricity Generation

On 1 April 2015, the Crown Decree for experiments with decentralized renewable electricity generation entered into effect. In brief, Article 2 of the Experimentation Decree empowers the Ministry of Economic Affairs to grant individual exemptions to Article 16, third paragraph of the Dutch Electricity Act, which exclusively assigns the task of grid operation to the designated system operators. By lifting this restriction, other actors are – under specific conditions – allowed to carry out grid operation tasks (this exemption applies only to ‘project grids’; in ‘large grid projects’ DSOs continue to exercise their legal tasks, see next paragraph). To specify, the Dutch Experimentation Decree is so-called experimentation by ‘derogation’ (as compared to devolution), as it entails derogation from existing legal provisions, which normally do not allow for the performance of the experiment’s activities (Heldeweg, 2015, 2016).

The Experimentation Decree allows experiments for the purpose of (1) increased utilisation of renewable energy or combined heat and power (CHP) at local level; (2) more efficient use of the available energy infrastructure; (3) increased involvement of end users in their own energy provision (Besluit experimenten decentrale duurzame elektriciteitsopwekking, 2015). The Experimentation Decree distinguishes between two types of projects, depending on their size: ‘project grids’ with a maximum of 500 connected users (and one connection of the project grid with the national grid) and ‘large grids’ with a maximum of 10,000 connected users where the regional DSO

continues to exercise its legal tasks (Decree Article 1 and 2). The Decree allows for an exemption of maximum ten years. However, a first official evaluation of results regarding the above mentioned purposes is to be carried out after four years. For details on the background and content of this Experimentation Decree see Section 6 in Heldeweg (2016); in this chapter I focus on the governance arrangements adopted under this Decree.

Regarding the requirements for governance, the Experimentation Decree applies to projects operated by associations, meaning owners' associations and energy associations. These associations must be entirely controlled by their members, which means that DSOs and energy suppliers are not allowed to exercise any control (Decree Article 7(1j)), but members decide on the organisation, progress and distribution of costs of a project (Decree Article 7(1)). This governance choice to not include DSOs and energy suppliers is likely influenced by the as undesirable identified dominant position of these two actors in the IPIN pilot projects.

For associations this means that they have to demonstrate in their application that they possess the necessary organisational, financial, and technical expertise to fulfil all required goals of an experiment (Decree Article 7(1m)). Hence, to become a producer, supplier, and system operator of a local grid, associations have to prove that they can ensure reliability, safety, consumer, and environmental protection, and comply with the technical standards that apply to DSOs (Decree Article 4; Article 7(1)d,e). Additionally, the association has to finance the entire project (Decree Article 7(1)l). Associations, hence, become the generator, supplier, and system operator of a local grid. This has two main consequences: first, the strict division of market and grid activities vanishes. Second, for 'project grids' associations have the option to take over the responsibilities of current DSOs and energy suppliers.

To conclude, the current legal framework of the electricity sector fosters governance arrangements which are not appropriate for dealing with the transition of the electricity system. Legal experimentation allows to derogate from the standard legal framework and can help to develop novel legislation. The Dutch Experimentation Decree assigns new roles and responsibilities; but the questions remains which governance arrangements exactly result from the Decree, and whether these are suitable for application outside of experimental settings. To address this question, in this chapter legal and governance research are combined.

5.3. Method

To address the research question posed in this chapter, I analyse the application of the Experimentation Decree in decentralized electricity systems. That is, I evaluate which consequences this Decree has on the governance arrangements adopted in experimental electricity grid projects. This evaluation hence involves an

interdisciplinary approach that combines legal and governance research. More specifically, the research in this fifth chapter entails empirical legal research.

Smits (2012) identified four types of legal studies and the questions that are asked about law in each of them: (1) descriptive (what does the law say?); (2) normative (what should the law say?); (3) empirical (what is the effect of law?); and (4) meta-juridical legal studies (what is law, why and when is it valid, how does it evolve?). As I am interested in the effects that result from the application of the Experimentation Decree in practice, the research conducted in this fifth chapter can be defined as empirical legal studies. This empirical legal analysis of the consequences of the Experimentation Decree on adopted governance arrangements involves two steps.

First, I identify which experimental governance arrangements emerge through the Experimentation Decree. I do so by comparing the governance arrangements established in the Dutch Electricity Act vis-à-vis those defined in the Experimentation Decree. This comparison focusses on generation/collective generation, supply/peer-to-peer supply, and system operation; the core components of the electricity supply chain and relevant aspects for the realization of smart grids.

Second, I compare the governance arrangements as established in the Experimentation Decree to those adopted in the nine projects that were granted an exemption via the Experimentation Decree in 2015 and 2016. Four of these nine projects derive from the first tender procedure of 2015, and an additional five projects resulted from the second tender procedure of 2016 [for details on these projects see RVO (2016a)]. This analysis includes a reflection on the three goals of the Experimentation Decree: to increase the utilization of RES, to use the energy infrastructure more efficiently, and to increase the involvement of end users. This evaluation is inherent to empirical legal studies: ‘If law is primarily used as a policy instrument to pursue certain goals, the empirical testing of the extent to which these goals are achieved is only one step away’ (Smits, 2012, p. 30).

Based on these two steps it is possible to evaluate whether the experimental legislation leads to new, alternative governance arrangements in decentralized electricity systems, and which lessons can be learned for a wider application of these arrangements outside of experimental settings.

As regards data collection, Smits (2012) explains that empirical legal studies ‘derives its methods from non-legal disciplines’ (p. 31). The qualitative research conducted in this chapter is based on document analysis. Data was collected from publicly available material in a twofold way. First, I reviewed the official project applications, and consulted the official acceptance letters. Second, to enhance and corroborate the data from the official sources, where available, the projects’ websites and other secondary data sources (including news material) were analysed.

5.4. Design and Implementation of the Experimentation Decree

The identification of the governance arrangements that derive from legal experimentation calls for the analysis of both their design and their (envisioned) application. Therefore, Section 5.4.1 sets the Dutch Electricity Act vis-à-vis the Experimentation Decree and shows which governance arrangements are legally possible to be adopted. Following this, Section 5.4.2 takes a look at the governance arrangements that emerge in the nine projects under the Experimentation Decree. This analysis prepares for the discussion on the lessons learned regarding new, alternative governance arrangements for a decentralized electricity system outside of experimental settings.

5.4.1. Governance arrangements defined in the Experimentation Decree

This section addresses the governance arrangements defined in the Experimentation Decree for the core activities of the transitioning electricity supply chain, namely (collective) generation, (peer-to-peer) supply, and system operation. To demonstrate the novelty of these governance arrangements they are set against the current rules on these activities, as specified in the methods section.

5.4.1.1. *Collective generation*

Under the current regulation of the Dutch electricity sector, electricity generation and supply are market activities which means that they can be, subject to a permit, carried out by any person not involved in regulated grid activities. Despite the fact that capacity and sources of electricity generation are generally left to market forces to a large extent, some minimum governmental oversight remains with regard to the overall objectives of ensuring security of supply and sustainability (Hary, Rious, & Saguan, 2016).

Current legislation determines that single customers installing DG do not fall under the definition of generator which requires at least an ‘organisational entity’. In the Experimentation Decree’s projects, ownership of DG facilities is shared which allows the entity to fall under the definition of a generator, an organisational entity that generates electricity. This organisational entity can subsequently also sell electricity to others actors besides their contracted supplier (which is conventionally the only commercial partner for prosumers). Whereas shared ownership of electricity generation is possible under the current legal framework, and not a new development, the Experimentation Decree does allow associations to also be the supplier of the generated electricity for its own members, as specified in the below.

5.4.1.2. Peer-to-peer supply

Under current electricity sector legislation²⁵, electricity suppliers for domestic customers need to have a license for supply, which is granted by the Dutch National Regulatory Authority (NRA) (Roggenkamp, 2016). Therefore, prosumers are under the current legal framework limited to selling their surplus electricity to their contracted supplier and are thus not entitled to freely supply surplus electricity on the market. This prevents prosumers from developing an independent role in the electricity market.

This obstacle of selling to a contracted supplier is eliminated through the Experimentation Decree, as the Decree allows for peer-to-peer supply, which means that any domestic customer generating electricity can supply that electricity to other domestic customers within the project. Here, the license to supply electricity is automatically granted together with the general exemption (Decree Article 13). Additionally, associations can define their own local (dynamic) electricity tariffs (Decree Article 12), as the NRA does not control the height of these tariffs anymore, but merely oversees whether the association used an appropriate method for calculating them. The supply (and linked to this the dynamic pricing) is, however, limited to the members of the project.

5.4.1.3. System operation

A significant deviation from the Electricity Act is provided by the option to curtail the task of the designated regional DSO. The Experimentation Decree establishes two different governance arrangements, for ‘project grids’ and for ‘large grid’ projects, respectively. For the latter one, the regional DSO remains in charge (Besluit experimenten decentrale duurzame elektriciteitsopwekking, 2015). More rigorous is the chosen governance arrangement for ‘project grids’, where the system operator need not be the regional DSO, but system operation becomes the task of the association. From this follows that the Experimentation Decree allows for a fully integrated electricity entity, carrying out generation, system operation, and supply. Yet, acting as system operator, the association still has to comply with rules on third-party access to the grid, meaning that customers remain with the free choice of another supplier. In that sense, the governance arrangements leads to a re-bundling of generation, system operation, and supply, as well as provides end users with a more central role.

To sum up, the Experimentation Decree allows for associations to engage in collective generation, peer-to-peer supply, and in ‘project grids’ for system operation. Storage is not specifically defined under the Decree. As some of the projects plan to

²⁵ This is specified in the Dutch Electricity Act 1998, Article 95a. For details see reference Elektriciteitswet (1998).

install electricity storage facilities, storage becomes part of the integrated electricity supply chain operated by the associations. Yet, all these technological and legal options need to be deployed in practice. For this reason, I investigate in the next section which governance arrangements were, or are planned on being used in the individual experiments.

5.4.2. Adopted governance arrangements in the projects

The nine projects that were granted an exemption under the Experimentation Decree in 2015 (projects one to four in Table 5.1) and 2016 (projects five to nine in Table 5.1), respectively, reveal specific governance arrangements. My focus lies especially on the actors that participate in the projects and centres on ‘project grid’ experiments, as seven of the nine projects involve this type of grid (the two projects ‘Aardehuizen’ and ‘Kringloopgemeenschap’ are large grid projects in which the DSO remains in charge). Table 5.1 provides details on all nine projects.

Name	Location	Applicant		Main Stakeholder	Technologies
		OA	EC		
Zwijssen Veghel	Veghel	x		Starlight B.V. (project developer)	PV panels (200 kWp), CHP (20 kW electrical, 80 kW thermal), energy management via ICT, dynamic electricity tariffs.
Blackjack ²⁶	Amsterdam	x		JansZon B.V. (solar PV company)	PV panels, CHP, p2p, energy management via ICT.
Endona	Heeten and Raalte		x	Energy association Escozon	PV panels (park with 7.200 panels), a bio-digester, p2p, energy management via ICT.
Greenparq	Reeuwijk	x		Real estate company Green Real Estate B.V.	PV panels on the roofs of common facilities, heat pumps, p2p.
Schoonschip	Amsterdam	x		Research centre CWI	PV panels, heat pumps, solar thermal collectors, home batteries, p2p, energy management via ICT.
Noordstraat 11 Tilburg	Tilburg	x		Starlight B.V. (project developer)	PV panels (3000 Wp), solar thermal collectors, energy management via ICT.

(Continued on next page)

²⁶ The project was officially discontinued and excluded from participation under the Experimentation Decree in August 2016.

(Continued from previous page)

Name	Location	Applicant		Main Stakeholder	Technologies
		OA	EC		
Villa de Verademing	The Hague		x	Energy cooperation Villa de Verademing	Heat pumps, solar thermal collectors, PV panels, residential wind turbine, batteries, energy management via ICT, p2p.
Aardehuizen	Olst	x		Owners' association Aardehuizen Olst	PV panels, collective battery, energy management via ICT, p2p, dynamic electricity tariffs.
Kringloop-gemeenschap	Bodegraven and Reeuwijk		x	Energy cooperation De Windvogel	2.3 MW wind turbine (5 GWh/year), 16.000 PV panels (3.4 GWh/year), dynamic electricity tariffs.

Table 5.1: Overview of the nine individual projects

The Experimentation Decree states that associations have to be in charge of 'project grid' projects, and are the only entity that is allowed to carry out all tasks in the local electricity supply chain. The official project applications and acceptance letters reveal that six of the nine granted projects were applied for by an owners' association (short: OA), and in three cases an energy cooperative (short: EC) was leading the application process. As regards the (planned) activities of the associations, all projects state that distributed generation will be undertaken ($n = 9$), in seven projects energy management with ICT will be applied ($n = 7$), six times peer-to-peer supply ($n = 6$) is a priority, and three projects emphasize dynamic electricity tariffs ($n = 3$) in their plans. These planned activities involve governance arrangements, which are not exactly those that are defined in the Experimentation Decree, as the following two paragraphs explain.

5.4.2.1. Utilization of RES, more efficient energy infrastructure use & end user involvement

To repeat, the Experimentation Decree is intended for projects that increase the utilization of RES, use the energy infrastructure more efficiently, and increase the involvement of end users. All projects aim at the generation of renewable energy; in regard to the second and third goal their ambitions differ.

The Experimentation Decree states that the grid infrastructure can be used more efficiently when peak loads are decreased, mainly by means of synchronizing and steering demand and supply of electricity (Decree Article 8(2)b). This can inter alia include the remote-control of appliances in individual households and peer-to-peer supply of electricity, as six of the projects explicitly state the latter aspect as one of

their project goals. Three of the five projects from the 2016 tender also mention energy management with batteries as storage units for electricity, an aspect that is not defined in the Decree. Technologically speaking, this energy management with peer-to-peer supply and electricity storage enables a more efficient use of the electricity grid infrastructure; the second goal of the Experimentation Decree.

Moreover, decreasing peak loads and thus using the grid infrastructure more efficiently depend strongly on the involvement of single grid users (Goulden et al., 2014). Dynamic electricity tariffs can facilitate consumer engagement and behaviour change in the form of shifting demand (Kessels et al., 2016). Yet, in the projects that fall under the Experimentation Decree, dynamic electricity tariffs are only mentioned in three cases. As consequently there are few incentives for consumer involvement, the Experimentation Decree's third goal of increasing consumer involvement is likely to only be achieved partially. Another entrance point for consumer involvement is the requirement that associations must be entirely controlled by their members. This type of involvement might however only be passive for many consumers, e.g., voting at annual general members meetings. Additionally, the next paragraph shows that associations are not in control in all projects, but other stakeholders are in the lead; a sign for a rather passive involvement of the associations and in turn of their members.

5.4.2.2. Incumbent and emerging actors

The Experimentation Decree allows 'project grid' projects to experiment with having market and grid activities undertaken by one single actor: associations are generator, system operator, and also incorporate consumers as members. While it was associations who had to apply for an exemption under the Experimentation Decree, in practice, in five of the nine projects, it is not the association who is in the lead of the project. Two projects are led by a professional project developer, and one project each is led by a company specialized in solar PV panels (supply and installation), a research centre, and a real estate company. To be able to play this main role in the projects, these external stakeholders have to become a member of the association. When looking at the leading stakeholders in the individual projects it shows that more than half of the projects ($n = 5$) are not led by associations, but by a range of different stakeholders who seemingly want to play a stronger role in local energy planning.

Additionally, although the Experimentation Decree states that associations take over the responsibilities of DSOs and energy suppliers in 'project grids', several of these conventional stakeholders still seem to play a prominent role in some of the projects: for example, DSO 'Enexis' is an official project partner in Tilburg, and energy supplier 'Greenchoice' is responsible for ensuring security of supply in project 'Schoonschip'. Of course, security and technical standards need to be preserved, a criteria that incumbent energy suppliers and DSOs are well experienced with. Nevertheless, sufficient experimental space needs to be provided for alternative

governance arrangements with associations in the lead to be able to develop. In such novel governance arrangements a balance must exist between on the one hand safety and professional expertise in electricity provision, and on the other hand the involvement of associations. This balance can be facilitated if associations have the opportunity to become part of the professional level playing field dominated by incumbent stakeholders.

5.5. Discussion: Lessons Learned about the Experimentation Decree

The Experimentation Decree stipulates a central role for associations in the production and supply of renewable energy, and in the system operation of the distribution grid. Experimenting with law and governance for the distribution grid is a well-chosen focus as new technological developments enable, and even require novel governance arrangements, and particularly stakeholders at the local level can play an important role in local climate policy and action (Hoppe, Van Der Vegt, & Stegmaier, 2016). As the current legislation of the electricity sector is shaped to centralized production and transmission, searching for specific governance arrangements for activities emerging at the distribution level is useful. Following the perspective of empirical legal studies I assess the effect of the Experimentation Decree by comparing the governance arrangements established in the Decree to those adopted in practice, as well as evaluate whether those arrangements can serve as alternative governance arrangements applicable outside of experimental settings. In the following I discuss three main lessons of the legal experiment on alternative governance arrangements: re-bundling of activities, the role of new actors and emerging activities, and consumer involvement.

5.5.1. Re-bundling of activities in local electricity grids

The Experimentation Decree foresees a strong role for associations in allowing them to carry out generation, supply, and system operation (in ‘project grids’). Essentially, this governance arrangement bundles all activities of the electricity supply chain. This choice might be a response to the conclusion of the preceding IPIN projects which perceived the strict separation between market- and grid-related activities as an obstacle to newly-emerging activities in the electricity sector (see Subsection 5.2.2 above). Subsequently, one recommendation based on the experiences obtained through the IPIN projects included to allow for ‘flexible system operation’ (RVO, 2015b), meaning the bundling of those activities. In the Experimentation Decree this recommendation was implemented by bundling to a large extent all activities within the realm of the association.

Arguably, this design is rather limited in providing for experimentation with governance arrangements, as no other form than ‘bundling’ is thought of and implemented. Outside of experimental settings, this chosen governance arrangement might not be possible to be implemented as it bears the risk of eliminating competitive market forces. New technologies that can play a significant role in the future electricity system can be implemented by a variety of actors. Certainly, this requires new, and for sure more complex forms of coordination of actors, yet this does not justify for simply merging all activities with one entity. Even though the association must ensure third-party access for other suppliers, it is uncertain whether local end users choose another supplier than their own association or not. Yet, when members of the association decide to leave the project for various reasons, this withdrawal can threaten the integrity of the project which is built upon an integrated governance structure, a conclusion in line with Koenders and Pipping (2016).

5.5.2. Restrictions for new actors and emerging activities

As the Experimentation Decree only specifies the tasks and obligations of associations it does not provide room for other actors to play a role in the decentralized electricity system. This primarily creates uncertainties and potential barriers for participation of two main types of actors: actor that traditionally are not involved in energy projects, and not yet existing, newly-emerging actors. The experiments showed that actors from other sectors want to be involved in decision-making on electricity provision at the local level, as previously noted in Chapters 2 and 3. These actors are professional project developers, businesses (focussing on solar PV panels) and real estate companies. At the same time the roles and responsibilities of completely new actors and emerging activities are not defined in the Decree. In regard to this restriction, one might think of the following two examples. Firstly, a new type of actor could be an aggregator who manages flexibility of grid users (generators and consumers) on a larger scale, as specified in Braun and Strauss (2008). Secondly, related to this, electricity storage could be a new commercial activity in the electricity sector, which leads to the emergence of operators of storage facilities. Due to conflicting interests in regard to storage (Nykamp, Bosman, Molderink, Hurink, & Smit, 2013), regulating this activity is essential.

5.5.3. Limited active consumer involvement

Another important aspect is the limited *active* consumer involvement in the experiments. Involving end-users is crucial for the integration of DG in the low-voltage grid (Goulden et al., 2014), and ‘marks a major shift in the nature of electricity systems and their governance’ (Darby & McKenna, 2012, p. 767). Verbong et al.

(2013) summarize three main barriers for active consumer involvement in the Dutch electricity sector, as identified by Huygen (2010): (a) the limits on selling generated electricity; (b) the lack of dynamic tariffs; and (c) proportionally high costs for the utilization of the transmission grid. The first and third of these barriers are eliminated in the experiments: collective generation and peer-to-peer supply are widely used and in consequence, the transmission grid need not be utilized. Dynamic electricity tariffs are possible under the Decree, however, they are not used in the majority of the nine projects. This lack of financial incentives puts a limit on upscaling. Involving consumers actively is crucial as they can play an important role at the low voltage level in the form of purchasing generation or storage technologies, providing access to their data and allowing the remote-control of their appliances (Verbong et al., 2013). Additionally, 'project grid' projects are limited to 500 connected users, which is an immediate cap to upscaling for at least the next ten years (the maximum duration of the experiments). Thus, it is doubtful whether the European trend towards more interest in consumer engagement in (smart) DG projects (Gangale, Mengolini, & Onyeji, 2013) will be as well the case in the projects under the Experimentation Decree.

To conclude, the Experimentation Decree is very restricted in regard to the governance arrangements that it specifies. This hinders not only the upscaling of these experiments, but already manifests itself in the projects that fall under the Decree. Those restrictions derive mainly from the exclusion of (potential) stakeholders; in this regard I want to emphasize the message of Heldeweg (2016) that in experimentation legal safeguards are needed to ensure the inclusion of stakeholders, as 'these safeguards may well prove to foster not only the yield of experimentation, but also the potential for up-scaling' (p. 13).

5.6. Conclusion

This fifth chapter addressed research sub-question A3 of '*which lessons can be learned from legal experiments with alternative governance arrangements for decentralized electricity systems?*' The legal experiments analysed in this chapter are those nine projects that fall under the Dutch Experimentation Decree for decentralized renewable electricity generation. The comparison of the governance arrangements defined in the Decree to those established by the current legal framework showed that for experimental 'project grids' one main actor has to carry out all tasks in the electricity supply chain: associations (owners' associations and energy associations). These associations can engage in collective generation, peer-to-peer supply and system operation, three aspects that are relevant for the realization of smart grids. In light of the lack of end user involvement in smart grid projects constituted in Chapters 3 and 4, this set-up is at first sight useful to alleviate said problem. However, the

empirical legal analysis conducted in this chapter reveals three lessons that indicate shortcomings of the Experimentation Decree.

First, *de jure*, a re-bundling of activities in local electricity grids occurred because associations should carry out generation, supply and system operation. Second, due to the prominent positions of associations, the involvement of other actors and room for emerging activities in decentralized electricity systems is legally being restricted. The third lesson concerns the effect of the Experimentation Decree on the governance arrangements adopted in practice: active consumer involvement was found to be limited in the projects and additionally it was not associations, but other actors that took the lead in the projects. This third finding reveals that the rules established in the Experimentation Decree (experimental rules-in-form) are in conflict with the practices that are adopted in the projects (rules-in-use). Thus although associations are supposed to be in charge in the local experiments, the analysis of this chapter confirms the empirical findings of Chapters 3 and 4 as regards the lack of end user involvement.

Based on these results, I can conclude that, in their current form, the usefulness of the experimental governance arrangements for projects outside experimental settings is limited. On the one hand, bundling all activities in the local electricity supply chain through associations does not allow to experiment with other governance arrangements, such as the involvement of new actors or emerging activities that could be central to accommodate current developments in the distribution grid. On the other hand, due to the conflict between rules-in-use and rules-in-form, the experimental rules-in-form adopted in the Experimentation Decree might not establish the most appropriate practices as they are excluding stakeholders who want to play a role in decentralized electricity systems, and still do not sufficiently ensure the involvement of end users.

Overall, the chosen focus of the experiments on providing residents with a more central role in local electricity grids is an appropriate development due to lack of end user involvement identified in Chapters 3 and 4. This focus is also in line with developments at the European Union level. As part of the EU's legislative proposals of the 'Clean Energy for All Europeans' package (also referred to as 'Clean Energy Package' or 'Winter Package'), in June 2018, the Council of the European Union endorsed the revision of the Renewable Energy Directive (2009/28/EC). This revision places emphasis on enabling renewable self-consumers (article 21) and renewable energy communities (article 22) to actively participate in the energy system (Council of the European Union, 2018).

In conclusion, whereas the focus on associations is a well-chosen, a restricted design of experiments is not beneficial for finding new, appropriate governance arrangements for decentralized electricity systems. In consequence, further research is needed in regard to identifying appropriate (not-too-restricted) governance arrangements for decentralized electricity systems, including smart grids.

Synergy Part A

The research conducted in part A of this dissertation was guided by research objective A: to obtain empirical insights into the governance arrangements inherent to decision-making on the introduction of smart grids in local settings. Chapters 3, 4 and 5 of this dissertation have provided these empirical insights. In particular, three overarching findings can be singled out from the research conducted in part A: (1) efficiency in local energy planning on the introduction of smart grids is low; (2) there is lack of residents' participation in the local planning process of their city district's energy infrastructure; and (3) several rules-in-use are disabling local energy planning as well as conflicting with (experimental) rules-in-form. Chapters 3, 4 and 5 have shed light on the reasons behind these three aspects, and have shown in which ways they are interrelated.

Efficiency concerns how quickly and effectively the energy planning process leads to the realization of smart grid ambitions. During the analysis of the consequences of local polycentric decision-making arenas on smart grid introduction (Chapter 3) it became evident that efficiency can go at the expense of local residents participating in decision-making processes. In the projects analysed in Chapter 4 the progress of achieving pre-set goals for a smarter energy infrastructure varied strongly: in one pilot project all goals were achieved after four years, in another project upgrading the energy system took fifteen years, and in two further cases the goals had not been achieved in the period under analysis (after five and seven years respectively). This variety and lack of progress on decision-making was neither related to the type or envisioned composition of a local energy infrastructure, nor to the provision of governmental subsidies. Instead, it was found to be influenced (and disabled) predominantly by rules-in-use.

Regarding the participation of local residents, Chapter 3 demonstrated that in both analysed cases there was very little local self-determination through residents' involvement. While no specific reasons for this lack of involvement could be identified, the analysis did reveal tensions between participation and efficiency. In Chapter 4, in three out of the four studied projects private end users (householders) were not involved in the development of local smart grids. This was mainly related to the fact that initiatives had a top-down character, often initiated by local governments or distribution system operators. Furthermore, although the Experimentation Decree for Decentralized Renewable Electricity Generation studied in Chapter 5 provided for a central role of associations and aimed at the active involvement of consumers in experimental local grid projects, these objectives had eventually not been realized in all nine studied projects. Rather, incumbent stakeholders were in the lead in several

projects and incentives for active consumer involvement (namely dynamic electricity tariffs) were only considered in three projects.

The third overarching result of part A of this PhD thesis concerns the rules-in-use as well as the rules-in-form applicable to local energy planning. The analysis in Chapter 4 showed that institutional conditions are foremost responsible for enabling or disabling decision-making processes on smart energy infrastructure introduction; this includes the influence of these conditions on residents' participation in and efficiency of local energy planning. In the four cases analysed in Chapter 4 it was notably rules-in-form (choice rules) in the form of legal barriers that prevented DSOs and housing associations to invest in the projects, which was found to be linked to disabling position and payoff rules. In Chapter 5 a conflict was noticed between the rules-in-form defined in the Experimentation Decree of 2015 and the rules-in-use that were adopted in the nine experiments. The Experimentation Decree specifies that associations are to be responsible for generation, supply and grid operation in the projects (experimental rules-in-form), yet in practice in many projects it is actually other stakeholders who were in charge of such projects (rules-in-use).

These three aspects of low efficiency, lack of residents' participation and disabling/ conflicting rules show that improvements are needed in local energy planning on the introduction of smart grids. In particular, based on part A of this PhD thesis, the need for developing an appropriate institutional architecture, as well as for devising a supportive process architecture can be established.

An institutional architecture is required that specifies appropriate 'rules of the game' for decision-making processes on the introduction of smart grids. These 'rules of the game' should consider that a balance is needed between efficiency of decision-making and the involvement of specific local participants, as well as ensure that rules are enabling the process and in consistency with further rules. Chapters 2, 3 and 4 have shown that the Institutional Analysis and Development framework, and specifically the seven rules-in-use of this framework, can help to analyse as well as create appropriate institutional arrangements for local decision-making processes. The design of these institutional arrangements needs to ensure that the individual rules that make up these arrangements are not in conflict with one another. Based on the findings of part A, I further suggest that stakeholders involved in local energy planning firstly agree on the institutional architecture, and only after this is accomplished, to secondly discuss the question of what the energy system should look like and which outcome it should produce. Doing so can increase efficiency (e.g., by discussing at the outset of the project who is financing the project; payoff rules) and can also facilitate the participation of local residents (e.g., when talking about boundary rules).

In addition to an institutional architecture, based on the empirical analyses I identify the need for a process architecture. A process architecture should help to structure the decision-making procedure in such a way that the lacking balance

between efficiency of energy planning and the participation of local stakeholders is remedied. The emphasis of this participation should lie on enabling the involvement of local residents (or community energy initiatives) in the local energy planning process, while not neglecting the involvement of additional stakeholders such as DSOs. Ideally, involving local community members not only makes the planning process more democratic, but also increases the public acceptance of (collectively) chosen energy system components. To facilitate a purposeful participation of stakeholders, a process architecture can show who needs to be involved in which phase of the local energy planning process (e.g., when technical experts are needed). In regard to efficiency it can help to define at which point during a decision-making process which specific content needs to be talked about; for instance when to select technical components that are suitable for the local energy system.

In part B of this PhD thesis the empirically-obtained insights from part A – and in particular the three overarching needs to improve efficiency, participation and the consistency of rules – are used to develop this outlined institutional and process architecture. These two architectures are considered heuristics that can help improve local energy planning on the introduction of smart grids, as well on the introduction of smart energy systems more generally. In Chapter 6 the institutional architecture is developed, and in Chapter 7 the process architecture is presented.

Part B

Chapter 6

Smart Design Rules for Smart Grids: The ILTIAD Framework

Abstract

Part A of this dissertation identified the need for an appropriate institutional architecture for decision-making on the introduction of smart grids. In response to this, in this sixth chapter smart design rules for smart grids are developed and applied for the creation and alignment of ‘rules of the game’ for local energy planning. Specifically sub-question B1 is addressed, being ‘*how can institutional arrangements for the introduction of smart grids be designed to be lawfully consistent?*’ Through synthesizing the previously used Institutional Analysis and Development (IAD) framework with a normative dimension reflected by institutional legal theory (ILT), a theoretical framework for analytical description and prescriptive design of institutional arrangements is developed in this chapter: the ILTIAD framework. This framework connects empirical institutional analysis of local decision-making processes, as guided by the IAD framework, with the normative analysis of relevant legal aspects, as defined through institutional legal theory. After the theoretical discussion of this ILTIAD framework, the framework was applied to two example cases to demonstrate its heuristic value. Firstly, the ILTIAD framework was applied to the ‘Bothoven-Noord’ case (one of the cases studied in Chapters 3 and 4) to analyse the three identified legal consistency requirements and the normative barriers and opportunities regarding the institutional arrangements for an envisioned smart grid design. In a similar manner, secondly, the Dutch Experimentation Decree for Decentralized Renewable Energy Projects (as previously discussed in Chapter 5) was analysed to understand how rules-in-use and legal rules-in-form interact, and particularly whether institutionalized experimentation follows an energy democratization or an energy justice frame.

This chapter is based on the two manuscripts ‘Lammers, I., & Heldeweg, M. A. (2016). Smart design rules for smart grids: analysing local smart grid development through an empirico-legal institutional lens. *Energy, Sustainability and Society*, 6(1), 36’ and ‘Heldeweg, M. A., & Lammers, I. (under review). An Empirico-Legal Analytical & Design Model for Local Microgrids: Applying the ‘ILTIAD’ model, combining the IAD-Framework with Institutional Legal Theory’. *International Journal of the Commons*’.

6.1. Introduction

In this chapter an institutional architecture for decision-making on the introduction of smart grids is developed. This institutional architecture is created because the empirical findings of part A of this dissertation have shown that appropriate ‘rules of the game’ are needed for decision-making on the introduction of smart grids. On the one hand, these ‘rules of the game’ should help balance efficiency of energy planning and local stakeholder participation. On the other hand, they should ensure that rules-in-use and rules-in-form are not in conflict. In this chapter both of these aspects are taken into account.

The research conducted in part A established that the Institutional Analysis and Development framework (E. Ostrom, 2005, 2011) is suitable for the analysis as well as the creation of an institutional architecture. Therefore, the institutional architecture that is developed in this chapter is based on the IAD Framework. Yet, as the IAD framework is mostly concerned with analytical description, a normative dimension is added to the IAD Framework. The main goal is to connect the empirical institutional analysis of local energy planning with the normative analysis of relevant legal aspects. Normative is in this dissertation defined as action-guiding or action-determining (MacCormick & Weinberger, 1986). I believe that a framework that combines the IAD framework with institutional legal theory (MacCormick and Weinberger 1986; Ruiter, 1993) can provide such a connection. In addition, the developed institutional architecture moves beyond the identification of individual institutional conditions, and instead focusses on the design of institutional arrangements, that is on the combination of several institutional conditions.

The research in this chapter is guided by research sub-question B1 ‘*How can institutional arrangements for the introduction of smart grids be designed to be lawfully consistent?*’ Through synthesizing the previously applied IAD framework with a normative dimension reflected by institutional legal theory, the ILTIAD Framework is developed in response to this research question. I consider the ILTIAD Framework a suitable heuristic for the analytical description and *ex ante* prescriptive design of institutional arrangements for the introduction of smart grids. This inter alia involves ensuring the lawful consistency of rules. To summarize upfront, ILTIAD framework allows for the identification and mapping of prescribed patterns of social interaction (rather than merely of individual rules) and of the consequential aspects that apply to each situation, that is, the normative constraints and opportunities²⁷. As

²⁷ To add an institutional legal lens to the IAD Framework follows from the assumption that participants in action situations (of setting up and operating a smart energy system) intend to proceed in a lawful way, both as regards their actions as with respect to the outcomes. Such lawfulness has two sides: firstly, the requirement of acts and outcomes which are in accordance

a result, the ILTIAD framework can be used as a heuristic in the form of an institutional architecture for establishing new or improved institutional arrangements for smart grid projects.

This chapter is structured as follows. Section 6.2 introduces the core elements of the IAD framework that are of relevance for my theoretical synthesis. Section 6.3 presents an overview of institutional legal theory. The IAD framework and institutional legal theory are thereupon combined into the ILTIAD framework, which places emphasis on institutional levels (Section 6.4), as well as on legal consistency (Section 6.5). To show the heuristic usefulness of the ILTIAD framework it is applied to two situations. First, in Section 6.6., the legal consistency of institutional arrangements for the envisioned smart grid design for the ‘Bothoven-Noord’ case (one of the case studies addressed in Chapters 3 and 4) is analysed with the ILTIAD framework. Second, in Section 6.7, the ILTIAD framework is used to analyse whether the legal experimentation undertaken through the Experimentation Decree for Decentralized Renewable Electricity Generation (as was discussed in Chapter 5) follows an energy democratization or an energy expansion frame. Section 6.8 concludes and reflects on the research question that was addressed in this chapter.

6.2. The Institutional Analysis and Development Framework

The Institutional Analysis and Development framework (see Figure 6.1) allows to inquire how rules affect an action situation; in this research the local decision-making process on smart grid introduction.

Figure 6.1: The Institutional Analysis and Development Framework

Source: E. Ostrom (2011)

with the law, and secondly, the opportunity of making changes in the law, thus affecting the legal space within which acts and outcomes are in accordance with the law (e.g., signing a contract or issuing a permit).

Through such an empirical focus on rules it becomes possible to analyse the institutional setting of the decision-making process on the introduction of local smart grids, as undertaken in Chapter 4 (Lammers & Hoppe, 2019).

E. Ostrom et al. (1994) actually describe the IAD framework as a ‘conceptual tool for inquiry about how rules affect a given situation’ (p. 43). This situation is more specifically referred to as action situation and seven different rules-in-use²⁸ influence (together with biophysical conditions and attributes of community) this action situation, as shown in Figure 6.2 below and explained in the next subsection.

Figure 6.2: Effect of rules-in-use on the internal structure of the action situation

Source: E. Ostrom (2011)

6.2.1. Rules-in-use and rules-in-form

Elinor Ostrom distinguishes between two types of rules: rules-in-use and rules-in-form. According to her, rules-in-use are those rules to which participants would refer if they had to explain and justify their behaviour to other participants in the action situation, while rules-in-form are always written statements, resulting from formal legal procedures (E. Ostrom, 2011).

In this chapter, a more legal definition is given to the difference between rules-in-use and rules-in-form as there is a fundamental difference between the empirical/descriptive nature of IAD rules-in-use and the normative/prescriptive nature of legal rules. For this reason, rules-in-use are defined as *descriptive* institutional

²⁸ Boundary rules are by E. Ostrom also referred to as entry- and exit rules, and choice rules are also called authority rules in her work.

statements about an empirically observable state of affairs, and rules-in-form are considered *prescriptive* institutional statements projecting a normative state of affairs. More precisely, rules-in-form manifest themselves as *ex ante* (to some social practice) prescriptions, validated by the existence of a legal system. Regarding the link between these two type of rules I consider that rules-in-use of a given action situation are causally related (inter alia) to corresponding legal rules-in-form and that these rules are not in conflict with each other; either because overall actors prefer to act lawfully, or because empowered rule makers introduce new legal rules to impact on existing behaviour.

6.2.2. Multiple levels of analysis

Another element of the IAD framework that the ILTIAD framework builds on is that of multiple levels of analysis. E. Ostrom (2005, 2007) speaks of multiple levels/situations of analysis: metaconstitutional (MCL), constitutional (CL), collective choice (CCL) and operational level (OL) (see Appendix K for a graphical representation of these levels). According to E. Ostrom (2005, 2007), it is rules-in-use that are determined at each prior level: *constitutional choice rules* are defined at the metaconstitutional level (at this level constituting and reconstituting of ongoing relationships takes place), *collective choice rules* are determined at the constitutional choice level (that is, who is eligible and the specific rules used in changing operational rules, i.e., ‘making grids’ possible) and *operational rules* derive from the options and limits set out at the collective choice level (affecting day-to-day decisions made by participants, i.e., ‘making grid’). These operational rules in turn influence the action situation at the operational level (‘operating grid’). All these rules are hence crafted at a deeper level, and always exogenous to the higher level. In regard to this making of rules across institutional levels it is important to be aware of two subtleties which are taken into account in the ILTIAD framework and are particularly important when it comes to ensuring legal consistency, as described in Section 6.5.

First, actors that are part of an action situation often have the ability to change at least some of²⁹ the rules that affect their own (action) situation. To do so, actors have to ‘move’³⁰ to a deeper *analytical* level, e.g., from the operational level to the collective choice level, where they can decide to adopt new operational rules that (re)define their room to manoeuvre at the operational level. E. Ostrom et al. (1994) emphasize that the option of actors to ‘move’ from one level to another should not be ignored in the analysis, as ‘choices of actions *within* a set of rules as contrasted to

²⁹ Often other actors are also involved in changing rules, such as when a regulator unilaterally determines the operational level rules.

³⁰ Actors can undertake such a move verbally and mentally, while physically still sitting at the same table.

choices *among* future rules are frequently made without recognizing that the level of action has shifted' (p. 285).

The second important point to note is that several action situations can exist at the same institutional level. To explain, 'while the concept of a 'single' [action situation] may include large numbers of participants and complex chains of action, most of social reality is composed of multiple [action situations] linked sequentially or simultaneously' (E. Ostrom et al., 1994, p. 45). An example of dual action situations at the constitutional level is the Dutch Electricity Act (at CL) that grants the power to establish a Crown Decree (at CL) which empowers the Minister of Economic Affairs to grant licences to experiment (at CCL). Furthermore, note that when performed by the same actor configuration, such as by a prime legislator (involving various actors within, such as chambers of parliament, the executive government), this iteration between action situations will not necessarily be noticeable, particularly when the making of rules happens simultaneously as it originates in the same broad power.

6.3. Institutional Legal Theory

In this section I introduce institutional legal theory and identify the normative elements that will be synthesised with the IAD framework. In brief, institutional legal theory allows for a 'realistic analysis, explanation, or description of the legal sphere and indeed of all those distinctively human and social institutions and phenomena which correlate with, depend upon, or presuppose legal or other rules or norms' (MacCormick & Weinberger, 1986). For this purpose, the concept of legal institutions is central to institutional legal theory.

6.3.1. Legal institutions

Ruiter (1994) explains that 'according to institutional legal theory, institutions are not mental constructs that account a posteriori for actual behavior, but a priori given normative entities guiding correspondent behavior' (p. 100). Institutions in law, that is legal institutions, thus exist for the purpose of bringing about normative consequences. MacCormick and Weinberger (1986) explain that 'what gives them their complete constitution and definition is a complex set of rules including both pre-requisites for existence of particular instances, and normative consequences following from their existence; and also providing for some mode of termination' (p. 24); these are called institutive, consequential and terminative rules. Put differently, a legal institution is a regime of interrelated legal rules and can be instantiated, has normative

consequences, and can be terminated³¹. MacCormick and Weinberger (1986) emphasize that legal institutions are ‘essential to the enterprise of analysing legal systems into coherent sets of interrelated rules’ (p. 51-52). This is precisely one of the heuristic merits of legal institutions: the provision of coherent regimes – instead of the ad-hoc clustering of single rules – to be prescribed and applied to a social practice, such as that of establishing and/or operating a smart grid. Seven types of such legal institutions can be distinguished.

6.3.1.1. Seven types of legal institutions

Ruiter has done important work in systematically identifying abstract types of legal institutions (Ruiter, 1993, 2001) and developed a classification of ‘seven fundamental categories of representations of particular phenomena’ (Ruiter, 1997, p. 364), as summarized in the Table 6.1.

#	Legal Institutions	Brief definition	Example
1	Legal quality	Attribute of a person	e.g., ‘adulthood’
2	Legal status	Attribute of an object	e.g., ‘res nullius’
3	Personal legal relation	Relation between persons (‘P2P’)	e.g., ‘marriage’, ‘service contract’, ‘public-private partnership’
4	Objective legal relation	Relation between person(s) and object(s) (‘P2O’)	e.g., ‘ownership’
5	Legal configuration	Relation between objects (‘O2O’)	e.g., ‘easement’
6	Legal person	Personification of relations	e.g., ‘foundations’, ‘associations’
7	Legal object	Objectification of relations	e.g., ‘tradable rights’

Table 6.1: Seven categories of fundamental legal institutions

Following Ruiter (1997), I see three orders of legal institutions. First order legal institutions (numbers one to five in Table 6.1) concern prescriptive patterns of behaviour regarding (1) the legal quality of persons (e.g., public authority), (2) the status of objects (e.g., nature conservation park), (3) the nature of relations between persons (e.g., contracts), (4) between objects (e.g., right of way) and (5) between persons and objects (e.g., ownership). Second order legal institutions are legal persons (e.g., enterprises) and legal objects (e.g., tradable rights), that is numbers six and seven in Table 6.1. In addition, third order legal institutions are contextualisations, as environments of typical-of-type legal relations, such as of states, markets and civil

³¹ Legal institutions are established only when there is a societal need to do so. While to create institutions such as contracts, licences, legal persons and competitive markets, we need to keep in mind that there may yet be agreements, permissions, organisations and markets that remain informal (Heldeweg, 2017).

networks. As explained, all these legal institutions are underpinned by constitutive, institutive, consequential and terminative rules (about their conception, instantiation and operation). This representation is not to suggest that there are no hybrids. Regulated markets, such as many energy markets that combine liberalization of energy services with safeguards concerning public values (such as universal service, reliability, affordability, and sustainability), present an important example of such a hybrid with relevance to smart grids, as further explained in the next paragraph.

To give examples of instances of the three different orders of legal institutions, I take the Dutch Electricity Act, the Experimentation Decree for Decentralized Renewable Electricity Generation (short: Experimentation Decree) and the related licences to experiment with local energy grids (see Chapter 5 for details). In first order, examples are the public authority of a Minister to grant a licence or of the legislator to introduce the Electricity Act and of government in establishing the Experimentation Decree. In second order, the existence of associations engaged in experimenting in the local electricity grid is an example of a subtype of legal personality. In third order, the EU regulation to liberalize the former public hierarchy order of energy production and distribution, to become a hybrid regulated market (in-between public hierarchy and competitive market) presents a type of an institutional environment that is to be implemented/instantiated in 28 EU member states. Once instantiated, these regulated energy markets operate as regimes (i.e., patterns of rules) that prescribe which actors can be engaged in energy production, distribution and provision, and which freedoms there are in terms of engaging in relations between them.

MacCormick and Weinberger (1986) summarize that identifying different types of legal institutions makes it possible to achieve two potentially conflicting goals: ‘On the one hand, we can break down complex bodies of legal material into comparatively simple sets of interrelated rules; and yet on the other hand we can treat large bodies of law in an organized and generalized way, not just as a mass of bits and pieces’ (p. 53). In the next subsection legal institutions are further broken down into two types of rules.

6.3.2. Rules of power and rules of conduct

The rules that make up legal institutions are called rules of power and rules of conduct. The regimes of legal institutions project a prescriptive pattern of behaviour, determined by relevant legal rules of conduct and of power. MacCormick and Weinberger (1986) state that one of the most important and prominent theses in modern legal philosophy is that ‘law can only be understood if we do carefully distinguish between rules which confer powers and rules which impose duties’ (p. 60). Following institutional legal theory, rules that confer power are called secondary ‘rules of power’. This the need for rules of power is not present in the work by E.

Ostrom, which is understandable given her focus on rules-in-use as descriptions of (allegedly) general acceptance of some social practice. As the following paragraphs explain, ‘rules of power’ determine the ‘legal ability space’; in addition ‘rules of conduct’ determine the ‘legal liberty space’.

6.3.2.1. *Legal ability space & rules of power*

Secondary rules ‘contain various provisions *about* primary rules, whether provision for recognition of them, for alteration in them or for adjudication of alleged breaches for them’ (MacCormick & Weinberger, 1986, p. 18). In total, there are three kinds of secondary rules: rules of recognition (what upholds the legal system and when is a rule legally valid?), rules of power (who is authorized to perform which legal acts?), and rules of adjudication (who decides what the law says and how it should be applied?)³². Of particular interest in this PhD thesis are rules of power (and immunity) because they determine the legal ability space applicable to participants: the opportunity of making legal changes is about legal powers to make changes, and legal immunities to not be subject to such changes, which together make for a given legal ability space (Lindahl, 1972). To explain, the ILTIAD framework places emphasis on rules of power as these rules are relevant especially to the design and change of institutional arrangements, as making legal changes is about the ability to intentionally introduce new, or alter or terminate existing legal rules. Put differently, rules of power are particularly relevant to normative change as they make it possible to create new, or to alter or terminate existing rules of conduct.

6.3.2.2. *Legal liberty space & rules of conduct*

Primary rules are duty-imposing rules. Primary rules of conduct define normative positions as regards factual behaviour; they concern the lawfulness of performing factual actions or establishing certain factual outcomes. These rules of conduct determine the legal liberty space (Hart, 1961, pp. 91-99). To be precise, this legal liberty space is the realm of actions and outcomes that is legally available to participants in a particular action situation (Lindahl, 1972). To create but also to change and perhaps terminate primary rules, we need secondary rules. In particular one should always look ‘behind’ the primary rules, prescribing a (desired) normative fact, to see if one can identify a secondary rule of power, to determine: (1) if there is

³² Second order rules of adjudication enable enforcement of rules of conduct (and power) against transgression. Additionally second order rules of recognition specify on what grounds the former rules count as valid/legal rules within a generally accepted legal system. Ultimately rule chance only works if rules of power (and thus rules of conduct) are supported by the rule of recognition, which upholds the legal system (as the validity generating framework) – that ultimately rests upon presumed social acceptance (by at least most of the people, most of the time).

one such relevant and valid rule of power; and (2) if a legal act has been performed or is performable upon this rule of power to validly introduce, alter or terminate the given or desired rule of conduct.

From this follows that rules of conduct and rules of power are jointly relevant both in instantiation of a legal institution (often by use of legal powers, e.g., use of ownership, contractual or of regulatory power, sometimes by factual activity, e.g., ‘management of business’), and in consequential rules (once a legal institution is in place the legal space may involve both ability and liberty). That is, making institutive, consequential and terminative rules involves the making of rules of power (to instantiate or terminate, or as power of an actor within a legal institution once instantiated) and of rules of conduct (to instantiate or terminate by factual acts, or factual acts allowed once a legal institution is instantiated). Thus, a legal institution combines several rules of conduct (involving various, possibly related rights and obligations; legal liberties) or rules of power (involving legal powers and immunities; legal abilities). These regimes of rules intend to coherently describe types of realizable patterns of social behaviour (e.g., acting as firm, or parties agreeing on a contract), and at the same time prescribe lawful realization of incidents of such types of behaviour (e.g., how (not) to behave as a specific firm or how (not) to establish a certain contract). Overall, breaking down complex institutions into individual rules of power and of conduct is important as changing rules needs to be done carefully, and with concern for the functioning of the whole regime. Accordingly, ensuring the functioning of regimes across institutional levels is essential.

6.4. Combining IAD and ILT: Legal Institutionalization across Institutional Levels

The ILTIAD framework places emphasis on the relevance of institutional levels (operational, collective choice, constitutional and metaconstitutional level). As introduced in Section 6.1, E. Ostrom sees rule-change as the outcome of an action situation at a deeper level, and only focusses on rules-in-use. From a legal point of view this does not suffice as rules are different at different levels: the given deeper level comes equipped with rules of power, granting the participants (at that level) the ability to make legal changes. Thus legal powers put a new perspective on understanding relations between institutional levels because interactions on deeper levels can only change legal rules for higher levels if there are rules of power available upon these deeper levels.

As the making and use of rules of power and of conduct takes place at different institutional levels, the ILTIAD framework – based on the four institutional levels

identified by E. Ostrom – depicts at which level which type of rules are made (see Figure 6.3³³).

Figure 6.3: The ILTIAD Framework's institutional levels with rules of conduct and of power

To explain, the *metaconstitutional level* is underlying all other levels and no prior rules-in-form exist at this point. The foundation for a legal order manifests itself at this metaconstitutional level (constitutions, bill of rights and conventions) and rules of recognition are established allowing to make rules of power at the constitutional level. At the *constitutional level* in turn for instance the Civil Law Code or Electricity Act are created and two types of rules are made: rules of power (RoP) are made for the collective choice level, and rules of conduct (RoC) are made for the collective choice as well as for the operational level. For instance, the Dutch Experimentation

³³ Where E. Ostrom (2005, 2007) takes a bottom-up approach and focusses on deeper levels, for legal scholars the notion of a higher level is more customary; it was chosen here to follow E. Ostrom's approach.

Decree (see Chapter 5 for details) constitutes a change at the constitutional level that provides the legal power to the Minister of Economic Affairs (at CCL) to allow associations to experiment with new institutional settings at the collective choice and operational level³⁴. Furthermore, at the *collective choice level*, actors can then introduce rules of conduct for factual activity at the operational level. Examples of actions at the collective choice level are the contracting among operational level participants, and the granting of licenses or subsidies (by an actor that will not participate at the operational level). Finally, at the *operational level* no rules are made, but the performance of factual activities takes place, e.g., the managing of a neighbourhood cooperative or the installation of renewable energy technologies.

6.5. The ILTIAD Framework and Legal Consistency

As the ILTIAD framework shows at which institutional level rules of conduct and of power are made for the next level(s), the framework makes it possible to ensure the consistency and alignment of legal institutions inside and across action situations and institutional levels. The aspect of prescriptive consistency is a key requirement of legal systems, as in essence these are about channelling types of human behaviour through normative positions that provide a clear direction of ought. The ILTIAD framework allows to identify and to design how rules and relations need to be consistently arranged. This consistency is important because part A of this dissertation found institutional conditions in decision-making practices on the introduction of smart grids to be in conflict with one another. With the help of the ILTIAD framework, I emphasize that legal institutions need to be internally consistent (legal institution consistency), be in alignment with one another inside an action situation (action situation consistency), as well as be consistent across institutional levels (level consistency).

a. Legal institution consistency

Legal institution consistency is about the consistent design of IAD-rules that make up one legal institution (in a particular action situation). IAD-rules (of all seven types) need to be grouped consistently within a given action situation to make for proper legal institutions (e.g., a contract or cooperative) to exist and operate within that action situation. Together all seven IAD-rules should always group to make a consistent legal quality, legal personality or a consistent institutional environment. For example, this could involve the preparation of the possible introduction or change of an aggregation rule that fits the position rule of equal party autonomy in contracting, and/or the termination of rules that hamper such fit. When IAD-rules cannot be consistently

³⁴ As explained in Section 6.1, at each level, multiple action situations can exist.

grouped to form a type or incident of a legal institution at the collective choice level, for instance when there is no fitting information or aggregation rule for making an P2P-contractual arrangement, then collective action level results cannot lawfully be achieved.

b. Action situation consistency

Action situation consistency entails that inside one action situation the different legal institutions – and more particularly the IAD-rules that make up these legal institutions – are consistent with one another. This means that all IAD-rules fit not only to form particular legal institutions (under a.), but also that together the IAD-rules of the thus formed legal institutions align within the action situation, so that legal institutions can functionally interlink properly. An example would be to prepare the possible introduction or change of a legal person to fit the position rule for making a P2P, and/or the termination of position rules that hamper such fit. Put differently, missing links occur when a P2P cannot be agreed because of the absence of legal personality (that is, a lack of matching position rules as functional barrier). A project fails when the creation and/or use of various legal institutions do not lawfully add up to the desired outcomes.

c. Level consistency

The third type of consistency is level consistency. This level consistency is about ensuring that a properly established action situation (consistent according to b.) aligns consistently with outputs at lower or inputs at higher institutional levels of action situations. More precisely, it entails considering the design of IAD-rules within different legal institutions across different action situations at various levels. For instance, if at the constitutional choice level the possible introduction or change of a choice rule of a legal power within a regulated electricity market is prepared, it needs to fit a broader scope for instantiating P2Ps at the collective choice level, and/or the termination of choice rules that hamper such fit.

Following this theoretical explanation, in the next two Sections 6.6 and 6.7 the developed ILTIAD framework is applied to two examples to demonstrate its heuristic value.

6.6. Application of the ILTIAD Framework to the Bothoven-Noord Case

In this section the ILTIAD framework is applied to an empirical case in order to identify legal aspects that concern normative constraints and opportunities to establishing and maintaining a smart grid system in the Bothoven-Noord city district, Enschede, the Netherlands. This analysis focusses on the three types of legal consistency identified in Section 6.5. As a result, the ILTIAD framework serves as a

heuristic to depict prescribed behaviour, including consequential aspects (barriers and opportunities) that may not yet have been considered by stakeholders for realising a desired smart grid system, but may impact on their behaviour (whether in desirable ways or not). This knowledge will consequently help to prevent that during decision-making institutional conditions are disabling the process, or are in conflict with one another; one of the findings made in the empirical chapters of part A of this PhD thesis. Section 6.6.1 introduces the case, followed by the analysis of the three types of legal consistency in Section 6.6.2.

6.6.1. Introducing the case

To exemplify the heuristic advantages of the ILITAD framework I chose to apply the framework to the project ‘Bothoven-Noord: op weg naar een energieneutrale wijk’ (short: ‘Bothoven-Noord’ case). As discussed in Chapters 3 and 4, and described in detail in Appendix I, this project was initiated in 2013 with the aim to install smart grid components in the Bothoven-Noord city district. The project initially involved employees from the municipality of Enschede, housing associations ‘De Woonplaats’ and ‘Domijn’, DSO ‘Cogas’, DSO ‘Enexis’ and from ‘Pioneering’, a platform that connects stakeholders in the construction sector. The analyses conducted in Chapters 3 and 4 showed that although stakeholders met on a regular basis, no progress was made as regards the installation of smart grid components; the only components of a future smart grid that had been installed were smart meters.

In this section I therefore apply the ILTIAD framework to an envisioned smart grid design that the project group had (briefly) discussed in the beginning of their collaboration. Doing so will allow to identify which barriers and opportunities exist for realizing such smart grid. The action situation of interest is thus the decision-making process under existing general rules of law on the Bothoven-Noord smart grid project.

To explain, the project group envisioned that solar PV panels and Home Energy Management Systems (HEMS)³⁵ are to be offered to all tenants of the housing associations. The tenants of the housing associations are to obtain such solar PV panels and HEMS from an installation company under the following arrangement: if tenants of ‘De Woonplaats’ and ‘Domijn’ wish to have a HEMS or solar PV panels installed, the installation company will provide this technology and ‘De Woonplaats’ and ‘Domijn’ will pay for it. The housing associations in turn will increase the rent of those households where such devices are being installed (the project group members

³⁵ These HEMSs show the electricity consumption as well as the production of electricity from solar PV panels, in order to increase the energy consciousness of consumers and ideally decrease their energy demand and thus costs

believe that tenants will eventually make a profit as a result of overall lower energy costs). A company that is certified as an independent service provider will be responsible for retrieving the households' electricity consumption and production data via the installed smart meters. With the help of ICT and through dynamic pricing incentives (in 15-minute intervals) this independent service provider is supposed to make it possible for connected households to, depending on their preferences, choose their ideal moment of consumption, e.g., being the lowest price or most sustainable electricity supply.

To clarify this envisioned smart grid design, it helps to look at it through the legal-institutional lens of ILITAD, and more precisely to describe it in terms of two specific first order legal institutions: ownership (objective legal relations, P2Os) and contracts (personal legal relations, P2Ps).

The six objective legal relations, that is, ownership arrangements, needed for the envisioned smart grid in Bothoven-Noord are:

- a. DSO Enexis: ownership of electricity grid and smart meter;
- b. Housing associations: ownership of houses;
- c. Energy supplier: ownership of electricity being supplied;
- d. Installation company: ownership of wall display and/or solar PV panels;
- e. Tenants: privacy rights concerning 'smart meter data'.³⁶

Furthermore, six personal legal relations, in other words contracts, are needed, as summarized in Table 6.2. Looking at these P2Os and P2Ps shows that certain actors have been inadvertently excluded from the project group: tenants, the energy supplier, an installation company, as well as an Independent Service Provider. Furthermore, other participants who are currently involved are actually, at least legally speaking, redundant ('Cogas', 'Pioneering', and the municipality of Enschede). However, the question remains whether this smart Grid design can come into existence under the existing general rules of law. To shed light on this question, the ILTIAD framework is applied in the next subsection to analyse legal consistency of institutional arrangements for the envisioned smart grid design, and based on this, show which options and barriers exist for stakeholders to arrive at their desired smart grid vision. On the one hand such a descriptive analysis of the legal state of affairs is relevant as a matter of determining existing legal liberties and abilities. On the other hand, it also provides the point of departure for a prescriptive legal design analysis into which changes in these liberties and abilities are needed to secure the desired outcome.

³⁶ I consider privacy as a right connected to in-house privacy, that is, to what one does in one's own house, being the object one lives in. This privacy may be perceived as a P2O 'right in rem' (held exclusively by one person, against all others).

P2Ps (contracts)	Details
Housing associations & their tenants in Bothoven-Noord	Rental contract & installation agreement linked to rent increase;
Energy supplier & the tenants in Bothoven-Noord	Contract about the supply of electricity & dynamic electricity/network tariffs (priced at 15-minute intervals);
Tenants & DSO Enexis (implicit contract)	When tenants contract with an energy supplier this implies the coming into existence of a contract with the DSO to which tenants have to pay a network tariff for electricity provision; Enexis charges a dynamic electricity/network tariff;
Installation company & the housing associations	If tenants of the housing associations wish to have a wall display or PV panels installed, the installation company will provide this technology and the housing association will pay for it (while increasing the tenants' rent);
Independent Service Provider & the tenants	Tenants give permission to the Independent Service Provider to read their smart meter, and in turn receive the data about their daily consumption.

Table 6.2: Personal legal relations for the envisioned smart grid design

6.6.2. Applying the ILTIAD framework to analyse legal consistency

This section provides the results of applying the ILTIAD framework to analyse all three legal consistency requirements (as introduced in Section 6.5), for the envisioned smart grid system of the 'Bothoven-Noord' case. This analysis allows to identify relevant legal aspects and more specifically shows which barriers and opportunities currently exist for the project group to realize the envisioned smart grid design.

I first analyse level consistency (consistency of legal institutions across levels), secondly, action situation consistency (consistency of the IAD-rules of legal institutions within an action situation, exemplified for one rules-in-use type), and thirdly, legal institution consistency (consistent design of IAD-rules that make up one legal institution)³⁷. For each of these consistency analyses I discuss one of the P2Ps or P2Os, identified in the previous subsection as an example.

1. Level consistency: P2P housing associations and tenants

For the Bothoven-Noord smart grid project, the relevant regulated market context is determined at the constitutional level by the following national regulations: the Dutch

³⁷ As I believe it helps in understanding the complexity of the case, I followed the reverse order from that used in Section 6.5.

Housing Act 2015³⁸, the Dutch Electricity Act 1998³⁹ and the Dutch Rental Subsidy Act 1997⁴⁰.

To analyse level consistency I chose to take the P2P between the housing associations and their tenants as an example as housing associations own one third of all houses in the Netherlands (CBS, 2011). To repeat, this P2P for the envisioned smart grid system (in addition to the already existing rental contract) results from the installation agreement of the HEMS and solar PV panels, which are linked to rent increases. The level consistency analysed is that between the collective choice level (where the P2P is analytically located) and the constitutional level (where the Dutch Housing Act and the Dutch Rental Subsidy Act are of relevance). That is, the addressed level consistency is about ensuring that the needed IAD rules of the P2P at the collective choice level align with the outputs of the constitutional level.

The Dutch Housing Act determines that housing associations can only increase the rent for social housing once a year by a certain fixed percentage (in 2015 2.5% up to a maximum rent of €710.68 a month) and, linked to specific conditions, after measures have been taken to improve a dwelling, e.g., through the installation of solar PV panels. However, tenants have to agree on such measures (and in turn to an increase of their monthly rent) beforehand. In cases in which a housing association wants to implement such measures to a housing complex of more than ten housing units, at least 70% of all tenants have to agree. In consequence, the Dutch Housing Act unilaterally limits the legal ability space – particularly as regards choice (can/cannot contract), aggregation (mutual consent to contract) and payoff rules (height of monthly rent) – for the P2P between the housing associations and their tenants, as the housing associations' freedom to contract is dependent on the tenants' agreement. This could present an insuperable barrier to the introduction of the envisioned smart grid.

However, not only housing associations are limited, also not all tenants are free to decide whether or not to contract about the installation of a HEMS/solar PV panels and negotiate the rent increase that is linked to it. For some tenants of social housing the Dutch Rental Subsidy Act indirectly limits the legal ability space to enter into a contract: tenants whose income qualifies them for a monthly government rental subsidy (<€34,911 a year), can only receive this subsidy while they live in dwellings with a set maximum rent of €710.68 per month (in 2015). If this rent figure is exceeded, e.g., through contracting on the installation of a HEMS or solar PV panels, these tenants will no longer receive the rental subsidy. Thus for tenants who receive a

³⁸ Herzieningswet toegelaten instellingen volkshuisvesting & Novelle Herzieningswet toegelaten instellingen volkshuisvesting.

³⁹ Wet van 2 juli 1998, houdende regels met betrekking tot de productie, het transport en de levering van elektriciteit.

⁴⁰ Wet van 24 april 1997, houdende nieuwe regels over het verstrekken van huursubsidies.

rental subsidy, the Dutch Rental Subsidy Act limits the choice rules (can or cannot contract) and the payoff rules (the extent of the rent increase), which constitutes another potential barrier to implementing the envisioned smart grid design.⁴¹

Level	Actions & Outcomes
<i>Collective Choice Level</i>	Contracting among OL participants: P2P between housing associations and tenants (second order legal institution)
<u>Outcome of constitutional level</u>	
<ul style="list-style-type: none"> • Legal ability space (generally) for contracting among participants; • Unilaterally limited legal ability space for housing associations (annual rent increase, maximum rent for social housing); • Indirectly unilaterally limited legal ability space for tenants (maximum income and rent to qualify for rental subsidy); • 70% of tenants have to agree to measures in housing complexes. 	
<i>Constitutional Level</i>	Dutch Housing Act 2015, Dutch Rental Subsidy Act 1997

Table 6.3: Legal institutionalization across institutional levels

To sum up, as regards the P2P between the housing associations and their tenants (at the collective choice level), the Dutch Housing Act and Dutch Rental Subsidy Act (at the constitutional level) present a barrier to the introduction of the envisioned smart grid, as neither housing associations nor tenants (who receive a subsidy) have the legal ability space to contract for a rent of more than €710.68 a month (see Table 6.3 for a summary).

2. Action situation consistency: aggregation rules for all P2Ps

Action situation consistency refers to the consistency of legal institutions, and of the IAD rules that constitute these legal institutions, inside one action situation (at the same institutional level). To exemplify this action situation consistency I chose to analyse whether the aggregation rules of all needed P2Ps (first order legal institutions) align within the action situation (summarized in Table 6.4).

The general aggregation rule is that in contracting all parties need to agree; that is, mutual consent and mutual expression (through offer and acceptance) of the willingness to contract are necessary. This standard aggregation rule applies for the P2P between the Independent Service Provider and the tenants, as well as for that between the energy supplier and the tenants. As regards the P2P between DSO

⁴¹ This ‘indirect’ limit of the ability space to contract is a factual limitation to use an existing ability space caused by either the discontinuation of a claim to subsidy or the inability of government to establish a new or renew an existing subsidy relation.

‘Enexis’ and the tenants, the aggregation rule is implied, as this P2P is automatically established when a contract with an energy supplier is entered into.

However, while the general aggregation rule also applies for the P2P between the housing associations and the tenants as regards the rental contract, contracting on the installation of solar PV panels or a HEMS for housing complexes is subject to a different aggregation rule: only 70% of tenants have to agree (as stated in the Dutch Housing Act 2015). Mutual consent and expression of 30% of tenants is therefore not required. Yet tenants who receive a rental subsidy and have a rent that is close to the threshold for qualifying for this subsidy (€710.68 per month in 2015) do not have the legal ability space to agree on any rent increase (if they want to continue to receive the subsidy). This limitation could present a potential conflict in agreeing to contract.

P2Ps	Aggregation rules
Independent service provider & tenants	Standard: mutual consent and mutual expression of the willingness to contract.
Energy supplier & tenants	Standard: mutual consent and mutual expression of the willingness to contract.
DSO Enexis & tenants	Implicated aggregation when P2P between energy supplier and tenants comes into existence.
Housing associations & tenants (on HEMS/solar PV panels)	For housing complexes only 70% of tenants have to agree; tenants with rental subsidy and rent close to €710.68 do not have legal ability space to agree.
Installation company & housing associations	Dependent on agreement of tenants and housing associations. Then standard aggregation rule.

Table 6.4: Aggregation rules for all P2Ps

Related to the above, for the contract between the installation company and the housing associations, the standard aggregation rule of mutual consent and mutual expression between these two parties is not sufficient for the creation of this P2P. Only if at least 70% of tenants agree on the installation of the HEMS/solar PV panels and the linked rent increase with ‘De Woonplaats’/‘Domijn’ (i.e., the P2P between the housing associations and tenants is realized), the P2P between the housing associations and installation company can come into existence.

In conclusion, because the aggregation rules of two legal institutions are linked, action situation consistency of all five needed P2Ps depends inter alia on whether at least 70% of tenants agree on the installation of the HEMS/solar PV panels. In addition to the aggregation rules, the other six IAD-rules that make up the five P2Ps need to be evaluated to assess overall action situation consistency.

3. Legal institution consistency: P2P energy supplier and tenants

Legal institution consistency is about the consistent design of IAD rules that make up one legal institution, in the example chosen here the P2P between the energy supplier

and the tenants in Bothoven-Noord. For the functioning of the envisioned smart grid, this electricity contract needs to facilitate dynamic pricing.

The analysis revealed that while two rules-in-use (information and scope rules) are aligned with all other IAD-rules for the needed P2P, position, boundary, choice, aggregation and payoff rules are partially conflicting with each other under the existing general rules of law, as summarized in Table 6.5 and explained in the next paragraphs.

The standard *position and boundary* rule applies that an energy supplier and tenants can participate in the project as they have the ability to contract. However, currently neither an energy supplier, nor any residents of Bothoven-Noord are even aware of the smart grid project plans. Furthermore, the Dutch Electricity Act limits the *choice rules*, and more precisely the liberty space for energy suppliers, as these companies have to purchase the electricity that contracted households generate, in other words, to only bill consumers for their net purchase of electricity (net metering).

Rules-in-use	P2P energy supplier & tenants Bothoven-Noord
Boundary rule	Ability to contract (but need to be made aware of/invited to join project)
Position rule	Ability to contract
Choice rule	For energy suppliers limited liberty space as regards net metering
Aggregation rule	Mutual consent and mutual expression of the willingness to contract
Payoff rule	Decided freely by contractual parties, however limited legal ability space for energy suppliers
Information rule	Information available to both contracting parties
Scope rule	Derive from legal ability space of contractual parties

Table 6.5: Legal institution consistency for P2P energy supplier and tenants

The general *aggregation rule* is that in contracting, all parties need to agree; that is, mutual consent and mutual expression (through offer and acceptance) of the willingness to contract are essential. Yet, the just outlined choice rule of net metering, as well as the payoff rules limit the application of this standard aggregation rule.

Given the regulatory market context, *payoff rules* are decided freely by the contracting parties. However, the price that an energy supplier charges consumers in the Netherlands consists of four parts: (1) a fixed charge, (2) energy tax, (3) a price per kWh electricity consumed, (4) 21% VAT on all kWh charged for. An energy supplier only has the legal ability space to change payoff rules as regards the price of the kWh of electricity consumed. This fits the limitations of the choice rules, and is also conflicting with the aggregation rule due to the fact that energy suppliers cannot agree to contract on *any* electricity price.

As regards *information*, the contractual parties have the obligation to make all information available to each other. The *scope rules* derive from the objective legal relations (P2O) of the contracting parties.

In sum, the rules-in-use as regards the P2P between an energy supplier and the tenants in Bothoven-Noord are partially in conflict, which creates two main barriers for the functioning of the envisioned smart grid. Firstly, a barrier exists as it is not sufficient for two contractual parties to be able to contract, but parties also have to be invited to join the project. Secondly, energy suppliers are limited when it comes to agreeing on the price of electricity.

To conclude, this Section 6.7 has shown that the application of the ILTIAD framework made it possible to identify the pivotal role of constitutional level institutional choices for collective choice level decisions on establishing and implementing an envisioned smart grid in the city district Bothoven-Noord. By focussing on legal consistency it became evident which prescribed patterns of social interaction exist for (envisioned) local energy projects as well as which (often sequential) changes would be needed at various institutional levels. The ILTIAD framework thus makes it possible to *ex-ante* alleviate one of the drawbacks of local energy planning on smart grids that was identified in part A of this dissertation: the disabling influence of, and conflict between institutional conditions.

6.7. Application of ILTIAD to the Dutch Experimentation Decree for Decentralized Renewable Electricity Generation

To understand what is involved in designing proper legal arrangements towards legal experimentation, in this section the ILTIAD framework is applied to the Dutch Experimentation for Decentralized Renewable Electricity Generation. In Chapter 5 (Lammers & Diestelmeier, 2017) this Experimentation Decree (and the governance arrangements established by it) was discussed in detail; the below Subsection 6.7.1 therefore only provides a brief background and summary of this Decree.

As part A of this dissertation found that efficiency and local stakeholder participation in decision-making on the introduction of smart grids are not in balance, in the analysis of this experimental legislation I particularly reflect on the emphasis placed on the involvement local participants (democratization) versus the quick realization of more smart grids (expansion). Subsection 6.7.2 introduces these underlying transition justice concerns of energy expansion versus energy democratization.

In Subsection 6.7.3 I demonstrate how the abstract ILTIAD framework provides a lens to identify legal aspects regarding possible avenues of institutionalized experimental design towards new futures. Instead of focussing on the three types of legal consistency that were analysed in Section 6.6, in this section the ILTIAD framework is used to analyse the legal experiments in regard to institutional levels, consequences of choice as regards institutional environments, and the interaction of rules-in-use and legal rules-in-form. The last Subsection 6.7.4 reflects of whether this

institutionalized experimentation follows an energy democratization or an energy justice frame.

6.7.1. Regulatory disconnect & legal experimentation in the Netherlands

The current Dutch legal setting has two main consequences which both reflect a divide between desired rules-in-use and existing rules-in-form. On the one hand, no standard rules-in-form (i.e., legal rules) exist that allow newly emerging actors to play a role in smart grid projects; e.g., the rules-in-form of the Dutch Electricity Act currently only specify the involvement of DSOs and energy suppliers. On the other hand, as a matter of desired rules-in-use (constituting generally accepted practice), DSOs who want to continue to play a central role in smart grid projects, for example by providing residents with smart appliances, have been receiving warnings from the Dutch Authority for Consumers and Markets for doing so (ACM, 2015).

The existing divide between desired rules-in-use and existing rules-in-form for the institutional setting of innovative smart grid projects exemplifies the concept of ‘regulatory disconnect’ between regulation and innovation. Such disconnects can ‘arise when innovation in the market develops in a faster tempo or differently than envisaged compared to respective regulation. The regulatory disconnection is not automatically problematic, but in certain cases it could lead to regulatory failure and should be eliminated’ (Butenko, 2016, p. 702).

To identify new institutional arrangements for local (smart) energy systems, attempts have been undertaken in the Netherlands to achieve evidence-based institutional change through legally facilitated experimentation for local energy systems: on 1 April 2015 the Dutch Experimentation Decree for Decentralized Renewable Electricity Generation entered into force. This Decree empowers the Dutch Minister of Economic Affairs to allow experiments where associations take over the grid operation responsibilities of DSOs in local, small grid projects. In total nine projects received experimental status in 2015 and 2016. Chapter 5 summarizes the main changes that these projects (experimental action situations) entail. In this chapter, I look at the identified changes through applying the ILTIAD framework. I specifically add this normative dimension as the design of this legal experimentation involves as change of rules-in-form to accommodate (desired) rules-in-use. As this modification of rules-in-form can be guided by ‘democratization’ or by ‘expansion’ concerns, the analyses in the following sections take into account these underlying frames.

6.7.2. Democratization vs. expansion

Part A of this dissertation has identified that a balance is lacking between efficiency of energy planning and the participation of local stakeholders in these planning practices. Looking at this finding in terms of underlying transition justice concerns, possible avenues of institutionalized experimental design could follow an energy democratization versus an energy expansion frame.

Democratization would emphasize procedural justice (of a key cooperative mode of decision-making) and substantive justice (of the community as key beneficiary) that empower and benefit communities. Guidance by ‘expansion’ would lead to a focus on creating as many local renewable energy grids as possible while retaining competitive exchange, such as by local energy grid management as commercial undertaking, perhaps as ‘micro energy markets’ of a limited set of households, basically fitting the model of the existing regulated energy market (Hoffman & High-Pippert, 2015; Simcock, 2016; Sovacool, Burke, Baker, Kotikalapudi, & Wlokas, 2017). In practical terms this is to say that when designing legal experiments the legislator has to consider objectives as regards the choice between democratization and expansion. As Table 6.6 suggests, there are basically three options.

Expansion	Hybrid	Democratization
Participation and sharing only in as much as efficient towards expansion (involve communities only to reduce NIMBY-ism)	Only input or only output legitimacy (as value in itself)	Input & output legitimacy (as value in itself): procedural and substantive justice is key

Table 6.6: Three institutional designs for experimentation in (local) renewable energy projects

A choice in policy objectives – on the spectrum from renewable energy expansion to energy democratization – requires designing proper legal arrangements towards such experimentation. The ILTIAD framework can facilitate this. Therefore, in the next subsection I analyse the Dutch Experimentation Decree through the ILTIAD lens.

6.7.3. Dutch legal experimentation seen through the ILTIAD lens

The institutional legal framing of the experimentation, across various institutional levels, is vital to what evidence-based future may occur. In this section therefore, first the institutional levels involved in the Experimentation Decree are analysed. This is followed by a discussion of the choices of institutional environments, as well as the divide between rules-in-use and legal-rules-in-form and the underlying policy objectives in terms of energy justice concerns.

6.7.3.1. Institutional levels

For the analysis and the design of institutional settings all three institutional levels have to be taken into account. In analytical terms, the Dutch Experimentation Decree constitutes a change at the constitutional level⁴², which provides the legal power to allow associations to experiment with new institutional settings at the collective choice and operational level, that is, outside of the current Dutch legal framework. This can be summarized as projects being established on the collective choice level in ‘standard’ action situations (under the current rule of law), and in ‘experimental action situations’ (AS – 1) that derive from the Experimentation Decree. The main goal of the experiments is to obtain information. This information might in the end be used to change the current legal framework at the constitutional choice level (AS – n, change?). As exemplified in the graphic (Figure 6.4) below.

Figure 6.4: Institutional levels and experimentation

For the analysis, and especially for the design of (experimental) smart grids, institutional arrangements have to be consistent inside each action situation (action situation consistency), as well as across action situations at the three analytical levels (level consistency). Under general rules of law as outlined in the Dutch Electricity Act consistency however is absent. Either no standard permissive rules-in-form exist for actors who want to participate in smart grids at the collective choice or operational level (e.g., newly emerging actors such as ‘aggregators’), or the rules-in-use followed

⁴² In fact, as explained in Subsection 6.2.1., there are two constitutional levels because the Electricity Act (at CL) grants the power to establish a Crown Decree at the constitutional level (i.e., the Experimentation Decree) which empowers the Minister of Economic Affairs to grant licences to experiment (at CCL).

by certain actors are in conflict with the rules-in-form (e.g., DSOs who want to provide households with smart washing machines). Legal experimentation can help overcome this lack of consistency.

6.7.3.2. Institutional environments

The aspect of consistency also manifests with regards to (the choice of) institutional environment, such as that of a regulated energy market. As a third order legal institution this environment affects the legal space available to the use of first and second order legal institutions. An important example is that of how DSOs can be involved in smart grid projects and whether communities involved in such energy systems could operate as an energy company, selling their surplus to third parties in the energy market.

Three key basic forms of institutional environments exist: public hierarchy, competitive market and civil society (Powell, 1990; Rhodes, 2007; Thompson, Frances, Levačić, & Mitchell, 1991). These three distinctive modes of governance entail different interactions, being unilateral public interest interventions next to private interest exchanges and community interest cooperation. Looking at these three institutional environments with the help of the ILTIAD framework allows to identify their consequential rules in terms of legal opportunities and constraints, e.g., requirements of legitimacy, such as of democratic government (voice), competitive exchange (exit), or voluntarism (loyalty)⁴³. This also brings that governments should respect human rights, that companies in a market may not form cartels and that community networks shall put stakeholder interests first. By way of a very concise summary, Table 6.7 presents the three basic types of legal institutions.

Public hierarchy	Competitive market	Civil society
Command	Exchange	Cooperation
Public interest	Private interest	Community interest
Voice	Exit	Loyalty
Constitutional & administrative law	Competition law	Law of association & societal enterprise

Table 6.7: Three key basic types of institutional environments

The regulated energy market is a hybrid that seeks to best combine command (e.g., regulations and licences) and exchange (buying and selling of energy), and thus serving both public and private interests of reliable, affordable and sustainable energy provision. Public hierarchy safeguards where deemed necessary to avoid that (short

⁴³ Aside from specific legal requirements, such as of administrative law, competition law and law of social enterprise and free association.

term) private interests neglect particularly the (long term) interests of universal access and reliability.

The Experimentation Decree specifies that associations take over grid operation responsibilities of DSOs in local, small grid projects. The question remains, what is this experimentation trying to prove? Is it about the future of community electricity grid projects as one of civil energy society, or is it about a possible modification of the regulated energy market, or perhaps a hybridization in between the former and the latter? The below graphic, Figure 6.5, pictures the question that is at stake here.

Figure 6.5: Institutional choice

Using the ILTIAD framework to compare experimental rules-in-use with legal-rules-in-form to experiment can shed light on this question of whether experimental practice builds on the regulated energy market type of energy provision, or rather presents a move towards a civil energy society mode.

6.7.3.3. Rules-in-use vs. rules-in-form and democratization vs. expansion

Drawing on the ILTIAD framework allows to identify that the rules-in-form (those rules that are specified in the Experimentation Decree) and rules-in-use (those rules that are used in the experiments) are contradictory. To explain, although the current Experimentation Decree specifies that associations are to be responsible for generation, supply and grid operation, in practice in many projects it was other stakeholders such as professional project developers, companies, research centres and a real estate company that led those projects. Furthermore, although the current rules-in-form state that DSOs cannot exercise control in the experimental projects and

associations must be entirely controlled by their members, DSOs and energy suppliers still seem to exercise control. For more details on these findings please refer to Chapter 5.

From this state of experimental affairs the ILTIAD-approach reveals that *de jure*, as reflected in the rules-in-form, democratization seems to be the objective of the experimentation, as the way actors are positioned – particularly the associations – driven by both procedural justice (of having the key say in the project) and substantive justice (of sharing the benefits of the project). *De facto*, practice however paints a picture in which the position of associations is rather ‘superficial’, while commercial interest driven actors are in charge.

Furthermore, the desire to introduce experimental local grid projects with associations responsible for all activities in the local energy system seems to challenge the currently existing regulated energy market balance. Such a perspective is at odds with the separation of the roles of producers and consumers in energy provision and their competitive exchange mode of allocating energy services. It begs the question whether local grid projects are seen as guided by ‘democratization’ or by ‘expansion’ (Szulecki, 2018). This question is will be discussed in the next subsection.

6.7.4. Discussion

With respect to the facts of the matter, this state of affairs raises the question how to move forward with experimentation. Should the legislator ‘get real’, place expansion of renewable energy upfront and regard experimentation as one that should be about how local energy grids can be best reconciled with the institutional environment of the regulated energy market? In this situation participation of associations is rather more about reducing NIMBY-ism than about having a key ‘say’ (Devine-Wright, 2012). Or do the experiments require stronger institutional support to indeed strengthen (support for) the role of associations and find a pathway towards ‘true’ energy democratization, with an accompanying institutional legal framework?

Clearly, ‘democratization’ would be a course where experimentation would need to be channelled to facilitate an evidence-based legislative decision on the desirability of establishing a community energy society – aside the regulated energy market (with consequences for the use of first and second order legal institutions, being contracting, permitting, ownership, legal personality, transferable legal objects/rights). All of this would have to bring input legitimacy as procedural justice to the involved associations, and output legitimacy as substantive justice to the associations – as said: having both the ‘key say’ about and the main benefits from the projects.

Should ‘expansion’ be the key objective then the existing regulated energy market could be the governance point of departure, and experimentation should be channelled towards evidence about the need for minor rather than major legal modifications.

Clearly the position of associations would not be one of being the key or prime stakeholder in terms of procedural and substantive justice, but rather one that merely ensures reducing NIMBY-ism to allow for an effective and efficient rollout of local community energy grids.

The in-between hybrid governance position would only bring input legitimacy as procedural justice to associations (without a major stake in benefits), or only output legitimacy/substantive justice, without the key say in the project undertaking. This may be the ‘best of both worlds’, but the hybrid character brings an intrinsic complexity, of reconciling private interest-driven behaviour of commercial actors and community interest-driven behaviour by associations – with a complex detailing on fitting first and second order legal institutions in its instrumentation. Again, the legal arrangement for experimentation would have to reflect to include this option if it is to yield useful information to consider this mode of governance as a viable future option.

A Dutch legislative proposal, called ‘Wet VET’⁴⁴, is now on its way to further flexibility by allowing various actors, particularly DSOs, temporary and/or experimental possibilities of derogation from the Electricity Act. Based on the focus of this proposal it can be concluded the Dutch prime legislator is currently pursuing a more expansionist approach, enabling DSOs to foster the energy transition through projects that private actors within the market are unlikely to undertake. It is too early to tell what this means in terms of the frame of the Dutch energy transition, as this largely depends on the yet to be proposed changes to Dutch legislation.

To recap, to understand what is involved in designing proper legal arrangements towards legal experimentation, and demonstrate the use of the ILTIAD framework, a theoretical expose was presented in this Section 6.7. Applying the ILTIAD framework to the first findings of Dutch experimental local electricity grid projects clarifies that a choice in policy objectives – on the spectrum from renewable energy expansion to energy democratization – requires thorough consideration of institutional aspects, first and foremost in the design of the legal arrangements for the relevant experimentation. From this follows that the ILTIAD framework can improve our understanding of how rules-in-use and legal rules-in-form interact and what this means in terms of the institutional modes of (experimental) governance, and particularly for the consequences of choice as regards the institutional environment (as third order legal institution). The ILTIAD framework thus not only makes it possible to identify *ex ante* how rules and relations need to be consistently arranged, but also allows to reflect on what is involved in preserving participation while accelerating the expansion of smart grid projects. As explained in the following Section 6.8., these heuristic

⁴⁴ This legislative proposal is called ‘voortgang energietransitie’, in short ‘Wet VET’ (Wet VET, 2018) and is discussed more extensively in Subsection 8.3.2 as regards the implications of this PhD thesis’ findings for policy-making in the Netherlands.

advantages of the ILTIAD framework are particularly suitable as an institutional architecture that was called for in part A of this dissertation.

6.8. Conclusion

In this chapter the research sub-question B1 '*how can institutional arrangements for the introduction of smart grids be designed to be lawfully consistent?*' has been addressed through developing the ILTIAD framework. To summarize, this chapter has shown that the ILTIAD framework is a useful heuristic for analysing and designing institutional arrangements. Whereas the Institutional Analysis and Development framework is mainly concerned with analytical description, the ILTIAD framework additionally allows for prescriptive design of institutional arrangements for smart grids.

In particular, the developed ILTIAD framework facilitates the identification and mapping of prescriptive patterns of social interaction (rather than merely of individual rules), which are relevant to the lawful design of institutional arrangements for smart grids. To ensure this lawfulness inside and across action situations and institutional levels, three types of legal consistencies have to be met: legal institutional consistency, action situation consistency, and level consistency. By focussing on legal consistency in terms of normative alignment, the ILTIAD framework allows actors to identify which barriers or opportunities exist for realizing a specific smart grid (and if needed, based on this, to contemplate and evaluate alternatives). This heuristic value of the ILTIAD framework was demonstrated through analysing the legal consistency requirements regarding the institutional arrangements that would be needed for an envisioned smart grid design in the 'Bothoven-Noord' case (one of the case studies analysed in Chapters 3 and 4).

Furthermore, the ILTIAD framework allows to reflect on what is involved in designing legislation that allows to preserve participation while accelerating the expansion of smart grid projects. To emphasize this additional heuristic value of the ILTIAD framework, the Dutch Experimentation Decree for Decentralized Renewable Energy Projects (as previously discussed in Chapter 5) was analysed with these energy justice concerns of democratization versus expansion in mind.

In sum, the ILTIAD framework is an appropriate institutional architecture that facilitates the creation and alignment of 'rules of the game' for decision-making processes on the introduction of smart grids. More specifically, and in a response to the results of part A of this dissertation, the ILTIAD framework can facilitate to find a balance between efficiency of energy planning and local stakeholder participation, as well as ensure that rules-in-use and rules-in-form are not in conflict. Specifically, the ILTIAD framework can be used as a heuristic for creating or improving institutional arrangements for (planned) smart grid projects, while taking into account

energy democratization and energy expansion concerns. Moreover, due to the focus on general normative 'heuristic concepts' (such as that of legal institutions) the ILTIAD framework is also suitable for the introduction of additional smart energy infrastructures (e.g., smart heating grids) as well as for smart energy systems, that is, for a wider energy system integration that moves beyond the electricity sector.

Still, it should be recognized that the ILTIAD framework is still in its infancy and can benefit from further elaboration and sophistication. Continued simultaneous research on empirical smart grid planning and on improving the ILTIAD framework has the potential of being reciprocally beneficial. Thus a promise lies ahead that should appeal to the research agenda of those interested in the heuristics of understanding and improving institutional arrangements for the energy transition, and for smart energy system and smart grid projects more specifically.

Chapter 7

Rethinking Participation in Smart Grid Planning

Abstract

While the technical layout of smart grids is well-advanced, their realization is slowed down by current decision-making practices. Part A of this dissertation identified the need for a process architecture for decision-making on the introduction of smart grids to alleviate this problem. In this seventh chapter I develop such process architecture that focusses on the reorganisation of local energy planning practices in order to ensure a better balance between efficiency and local stakeholder participation in decision-making on the introduction of smart grids. Specifically, I address sub-question B2 ‘*how can decision-making on the design and implementation of smart grids be accelerated?*’ Inspired by engineering design thinking and based on two workshop sessions, I identify five design phases and an implementation phase, and distinguish between a design component and a participation component. The qualitative decision-making approach that I develop in this chapter allows for the effective participation of external stakeholders at four specific moments in the decision-making process. Furthermore, it clarifies positions and expectations as well as aims at ensuring the acceptance of proposed designs by local stakeholders. This way, efficiency and effectiveness in smart grid planning can be increased without compromising the participation of local stakeholders. While applied to the Dutch context of energy planning in this chapter, the developed decision-making approach is useful for project participants as well as policy-makers in a wide variety of settings and for different types of smart energy infrastructures.

This chapter is based on Lammers, I., & Arentsen, M. J. (2017). Rethinking Participation in Smart Energy System Planning. *Energies*, 10(11), 1-16. doi:10.3390/en10111711.

7.1. Introduction

The Dutch government, market players and societal organizations consider smart grids an important backbone of the Dutch energy transition (Ministerie van Economische Zaken, 2011; SER, 2013). Smart grids are assumed to facilitate the efficient integration of electricity production from decentralized renewable energy sources, demand response and load management through real-time remote control of many different sustainable energy technologies, ranging from heat pumps to electric vehicles and smart appliances (Blumsack & Fernandez, 2012; IEA, 2011). Despite the assumed high sustainability potential, the implementation of smart grids is still predominantly rhetoric instead of practice (Gangale et al., 2017).

Looking at the current practice of energy planning in Dutch infrastructure projects, many projects start with high sustainability ambitions, but quite often end up with compromised outcomes (Commissie Elverding, 2008). As part A of this dissertation has shown, local energy planning practices on the introduction of smart grids are characterized by low efficiency, a lack of residents' participation as well as by disabling and conflicting rules-in-use. The costs of these drawbacks are significant, since decision-making takes lots of time and outcomes are not always facilitating the energy transition. In this chapter, therefore, I focus on balancing efficiency of decision-making and the participation of local stakeholders in energy planning. I do so by developing a process architecture in the form of a qualitative decision-making approach.

The Dutch government recognises that the speed and quality of decision-making on energy projects need to increase (Ministerie van Economische Zaken, 2016). To achieve this goal, more and earlier participation by all potential stakeholders is recommended by the Dutch government. In this chapter, I explain that there is indeed room for improvement in current Dutch energy planning practices, but that merely increasing participation will not lead to quicker and higher quality outcomes. In my view, improving decision-making in energy planning is not just a matter of more participation, but rather of a better-structured and focused participation.

Current literature on smart grid design does not address this aspect of decision-making among stakeholders for the introduction of smart grids, as the following examples show. Current decision-making models and support tools focus on entirely different aspects, for instance the development and application of algorithms for renewable energy systems (An, Liu, Zhu, Dong, & Hur, 2016; Chang & Chih-Hsien Peng, 2016; Ou & Hong, 2014; Stamatescu et al., 2017), the general technical architecture (CENCENELEC, 2012), or energy efficiency measures in individual buildings (Choi, Shin, Lee, Kim, & Cho, 2017; Magrassi, Del Borghi, Gallo, Strazza, & Robba, 2016). While these technical aspects are important, all components have to

be implemented by stakeholders in practice. This calls for collective decision-making among stakeholders. However, the current Dutch approach of consensus-seeking slows down progress and leads to compromised results (Commissie Elverding, 2008). For the design and implementation of smart grids in particular, this current decision-making approach is not appropriate.

I therefore argue for the need to re-design the decision-making process on local energy planning. A new approach needs to help rebalance stakeholder participation and efficiency in decision-making on local sustainable energy infrastructures, in particular on smart grids. The goal is to make the decision-making process more organised and structured (and thus accelerate it) while ensuring participation. This rebalance is needed for realising the Dutch energy transition and more specifically for increasing the speed and quality of decision-making on the introduction of smart renewable energy technologies. This chapter, therefore, addresses the following sub-question B1: *how can decision-making on the design and implementation of smart grids be accelerated?* While the focus of this research question is on improving the governance on the introduction of smart grids, the decision-making approach developed in response to this research question can also be used for the introduction of additional smart energy infrastructures (such as smart heating grids) as well as for integrated smart energy systems that combine smart electricity, thermal and gas grids (Lund et al., 2017). This is the case because the decision-making approach is created with the aim to be suitable for a wide range of energy planning situations, as well as because in Chapter 4 no differences were found in energy planning practices based on the type of energy infrastructure (electricity/heat) in question.

This chapter is structured as follows. In Section 7.2, I analyse in more detail the current practice of local energy planning in the Netherlands. I conclude that under current practice, the design of a potential smart sustainable solution is often overshadowed by what the consensus-based decision-making process generates as a feasible solution. To develop an alternative decision-making approach, in Section 7.3, I take inspiration from the rational approach of engineering design practice (Pahl, Beitz, Feldhusen, & Grote, 2007). In a typical engineering approach, the problem is analysed, a set of design principles (functionalities) is formulated, possible solutions are designed, possibly tested and compared, and then the implementation of the design commences (Pahl et al., 2007). Section 7.3 additionally specifies the method of using workshop sessions for the creation and validation of my suggested approach. The resulting qualitative decision-making approach for the design and implementation of smart grids, and more broadly for that of smart energy systems, is presented in Section 7.4. It should be noted that my approach is about decision-making as an act to attain results and not about the results (energy infrastructure) themselves. Finally, Section 7.5 summarises and discusses the findings of this chapter.

7.2. Current Dutch Decision-Making Practices in Energy Projects

Following the liberalisation of energy markets in Europe, the institutional and technical outlook of the energy system underwent major changes. Among other aspects, the ‘vertical integration slowly eroded into an unbundled value chain with hybrid modes of organisation and diffuse property rights structures’ (Künneke & Finger, 2009, p. 7). This also affected energy planning in the Netherlands. Under the old system, the integrated energy company was in charge of rolling out the energy infrastructure in residential areas. The options were rather straightforward: electricity and natural gas grid connections. In the mid-1990s, heat distribution was increasingly considered and implemented in several urban areas, but that was it. In the following years, the technical options for local energy infrastructures increased tremendously, while at the same time, the local responsibilities and division of tasks in energy infrastructure planning and implementation blurred. Moreover, decision-making on local energy planning became crowded due to an increase in the number of stakeholders involved: ‘the emergence of new actors and actor constellations in the dissemination of sustainable energy technologies has made local energy policy and planning more complex’ (Elle et al., 2002, p. 54). The old energy company split up into at least two independent companies: energy production/supply and distribution system operator (DSO). The number of stakeholders increased with the rise of available sustainable technical options and community energy initiatives gave the local community a voice in the process (Arentsen & Bellekom, 2014). The importance of local communities is also highlighted in a recent Dutch legal experiment (Crown Decree for Decentralized Renewable Electricity Generation) that puts associations in charge of local electricity grids, as studied for a legal (Heldeweg, 2016) and governance perspective (see Chapters 5 and 6 of this dissertation).

The increased diversity in technological options and stakeholders was not accompanied by a new formalised institutional environment with clear rules on tasks, duties, and responsibilities. Such rules are crucial for the organisation of future electricity systems, as Verbong et al. (2013) emphasise. However, Wolsink (2012) explains that ‘there remains a complete lack of understanding of the need for institutional change required to establish [smart grids]’ (p. 833). In the Netherlands, decision-making on local energy planning, therefore, became a process of localised ‘muddling through’ with undefined, unpredictable outcomes. In line with the Dutch ‘polder model’ of consensus decision-making (Coenen et al., 2001), many stakeholders sit around the table discussing smart energy options with democracy dominating the process at the expense of efficiency. Efficiency through faster decision-making is needed, though, as the Netherlands is generating more electricity from renewable energy sources and stakeholders are recognizing the need for smart grids to balance the changing electricity supply and demand patterns in the electricity

system (SER, 2013). Several initiatives to improve decision-making in energy planning processes have been implemented over the last years, as described below.

7.2.1. Elverding Advisory Committee

In 2008, the Dutch government established an advisory committee (called ‘Elverding’ advisory committee) for accelerating decision-making on infrastructure projects to investigate the causes for the delays in large infrastructure projects. The report states that ‘the demand of our [Dutch] consensus culture to combine the almost incompatible fails in many cases due to administrative and political incapacity to make decisions and to execute decisions once they have been made’ (Commissie Elverding, 2008, p. 4)⁴⁵. The indecisiveness and lengthy procedures eventually led to a loss in quality of project outcomes. Moreover, the decision-making process was also responsible for causing project delays due to the fact that it was not sufficiently well-structured. To alleviate this barrier and achieve ‘faster and better decision-making’, the committee recommends structuring the process into three phases: exploration, plan elaboration, and execution. The committee also recommended earlier and greater involvement of stakeholders at the start of the exploration phase, by jointly working on the problem analysis and formulation of ambitions (Commissie Elverding, 2008). This structuring of the decision-making process is colloquially referred to as ‘Elverding approach’, and for instance emphasized in the Dutch ‘Energy Agreement’ to be used in all projects that have an impact on the environment (SER, 2013).

7.2.2. Pilots for ‘faster and better’ decision-making

In light of the creation of a new Dutch Spatial Planning Act, two pilot projects on energy infrastructures were started in 2015 to implement the ‘faster and better’ decision-making process proposed by the Elverding advisory committee. Even in projects where this new approach was used, several factors still limit the speed and quality of decision-making in energy projects, as identified by Kwast and Wesselink (2016). The main barriers are as follows. Firstly, a great many stakeholders with different objectives and tasks (investment, commissioning, control) are involved, but the different roles of these participants are not clear. Secondly, the set-up of projects is not being carefully established and properly thought through, and decision-making is not overarching and inclusive, but mainly takes place inside individual organisations. Thirdly, the identification and definition of projects often relates too

⁴⁵ Translation from Dutch by the authors. Original Dutch text: ‘De behoefte in onze consensuscultuur om het bijna onverenigbare toch te verenigen, strandt vervolgens in veel gevallen op bestuurlijk en politiek onvermogen om besluiten te nemen en een eenmaal genomen besluit ook door te zetten.’

much to their function (technology), which is especially the case for projects where distribution system operators are in charge and, for example, give priority to the security of supply. A last observation by Kwast and Wesselink (2016) is the high external influence of the Ministry of Economic Affairs, even though no representative of the Ministry is directly involved in projects. Overall, ‘faster and better’ decision-making is not happening yet, which seems to derive mainly from a lack of clarity on tasks and roles in the decision-making process.

7.2.3. Views of the Dutch Minister of Economic Affairs

In 2016, the Dutch Minister of Economic Affairs recognised that the quality and speed of decision-making on energy infrastructures in the Netherlands have to increase in order to realise the Dutch energy transition ambitions (Ministerie van Economische Zaken, 2016). However, the steps that are proposed for improving energy planning make me doubt whether this goal will be achieved. The Minister stresses that decision-making on energy projects should entail that stakeholders (e.g., citizens, companies, local governments, societal organisations) jointly identify public interests, and then formulate policies and projects based thereupon. He stresses the importance of involving potential stakeholders in the decision-making process as early as possible, and especially of ensuring their participation in finding solutions to the problem, and in selecting and narrowing down alternatives (Ministerie van Economische Zaken, 2016). This priority of more and earlier participation in decision-making on energy projects is also enshrined in the new Dutch Spatial Planning Act (Dutch: Omgevingswet) that will enter into force in 2021 (Ministerie van Economische Zaken, 2016; Rijksoverheid, 2017a).

However, the Ministry’s document does not explain how earlier and intensified participation may accelerate processes and outcomes. I strongly doubt that the speed and quality of decision-making will increase by the changes suggested by the Ministry. I base this conclusion on four factors that, according to my analysis, overshadow Dutch practices of decision-making in energy planning and have been neglected in the Ministry’s latest proposals to improve decision-making.

- Firstly, it can be concluded that the current consensus-based approach with a large amount of stakeholders slows down decision-making processes instead of speeding them up (see Commissie Elverding, 2008 and Chapters 3 and 4 of this dissertation). Involving more stakeholders in earlier phases of the process will complicate processes, simply due to the increase in voices and increased diversity among voices. The combination of diversity and consensus-orientation especially holds the risk of slower decision-making processes.
- Secondly, the consensus-oriented nature of decision-making is likely to cause a loss of ‘quality’ for the final decision taken – if a decision is taken at all

(Ministerie van Economische Zaken, 2016). This is especially disadvantageous for innovative energy solutions, which are unlikely to be the most evident and feasible solution that the (vested interest) decision-making process offers (Hoppe, 2012).

- Thirdly, appropriate ‘rules of the game’ are lacking for the collaboration among stakeholders, which complicates and slows down decision-making (see Kwast and Wesselink, 2016 and Chapter 4 of this dissertation). If ‘rules of the game’ are missing, e.g., on roles and responsibilities, different stakeholders with diverse perspectives, interests, and ambitions will probably need far more time to agree on anything at all.
- Finally, in the current practice smart energy solutions are the outcome of a consensus-based decision-process, instead of a thoughtful activity to solve an identified problem, in this case the need for sustainable energy infrastructures.

7.2.4. Participation and smart grid introduction

As shown, in Dutch energy planning currently participation (the consensus-seeking by many actors) determines content, slowing down progress and leading to compromised outcomes. In this chapter I develop a decision-making approach with functional participation, as presented in Chapter 7.4; to exemplify how this approach works, I apply it to the ‘Smart Grid MeppelEnergie’ project, one of the four cases analysed in Chapter 4 (Lammers & Hoppe, 2019). This project was co-financed by the Dutch government for the period from 2012 to 2016 via the Switch2SmartGrids tender. The main project partners were DSO ‘Rendo’, the municipality of Meppel, and regional energy supplier ‘MeppelEnergie’.

Although the name of the project includes the term ‘*smart grid*’, which is defined in this dissertation as involving the electricity grid infrastructure only, the MeppelEnergie project actually is concerned with not just the electricity grid, but mainly with the local heating and cooling grid infrastructure. Due to the fact that the decision-making approach developed in this chapter is not only intended for smart electricity grid projects, the ‘Smart Grid MeppelEnergie’ case with its many planned smart infrastructure components was chosen to illustrate the broad heuristic value of the decision-making approach. To explain, the goal of the MeppelEnergie project was the installation of a hybrid smart energy infrastructure: terraced homes would receive heat/cold via a combined heat and power (CHP) plant that is fed with biogas, and (semi-) detached homes would be provided with individual heat pumps that receive electricity from the CHP. The system was to become ‘smart’ in several ways. First, the heat pumps were to turn on when heat supply is too low/demand is too high; as these heat pumps use electricity, the supply of electricity at these times would have to be taken into account as well. Second, remote-control of electric vehicles, in-house

appliances (e.g., smart washing machines), and the heat pumps was to be used to balance electricity supply and demand. Furthermore, this system was supposed to provide financial benefits to the end users, as well as involve them actively in the project, e.g., via apps and games for energy saving. However, in the end, only a district heating grid fed with biogas will be implemented and ‘smart’ solutions will not be realized; end users have not been and will not be actively involved either. Furthermore, the goal to actively involve residents in the planning process on designing the local energy system was neither achieved.

This example illustrates that smart energy infrastructures are highly sophisticated technical systems that involve a change to the current energy infrastructure, and thus require specific knowledge and expertise to be able to design as well as implement such systems. It is neither fruitful nor efficient to involve non-experts such as residents in all steps of the technical design of a smart electricity or smart heating grids. The involvement of residents is much more purposeful in providing feedback to fine-tune the technical design of experts, for instance to co-design and select the most accepted options for the remote-control of household appliances. I believe that involving residents at specific moments during the technical design process – instead of not at all or through continuous co-design from the beginning – is more functional and will lead to the faster achievement of smart and sustainable outcomes.

In the next sections of this chapter I will suggest an approach to rebalance efficiency and participation in decision-making on the establishment of smart grids, guided by the principle that the content of the design should determine who participates how and when. I argue for a reorganisation of current decision-making practices to increase efficiency and thus accelerate the design and implementation of smart grids and smart energy infrastructure projects in general. I make participation instrumental to achieving the most sustainable technological solutions for the Dutch energy system. As indicated in the introduction, my approach is inspired by the engineering design process, which is explained in more detail in the next section.

7.3. Engineering Design as Inspiration for Developing a Functional Decision-Making Approach

To develop a decision-making approach that rebalances efficiency and participation I take inspiration from the rational approach of engineering design practice.

7.3.1. Engineering design

Engineers transform problems systematically and step-by-step into technically designed solutions. In doing so, the engineering approach distinguishes between the designing activities and the activity of implementing the (socio) technical design. I

use the engineering approach as inspiration to find ways to increase effectiveness and efficiency of decision-making in energy planning. Effectiveness concerns the realisation of sustainable energy ambitions. Efficiency is mainly related to a more functional and structured participation of stakeholders. This view on participation ‘stresses the functional role of participation as an instrumental tool’, in which the ends of these functions can differ (Coenen, 2009, p. 6). Following this perspective for designing and implementing smart grids, participation has to be functional to achieving the most sustainable, smart solutions (which of course has to adhere to additional criteria such as for instance legitimacy and justice), without leading to unnecessary delays.

7.3.2. Rational decision-making

The design and implementation of smart grids through the functional approach of participation is facilitated by structured, rational decision-making. Herbert A. Simon is considered a pioneer of the study of rational decision-making in organisations (Simon, 1947). To summarise, ‘Simon argues that rationality is essentially procedural, that is to say, it may be viewed as selecting goals and course of action which will best achieve the values of purposes’ (Parsons, 1995, p. 278). He refers to the ideal rational decision-model as that of the ‘economic man’, and contrasts it with that of the ‘administrative man’, who is subject to bounded rationality. While rationality is limited in practice, Simon advocates that it should always be the objective of decision-making. Following this line of thinking, a multitude of rational, phase-oriented models have been developed, often based on a policy cycle (Hoogerwerf, 1998).

The rational decision-making model was criticised by Lindblom in his famous paper ‘The science of muddling through’ (Lindblom, 1959). Lindblom refers to the rational model as the ‘rational comprehensive approach’ and sets it against the model of ‘successive limited comparison’. Whereas the rational model entails the clarification of values or objectives, means-ends analysis, comprehensive analysis, and a theoretical basis, ‘successive limited comparison’ takes the form of ‘muddling through’. The latter incremental approach is, according to Lindblom, superior. A similar comparison is made by Allison (1971) in ‘Essence of Decision: Explaining the Cuban Missile Crisis’, where he argues against the usefulness of the rational actor model in analysing decision-making by nation states. In line with this reasoning, several models and theories have been developed, based on the perspective of the ‘administrative man’ and emphasising the role of coalitions, goals, and interests. Well-known models are the garbage can model (Cohen, March, & Olsen, 1972), the multiple streams model (Kingdon, 1984), and the advocacy coalition framework (Sabatier, 1988).

These coalition and network-based approaches are based on a more coincidental coming together of actors, and do not provide structure regarding stakeholder involvement in decision-making. As explained in Section 7.2, for realising the energy transition in the Netherlands these ‘muddling through’ approaches are neither effective for achieving pre-set goals, nor efficient. For technologically sophisticated smart grids and particularly for smart energy systems (energy systems integrate smart electricity, thermal and gas grids) specific expertise, input and agreements at particular points in time are needed to increase the efficiency and effectiveness of decision-making. More recently, scholars have followed similar thinking for the design of technological systems and infrastructures, but mostly address the design of institutions (Koppenjan & Groenewegen, 2005), how to align technical and economic designs (Scholten & Künneke, 2016), only formulate general advice for co-design (Schot & Rip, 1997) or add an actor perspective (Herder, Bouwmans, Dijkema, Stikkelman, & Weijnen, 2008). My approach, on the other hand, focuses on specific steps for functional stakeholder participation with the help of the engineering approach for technical design processes.

7.3.3. Method

To specify the content of the decision-making phases with a design component and participation component, an exploratory focus group session and a validation session were organised (Oates, 2000). The exploratory focus group session took place on 8 May 2017. Participants discussed the statement ‘accelerating smart technology implementation in the Dutch energy system requires reinventing participation to improve efficiency’. Seven participants joined this session due to their own interest in the topic: three employees from different Dutch DSOs, one member of a community energy initiative, and three researchers from the field of social science working at different universities. Based on this exploratory session, an initial proposal for the decision-making phases and content thereof was developed. On 19 May 2017, this proposal was presented to experts on smart grid development for their feedback and fine-tuning in order to develop the most accurate and useful approach. This validation session was attended by experts from a community energy initiative, an applied research institute, the Netherlands Standardisation Institute, as well as by a project developer for smart cities, and by researchers from the fields of electrical engineering, mathematics, and computer science working at different universities.

Whereas these focus group sessions provided important information and validation, the adopted method has its limitations in terms of the representativeness of stakeholders and the potential hesitation of participants to voice their opinions in front of others. Furthermore, the discussions are often broader than is the case with,

for example, in-depth expert interviews. However, this broad feedback was exactly what I sought for fine-tuning my suggested approach.

7.3.4. From the engineering design process to a decision-making approach

For the development of a detailed decision-making approach for smart grids, I take the governance models described in Section 7.3.2 in mind, but mostly take inspiration from the engineering design process. Pahl et al. (2007) explain that engineers make a distinction between a design and its implementation. The engineer analyses the problem, formulates a set of design principles (functionalities), creates possible design solutions, and only then starts working on the implementation of the design. The phases of this engineering design process can be summarised as follows:

1. task clarification;
2. requirements;
3. conceptual design (principle solution);
4. detailed design; and
5. implementation of the solution.

Task clarification starts after an external request or development order to the engineers. As I am interested in every step of the design process and do not assume that such an external order is given for the realization of a smart energy infrastructure, I will add ‘task definition’ as the initial design activity, leading to six phases. Details on each of these six phases will be provided in the next Section 7.4.

7.4. Results

This section presents my suggestions to improve the effectiveness and efficiency of decision-making on the design and implementation of smart grids. Based on the engineering design process and specified through the workshop sessions, I lay out the six steps of balanced participatory decision-making on smart energy infrastructures, which includes but is not limited to smart (electricity) grid infrastructures. I first provide a general overview of the actors and phases in the suggested decision-making approach in Subsection 7.4.1. Following this, I explain the approach in reference to the project ‘Smart Grid MeppelEnergie’ described in Subsection 7.2.4.

7.4.1. Actors and phases

Looking at the entire process, I can distinguish between six design activities (what needs to be done when), design performers (who is in charge of each activity), and

design products (what is the product/result of each activity), as summarised in Table 7.1 and explained below.

In addition to the design performers, external participants – actors aside from the core design performers – need to participate in certain phases of decision-making. The involvement of external participants, such as residents, should not merely happen for the sake of involvement, but should be functional and purposeful to the outcome. While the design performers often need to possess technical expert knowledge and are deeply involved in the project, the contribution of external participants to a project is important as well. External participants can for instance provide information on local needs, co-finance an electricity storage facility or participate in demand response (which includes providing access to their smart meter data). Furthermore, involving them is important for the acceptance of chosen energy infrastructure options.

Phase	Activity	Design Performer	Design Product
1	Task definition	Problem owner	Problem definition
2	Task clarification	Problem owner/expert	Task definition
3	Requirements	Problem owner/expert	Design conditions
4	Conceptual design	Expert	Technical options for the smart energy infrastructure
5	Detailed design	Expert	Detailed smart energy infrastructure design
6	Implementation	Project manager	Realised infrastructure

Table 7.1: Design activities, performers, and products

This involvement of external participants can be structured by identifying four specific moments for external stakeholder participation in the decision-making process and the kind of outcomes to be achieved as the result of those specific participation moments. Integrating these moments of participation with the components of design (Table 7.1) leads to Table 7.2. This table indicates the general positions of design performers and external participants, which are further determined by the specificity of individual projects. Note that the symbol ‘/’ in Table 7.2 means no involvement and that each position can be occupied by more than one actor. For instance, a municipality and a housing association can be problem owners together. A flowchart that summarises the steps in a different format can be found in Appendix L.

The moments for participation have been chosen based on the assumed functionality of the input of external participants in the different phases of the decision-making process. Along these lines, participation is conceived as a function of improving and fine-tuning the design of the expert. This is different from the current position of participation in energy planning, which is aimed at being an inherent part of each step in the design process. My approach implies that the participation by external participants is prepared and structured by the activities and

results realized by the design performers. The input from external participants is useful for fine-tuning the technical design at several moments throughout the development process, and helps increase the acceptance of the design.

	Activity	Design Performer	External Participants	Outcome
1	Task definition	Problem owner	/	Problem definition
2	Task clarification	Problem owner/expert	/	Task definition
	Moment 1	/	<i>Project dependent</i>	Joint task definition
3	Requirements	Problem owner/expert	/	Design conditions
4	Conceptual design	Expert	/	Technical options for smart energy infrastructure
	Moment 2	/	<i>Project dependent</i>	Selection of preferred smart energy infrastructure design
5	Detailed design	Expert	/	Detailed smart energy infrastructure design
	Moment 3	/	<i>Project dependent</i>	Joint detailed smart energy infrastructure design
6	Implementation	Project manager	/	Realised infrastructure
	Moment 4	/	<i>Project dependent</i>	Operational infrastructure

Table 7.2: Decision-making phases with design performers and external participants

When it comes to the involvement of external participants in the decision-making process, a diversity in participants should be sought after. This could for example be done by providing specific support for community members with a low socio-economic status or single-parent households to participate, or alternatively, by drawing lots.

7.4.2. The decision-making approach applied to an example project

This section explains the decision-making approach in reference to the example of the project ‘Smart Grid MeppelEnergie’, as summarised in Table 7.3. The project’s compromised outcome makes this case an interesting one for exemplifying how the decision-making process could have been structured with the help of the decision-making approach I developed.

	Activity	Design Performer	External Participants	Outcome
1	Task definition	Municipality (problem owner)	/	Problem definition
2	Task clarification	Municipality (problem owner), energy supplier (expert)	/	Task definition
	Moment 1	/	Board of community energy initiative	Joint task definition
3	Requirements	Municipality (problem owner), energy supplier (expert), consultation with DSO	/	Design conditions
4	Conceptual design	Energy supplier (expert)	/	Technical options for smart energy infrastructure
	Moment 2	/	Members of community energy initiative	Selection of preferred smart energy infrastructure design
5	Detailed design	Energy supplier (expert)	/	Detailed smart energy infrastructure design
	Moment 3	/	All residents living in the city district	Joint detailed smart energy infrastructure design
6	Implementation	Municipality and energy supplier hire project manager	/	Realised infrastructure
	Moment 4	/	All residents living in the city district	Operational infrastructure

Table 7.3: The decision-making approach applied to a specific example

Phase 1 and 2, defining and clarifying tasks, are first and foremost the responsibility of problem owners, which are often parties with law-based authority (e.g., a municipality or housing association), with professional expertise (e.g., an energy supplier or DSO), or with a strong interest in renewable energy (e.g., a community energy initiative).

7.4.2.1. Phase 1: Task definition

In the chosen example, the task definition was undertaken by the problem owner, a municipality. The municipality had to be clear about the overall purpose of embarking on the project and the desired goals. National, regional, and local sustainable policy ambitions have been taken as reference points for the problem owner. If such policy

ambitions as a project reference are missing at the local level, it might be advisable to clarify them first, before continuing further discussions. The board of a municipality might, for example, have the authority to set a sustainability target for a district (e.g., being energy-neutral in 2030, having to install a district heating grid). Task definition can be very straight-forward if it is the individual task of one or a small group of initiators with legal authority over a specific area (e.g., a municipality together with a housing association).

7.4.2.2. Phase 2: Task clarification and participation moment 1

Similar to task definition, clarifying tasks is first and foremost the responsibility of problem owners. If the task is clear, external participants can be consulted during the first moment of participation.

Task clarification

After the task has been defined in general terms and the sustainability context and conditions have been set, the task has to be narrowed down and specified. Following the engineering design thinking outlined by Pahl et al. (2007, p. 145), three questions are considered helpful for this specification:

- What are the objectives that the intended solution is expected to satisfy?
- What properties must it have?
- What properties must it not have?

In terms of the design performers, the problem owner first of all needs to clarify and specify its objectives. If a municipality wants to achieve an energy-neutral district by 2030, this goal has to be specified into, inter alia, a certain percentage of distributed generation from renewable sources or the amount of desired energy saving or CO₂ reduction. Additionally, the (municipal) budget and commitment should be established at this point, and specific deadlines and cost targets should be addressed for the project as a whole. This requires the involvement of experts from different disciplines, such as engineering, law, and innovation. In the chosen example of ‘Smart Grid MeppelEnergie’, the municipality consulted a local energy supplier with expertise in renewable energy project development.

Participation moment 1

Once the task has been clarified by the core design performers, input from external actors is useful. This way, a joint task definition can come about and initial public support can be created (participation moment 1). To exemplify, after the municipality has specified the task in terms of the type and the dimensions of a smart energy infrastructure with the help of the energy supplier, it is useful to discuss the smart energy system idea with external participants. If a community energy initiative of local residents exists, the board of this initiative can be consulted to probe its view on

the project, as the members of the community energy initiative will most likely be among those directly involved in the energy system (e.g., allow the remote-control of their heat pumps). The purpose of this first moment of participation is to come up with a joint task definition and to create general public support. Right from the beginning, it should be clear to participating stakeholders what kind of input is expected from them and how their input will be integrated in the task definition. This participation moment is intended to provide input on the pre-defined task definition; it is not an open invitation to brainstorm about smart energy infrastructure ideas and preferences.

7.4.2.3. Phase 3: Requirements

Specifying the exact shape of the project continues in the third phase, in which the specific requirements are established. Pahl et al. (2007, p. 150) recommend that engineers address four questions in order to come up with a detailed (technical) requirements list that states the goals and the circumstances under which these goals have to be met:

1. What is the problem about?
2. Which wishes and expectations are involved?
3. Which constraints exist?
4. What (technical) paths are open for development?

The final requirements can be quantitative or qualitative, and can take the form of either demands or wishes. Additionally, the person responsible for each requirement should be listed. The resulting final list of requirements is referred to as the specific design conditions. Due to the rather technical nature of the design conditions, experts are, along with the problem owners, the main design performers in this phase. Experts such as an energy supplier can delineate the specific technical conditions and constraints, as well as show which paths are (not) open for development. On the one hand, the experts developing the requirements list have to take into account the current situation, e.g., make an inventory of the energy consumption of residents in the area, the energy efficiency of buildings, and the state of the existing technical infrastructure. On the other hand, the participants of the focus group session emphasised that the possible consequences of all technical design alternatives have to be considered at this point. This especially entails the consequences for grid infrastructure, be it electricity, gas, or heat infrastructure. For instance, before installing heat pumps in each household of a city district, the responsible DSO must be consulted early on in the decision-making process to take into account (and ideally prevent) (un-)necessary investments in grid infrastructure that would be needed to accommodate increasing electricity demand.

Ideally, potential investors are identified and involved in this phase as well. Participation from external actors (non-experts) is not beneficial in this phase, as residents, for example, do not have the expertise to choose which specific technical

requirements and constraints certain smart meters need to have. The external participation component is relevant in the next phase when the design conditions lead to the creation of a conceptual design.

7.4.2.4. Phase 4: Conceptual design and participation moment 2

In the fourth phase, we are moving from design requirements to the identification of a conceptual design (also called principle solution). In engineering design thinking, this step ‘involves selecting preliminary materials, producing a rough dimensional layout, and considering technological possibilities [acknowledging that] it is possible that there will be several principle solution variants’ (Pahl et al., 2007, p. 131). For designing a smart energy infrastructure, in this phase the focus should lie on the overall feasibility of options. To investigate feasibility, I distinguish between the design stage and the participation stage.

Conceptual design

For deciding which options of technical design alternatives are feasible, expertise is needed. Feasibility conventionally focuses on technical and financial feasibility, which are often investigated by developing a business model, or at least by conducting a cost-benefit analysis. Chesbrough and Rosenbloom (2002) explain that ‘a successful business model creates a heuristic logic that connects technical potential with the realisation of economic value’ (p. 529). For spatial projects that are concerned with the energy infrastructure (in a city district), next to technical and economic conditions, the environmental, legal, ethical, and political feasibility of options have to be evaluated as well. An energy supplier is the design performer in this phase in my example, this company most likely has quite some expertise in-house but probably has to consult with other professional parties to obtain information on each type of feasibility.

Participation moment 2

Out of the feasible technical options explored and suggested by the experts, one option needs to be chosen as the preferred design for the specific project. For the selection of the preferred smart energy infrastructure, input from external participants is once again very useful in order to collectively choose one option for further elaboration (participation moment 2). Particularly stakeholders who might be affected by the smart energy infrastructure should be involved, for instance the members of a community energy initiative. This second moment of participation is structured and fed by the design options prepared by the expert. The problem owner (municipality), together with the expert (energy supplier), investors and external participants (members of community energy initiative), should decide on the preferred design option that will be taken further in the design process. Participation during this second

moment thus helps to select the most preferred option for the smart energy infrastructure design.

7.4.2.5. Phase 5: Detailed design and participation moment 3

After the conceptual design comes the detailed design (also referred to as the embodiment design), linked to participation moment 3. In brief, the detailed design phase will elaborate on the chosen option, taking into account the feedback provided during participation moments 1 and 2.

Detailed design

The detailed design is an additional and final specification of the conceptual design developed in phase 4. Following Pahl et al. (2007), this includes, among other aspects, checking the functions, durability, operation, and costs, for which ‘technological and economic considerations are of paramount importance’ (p. 227). While technical and financial feasibility have been investigated in phase 4, agreement about the actual financing of the selected options now needs to be reached and the safety of the design now needs to be secured. All of these aspects of the smart energy infrastructure have to be specified by experts. Once a detailed smart energy infrastructure design has been created, involvement of external participants becomes functional for the final fine-tuning during participation moment three.

Participation moment 3

The third moment for effective and productive interaction with stakeholders is in response to the expert’s detailed design. Stakeholders now get a clear idea of all the details of the technical design and its implications for energy usage. At this point (participation moment 3), they are able to provide input for final changes and modifications to the technical design. During this third moment of participation, many stakeholders already know what to expect in terms of the smart energy infrastructure, since they were previously involved in selecting the preferred design or might know someone who was. As a result, the discussion can at this point concentrate on the final fine-tuning of the smart energy infrastructure design. Ideally, all residents in the district where the project is taking place should assess the practical implications of the design on their daily life, for instance in terms of user-friendliness, economic practicalities, local culture and practices, learning requirements, and the landscape of the district. Final adjustments can then be made based on the residents’ input. To sum up, the problem owner, expert, and external participants jointly decide on what the final, detailed design of the smart energy infrastructure will look like.

7.4.2.6. Phase 6: Implementation and participation moment 4

After finishing the technical design using the structured input and involvement of stakeholders, the design needs to be implemented. Following the decision-making approach I suggest, implementation is clearly distinguished from design. However, modifications of the design might be needed during implementation for practical or unforeseen reasons. During this implementation phase, design performers and external participants are closely connected.

Implementation

Due to the fact that the design of the smart energy infrastructure is the result of five thoughtful, detailed steps, all aspects of the technical design that will be implemented are clear. Consequently, implementation is no longer an act of designing and thinking, but of doing and acting. Implementation means organising processes and coordinating people and resources. For this task, the involvement of a project manager (e.g., a company hired by a municipality and energy supplier) that also focusses on the process can be beneficial (De Bruijn, Ten Heuvelhof, & In 'T Veld, 2010). Such process manager should not only have organising competences, but also be a communicator, as the implementation phase requires a great deal of communication: communication with installation companies (e.g., as regards to which phases of the three-phase circuit heat pumps are to be connected), with the project owner, the licencing authorities, and financial organisations, and last but not least with the future users of the smart energy infrastructure. Thus, stakeholder communication and management can be considered a core competence for the project manager. As will be discussed in Section 7.5 the involvement of project/process managers is also beneficial in earlier phases of the decision-making process.

Participation moment 4

Implementation essentially means managing the participation and division of tasks among different actors, as indicated in the previous paragraph. The participation of future users of the smart energy infrastructure (e.g., the residents in the district) needs to receive special attention and needs to be organised in a structured way throughout the whole implementation process. Fortunately, participants are very likely to be familiar with the project as they, or people they know (e.g., neighbours) were involved in earlier participation moments. Of course, implementation has and can have its own dynamics (in the Netherlands), due to unforeseen financial, legal, or social circumstances and setbacks during activities (bankruptcy of companies for instance). However, from a participatory perspective, continued open communication with stakeholders is very important. Discussion of the modes of communication even before implementation could be a good start; for example, an online communication

platform could be established with the help of modern online communication technology.

7.4.3. Summary

To summarise, I distinguish between six phases in the planning process during which design performers and external participants are invited to functionally participate in the decision-making process. The decision-making approach developed in this chapter entails that external participants fine-tune the technical designs made by experts. This involvement of external participants at specific moments in the decision-making process is believed to increase the acceptance of chosen designs as well as the speed for decision-making. As a result, the suggested approach is considered the basis for a more effective and more efficient planning process for the realisation of new smart renewable energy infrastructures. As the suggested structured decision-making process identifies roles and positions instead of specifying specific actors, the process can be applied to a wide variety of energy planning situations. Besides the example used here with a Dutch municipality as the problem owner, smart energy infrastructure projects can be initiated by a wide variety of actors under the current Dutch energy planning practice depending on the context, e.g., community energy initiatives, housing associations or DSOs. Furthermore, it has to be emphasised that stakeholders can go back and forth between decision-making phases where this is deemed necessary.

Based on the focus group sessions and following a range of scholars (De Bruijn et al., 2010; Hoppe et al., 2015; Kickert et al., 1997), I recommend involving a process manager or network manager in the decision-making process. A process manager is especially needed during implementation, but can also help during earlier phases with structuring and facilitating the design activities and participation moments. For each of the six design phases, a process manager could help the design performers set goals and deadlines and ensure that actors stay on track and adhere to the rules and agreements that were made. Furthermore, and particularly for the participation moments, a process manager can safeguard that all parties are heard and communication is effective (De Bruijn et al., 2010). In addition, such a manager could be take up practical aspects such as inviting participants, arranging meeting locations, compiling the agenda, and moderating discussions. This streamlining can eventually increase the speed of decision-making even more.

7.5. Discussion and Conclusion

In this chapter, I presented a decision-making approach for local energy planning by addressing sub-question B1 *'how can decision-making on the design and*

implementation of smart grids be accelerated?’ Whereas under the current practice more and early participation of stakeholders compromises the degree of sustainability of the results and slows down progress, I emphasise the functional participation of actors in order to increase the acceptance of chosen designs and more generally the effectiveness and efficiency of decision-making on the introduction of smart grids. Inspired by the engineering design process and based on workshop sessions, I identified a design component and a participation component for six phases of the decision-making process: (1) task definition; (2) task clarification and participation moment 1; (3) requirements; (4) conceptual design and participation moment 2; (5) detailed design and participation moment 3; (6) implementation and participation moment 4. The four identified participation moments facilitate the functional involvement of external participants, e.g., residents. As smart energy infrastructures (including smart grids) are technologically sophisticated systems that require the knowledge and expertise of experts, the purpose of the involvement of external participants should be to fine-tune and optimise the technical design of the expert.

Overall, this chapter provides a new governance perspective on the design and implementation of technical smart grids. The new governance approach is based on functional external participation in a technically-oriented design process conducted by professionals. To recall, based on the empirical findings of part A of this dissertation I could identify the need for a balance between efficiency and participation of local stakeholders in local energy planning. In response to this, I consider the process architecture developed in this seventh chapter helpful for accelerating the introduction of smart grids and smart energy infrastructures while ensuring the importance of public participation in the process. The reasons for this are the following. First, my approach structures and prepares participation through clarifying positions and expectations in energy infrastructure design and implementation processes up front. This clarification is becoming more important in the ever more diffuse, polycentric setting of renewable energy infrastructure planning in the Netherlands. Second, my approach rebalances participation and the realization of effective, sustainable outcomes of energy planning in the Netherlands, because it can increase the acceptance of proposed designs and prevent the watering down of sustainability outcomes. Third, the suggested approach can facilitate the collaboration of practitioners during the design and implementation of smart energy infrastructures in a wide range of contexts, including the upgrading of existing infrastructures and the development of new ones. Lastly, the focus on the entire decision-making process provides an overarching approach that goes beyond individual aspects of renewable energy system implementation, but also encompass aspects such as end user involvement (Verbong et al., 2013) and public acceptance (Wolsink, 2012).

I realise that the decision-making approach with my suggested repositioning of public participation in energy planning processes needs empirical validation.

Empirical research can also identify suggestions for improvement of the developed energy planning approach with its sharper distinction between professional experts developing the technical design and stakeholders (non-experts) providing input for optimising the design. It might be that stakeholders have additional, or different ideas about the repositioning of roles and positions in the design and implementation process of smart energy infrastructures. I believe that with a clear explanation, my decision-making approach can convince external participants of the significance and importance of their role as fine-tuning designs. However, I also realise that problem owners and professional experts need to position themselves accordingly vis-à-vis external participants. If problem owners and professionals do not act according to the suggested approach and external participants feel excluded, situations of distrust might occur, which can be very harmful for open effective decision-making in energy infrastructure planning. An important next step in research, therefore, would be to empirically compare energy planning settings in the Netherlands with conventional participation to a project in which my suggested functional participation approach is applied. This might illustrate the assumed advantages of the functional participatory approach I described in this chapter. This kind of knowledge will help to convince problem owners, professional designers, and stakeholders to work together in the common interest of achieving optimal sustainability outcomes in the planning of smart grids and additional smart energy infrastructures.

Chapter 8

Conclusion

8.1. Introduction

This dissertation started out with the observation that improvements need to be made to the ‘rules of the game’ inherent to local energy planning, particularly as regards making progress on the introduction of smart grids. The research in this PhD thesis was therefore guided by the main research question ‘*How can local governance on the introduction of smart grids be improved?*’ I focussed on the Dutch context as smart grids are considered important for the Dutch energy transition, but decision-making in energy planning and on the introduction of smart grids is rather slow in the Netherlands.

To address the main research question, two research objectives have been formulated:

- A. To obtain empirical insights into the governance arrangements inherent to decision-making on the introduction of smart grids in local settings.
- B. To use the empirically-obtained insights to develop heuristics that can facilitate the introduction of smart grids in local settings.

Research objective A was pursued in Chapters 3, 4 and 5 where empirical observations were made to identify the governance arrangements pertaining to the introduction of smart grids. Chapters 6 and 7 focussed on research objective B and used the empirical findings from Chapters 3, 4 and 5 as well as theoretical insights to develop an institutional architecture and a process architecture that can help advance the governance of smart grid introduction.

This final, concluding chapter presents a synthesis and discussion of the previous chapters’ findings. In Section 8.2 the research questions are answered in detail. Section 8.3 reflects on the implications of the findings for future academic research and for policy-making. The final Section 8.4 presents recommendations for the introduction of smart grids.

8.2. Answering the Research Questions

This section summarizes the answers to the research questions of this PhD thesis. The three sub-questions which are related to research objective A – sub-questions A1, A2 and A3 – have been answered in Chapters 3, 4 and 5, respectively. The two sub-questions derived from research objective B – sub-questions B1 and B2 – have been addressed in Chapters 6 and 7.

A1: *Which consequences can a polycentric local decision-making arena have for the realization of a renewable energy transition, in particular for the introduction of smart grids?*

The introduction and background chapters, Chapters 1 and 2, established that the number and diversity of actors involved in local energy planning have increased. With the emergence of multiple centres of decision-making governance arrangements in local decision-making arenas became polycentric. To answer sub-question A1, in Chapter 3 I therefore investigated two cases in light of the consequences that polycentric decision-making arenas can have on the process of local energy planning, in particular regarding the introduction of smart grids. One of the cases (JEM Zwolle) concerned a pilot project on a local smart grid, and the other case (Bothoven-Noord) aimed at the roll-out of technological smart grid components.

First, the analysis showed that the decision-making settings in both cases portray polycentric characteristics. This analysis was undertaken by mapping the characteristics of both cases in terms of configurations of units that are multi-level, multi-purpose, multi-sectoral and multi-functional. Second, the functioning of these polycentric configurations was assessed by using four criteria: control, efficiency, political representation and self-determination. Based on this analysis, I conclude that tensions prevail in the polycentric configurations between on the one hand control and efficiency, and on the other hand self-determination and political representation. Put differently, having control and working efficiently can lead to faster results but can go at the expense of public participation; involving local communities and political representatives makes the process more democratic but can slow down decision-making. A balance between efficiency and local participation can help to make progress by means of an open democratic process.

Due to these findings, I recommended at the end of Chapter 3 that in order to structure the local dynamics in a productive and inclusive polycentric configuration, having appropriate institutional arrangements can help. Such institutional arrangements (rules) should inter alia facilitate that local residents (communities) are involved during decision-making, as well as that progress is made on smart grid introduction.

A2: *Which institutional conditions enable or disable decision-making processes regarding the introduction of smart electricity and heating grids in selected city district development projects in the Netherlands?*

Sub-question A2 has been answered in detail in Chapter 4 of this dissertation. This fourth chapter sheds light on the institutional conditions that are at play in polycentric decision-making processes on the introduction of smart electricity and heating grids

(smart energy infrastructures). Whereas the focus of this PhD thesis is on smart electricity grids, in this fourth chapter additionally the institutional conditions in two heating grid cases were analysed to investigate whether differences in decision-making processes exist based on the type of energy infrastructure in question. A total of four cases was studied, two in which stakeholders had high smart energy infrastructure ambitions ('Intelligent Net in Duurzaam Lochem' and 'Smart Grid MeppelEnergie') and two where a lower degree smart energy infrastructure ambitions prevailed ('Bothoven-Noord: op weg naar een energieneutrale wijk'⁴⁶ and 'Hart van Zuid'). To investigate the dynamics of institutional conditions in the cases' decision-making processes over time, data were analysed, and cases were compared using the Institutional Analysis and Development framework (E. Ostrom, 2005, 2011) in combination with causal process tracing.

The findings of Chapter 4 demonstrate that institutional conditions are foremost responsible for enabling and disabling decision-making processes on smart energy infrastructure introduction, while external events, generally speaking, had less influence on the decision-making process. Moreover, differences in goal achievement of local energy planning processes were found to neither be related to the amount of smart energy infrastructure components that stakeholders aimed at introducing, nor to type of energy infrastructure in question.

In response to sub-question A2, three overarching conclusions were made in Chapter 4. First, it was especially the combination of position, choice and payoff rules that disabled the decision-making process: choice rules in the form of legal barriers (rules-in-form) prevented DSOs and housing associations to invest in smart energy infrastructure projects (payoff rule) and partially led these stakeholders to take on a passive role in the decision-making process (position rule). Second, the analysis of boundary rules revealed that consortia were formed ad hoc, mostly by inviting experts from the initiators' own professional networks, and that in three out of four projects end users were hardly involved in the development of the local smart energy infrastructure. Third, progress of achieving the pre-set goals varied strongly for the analysed cases, ranging from four years, over fifteen years, to not having been achieved at all in two cases. Together, these findings allowed me to conclude that existing 'rules of the game' (institutional conditions) are not all appropriate for decision-making on the introduction of smart electricity and heating grids in local settings.

A3: *Which lessons can be learned from legal experiments with alternative governance arrangements for decentralized electricity systems?*

⁴⁶ In English: 'Bothoven-Noord: towards an energy neutral district'.

In Chapter 5, sub-question A3 was answered by analysing the experimental governance arrangements that emerged because of the Dutch Experimentation Decree for Decentralized Renewable Electricity Generation⁴⁷ (in short: Experimentation Decree). The Dutch government established this Decree in 2015 to allow for legal experiments with alternative governance arrangements for (smart) local electricity grid projects. The reason for creating this Decree is to investigate in how far a different governance arrangement can contribute to increasing the distributed generation of electricity, can foster the efficient use of the energy infrastructure, and can improve consumer involvement; three goals that are linked to the introduction of smart grids. To investigate which lessons can be learned from this legal experiment with alternative governance arrangements, I conducted an empirical legal analysis. I first identified which alternative governance arrangements emerge through the Experimentation Decree (as compared to those fostered through the Dutch Electricity Act), and second, compared these to those governance arrangements adopted in the nine projects that were granted experimental status under the Experimentation Decree in 2015 and 2016.

To summarize, the Decree allows associations (owners' associations and energy associations) to engage in collective generation, peer-to-peer supply and system operation in an experimental 'project grid' project; three aspects that are relevant for the realization of smart grids. Yet, my analysis showed that the envisioned experimental governance arrangement has been adopted to different extents in the nine experiments. Particularly, three lessons can be drawn on the basis of my analysis, two as regards the design of the Decree, and a third one concerning the effect of the Decree in practice. First, *de jure*, a re-bundling of activities in local electricity grids occurred because associations are to carry out generation, supply and system operation. Second, due to the prominent positions of associations, the involvement of other actors and room for emerging activities in decentralized electricity systems is legally being restricted. A third lesson derives from the governance arrangements that were adopted in the nine experiments. Despite the provisions of the Experimentation Decree, active consumer involvement was found to be limited in the projects and additionally it was not associations, but other actors that took the lead in the projects. This shows that the rules established in the Experimentation Decree (experimental rules-in-form) are in conflict with the practices that are adopted in the projects (rules-in-use), as well as confirms the empirical findings of Chapters 3 and 4 on the lack of end user involvement. It is concluded that in consequence, in their current form, the usefulness of the experimental governance arrangements for projects outside of experimental settings is limited.

⁴⁷ In Dutch: 'Besluit van 28 februari 2015, houdende het bij wege van experiment afwijken van de Elektriciteitswet 1998 voor decentrale opwekking van duurzame elektriciteit'.

In sum, the answers to sub-questions A1, A2 and A3 provided in-depth empirical insights into the governance arrangements inherent to decision-making on the introduction of smart grids in local settings (research objective A). Three overarching findings can be singled out from the research conducted in relation to research objective A: (1) efficiency in local energy planning on the introduction of smart grids is low; (2) there is lack of residents' participation in the local planning process of their city district's energy infrastructure; and (3) several rules-in-use are disabling local energy planning as well as are conflicting with (experimental) rules-in-form. These three empirical insights showed that improvements are needed in local energy planning practices on the introduction of smart grids. Specifically, in combination the answers to sub-questions A1, A2 and A3 revealed the need for developing an appropriate institutional architecture, as well as for devising a supportive process architecture. Through answering sub-questions B1 and B2 both of these aspects were addressed in Chapters 6 and 7 of this PhD thesis, respectively.

B1: *How can institutional arrangements for the introduction of smart grids be designed to be lawfully consistent?*

As the empirical findings of part A of this dissertation have shown that appropriate 'rules of the game' are needed for decision-making on the introduction of smart grids, in Chapter 6 an institutional architecture was developed in response to research sub-question B1. Through combining the descriptive Institutional Analysis and Development framework with a normative dimension reflected by institutional legal theory, an institutional architecture for the analytical description and prescriptive design of institutional arrangements was developed: the ILTIAD framework. This architecture focusses on ensuring that the rules that constitute institutional arrangements are lawfully consistent. In addition, the ILTIAD framework can help to understand which consequences the design of institutional arrangements can have for efficiency of energy planning (expansion) and local stakeholder participation (democratization).

Central to the ILTIAD framework is the concept of legal institutions, which are defined as the combination of legal 'characteristics', being first order legal institutions (e.g., the public authority of a Minister), second order legal institutions (e.g., an energy association) or third order legal institutions (e.g., a hybrid regulated energy market). Each type of legal institutions consists of rules of power and rules of conduct; together these rules describe the realizable patterns of social interaction. The ILTIAD framework shows at which institutional level (being the operational, collective choice, constitutional and metaconstitutional level) these rules of power (defining the legal

ability space⁴⁸) and rules of conduct (as legal liberty space⁴⁹) are created for the next level(s). Based on this, the ILTIAD framework makes it possible to ensure the lawful consistency of rules inside and across action situations and institutional levels, the focus of sub-question B1. In particular, the ILTIAD framework allows to analyse and design three types of legal consistency, being that legal institutions are internally consistent (legal institution consistency), are in alignment with one another inside an action situation (action situation consistency), as well as are consistent across institutional levels (level consistency).

After the conceptual discussion of the ILTIAD framework it was applied to two different examples to show its heuristic value. First, I analysed the legal consistency of institutional arrangements of an envisioned smart grid design for the ‘Bothoven-Noord’ case (one of the cases studied in Chapters 3 and 4). By focussing on legal consistency it became evident which normative constraints and opportunities exist for the local smart grid project, as well as which (often sequential) changes would be needed at various institutional levels. This analysis especially revealed the pivotal role of constitutional level institutional choices for collective choice level decisions on establishing and implementing the envisioned smart grid. Second, I used the ILTIAD framework to identify legal aspects regarding possible avenues of institutionalized experimental design established through the Experimentation Decree for Decentralized Renewable Electricity Generation (as was discussed in Chapter 5). This analysis showed that the ILTIAD framework can improve our understanding of how rules-in-use and legal rules-in-form interact, and particularly whether institutionalized experimentation follows an energy democratization or an energy justice frame. These two examples allow to conclude that the ILTIAD framework is a useful institutional architecture for facilitating the introduction of smart grids in local settings. In addition, due to it being based on general normative heuristic concepts (such as that of legal institutions) it can also be used for the introduction of additional smart energy infrastructures as well as for that of integrated smart energy systems.

B2: *How can decision-making on the design and implementation of smart grids be accelerated?*

In Chapter 7 a process architecture was developed in response to sub-question B2 regarding the acceleration of decision-making on the design and implementation of smart grids. Since the empirical findings of Chapters 3 to 5 have shown that a balance is lacking between efficiency of energy planning and the participation of local

⁴⁸ Legal ability space: legal powers to make changes, and legal immunities to not be subject to such changes (rules of power, second order).

⁴⁹ Legal liberty space: realm of actions and outcomes that is legally available to participants in a particular action situation (rules of conduct, first order).

stakeholders, the developed process architecture focusses on alleviating this problem. Inspired by engineering design thinking and based upon workshop sessions, a process architecture in the form of a qualitative decision-making approach was developed. The core of this decision-making approach is the functional participation of actors in order to increase the acceptance of chosen designs and more generally the effectiveness and efficiency of decision-making processes.

The decision-making approach distinguishes between five design phases and one implementation phase, and identifies four moments for the participation of external, local participants: (1) task definition; (2) task clarification and participation moment 1; (3) requirements; (4) conceptual design and participation moment 2; (5) detailed design and participation moment 3; (6) implementation and participation moment 4. Since the introduction of smart grids requires technical expertise, this decision-making approach places energy system experts (e.g., energy supplier, DSO) in the lead, but ensures the participation of external stakeholders (non-experts) at four specific participation moments in the decision-making process. These external participants are often local community members, which generally do not possess the (technical) energy system expertise that is required to make changes to a local energy infrastructure. However, the input from these external participants is relevant for fine-tuning the technical designs of experts and can help increase the acceptance of the chosen smart grid design.

Overall, the process architecture clarifies positions, tasks and expectations of stakeholders in energy infrastructure design and implementation processes up front, which helps to increase the acceptance of proposed designs as well as to accelerate the decision-making process. In addition, as the decision-making approach defines a general structure, it is a suitable heuristic for a variety of energy planning situations, including next to smart electricity grids, also for instance smart heating grids and integrated smart energy systems.

To summarize, research sub-questions B1 and B2 used the empirically-obtained findings from part A of this dissertation, together with theoretical insights, to develop two heuristics that can facilitate the introduction of smart grids in local settings (research objective B). The institutional architecture developed in Chapter 6 facilitates the analytical description and *ex ante* prescriptive design of institutional arrangements for the introduction of smart grids. Thus, instead of trial-and-error approaches for the design of 'rules of the game', the institutional architecture shows instantly which normative constraints and opportunities exist for a local smart grid project, as well as which changes would be needed to arrive at a desired smart grid. This involves ensuring the lawful consistency of rules, an aspect that is central to the ILTIAD framework. The process architecture outlined in Chapter 7 specifies the functional participation of actors in different phases of decision-making. The aim of this process

architecture is to increase the acceptance of chosen designs and more generally the effectiveness and efficiency of decision-making processes on smart grid introduction.

In conclusion, and in reflection of the main research question, the research conducted in this PhD thesis has provided several insights into how the local governance on the introduction of smart grids can be improved, as well as developed two heuristics for its improvement. These two architectures are not considered panaceas, but ideally they can help accelerate decision-making processes on the introduction of smart grids, while ensuring the participation of local community members. An additional advantage is that these two heuristics are not only suitable for the introduction of smart grids in Dutch local settings, but also for the realization of additional smart energy infrastructures (e.g., smart heating grids) and integrated smart energy systems in different contexts.

These two architectures have to be considered in combination, though: inside each phase of the decision-making process (as defined in the process architecture) several interactions between stakeholders take place – possibly at different analytical levels – that require institutional arrangements (as defined in the institutional architecture). To elaborate, the process architecture specified in the decision-making approach indicates six phases of decision-making on the introduction of smart grids. In each of these six phases one specific activity is focused on, e.g., the identification of requirements (phase 3). The stakeholders that interact in each decision-making phase and discuss a specific activity, can differ. An appropriate institutional architecture is needed for the decision-making process that takes place inside each decision-making phase⁵⁰. Due to the different constellations of stakeholders involved, and the different activities discussed in each phase of decision-making, ‘rules of the game’ need not only be specified at the beginning of a project, but also have to be reviewed and if needed revised throughout the project, e.g., when the combination of stakeholders changes and/or when a new activity is being discussed.

8.3. Discussion

This section discusses the findings of this PhD thesis and reflects upon their implications for future academic research on smart grids on the one hand, and on the implications for policy-making in the Netherlands on the other hand.

⁵⁰ Note that inside each phase interactions can take place at different analytical levels, e.g., when a project consortium decides to apply for an exemption under the Dutch Experimentation Decree (at the collective choice level) and the Minister of Economic Affairs grants this exemption (at the constitutional choice level).

8.3.1. Implications for future academic research on smart grids

This dissertation makes empirical contributions, as well as theoretical contributions to the academic literature on smart grids.

8.3.1.1. Empirical contributions to the academic literature

The empirical findings made in this dissertation bridge a variety of knowledge gaps. Whereas the technological components of smart grids are fairly well-developed, research on their introduction in practice, and specifically on aspects of governance, is still in its infancy. Where non-technical aspects of these systems are being studied, scholars' largely focus on individual aspects, such as the behaviour of end users, the visions of actors, or the domestic energy practices inside households. The research presented in this PhD thesis moves beyond such individual elements and empirically focusses on the entire local energy system planning process and on all stakeholders involved in local energy planning.

As a result, the knowledge gap regarding the institutional conditions that shape the multi-stakeholder decision-making processes on the introduction of smart grids has been addressed in this dissertation (Sovacool, 2014; Von Bock und Polach et al., 2015). Important to note is that while external events were found to shape decision-making processes, they have, generally speaking, a less influential role than institutional conditions. This PhD thesis specifically broadens the empirical domain by showing which combination of factors slowed down or hindered decision-making: being position rules, choice rules and payoff rules. The analysis of the case studies in Chapter 4 also confirmed results from previous studies regarding the slow achievement, or failure to achieve established project goals for renewable energy systems.

In addition to providing insights into the rules that govern the interactions between stakeholders involved in local energy projects, my empirical research revealed tensions between the involvement of end users (local community members) on the one hand and the efficiency of the process of attaining pre-set goals for a sustainable energy infrastructure on the other hand. To alleviate this tension, a functional decision-making approach was developed in Chapter 7. This decision-making approach has not yet been empirically validated; hence further research that empirically compares local energy planning settings with conventional participation to a project in which the suggested functional participation approach is applied, is recommended.

Furthermore, whereas empirical legal studies often have a quantitative focus, the empirical legal study I conducted in Chapter 5 provides valuable qualitative insights into the effect of legal provisions on governance arrangements adopted in local electricity grid projects. Through studying the effect of a Dutch Crown Decree

(Experimentation Decree) in nine cases (see Chapters 5 and 6), I uncovered conflicts between rules-in-use and (experimental) rules-in-form. The ILTIAD framework developed in Chapter 6 can facilitate the prescriptive design of lawfully-consistent rule combinations, as explained in the next subsection.

In essence, the empirical insights of this dissertation were especially obtained due to the in-depth nature of the case studies that were conducted. That is, the empirical part of this dissertation focussed on a small number of cases because this was considered suitable for the exploratory, in-depth nature of the research. Further empirical research on a larger number of smart grid projects in local settings, and on the extent and nature of causal relationships regarding decision-making, is therefore strongly recommended for projects in the Netherlands as well as in other countries.

8.3.1.2. Theoretical contributions to the academic literature

The Institutional Analysis and Development framework (E. Ostrom, 2005) was the main theoretical lens adopted in this dissertation. The research conducted made several theoretical contributions related to the application and elaboration of this framework.

First, the IAD framework was applied to a new empirical research domain, namely that of energy system projects in local settings. Conventionally, the IAD framework was only used to study traditional common pool resource problems in natural resource systems, such as fisheries or irrigation systems. Only recently, a few scholars have started to use the IAD framework to study energy policies and renewable energy projects (Iychettira et al., 2017; Koster & Anderies, 2013; Newell et al., 2017). The findings of this dissertation contribute to this expanding research agenda by using the IAD framework as a theoretical lens to extensively study smart grid projects in local settings. Furthermore, in the literature review presented in Chapter 2, the IAD framework's concept of the 'action situation' was conceptualized from an energy governance and energy policy studies perspective in order to analyse literature from these disciplines.

Second, in Chapter 4 the IAD framework was used in combination with causal process tracing. Considering that institutional arrangements are often studied as static concepts, this combination with causal process tracing allowed to conduct a dynamic analysis over time. The basis for this was the identification of key events for each decision-making process to single out the most relevant sequentially linked action situations for analysis. Following this, the institutional conditions at play in a decision-making process were analysed for different moments in time. This dynamic focus is especially useful for the study of institutional conditions in decision-making processes on (smart) energy infrastructure introduction as these processes are often lengthy and complex, making it difficult to understand them by looking only at one specific point in time.

The third and possibly largest theoretical contribution made in this PhD thesis is the development of the ILTIAD framework. This contribution is likely of particular interest to scholars that work with the IAD framework and/or are engaged in the academic literature on new institutionalism as well as on institutional legal theory. In brief, by drawing on institutional legal theory, a normative perspective was added to the IAD framework's focus on empirical institutional analysis. Thus, whereas the IAD framework is mainly concerned with analytical description, the ILTIAD framework additionally allows for prescriptive design of institutional arrangements for local smart grids, and smart energy systems more broadly. Specifically, it allows for the identification and mapping of prescriptive patterns of social interaction rather than merely of individual rules. To this end, the lawful consistency of rule combinations is central. In sum, the ILTIAD framework allows for the design of normative alignment of rules *ex ante* to the start of projects, including the identification of normative constraints as well as opportunities to establishing and maintaining particular local smart grids. However, the ILTIAD framework has as of yet not been applied by stakeholders in an empirical setting; doing so is recommended in order to evaluate the applicability of the framework in its current form and enhance its user-friendliness.

8.3.2. Implications for policy-making in the Netherlands

This dissertation not only has implications for future academic research, but also for policy-making, in particular for policy-making in the Netherlands. In this subsection, the insights obtained through the research conducted in this PhD thesis are used to reflect on two recent policy developments: the Dutch 'Energy Agreement' and the Dutch legislative proposal 'Wet VET'.

In 2013, the Dutch government and a wide range of market players and societal organisations signed the 'Agreement on Energy for Sustainable Growth' (short 'Energy Agreement'), specifying the Dutch targets for sustainable growth until 2023. The results of this dissertation can be used to reflect on the goals of this Energy Agreement, and can pinpoint aspects that are important to be considered during the preparations of policies for the post-2023 period (e.g., the Dutch Climate Agreement that will be finalized at the end of 2018). The main implication of this PhD thesis in regard to the Energy Agreement is related to the emphasis that this Agreement places on the so-called 'energetic society' (in Dutch 'energieke samenleving'). This energetic society is defined as representing 'a society of articulate individuals and companies with fast learning curves, who themselves form a source of energy' (Hajer, 2011, p. 29) and is deemed to play an important role in achieving sustainability goals. In the Dutch Energy Agreement, the role of this energetic society is highlighted in regard to three aspects, (1) providing incentives for community energy initiatives to generate renewable energy locally; (2) involving local governments and individual

facilitators to support the energetic society; and (3) using the ‘Elverding-approach’ for the early involvement of all stakeholders in decision-making.

Based on this PhD thesis it can be concluded that placing a lot of responsibility on community energy initiatives and local governments as ‘energetic society’ (point 1 and 2) is too limited for the transition to more sustainable and smarter energy systems. Rather, the collaboration among a wide range of stakeholders is needed, and ‘rules of the game’ need to be clarified, *inter alia* on the roles and responsibilities of these stakeholders in local energy planning. Playing a role in the energy transition requires advanced technical expertise and skills. Community energy initiatives and local governments often do not possess this expertise. Results from the ‘Hart van Zuid’ case study (Chapter 4) showed that this lack of expertise by local government can lead to project delays and to additional costs for alleviating previously made mistakes (namely the need to install an expensive ‘backbone’ as the installed gas-powered district heating grids turned out to not be profitable). The role of individual facilitators that focus on one specific aspect of an energy project (e.g., providing innovative technological solutions) is also not sufficient support, as concluded in the ‘Bothoven-Noord: op weg naar een energieneutrale wijk’ case (Chapter 4). Furthermore, as addressed in Chapter 7, the ‘Elverding approach’⁵¹ (point 3) in its current form can lead to delays and the watering down of sustainability outcomes. In consequence, I conclude that the collaboration among a wide range of stakeholders – including those that possess technical expertise such as distribution system operators (DSOs) and energy suppliers – is important. This importance is also recognized in the proposed revision of the EU’s Renewable Energy Directive (2009/28/EC), which places emphasis on consumers (renewable self-consumers and renewable energy communities) and stipulates that DSOs cooperate with renewable energy communities (Council of the European Union, 2018). In addition, the roles and responsibilities of stakeholders (and more specifically the institutional arrangements) during the different phases of decision-making have to be specified. The heuristics that have been developed in this PhD thesis (Chapters 6 and 7) can be useful for this.

The second development is the Dutch legislative proposal called ‘voortgang energietransitie’ (in short ‘Wet VET’; in English: ‘progress energy transition’) that has been adopted in January 2018 to further the transition to a more sustainable energy system. In light of the findings of this dissertation it is especially interesting to reflect

⁵¹ The ‘Elverding approach’ is based on the suggestions made by the Elverding advisory committee in its report ‘Faster and Beter’ on accelerating decision-making on infrastructure projects (Commissie Elverding, 2008). As explained in Chapter 7, the committee recommended structuring the decision-making process into three phases (exploration, plan elaboration, and execution) and advised for an earlier and greater involvement of all stakeholders at the start of projects (Commissie Elverding, 2008).

upon the governance arrangements that can emerge based on this new Wet VET. In short, the legislative proposal will provide more room for experiments regarding projects that focus on renewable energy. More specifically, the proposal foresees the creation of a Decree that broadens the provisions of the Crown Decree for experiments with decentralized renewable electricity generation (short: Experimentation Decree) that was extensively discussed in Chapter 5 of this PhD thesis. Whereas the Experimentation Decree provides associations with the option to play a central role in local electricity grid projects, the newly foreseen Decree will allow energy suppliers and DSOs to apply for exemptions (Wet VET, 2018). Furthermore, the legislative proposal provides for the opportunity to temporarily grand specific tasks to DSOs, foremost those that private market players are unlikely to take on themselves. This Dutch legislative proposal could clash with EU-level developments because the proposed revision of the EU's Renewable Energy Directive (2009/28/EC) places consumers at the core of the energy sector (as well as mandates that DSOs and renewable energy communities cooperate).

In particular, the findings from Chapter 5 allow me to conclude that the legal experimentation space provided in Wet VET can be viewed as a useful development as exemptions will not be restricted solely to 'associations' anymore. Yet, reflecting on the Wet VET in light of this dissertation also points towards potential pitfalls. First, it is questionable whether local residents will be involved in the design of projects that will be ran by energy suppliers or DSOs. The case studies have shown that residents are often not involved in projects which are initiated top-down (see Chapters 3 and 4), and that even in projects which are supposed to be run by associations other players seem to be dominating the process (see Chapter 5). Second, as conventional energy market players – and especially DSOs – are put in a central position, no room seems to be provided for newly emerging actors to play a role in local grid projects. For instance, the activity of demand response by aggregators that pool and manage the flexibility of electricity loads of various entities is not specified. This situation has already been criticized in relation to the analysis of the Experimentation Decree in Chapters 5 and 6. The involvement of and collaboration between conventional energy market players, end users, and emerging actors is necessary not only in light of e.g., energy justice considerations, but – provided that an appropriate institutional and process architecture exist – can also accelerate the introduction of smart grids and further the energy transition in general.

8.4. Recommendations for the Introduction of Smart Grids

This final section presents recommendations to stakeholders involved in the energy transition in the Netherlands. Specifically, recommendations are made that show how

decision-making processes on the introduction of smart grids can be governed, and ideally accelerated.

Recommendation #1: Take into account that smart grid introduction needs tailor-made governance approaches.

Before going into more specific recommendations, I want to point to the need for tailor-made governance approaches for the introduction of smart grids in local settings. The findings of this dissertation reveal several reasons for this. First of all, smart grids can take many different forms depending on the combinations of technologies. Secondly, the local circumstances in a city district are very diverse, including the bio-physical conditions, as well as the attributes of the community. Thirdly, in each local project different types of stakeholders are involved. In consequence, local energy planning processes are very diverse and a general one-size-fits-all approach is not suitable. For instance, the analysis of the Experimentation Decree from 2015 has shown that it is not useful to legally define one specific type of actor as being responsible for initiating local projects. Rather, I recommend the creation of tailor-made ‘rules of the game’ for the collaboration of stakeholders on the introduction of smart grids. In line with this, the heuristics that were developed in this dissertation are suitable for local energy planning practices in a wide variety of contexts as they allow for the tailoring to local conditions and provide room for innovative local solutions.

Recommendation #2: Combine top-down and bottom-up governance approaches for the introduction of smart grids.

For the introduction of smart grids an inclusive approach is recommended under which top-down and bottom-up initiatives are combined. In general, the number and diversity of stakeholders in local energy planning has increased. Examples of involved stakeholders are DSOs, energy suppliers, residents, community energy initiatives, technology manufacturers, data processing companies, energy storage providers, aggregators, local governments and housing associations. Yet, the empirical findings of this dissertation have in particular revealed a lack of residents’ participation in local energy planning processes on the introduction of smart grids. For the introduction of smart grids I recommend the involvement of bottom-up players such as local residents or community energy initiatives, as well as the top-down involvement of actors with technical expertise, for example DSOs or energy suppliers. This combination of stakeholders is especially beneficial as different types of stakeholders possess specific knowledge as well as innovative ideas. Residents can provide knowledge on local circumstances and needs, and involving them can increase the acceptance of

(collectively) chosen energy system designs, motivate them to co-finance technologies or participate in demand-side management. Yet, playing a role in the energy transition requires advanced technical expertise and skills which community energy initiatives often do not possess. Established energy market players such as DSOs or energy suppliers have this expertise and can themselves benefit from collaborating with local end users for the outlined reasons of local knowledge, acceptance and active participation. When these two types of stakeholders collaborate from the start of a project on, they can take into account and ideally prevent that suggested solutions have an adverse impact on the electricity grid.

To ensure that the collaboration of stakeholders is supportive of the introduction of smart grids, the process, as well as the interactions between stakeholders, have to be structured properly. The following three recommendations emphasize these aspects.

Recommendation #3: Ensure the functional participation of stakeholders in order to accelerate decision-making on smart grid introduction.

My third recommendation concerns the need for the functional participation of stakeholders in order to accelerate decision-making on the introduction of smart grids. The involvement of, and cooperation between a wide range of stakeholders (from the top-down and bottom-up) is important for the introduction of smart grids. Yet, the findings of this PhD thesis have revealed that a balance is missing between the involvement of end users (local community members) and the efficiency of the decision-making process as regards attaining pre-set goals for the local energy infrastructure. To alleviate this tension, I argued that stakeholders should not be involved for the sake of involvement, but play a functional role in the design and implementation of smart grids. A functional approach can accelerate the introduction of smart grids by aligning interests, using the available knowledge purposefully and ensuring the acceptance of solutions by all involved stakeholders. With this in mind, in Chapter 7 of this PhD thesis a decision-support approach was developed that provides external participants (e.g., local residents) with a functional role of fine-tuning the designs made by energy system professionals. Acting in accordance with this approach provides clarity on actors' positions, tasks and expectations, can facilitate the acceptance of chosen options, and overall help to realize more functional and more efficient participatory decision-making. Process managers (De Bruijn et al., 2010) can facilitate that stakeholders engaged in decision-making follow this functional approach.

Recommendation #4: Develop ‘default’ formal rules that facilitate the introduction of smart grids.

Based on the findings of this dissertation I recommend that formal ‘default’ rules should be created, as well as aligned in such a way that they facilitate the introduction of smart grids. In particular the analyses in Chapters 4 and 5 have shown that formal rules are not all appropriate for current smart grid practices. In the case studies conducted in Chapter 4 rules-in-form prevented stakeholders to undertake certain actions, that is DSOs and housing associations could not invest in smart grid projects. The Experimentation Decree analysed in Chapter 5 showed that experimental rules-in-form were not followed upon in practice; other actors besides the indicated associations were in charge of local grid projects. I therefore recommend that formal rules for the introduction of smart grids should not determine tasks for a specific type of actor, but take the form of ‘default’ formal rules that can be tailored to local conditions (see recommendation #1). These ‘default’ formal rules could define certain conditions that have to be met if one is to engage in local energy planning. For instance, a ‘default’ rule could specify that residents have to have a say in the decision-making process on the energy infrastructure in the city district where they live or work (a default boundary and aggregation rule); or alternatively, that when residents want to install a large quantity of solar PV panels in a their city district, the default boundary rule applies that the DSO has to be involved early on in the process. Such ‘default’ formal rules can help to ensure that (desirable) rules-in-use are in alignment with rules-in-form, and thus prevent conflicts or project delays. In regard to the creation as well as alignment of formal rules for the introduction of smart grids, the institutional architecture developed in this PhD thesis is of help. Instead of a trial-and-error approach for the design of institutional arrangements, this institutional architecture makes it possible to ensure *ex ante* the normative constraints and opportunities for the introduction of a local smart grid project, and in particular the lawful consistency of rules inside and across action situations and institutional levels.

Recommendation #5: Pay attention to the creation of appropriate ‘rules of the game’ before establishing specific project goals.

My final recommendation is that stakeholders should discuss the ‘rules of the game’ before establishing specific project goals. Put differently, determining the ‘rules of the game’ should precede talking about the content of collaboration, that is, discussing the specific energy system design and related goals. Clarifying inter alia roles and responsibilities at the outset of a collaboration can help to prevent the establishment of goals that are out of reach, and more generally accelerate the planning process. In particular, a structured and explicit discussion about the ‘rules of the game’ should

define who participates (boundary rule), who plays which role (position rule), what are everyone's do's and don'ts (choice rule), how decisions will be made (aggregation rule) and who wants to financially contribute (to) what (payoff rule). The analysis in Chapter 4 allowed to conclude that when stakeholders make sound agreements on the distribution of costs and benefits (payoff rule) in the beginning of a project, the payoff rules will enable the decision-making process and ultimately the achievement of project goals. In turn, this can help increase the overall feasibility of a project and ensure that project delays are prevented. Again, a process manager could take on the role of facilitating discussions about the 'rules of the game', but especially stakeholders themselves have to be explicit about creating rules and continuously check whether any rules need to be modified, e.g., when moving to a different phase of decision-making.

Appendix

Appendix A: Coding scheme for literature review

Categories		Codes
Actors	Actors	
Positions	<ul style="list-style-type: none"> - Policy entrepreneur - Strategic niche management - Network management 	
Actions	<ul style="list-style-type: none"> - Possible actions - Laws and regulations - Policy instruments 	
Information	<ul style="list-style-type: none"> - Information available to actors - Framing - Boundary spanning 	
Control	<ul style="list-style-type: none"> - Individual action/monocentricity - Coalitions (e.g., advocacy coalition, discourse coalition) - Co-creation - Co-production 	
Net costs and benefits	<ul style="list-style-type: none"> - Costs of project incurred - Pay-back time (potential costs) - Benefits of project incurred 	
(Potential) outcomes	<ul style="list-style-type: none"> - Goal - Outcome - Evaluation and implementation research 	
Bio-physical conditions	Physical and material conditions	
Attributes of community	Attributes of Community	
Barrier	Barrier	
Enabling condition	Enabling condition	

Table A1: Coding scheme for literature review

Appendix B: Selected articles of literature review (in alphabetical order)

Literature used in the Systematic Literature Analysis

1. Chmutina, Wiersma, Goodier, & Devine-Wright, 2014;
2. Devine-Wright & Wiersma, 2013;
3. Elle et al., 2002;
4. Frances & Stevenson, 2018;
5. Fuchs & Hinderer, 2014;
6. Gansmo, 2012;
7. Gustavsson & Elander, 2016;
8. Hoppe, 2012;
9. Jensen & Maslesa, 2015;
10. Klein Woolthuis, Hooimeijer, Bossink, Mulder, & Brouwer, 2013;
11. Lammers & Heldeweg, 2016;
12. Moss, Becker, & Naumann, 2015;
13. Muyingo, 2015;
14. Parks, 2018;
15. Quitzau, Hoffmann, & Elle, 2012;
16. Quitzau, Jensen, Elle, & Hoffmann, 2013;
17. Schroepfer & Hee, 2008;
18. Smedby & Quitzau, 2016;
19. Strasser, 2015;
20. Van Der Waals, Vermeulen, & Glasbergen, 2003;
21. Van Doren, Driessen, Runhaar, & Giezen, 2018;
22. Viétor, Hoppe, & Clancy, 2015;
23. Williams, 2010;
24. Williams, 2012.

Appendix C: Selected articles of literature review by journal

Figure C1: Selected articles of literature review by journal

Appendix D: Interview Guide in Dutch

[briefing]

Entry/exit rules

1. Wanneer en hoe is het project voor u begonnen?
2. Wie werd naast u in het project betrokken?
3. Hoe werden afspraken gemaakt over wie, wanneer in het project betrokken wordt?

Doelen en opties

4. Wat was uw doel voor het project?
5. Welke opties heeft de projectgroep overwogen om invulling aan het project te geven?
 - 5.1. Wanneer en door wie werd [de optie] ingebracht?
 - 5.2. Welke actoren hebben zich aan de projectdoelen gecommitteerd?

Afhankelijk van antwoord wel/geen slimme energie-infrastructuur:

- 5.3. Er bestaan verschillende definities van een slim energiesysteem. Wat verstaat u precies onder 'smart grid' (of 'smart energy system')?

Besluitvorming en key-moments

6. Zou u mij kunnen vertellen hoe de samenwerking in project X precies plaats heeft gevonden?
 - 6.1. Hoe werden de overwegingen tussen de verschillende opties voor de energie-infrastructuur in project X gemaakt? (b.v. collectief beraad/ in klein verband, process management/leiderschap)
 - 6.2. Wat is er gaandeweg het project in de manier waarop besluiten worden genomen veranderd? (inhoudelijk, procedureel, groepsleden)
7. Welke factoren hebben volgens u ertoe geleid dat uiteindelijk het besluit voor optie Y werd genomen?
8. Welke momenten in de besluitvorming waren volgens u belangrijk voor het verloop van het project? (stagnatie/doorbraak)

Succes, barrières & leren

9. Wat zijn volgens u de belangrijkste lessen die zijn opgedaan tijdens het project?
10. Wat zijn volgens u belangrijke barrières in het realiseren van het project?
11. Hoe zou de projectgroep met deze barrière(s) om moeten gaan?
12. Wat is volgens u noodzakelijk om de implementatie van de nieuwe (slimme) infrastructuur in project X een succes te laten worden?

Wet- en regelgeving

13. Welke invloed hadden wet- en regelgeving en beleidsinstrumenten op de besluiten? (B.v.: convenanten, subsidies, innovatieprojecten met pilots)

Debriefing

- We zijn nu aan het einde van het interview. Ik heb alleen nog één laatste vraag:
- 14. Zou u mij nog informatie kunnen geven met betrekking tot relevante documenten en personen die eveneens binnen het project betrokken zijn?
- Ik heb geen verdere vragen en wil u voor dit gesprek bedanken. Is er nog iets wat u mij wilt laten weten of hebt u nog vragen voordat wij het interview beëindigen? → Bedankt voor het interview.

Appendix E: Interview Guide in English

[briefing]

Entry/exit rules

15. When and how did the project start for you?
16. Besides yourself, who else was involved in the project?
17. How were agreements made regarding who was going to be involved at what point in the project?

Goals and options

18. What was the project's goal?
19. Which options did the project consortium consider to realize the project?
 - 19.1. When and by whom was [the option] brought up?
 - 19.2. Which actors committed themselves to the project goals?

Depending on the answer yes/no smart grid infrastructure:

- 19.3. There are several definitions of 'smart grid'. What is your definition of 'smart grid' (or 'smart energy system')?

Decision-making and key moments

20. Could you explain to me how the collaboration in project X took place?
 - 20.1. How were the considerations on the different options for the energy infrastructure in project X made? (e.g., collective deliberation/ by a small select group of people, process management/leadership)
 - 20.2. What has changed throughout the project in regard to the way in which decisions were made? (content, procedure, consortium members)
21. According to you, which factors have led to the decision to choose for option Y?
22. Which moments in the decision-making process were according to you important for the project's progress? (stagnation/ breakthrough)

Success, barriers & learning

23. According to you, which are the most important lessons learned from the project?
24. According to you, which are the most important barriers to realizing the project?
25. How should the project consortium manage with the barriers?
26. According to you, what is necessary to make the implementation of new (smart) infrastructure in project X successful?

Laws and regulations

27. Which impact did laws, regulations and policy instruments have on the decisions that were made? (e.g., covenants, subsidies, pilot projects)

Debriefing

- We are now at the end of the interview. I only have one last question:
- 28. Could you provide me with additional information in regard to relevant documents and people that were involved in the project?
- I do not have further questions and would like to thank you for this conversation. Is there anything else that you would like to let me know or would like to ask me before we finalize this interview? → Thank you for the interview.

Appendix F: Coding scheme for case analysis

Elements	Definition
Bio-physical conditions	Physical and material conditions, e.g., type of buildings, existing infrastructure and renewable energy technologies.
Attributes of Community	Characteristics and preferences of the involved community, e.g., socio-economic characteristics, political party in power, home-ownership.
Boundary rules	Specify the number of actors that participate in the local energy planning process (e.g., municipal policy officer), and how these actors join and leave the decision-making process.
Position rules	Specify the set of positions actors hold in the local energy planning process (e.g., project leader, network manager).
Choice rules	Specify the sets of actions that can (could have), may or must not (have) been taken at specific points in time, e.g., deriving from informal agreements or from policy instruments, laws or regulations.
Information rules	Specify the amount and type of information available to participants (e.g., about the technology, policies, meetings, or costs- and benefits) and how this information is used and shared (e.g., boundary spanning).
Aggregation rules	Specify how decisions are made, e.g., by an individual actor, or in collaboration with others (e.g., coalitions, co-creation).
Payoff rules	Specify the costs and benefits that derive from particular actions and outcomes, e.g., costs of project, pay-back time, distribution of costs and benefits among actors.
Scope rules	Specify the set of possible outcomes, as well as the jurisdiction and state of outcomes, e.g., geographic region and events affected, temporary or final status of the outcome.
Goal attainment	Original project goal vs. achieved outcome during the period under analysis.
Actors' capabilities	Actors' resources, valuations, information processing, and selection processes (called perceptions, motivations and anticipations in causal process tracing).
Key moments	An instance in the decision-making process that influenced the outcome of decision-making, i.e., the introduction of a smart grid.
Definition smart grid	Definition of the term 'smart grid' or 'smart energy system' used by the interview partners.

Table F1: Coding scheme for case analysis

Appendix G: Case narrative ‘Intelligent Net Duurzaam Lochem’

I identified the institutional conditions that were at play in the decision-making process during seven key moments in the project ‘Intelligent Net Duurzaam Lochem’ (short: Lochem project), a pilot project that took place between December 2011 and the fall of 2015 in a residential area in the city of Lochem.

The first key moment was the granting of a governmental ‘IPIN’ subsidy of €1,493,957 in December 2011. The proposal for this subsidy was initiated by the University of Twente in close collaboration with the community energy initiative ‘LochemEnergie’. These two initiators in turn invited other relevant actors (*boundary rule: the project initiators invite other actors*): DSO ‘Alliander’, technology providers ‘Locamation’ and ‘Eaton’, as well as the energy supplier ‘Trianel’. The goal for the project was to explore the impact and effects of fluctuating electricity on the grid and to engage residents in electricity saving and – balancing, including the use of electric vehicles. However once the subsidy had been granted, the scope of the project had to be downscaled as the granted subsidy was smaller than expected (*payoff rule & scope rule: less subsidy granted, as a consequence the set of possible outcomes decreases*).

After the project’s start, the exact objective was still unclear until DSO ‘Alliander’ organized a brainstorm session in December 2012, which I define as the second key moment. While technology provider ‘Locamation’ was officially the project leader, DSO ‘Alliander’ stepped in to support ‘Locamation’, and eventually was considered the ‘de facto’ project leader by all consortium members (*position rule: Alliander gains the position as ‘de facto’ project leader*). During the collective brainstorm session (*aggregation rule: all partners allowed to discuss the options for the project together*) the project’s scope in terms of the range of possible streets and electrical substations where the project was going to take place was identified (*scope rule: streets and electrical substations are identified as project locations*).

In January 2013, the third key moment, energy supplier ‘Trianel’ went bankrupt, and therefore had to leave the project (*boundary rule: energy supplier ‘Trianel’ goes bankrupt and leaves project*). This was considered problematic as community energy initiative ‘LochemEnergie’ had established strict requirements for householders to join the project (*boundary rule: strict requirements for householders to join*): a fifteen year commitment through the installation of solar PV panels (or alternatively, the participation in a collective solar PV park), membership of ‘LochemEnergie’, as well as switching to energy supplier ‘Trianel’. The bankruptcy of ‘Trianel’, as well as the delay in the installation of smart meters made recruitment of householders more difficult. Additionally, when the energy supplier ‘Eneco’ joined the project to substitute ‘Trianel’ (*boundary rule: ‘Eneco’ joins the project by invitation*), charging flexible electricity tariffs and peer-to-peer supply of electricity was not foreseen anymore. These developments in boundary rules decreased the scope of the project

(scope rule: fewer residents join the project and technical solutions are limited due to the exit of energy supplier 'Trianel').

The fourth key moment represents the first actual step in the realization of the smart grid: smart meters and the first collective solar PV park were installed between April and June 2013. DSO 'Alliander' financed these installations, it donated money to 'LochemEnergie' which arranged the installation of the first solar PV park on the roof of the city hall, and later on the installation of three additional solar PV parks (payoff rule: DSO 'Alliander' finances the installation of smart meters and the first solar PV park). With this fourth key moment the position of householders changed: for the first time they became actively involved in the project (position rule: the householders become active resource users), were enabled to monitor their energy consumption and production, and were invited to attend information evenings and participate in working groups (information rule: householders are enabled to obtain insight in their energy flows, and to attend information evenings and working groups).

The monitoring of electricity flows for the district as a whole, however, was delayed. While technology supplier 'Locamation' was supposed to deliver low-voltage sensors for several transformers in May 2013, it kept postponing the delivery (choice rule: technology provider 'Locamation' must deliver low-voltage sensors), to the frustration of DSO 'Alliander' and technology provider 'Eaton'. The steering group, created for overseeing the project and for strategic decision-making (aggregation rule: the steering group decides, the project group implements) could de-escalate the situation. Eventually, technology supplier 'Eaton' delivered the sensors in the beginning of 2014, decreasing the role of technology provider 'Locamation' in the project (position rule: 'Locamation' is not actively involved anymore), which constitutes the fifth key moment.

The two most influential key moments for the success of the project occurred in 2014 and 2015 respectively. During the sixth key moment in March 2014, the technical set-up of equipment in the city district's electricity grid was simulated. This simulation made it clear which actions could and could not be taken, and finally defined the choices regarding the energy management system in the city district (choice rule: the simulation shows which technical activities can and cannot take place).

The seventh and final key moment was the so-called 'stress test' on 2 April 2015 at 8pm (Hoogsteen et al., 2017). At this moment residents of three streets simulated a 'typical' Dutch situation regarding supply and demand of electricity in 2025: they charged 20 electric vehicles and baked off 20 pizzas in electric ovens, resulting in a peak load. Note that these electric vehicles had mainly been donated by DSO 'Alliander' to community energy initiative 'LochemEnergie' (payoff rule: DSO 'Alliander' donates electric vehicles to 'LochemEnergie'), and were – via car sharing – available to all residents in Lochem. The goal of the 'stress test' was to obtain information on the maximum capacity of the electricity grid, that is to test whether a

blackout would occur or not. The ‘stress test’ did cause a blackout because all ovens were connected to the same wire of the three-phase circuit, an apparently common practice among electricians that the DSO was not aware of. Soon after this successful event the IPIN project officially ended in the fall of 2015.

Appendix H: Case narrative ‘Smart Grid MeppelEnergie’

Our analysis established six key moments with their respective institutional conditions for the decision-making process in the project ‘Smart Grid MeppelEnergie’ for the period from spring 2010 to the May of 2017.

The first key moment took place in the spring of 2010 when the municipality of Meppel voiced the ambition to create a sustainable city district, called ‘Nieuwveense Landen’. For the construction of this district the municipality decided that a district heating grid would be installed instead of a conventional gas grid (*choice rule: the city district will get a district heating grid instead of a conventional gas grid*). To specify and realize its ambitions, the municipality invited the regional water board ‘Reest en Wieden’ as well as DSO ‘Rendo’ to join the project group, and in January 2012 established the energy company ‘MeppelEnergie’ with a 50/50 shareholdership between the municipality and DSO ‘Rendo’. To define the city district’s energy system, the municipality additionally invited several experts, one of them ‘EnergyValley’, a network agency supporting renewable energy products in the North of the Netherlands (*boundary rule: the municipality invites regional stakeholders with expertise, and together with a DSO establishes its own energy company*).

The second key moment is related to the granting of a governmental subsidy of €567,439 under the programme ‘TKI Switch2SmartGrids’ (S2SG) in October 2012. In the summer of 2012 ‘EnergyValley’ had submitted a proposal to this subsidy program on behalf of the municipality. In order to do this, ‘EnergyValley’ had invited additional stakeholders from its own professional network to join the project (*boundary rule: ‘EnergyValley’ invites experts from its own network*): ‘INRG’ (for the installation of in-home sensors), the University of Twente (for the development of algorithms) and Delft University of Technology (for facilitating consumer involvement). Besides this, ‘EnergyValley’ defined the creation of a hybrid smart district heating grid for heating and cooling of the city district, which would consist of, (a) terraced homes that would receive heat/cold via a combined heat and power (CHP) plant that is fed with biogas; and (b) of (semi-) detached homes with individual heat pumps that receive electricity from the CHP. This system was to be optimized by balancing all energy flows and should provide financial benefits to the end users, as well as involve them actively in the project, e.g., via apps and games for energy saving. During the specification of the project’s goals, disagreement existed between the municipality and DSO ‘Rendo’ regarding the accuracy of the estimated home sales per year; eventually 444 houses were listed in the project proposal.

However, prior to the start of the project, in the fall and winter of 2012, it became evident that two consortium members were experiencing problems that had a serious impact on their position in the decision-making process, comprising the third key moment. In May and December 2012 DSO ‘Rendo’ was subject to two fraud cases,

related to bribes in the sale of shares to former energy supplier 'Electrabel' as well as to the development of an electricity power plant in the city of Steenwijk. These events led to changes in staff and made 'Rendo' to focus on its core business, giving rise to a less innovative and less ambitious attitude of the DSO in the Meppel project. Another event was the explosion of a biogas plant in the city of Raalte (located some 40 kilometres from Meppel) in October 2012, which led the water board to reconsider the supply of biogas to the 'Nieuwveense Landen' district. During the third key moment, both 'Rendo' and the water board took on a less ambitious and less active role. In addition, as the subsidy had been successfully obtained the active role of 'EnergyValley' changed to that of a passive advisor (*position rule: DSO 'Rendo' and the water board take less active roles; 'EnergyValley' becomes a passive advisor*).

The fourth key moment occurred in the fall of 2014, when the first terraced homes were constructed, tailored to starters on the labour market. Originally, the first homes were supposed to be constructed in 2013, together with the renewable energy system, however, the financial and economic crisis delayed the pace of home sales and construction. This delay led to disabling *position rules*: the role of the municipality and the water board became even more passive as the project was stalling. The same applied to the consortium members of 'INRG', the University of Twente and Delft University of Technology, who all did not yet have the data they needed to work with. While 'MeppelEnergie' became the official project leader, *de facto* it was two employees of DSO 'Rendo' who were in charge (*position rule: 'Rendo' is 'de facto' project leader*). Yet these two employees were little experienced in running such a pilot project and in managing highly-educated independent researchers. As the roll-out of the heating grid infrastructure was the main focus of the project during this fourth key moment, the responsible DSO 'Rendo' made its own decisions (*aggregation rule: 'Rendo' takes decisions on its own*) and rarely communicated with the other consortium members (*information rule: 'Rendo' rarely communicates with partners*) outside of the consortium meetings that took place three to four times a year.

In the spring of 2015, a temporary, non-renewable energy infrastructure was up and running, the fifth key moment of the project. This system included boilers for feeding the district heating grid with natural gas, instead of the originally foreseen biogas-fed CHP and planned individual heat pumps. From the start of the project the decision had been made that the renewable energy system was to be installed once more than 150 homes had been built in order for the investment in the CHP to become financially feasible; in 2015 this had not yet been the case (*choice rule & payoff rule: the renewable energy system becomes profitable for installation once 150 homes have been built*). Additionally, it turned out that the costs of constructing the planned biogas pipeline between the sewage water treatment plant and the city district would become too high to generate profit (*payoff rule: costs biogas pipeline too high*). This resulted in the installation of a temporary, non-RE system without biogas, a CHP or heat

pumps, changing the scope of the project (*scope rule: temporary, non-renewable energy system installed*).

In the summer of 2016, a total of 150 homes had finally been constructed, meaning that a system fed with renewable energy would be financially attractive. Following this, for this sixth and final key moment DSO 'Rendo' opened a tender for local parties to come up with a sustainable solution for the local district heating grid in the fall of 2016. This decision to open a tender instead of continuing with the original goals and actor positions had two reasons. Firstly, the DSO was supposed to only have a role as grid operator in new projects, and not as an energy supplier anymore, making it hesitant to maintain its previously defined role as energy supplier for the 'Nieuwveense Landen' city district (*choice rule: the law mandates DSOs to stick to their core tasks in future projects*). Secondly, small and medium-sized enterprises (SMEs) can receive tax benefits for investments in renewable energy, and would therefore be able to offer consumers a cheaper solution than the DSO (*payoff rule: SMEs receive tax benefits for RE projects*). In May 2017 DSO 'Rendo' chose for the engineering company Croonwouter&dros, which by the end of 2018 must have replaced the temporary energy system with a renewable energy system that includes wood-burning stoves that feed the district heating grid through biomass for the coming thirty years. To conclude, as neither a CHP plant nor heat pumps were installed, these could not be steered and eventually the smartness of the energy system was only simulated mathematically. Additionally, the goal to actively involve residents in the planning process on the local energy system was neither achieved.

Appendix I: Case narrative ‘Bothoven-Noord: op weg naar een energieneutrale wijk’

The decision-making process on the project ‘Bothoven-Noord: op weg naar een energieneutrale wijk’ contained six key moments in the analysed period from September 2012 to August 2017.

The first key moment occurred in September 2012. Around this time, the local government of the municipality of Enschede and the two housing associations ‘De Woonplaats’ and ‘Domijn’ realized that they had overlapping ambitions to develop their assets in the city district of ‘Bothoven-Noord’. The municipality was responsible for a public park in the district, both housing associations owned social housing stock there, and one of them – ‘Domijn’ – additionally owned an old factory building. For this reason, the three parties wrote a joint vision document (in Dutch: ‘gebiedsvisie’) and formed a steering group to take decisions (*aggregation rule: a steering group is established to take decisions and to have oversight over the project*), a core team to support the steering group, as well as three working groups, one of them on the theme of sustainability. An employee from each of the three organizations became a member of this ‘working group sustainability’ (*boundary rule: municipality and housing associations establish and deliver personnel to work at a ‘working group sustainability’*). Together these members asked a consultancy agency to explore and suggest options for renewable energy in the city district. One well-received suggestion by the consultancy agency was the implementation of a smart grid. However, the ‘working group sustainability’ was not able to find partners to run and finance such a smart grid project.

This changed two years later, in November 2013, when the municipality of Enschede signed the ‘Green Deal Smart Energy Cities’ (a public-private collaboration that included projects in five Dutch municipalities⁵²), resulting in the second key moment. To help achieve the Green Deal’s goal of 100,000 energy-neutral buildings by 2019, the municipality chose the Bothoven-Noord district as a ‘kick-start project’, and together with the two housing associations invited additional experts to join a newly created ‘smart grid Bothoven-Noord’ consortium: DSO ‘Cogas’, DSO ‘Enexis’, and ‘Pioneering’, a platform that connects stakeholders in the construction sector (*boundary rule: two DSOs and one networking platform join the project via participation in a ‘Green Deal’*). The policy officer from the municipality was leading the project (*position rule: municipality project leader*), and initially the DSOs were looked at for providing smart grid solutions. All ‘working group sustainability’ members were part of this ‘smart grid Bothoven-Noord’ consortium, and at the same time oversaw the work of this group as well as that of six additional project groups in

⁵² See Subsection 4.4.1 for details on this Green Deal Smart Energy Cities.

which aspects relevant to a smart grid were discussed, for instance the generation of renewable energy and the renovation of buildings. This set-up had two consequences, (1) the components of the smart grid were considered in isolation; and (2) the ‘working group sustainability’ members (‘Domijn’, ‘De Woonplaats’ and the municipality) were aware of the progress in all six groups, while the other ‘smart grid Bothoven-Noord’ consortium members only received brief updates during the monthly meetings (*information rule: the housing associations and the municipality have more information*).

The third key moment occurred in September and October 2015, when Enexis installed smart meters in 1,450 houses in the city district (ahead of schedule). Besides this roll-out of smart meters however, DSO ‘Enexis’, as well as DSO ‘Cogas’, saw themselves as a passive, external advisers (*position rule: DSOs take on the role as passive external advisers*). As the active involvement of householders via apps (to provide insight into energy flows to end users and the DSO) was the initial aim of the smart grid project, the installation of these smart meters was an important stepping stone. While additional options were considered for achieving the goal of an energy neutral city district in 2040, the considerations on the production of renewable energy were not made by the project group as a whole, but were the task of individual organizations (*aggregation rule: individual organizations decide on renewable energy options, not the project group as collective decision-making body*). Housing association ‘Domijn’ investigated the installation of solar PV panels on the roof of the old factory building that it owns in the district, but could not establish a sound business case. DSO and energy supplier ‘Ennatuurlijk’, the owner of the district’s gas-powered district heating grid, was not interested in feeding the heating grid with locally generated renewable energy as it had the goal to interconnect all islanded heating grids in the city of Enschede and collectively feed them with industrial excess heat.

To move beyond the installation of smart meters, in October 2015 the ‘smart grid Bothoven-Noord’ consortium members joined up with business developer ‘Texel Development’ (*boundary rule: Texel Development invited to join*) and submitted a proposal to the governmental subsidy program ‘demonstratie energie-innovatie’ (short DEI)⁵³. The goal established in this proposal was the installation of home energy management systems (HEMS) in 500 households in Bothoven-Noord. In early 2016 a subsidy of €983,894 was granted to the business developer for the roll-out of HEMS in 1,000 households, 500 of which are located in the Bothoven-Noord district. The granting of this subsidy, key moment four, was a welcome development as no member of the smart grid consortium was investing in technical solutions (*payoff rule: DEI subsidy granted, project group members do not invest*). This reluctance to invest is related to the fact that all semi-public organizations (the DSOs and housing

⁵³ In English ‘demonstration of energy-innovations’.

associations) are legally required to focus on their core tasks, that is the housing associations have to focus on the provision of social housing, and the DSOs have to stick to energy system management (*choice rule: law specifies semi-public organizations focus on their core tasks*). In addition, the municipality took on the role of a passive facilitator (*position rule: the municipality moves from project leader to passive facilitator*).

The fifth key moment took place in May 2016 when an external project manager was hired (*boundary & position rule: external consultant hired as project manager and leads the project*). Furthermore, in line with the subsidy application, the project's name was changed to 'Energieketen in handen van de consument'⁵⁴, and the involvement of residents in the local energy system was emphasized. While the project manager structured the process more strictly with weekly telephone conferences and bi-monthly meetings, the development of the HEMS devices took longer than anticipated by the consortium members. Also, the business development company 'Texel Development' was only involved on the sideline and did not regularly participate in the consortium meetings (*position rule: 'Texel Development' passively involved*). In the meantime, the project group widened the *scope rules* of the project: a multitude of ideas and potential technologies was suggested, but no progress was made.

The sixth and final key moment of the period under analysis was the cancellation of the installation of the HEMS in August 2017. In January 2017 the installation of the HEMS still looked promising because a brainstorm session took place with a small group of residents. Even though consumer involvement was already the project's aim since 2013, the consortium members never previously got in contact with the local residents due to the absence of specific plans. However, as the project developer 'Texel Development' did not openly communicate its progress with the consortium members but kept on postponing the delivery of the HEMS, the housing associations – the official DEI subsidy partners – ended the collaboration in August 2017 (*information rule: 'Texel Development' does not communicate openly about progress in development of HEMS*). On the other hand, in July 2017 solar PV panels had been installed on the roof of the old factory building that is located in the district. However, the 280.000 kWh of electricity that these solar PV panels generate annually is used either by companies located inside the old factory building, or fed into the electricity grid; a local smart grid did thus not come into existence.

⁵⁴ In English 'energy chain in the hands of consumers'.

Appendix J: Case narrative ‘Hart van Zuid’

The decision-making process in the project ‘Hart van Zuid’ in Hengelo contained six key moments in the period between 2002 and November 2017, during each of which certain institutional conditions influenced decision-making on the introduction of the envisioned energy system.

The first key moment occurred in 2002 when the municipality of Hengelo formulated the ambition to create a local district heating grid to be fed with renewable energy sources (*choice rule: choice for a heating grid instead of a gas grid*) in the ‘Hart van Zuid’ city district, in the municipality of Hengelo (OV), the Netherlands. The local government established strict project targets for the realization of the district heating grid, with the aim to have interested energy suppliers realize them: the district heating grid should not become more expensive than conventional alternatives (*boundary rule: strict financial targets are set for energy suppliers to participate in the project*). Due to these strict financial requirements all attempts of the municipality to find parties to implement the district heating grid were unsuccessful (*payoff rule: companies could not offer any affordable solutions*). These attempts included negotiations with energy supplier ‘Essent’, a tender that had to be cancelled, and several offers from energy companies via a ‘marktscan’ (a policy instrument that investigates which surplus value companies can create for projects).

Five years later, in December 2007, the construction of homes in the ‘gas-free’ city district started and the installation of the heating grid could no longer wait as these newly-constructed houses had to be supplied with heat (*choice rule: heating grid must be installed as newly-constructed houses must be supplied with heat*). This led to the second key moment, when the municipality of Hengelo decided to start the project by itself (*choice rule: municipality starts project alone*). For the realization of the district heating grid the municipality created ‘Warmtenet Hengelo’ (in English: ‘district heating grid Hengelo’), a small department inside the municipality of Hengelo that was run by five to six employees who regularly hired experts to support them (*position rule: a department of the municipality becomes project leader*). This set-up led to the *aggregation rule* that each decision regarding the district heating grid had to go through the municipal council for approval, which was considered a slow process that was subject to a changing council every four years. However, the goal to turn this public utility into an independent company, with the municipality, the provincial government and the waste processing company/energy supplier ‘Twence’ as shareholders was stalled for reasons of state aid concerns by the European Commission (*choice rule: legal restrictions of state aid prevent the envisioned organizational solution*), and by the fact that eventually the provincial government and ‘Twence’ pulled back. As the houses needed to be supplied with heat, in the meanwhile the municipality started to install small islanded district heating grids that

were powered by natural gas, with the aim to interconnect them via a ‘backbone’ (a pipeline that delivers industrial excess heat to the heating grid in the ‘Hart van Zuid’ city district) at a later stage.

This third key moment occurred with the publication of a report by consultancy agency ‘CE Delft’ on the financial state of the district heating grid in ‘Hart van Zuid’ in its existing and future form. Prior to the commissioning of this report by a new alderman, the choice had always been to install the ‘backbone’ once enough end users had committed to receiving heat from the district heating grid to make the construction of the ‘backbone’ profitable (*choice rule: install the ‘backbone’ once sufficient end users have committed to being connected to the heating grid, making the ‘backbone’ profitable*). Until that point, the gas-powered, non-renewable islanded grids would be maintained, as these were assumed to be profitable. However, in the fall of 2014 the report by ‘CE Delft’ showed that the installed islanded grids did not generate profit, and that the financial situation could potentially only improve if more customers were to be connected or if the expensive ‘backbone’ were to be constructed (*information rule: municipal government officially informed that the installed natural gas-fed district heating grids are not profitable*).

Following the publication by ‘CE Delft’, in January 2015, the municipality decided to install the ‘backbone’, key moment four, as it had its back against the wall: stopping the undertaking (e.g., by providing each household with an individual gas boiler) would not only put the reduction of CO₂ emissions on hold, but would also be more expensive than installing the ‘backbone’ (*payoff rule: stopping the project deemed more expensive than installing the ‘backbone’; choice rule: municipality has to install ‘backbone’ to prevent even bigger financial and environmental losses*). Additionally, the municipality was aware that no one would take over the islanded district heating grids in their unprofitable state. The total investment for the ‘backbone’ was estimated at €14 million, for which the municipality could obtain €4 million in subsidies from the provincial government and €3 million from the Dutch government via the Green Deal ‘Warmtenet Hengelo: ‘backbone’ en HTSP-campus’, an instrument through which the Dutch government supports public-private partnership for innovative and sustainable projects (*payoff rule: the municipality received €7 million in subsidies by higher governments for the construction of the innovative ‘backbone’*).

The fifth key moment took place in May 2015, when the municipality opened a tender for the sale of its district heating grids in ‘Hart van Zuid’. While the goal had always been to establish an independent company to exploit these grids, the municipality’s decision to install the ‘backbone’ finally made an acquisition attractive to other companies. Initially DSO ‘Alliander’, DSO ‘Enexis’ and energy supplier ‘Ennatuurlijk’ responded to the tender, after which negotiations proceeded with ‘Alliander’ and ‘Ennatuurlijk’ (*boundary rule: ‘Alliander’ and ‘Ennatuurlijk’ join the*

project via a tender). During these negotiations ‘Alliander’ and ‘Ennatuurlijk’ were open about their business cases and required profit (*aggregation rule: transparency during negotiations*). Eventually, the municipality sold its district heating grids for the symbolical price of €1, making a loss of €8.5 million (*payoff rule: municipality sells grid for €1, makes an €8.5 million loss*), but finally getting rid of the financial risks. Additionally, the municipality assured to shoulder 65% of unexpected costs during the construction of the ‘backbone’, with DSO ‘Alliander’ becoming responsible for 25% and DSO ‘Ennatuurlijk’ for 10% (*payoff rule: unexpected costs are shared among consortium partners*).

In January 2017 then, the entire district heating grid was handed over to two newly created companies, constituting the sixth and final key moment. These companies were ‘Warmtenetwerk Hengelo’, with DSO ‘Alliander’ holding 95% of the shares and the municipality of Hengelo 5%, and ‘Warmtebedrijf Hengelo’, of which 95% of shares were held by DSO ‘Ennatuurlijk’ and 5% by the municipality (*position rule: two companies exert a large role, with a small role for the municipality*). This distribution of 95%/5% was chosen as it did not require extra financial administration, but did give certain voting rights to the municipality (*aggregation rule: 95%/5% influence companies/municipality*), which ‘Alliander’ and ‘Ennatuurlijk’ believed to ensure the municipality’s commitment to local district heating grid developments. Eventually, in November of 2017, DSO ‘Alliander’ and energy supplier ‘Ennatuurlijk’ had realized the envisioned renewable energy district heating grid in the ‘Hart van Zuid’ city district. With the completion and connection of the ‘backbone’, an open grid in a ‘cascade’ setting was created: the waste processing company ‘Twence’ would deliver steam from waste processing to the industrial company ‘Akzo Nobel’, which uses it for salt retrieval and afterwards sends the low temperature surplus heat to the district heating grid (responsibility of ‘Warmtenetwerk Hengelo’). This low temperature heat is then either used directly by end users, or turned into high temperature heat via a decentral power station from where it is delivered to residential customers (responsibility of the ‘Warmtebedrijf Hengelo’). For the installation and connection of this infrastructure all three parties had created a consortium which met monthly to discuss and approve any changes (*aggregation rule: monthly consortium meetings take place between project partners*).

Appendix K: The IAD framework with levels of analysis and outcomes

Figure K1: The IAD framework with levels of analysis and outcomes

Source: E. Ostrom (2005, p. 59)

Appendix L: Flowchart for the decision-making approach

Figure L1: Flowchart for the decision-making approach

Note: the abbreviation SES in Figure XII.A stands for 'smart energy system'

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Summary

RULES FOR WATT?

Designing Appropriate Governance Arrangements for the Introduction of Smart Grids

Our electricity system is in transition, involving, among others, a shift from fossil fuels to renewable resources, as well as from centralized to decentralized electricity production. In consequence, local demand and supply of electricity are becoming more difficult to predict and fluctuate more, while at the same time the consumption of electricity is increasing, notably through the electrification of mobility and space heating/cooling. As supply and demand of electricity need to be matched at all times, these developments challenge the operation and management of the electricity grid. Smart grids are considered a sustainable and energy-efficient solution to this challenge. With the help of information and communication technologies, smart grids can manage and optimize bi-directional flows of electrons and increased flexibility in demand. Smart grids, therefore, can facilitate the effective and efficient integration of electricity from intermitted renewable energy sources and the accommodation of more fluctuating demand patterns in the distribution grid.

This PhD thesis aims to contribute to the improvement of smart grid introduction in practice. It focusses in particular on the Dutch context because smart grids are considered important for the Dutch energy transition, but decision-making in energy planning and on smart grid introduction is rather slow and time-consuming. This problem is related to the increase in the number and diversity of actors in the transitioning energy system and to the fact that roles and responsibilities of stakeholders in local energy planning have blurred. To improve the introduction of smart grids, the ‘rules of the game’ governing multi-stakeholder local energy planning processes need to be reconsidered from the perspective of efficiency and effectiveness of the realization of sustainable and smart solutions. For that reason, this dissertation focusses on the institutional side of decision-making practices in local energy planning.

This research is guided by the research question *‘how can local governance on the introduction of smart grids be improved?’* To address this question, two research objectives are pursued in part A and part B of this dissertation, respectively:

- A. To obtain empirical insights into the governance arrangements inherent to decision-making on the introduction of smart grids in local settings.
- B. To use the empirically-obtained insights to develop heuristics that can facilitate the introduction of smart grids in local settings.

Part A of this dissertation consists of chapters 3, 4 and 5 which all provide empirical insights into the governance arrangements inherent to decision-making on the introduction of smart grids (research objective A). Specifically, I study a variety of governance arrangements from three different angles.

First, as the increase in the number and diversity of actors involved in energy planning has made local decision-making arenas polycentric, I analyse which consequences the polycentricity of arenas has for smart grid introduction (*chapter 3*). For this purpose, I conduct two empirical case studies and position the cases on the four criteria of polycentricity: control, efficiency, political representation and self-determination. This analysis reveals that tensions exist in polycentric configurations between on the one hand control and efficiency, and on the other hand self-determination and political representation.

Second, I empirically explore which ‘rules of the game’ (institutional conditions) enable and disable decision-making processes on the introduction of smart electricity and heating grids in Dutch city districts (*chapter 4*). I collected data for four cases and analysed and compared the case data with the help of the Institutional Analysis and Development (IAD) framework and causal process tracing. The results reveal that only stakeholders in the position of project leader were actively pursuing project goals (position rules), legal barriers as well as path dependency of previous decisions limited the available choices (choice rules), and agreement was lacking on sharing costs and benefits (aggregation rules).

Third, I analysed a legal experiment that was established to allow for alternative governance arrangements for (smart) local electricity grid projects: the Dutch Experimentation Decree for Decentralized Renewable Electricity Generation from 2015 (*chapter 5*). To analyse which effect the Experimentation Decree had on the governance arrangements adopted in nine experimental projects, I did empirical legal research. My analysis revealed that although the Experimentation Decree specifies that associations (owners’ associations and energy cooperatives) have to be responsible for local grid projects, other actors (project developers, solar PV panel supplier, research centre, real estate company) take the lead in the projects, and active consumer involvement is limited.

The research reported in part A of this dissertation has led to three overarching findings: (1) efficiency in local energy planning on the introduction of smart grids is low; (2) there is mostly a lack of residents’ participation in the local planning process of their city district’s energy infrastructure; and (3) several rules-in-use are disabling local energy planning as well as are often conflicting with (experimental) rules-in-form. These three aspects show that improvements need to be made to local energy planning practices on the introduction of smart grids. In part B of my PhD thesis I developed two heuristics in response to the need for such improvements.

Part B of this dissertation is dedicated to developing an institutional architecture and a process architecture that can both facilitate the introduction of smart grids (research objective B). Each of these architectures builds on the empirically-obtained findings from part A, as well as on additional theoretical insights.

The institutional architecture facilitates the analysis and lawfully consistent design of institutional arrangements for the introduction of smart grids (*chapter 6*). I refer to this architecture as ILTIAD framework because it combines the previously applied IAD framework with a normative dimension reflected by institutional legal theory (ILT). In sum, the ILTIAD framework shows which normative constraints and opportunities exist for a local smart grid project, as well as which changes in institutional arrangements are needed to arrive at a desired smart grid.

The second heuristic, the process architecture, is developed with the aim to accelerate decision-making on the design and implementation of smart grids (*chapter 7*). This architecture in the form of a decision-making approach specifies the functional participation of actors in different phases of decision-making and helps to increase the acceptance of chosen smart grid designs, and more generally the effectiveness and efficiency of decision-making processes on smart grid introduction.

The research conducted in this dissertation is particularly relevant because (empirical) research on the introduction of smart grids in practice, and specifically on aspects of governance, is still in its infancy. My empirical research bridges this knowledge gap by showing which ‘rules of the game’ shape the interactions between stakeholders involved in local smart grid projects, and by revealing the tensions that exist between end user involvement and efficiency of decision-making. The theoretical contributions of my research relate to the application of the IAD framework to a new empirical research domain of energy infrastructure projects in local settings, as well as to adding a normative dimension to the IAD framework with the help of institutional legal theory. These empirical and theoretical contributions cumulate in the two heuristics that I develop to facilitate the introduction of smart grids by stakeholders in practice. Based on my research, I recommend for the introduction of smart grids that the wide range of stakeholders currently involved in local energy planning does not need to be reduced, but that top-down and bottom-up approaches need to be combined, that stakeholder participation needs to be more functional than it is now, and that right from the start of projects appropriate ‘rules of the game’ concerning the roles and responsibilities of stakeholders in local energy planning need to be collectively developed, clarified and agreed upon.

In sum, this dissertation provides detailed insights into how the local governance on the introduction of smart grids can be improved, and suggests two heuristics to facilitate improvements. The two heuristics are not only suitable for the introduction of smart grids in Dutch local settings, but also for the realization of additional (integrated) smart energy infrastructures in different contexts.

Samenvatting

REGELS VOOR WATT?

Het Ontwerpen van Adequate Governance Arrangementen voor de Introductie van Smart Grids

Ons elektriciteitssysteem is in transitie omdat elektriciteit steeds meer met behulp van hernieuwbare bronnen zoals wind en zon, decentraal wordt opgewekt. Daardoor wordt lokale vraag en aanbod van elektriciteit minder voorspelbaar en fluctueert sterker, terwijl tegelijkertijd de vraag naar elektriciteit toeneemt, met name door de elektrificatie van mobiliteit en verwarming van gebouwen. Deze ontwikkelingen hebben consequenties voor het management van elektriciteitsdistributienetten om te garanderen dat vraag en aanbod van elektriciteit altijd in balans zijn. Smart grids (slimme netten) worden als een duurzame en energie-efficiënte oplossing voor dit energiemanagerment probleem beschouwd. ICT stelt smart grids in staat om vraag en aanbod elke seconde op elkaar af te stemmen en om decentraal opgewekte elektriciteit adequaat terug te leveren aan het net. Slimme netten kunnen naar verwachting, de integratie van decentrale elektriciteit uit hernieuwbare energiebronnen in het distributienet effectief en efficiënt faciliteren.

Dit proefschrift wil een bijdrage leveren aan het verbeteren van de introductie van smart grids in het Nederlandse elektriciteitssysteem. Smart grids worden belangrijk geacht voor een succesvolle energietransitie in Nederland maar de introductie van slimme netten verloopt nog verre van voorspoedig. Dit wordt mede veroorzaakt door de toegenomen hoeveelheid en diversiteit van actoren in lokale energieplanning en toegenomen onduidelijkheid over hun rollen, posities en verantwoordelijkheden. Om die reden is in lokale energieplanning een verandering van de ‘rules of the game’ noodzakelijk om er voor te zorgen dat lokale energieplanning efficiënter tot effectieve duurzame en slimme oplossingen leidt. Dit proefschrift richt zich daarom op de institutionele kant van besluitvormingsprocessen in lokale energieplanning over de introductie van slimme netten.

Het onderzoek wordt geleid door de onderzoeksvraag ‘hoe kan de introductie van smart grids in lokale settings worden verbeterd?’ Aan deze vraag liggen twee doelstellingen ten grondslag die in deel A en B van dit proefschrift zijn geadresseerd:

- A. Het verkrijgen van empirisch inzicht in de praktijk van besluitvorming over de introductie van smart grids in lokale settings.
- B. Op basis van de onder A verkregen inzichten, heuristieken ontwikkelen die de introductie van smart grids in lokale settings kunnen faciliteren.

Deel A van dit proefschrift bestaat uit drie empirische hoofdstukken (3, 4 en 5) over aspecten van besluitvorming over de introductie van smart grids (doelstelling A).

Daarbij zijn tal van governance arrangementen vanuit verschillende perspectieven bestudeerd.

Tegen de achtergrond dat lokale besluitvormingsarena's door de toename in het aantal en de diversiteit aan actoren polycentrisch zijn geworden, heb ik ten eerste geanalyseerd welke gevolgen de komst van polycentrische lokale besluitvormingsarena's kan hebben voor de introductie van smart grids (*hoofdstuk 3*). Ik heb twee case studies uitgevoerd en de cases gepositioneerd op de vier criteria van polycentrisme: controle, efficiëntie, politieke vertegenwoordiging en lokale zelfbeschikking. Mijn analyse laat zien dat een polycentrische configuratie spanningen kent tussen enerzijds controle en efficiëntie en anderzijds zelfbeschikking en politieke vertegenwoordiging.

Ten tweede heb ik empirisch onderzocht welke 'rules of the game' (institutionele condities) besluitvormingsprocessen over de introductie van slimme elektriciteits- en warmtenetten in stadsdelen in Nederland bevorderen en belemmeren (*hoofdstuk 4*). Ik heb data over vier cases verzameld en deze geanalyseerd en vergeleken met behulp van het Institutional Analysis and Development (IAD) raamwerk en *causal process tracing*. Mijn resultaten laten zien dat alleen belanghebbenden in de positie van projectleider actief projectdoelen nastreven (position rule), dat wettelijke barrières en padafhankelijkheid van eerdere besluiten de beschikbare opties beperken (choice rules), en dat overeenkomsten over kosten en baten ontbreken (payoff rules).

Ten derde heb ik een experiment met wettelijke regels geanalyseerd waardoor projecten met alternatieve governance arrangementen voor (slimme) lokale elektriciteitsnetprojecten werden toegestaan: het besluit experimenten decentrale duurzame elektriciteitsopwekking uit 2015, oftewel Experimenten AMvB (*hoofdstuk 5*). In totaal heb ik negen settings waarin met de regels werd geëxperimenteerd door empirisch-juridisch onderzoek bestudeerd. Mijn analyse laat zien dat de bepaling in de Experimenten AMvB coöperaties of vereniging van eigenaars verantwoordelijk maakt voor de experimentele lokale net projecten, maar dat in de praktijk juist andere actoren (projectontwikkelaars, leveranciers van zonnepanelen, onderzoeksinstituten en vastgoedmaatschappijen) de leiding nemen en actieve betrokkenheid van consumenten beperkt is.

Het empirische onderzoek dat in deel A van het proefschrift wordt weergegeven heeft tot drie belangrijke conclusies geleid: (1) de efficiëntie van lokale energieplanningsprocessen over de introductie van smart grids is laag; (2) participatie van bewoners in het lokale energieplanningsproces is veelal afwezig; en (3) meerdere rules-in-use belemmeren lokale energieplanning en zijn vaak in tegenstrijd met (experimentele) rules-in-form. Uit deze drie conclusies volgt dat lokale energieplanning over de introductie van smart grids verbeterd moet worden. In deel B van mijn proefschrift ontwikkel ik daarom twee heuristieken om smart grid introductie te verbeteren.

In deel B van dit proefschrift doe ik verslag van de ontwikkeling van een institutionele architectuur en een proces architectuur om de introductie van smart grids te faciliteren (doelstelling B). Deze twee architecturen bouwen op de empirische bevindingen uit deel A aangevuld met theoretische inzichten.

De ontwikkelde institutionele architectuur dient om de analyse en het (juridisch consistente) ontwerp van institutionele arrangementen voor de introductie van smart grids te faciliteren (*hoofdstuk 6*). Ik noem deze architectuur ‘ILTIAD framework’ omdat het ‘ILTIAD framework’ het eerder toegepaste IAD raamwerk combineert met een normatieve dimensie gebaseerd op en afgeleid van institutional legal theory (ILT). Samengevat, het ‘ILTIAD framework’ laat de normatieve beperkingen en mogelijkheden voor lokale smart grid projecten zien, en welke veranderingen in institutionele arrangementen noodzakelijk zijn om een smart grid te realiseren.

De tweede heuristiek, de proces architectuur, is ontwikkeld met het doel om de besluitvorming over het ontwerp en de implementatie van smart grids te versnellen (*hoofdstuk 7*). Deze architectuur stelt een aanpak voor besluitvorming over smart grid ontwerp en implementatie voor en specificceert participatie van actoren naar functionaliteit in de procesgang van besluitvorming over smart grids. De proces architectuur dient om de acceptatie van het smart grid ontwerp te vergroten om daarmee de effectiviteit en efficiëntie van besluitvormingsprocessen over de introductie van smart grids te verhogen.

Het voorliggende onderzoek is in het bijzonder relevant omdat onderzoek naar de governance van smart grid introductie nog in de kinderschoenen staat. Het empirische deel van mijn onderzoek heeft meer inzicht opgeleverd over de governance van smart grid introductie, onder meer door inzicht te bieden in de ‘rules of the game’ die de interacties tussen belanghebbenden in lokale smart grid projecten bepalen en door de spanning tussen betrokkenheid van eindgebruikers (participatie) en efficiëntie van besluitvorming (voorspoedige doelrealisatie) te laten zien. De theoretische bijdrage van mijn onderzoek ligt in de toepassing van het IAD raamwerk op een nieuw empirisch onderzoeksdomein van energie infrastructuurprojecten in lokale settings, evenals het toevoegen van een normatieve dimensie aan het IAD raamwerk met behulp van institutional legal theory. Deze empirische en theoretische bijdragen komen samen in de twee heuristieken die ik heb ontworpen om de introductie van smart grids in de praktijk te faciliteren.

Op basis van mijn onderzoek beveel ik het volgende voor de introductie van smart grids aan: het huidige aantal actoren in lokale energieplanning zou niet beperkt moeten worden, maar top-down en bottom-up benaderingen zouden gecombineerd moeten worden, deelname in lokale energieplanning zou functioneler georganiseerd moeten worden, en meteen aan het begin van een planningsproces zouden adequate ‘rules of the game’ over rollen, posities en verantwoordelijkheden gemaakt moeten worden (en er moet ook overeenstemming over bestaan).

Samengevat geeft dit proefschrift inzicht in hoe vooruitgang geboekt kan worden in lokale besluitvormingsprocessen over de introductie van smart grids. Beide heuristieken die daartoe zijn ontwikkeld zijn niet alleen toepasbaar voor de introductie van smart grids in elektriciteitsnetten in Nederland, maar ook voor de realisatie van andere slimme energie infrastructuren (bij voorbeeld slimme warmtenetten) of van geïntegreerde energiesystemen in verschillende contexten.

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Enschede, 10th of October 2018

Curriculum Vitae

Imke Lammers was born on 19 August 1988 in Nordenham, Germany. She followed her secondary education at Zinzendorfschule Tossens, Germany, as well as spent one year as exchange student at Saint Louis Park High School, United States. Imke holds a Bachelor's degree in Public Administration (specialization European Studies) from the University of Twente and two Master's degrees in European Studies from the University of Twente (MSc) and from the University of Münster (M.A.) respectively. During her studies, Imke spent an exchange semester each at the Science Po Lille, France, and at the Autonomous University of Barcelona, Spain. During her internships at EcoVillage Uganda, the European Institute of Public Administration (EIPA) and Saxion University of Applied Sciences, Imke deepened her interest and expertise in renewable energy and (local) governance practices.

In the summer of 2014, Imke started her PhD research on designing governance arrangements for the introduction of smart grids at the Department of Governance and Technology for Sustainability (CSTM) at the University of Twente. Her research was part of the research programme 'Uncertainty Reduction in Smart Energy Systems' (URSES), financed by the Netherlands Organisation for Scientific Research (NWO). During her PhD research, in the fall of 2017, Imke was a visiting researcher at the Energy Agency Styria, Austria. Imke has numerous publications in international peer-reviewed journals and presented her work at several international conferences and at events organised by organisations such as the International Energy Agency. In addition to her research work, Imke taught at Bachelor and Master level, supervised several Master students, was secretary to the board of the PhD student association P-NUT, as well as co-founder and member of the PhD association of the IGS research institute.

Scientific Output

Publications

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