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

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Abstract: Moving towards a low-carbon society calls not only for technological innovation, but also for new modes of governance. However, the current legal framework of the electricity sector, and the modes of governance that it establishes, impede innovation in the sector. To overcome this obstacle, in 2015 the Dutch government adopted a Crown decree for experiments with decentralized renewable electricity generation (Experimentation Decree) with the aim to generate insights on how to adjust the legal framework. The question remains whether regulation is being adopted to real-life settings, i.e., which lessons can be learned from experimentally acquired results regarding new modes of governance for decentralized electricity systems? To answer this question we apply an interdisciplinary approach: we investigate which modes of governance are established in the Experimentation Decree (legal research) and which ones are implemented in nine projects (governance research). Under the Decree, associations have to carry out all tasks in the electricity supply chain and can engage in collective generation, peer-to-peer supply and system operation. Other modes of governance, new actors for emerging activities and consumer involvement are limited. We conclude that the Experimentation Decree is too restricted regarding new modes of governance for a decentralized electricity system in real-life settings.

Keywords: renewable energy; governance; distributed generation; legislation; experimentation; energy transition

1. Introduction

The European Union aims at 20% final energy consumption from renewable sources by 2020 and 27% by 2030 [1,2]. The shift towards a low-carbon society not only implies a changing *source* of energy generation but also a changing *structure* of energy generation. Whereas energy generated from fossil or nuclear sources is mainly produced large scale at centralized locations, renewable energy generators are also capable of producing on small scales. Distributed generation (DG) from intermittent renewable energy sources (RES) for example is increasing rapidly, and related to the efficient integration of RES, smart grid technology is advancing [3,4]. Arguably, RES and smart grid technologies will, and already are reshaping our current energy system [5]. However, while technologies for these developments are ready for implementation, many European countries experience problems with policies and regulations for innovative renewable energy systems such as smart grids [4,6]. EU-wide research by the International Energy Agency summarises that one of the main uncertainties for smart grid implementation concern the “roles and responsibilities of actors,

sharing of costs and benefits and, consequently, new business models” [6] (p. 11). This transition in the energy sector also bears a potential conflict between existing and 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” [5] (p. 64). This shows that technological innovation alone is not sufficient for facilitating future energy systems, but equally requires new modes of governance. This article focuses on the search for such new modes of governance 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 modes of governance—impedes innovation in the electricity sector [6,7]: it is tailored to the conventional electricity system and divides tasks between incumbent actors [4,8–11].

Overcoming this obstacle, experimental legislation is considered a valuable option, as it entails the temporary testing of novel legal approaches [12]. 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” [8] (p. 273). A relevant example of legal experimentation in the energy sector is provided in The Netherlands. Comparable to several other countries [6,13–15], first, experimentation in The Netherlands primarily focussed on technology: in 2011, the Dutch government established 12 smart grid pilot projects (named IPIN projects “Innovatie Program voor Intelligente Netten” (Innovation Program for Smart Grids)) to investigate the integration of DG, storage, demand-response, and the development of new services and products [16–18]. While these IPIN projects were created to investigate the potential of technological options, they actually also demonstrated that these options additionally enable and even require new forms of governance and changes of the legal framework [19]. Based on these conclusions, the Dutch government allowed for experimental derogation from specific provisions of the Dutch Electricity Act: on 1 April 2015, the Crown decree for experiments with decentralized renewable electricity generation [20] (herein, Experimentation Decree) entered into effect. This Experimentation Decree aims at investigating in how far the experiments contribute to increasing DG, foster the efficient use of the energy-infrastructure, and improve consumer involvement [16]. Ideally, outcomes of the experiments can contribute to adjusting the legal framework applicable to the electricity sector.

However, inherent to experiments is the characteristic that circumstances differ from real-life settings. Therefore, the question remains, whether the Experimentation Decree enables the emergence of new modes of governance not only within the experimental setting, but also on a larger scale for real-life application in decentralized electricity systems. Experimenting with law and governance is one thing, yet implementing these settings on a larger scale is paramount in light of a future, emerging energy system. Therefore, the main research question of this article is *which lessons can be learned from experimentally-acquired results regarding new modes of governance for decentralized electricity systems?* This article sets out to answer this question through the lens of legal and governance research, which is reflected in the articles twofold goal: firstly, identifying which new modes of governance are envisaged under the Dutch Experimentation Decree compared to those established by the current legal framework. Secondly, investigating which governance modes are actually implemented in the local projects that participate in the experiment. We then discuss whether the experimental legislation leads to new modes of governance, and to what extent those experimentally acquired results on new modes of governance can serve as insight for real-life application in decentralized electricity systems.

This article is structured as follows: Section 2 introduces the relevance of experimentation, and our specific example of the Dutch Experimentation Decree. Section 3 explains our method that centres around nine specific projects of this experimental legislation in The Netherlands. Section 4 depicts the findings and analyses which new modes of governance are included under the Experimentation Decree and which are implemented in the projects. Section 5 discusses these findings regarding the research question, while Section 6 concludes.

2. Background: In Search for New Modes of Governance in the Electricity Sector Transition

As a prerequisite for this article's main analysis this section outlines the current modes of governance of 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 new governance forms.

2.1. Current Modes of Governance in the Electricity Sector

To understand the quest for finding new modes of governance, this section briefly describes the existing modes of governance of the electricity sector along 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. Large generation plants are connected to the high-voltage transmission grid which transports the electricity over long distances, explaining why the transmission grid is sometimes referred to as the 'backbone' of the electricity system. The main task of the transmission system operator (TSO) is to balance supply and demand, by dispatching electricity (near) real-time, based on increases in demand. In contrast to the 'backbone' transmission grid, via the low- and medium-voltage grid electricity is distributed to the final customers. Unlike for the TSO, the tasks of the distribution system operator (DSO) do not include active dispatching of electricity, but the distribution of electricity flows for final consumption, i.e., to end-users. Often, the technical setting 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 modes of governance correspond to this 'top-down' structure of the electricity system. This entails for example that most of the grid operation- and planning responsibilities are located at transmission level with the TSO, and that consumers remain largely passive regarding conscious electricity consumption [21,22].

Electricity sector regulation aims to facilitate competition in activities that are not related to the grid infrastructure, i.e., generation and supply of electricity [23]. This involves a separation of generation and supply on the one hand and grid operation on the other hand, legally coined as 'unbundling', with the objective to increase overall welfare by improving economic efficiency with a competitive market setting. Clearly, a liberal market for electricity generation and supply enabled many more actors to enter and participate in the sector as generators and suppliers of electricity. The current modes of governance are thus established by legislation which strictly separates potential commercial activities (generation and supply) from grid operational tasks. For this reason, generators and suppliers are not permitted to exercise any control over grid operation, and vice versa, grid operators are not allowed to engage in generation and supply.

In essence, the electricity grid infrastructure is highly capital-intensive and forms the essential part for electricity transportation, making it a network-bound industry. These characteristics make the electricity sector an integral subject of EU and national policy agendas and legislation. Legislation has been changing and extending with the development of the sector, however, the main objective remains facilitating secure and affordable electricity supply despite the capital-intensive and network-bound attributes of the sector.

2.2. The Quest for Novel Modes of Governance 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 [1]. Yet, the intermittency of RES and increasing amounts of DG pose challenges to the technical setting of the electricity system [24]. These technological challenges show that current modes of governance are not corresponding with new developments. Some examples illustrate this mismatch between technical

developments and modes of governance. Firstly, households 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 something else yet [25]. 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 [26]. 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 [27]. The issues 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 modes of governance which correspond to a clear top-down setting of the electricity sector.

In The Netherlands, first efforts have been launched to experiment with new modes of governance which incorporate the above mentioned challenges. In the context of this article this section provides some further background on the developments leading up to the legislative experimentation approach chosen in The Netherlands. 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” [16] (translation by the authors). This resulted in twelve pilot projects (named IPIN projects, see above) which were mainly launched in the beginning of 2012 for three or four years. The projects [28] mainly focused on the implementation of technical innovations, albeit the fact that the changing role of various actors in the IPIN projects was listed as equally important. For example, the consultation procedure of the discussion document of the ‘Taskforce’ considers 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 [29]. Nevertheless, in the majority of the projects (nine out of 12) the regional DSO became the leading actor in the project [19]. Additionally to this, a range of other governance obstacles appeared during the projects. One example is 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 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 [30].

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 new modes of governance. 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.

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” [31] (p. 181). A conventional, ‘one-size-fits-all’ approach is considered to be outdated, while the new role of the legislator should arguably be to adapt a legal framework that is suitable for the new, altered system [8]. 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" [12] (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 [12,32].

In the Dutch legal context 'experiment' is defined as an empirical, experimental determination of whether a specific instrument contributes to solving a societal problem [33]. The main aim of legal experimentation is thus to obtain information; "only a non-informative experiment is a failed experiment" [34] (p. 3). 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 [34,35].

2.4. Experimentation Decree for Decentralized Renewable Electricity Generation

On 1 April 2015, the Crown decree for experiments with decentralized renewable electricity generation (Besluit van 28 February 2015, houdende het bij wege van experiment afwijken van de Elektriciteitswet 1998 voor decentrale opwekking van duurzame elektriciteit [20]) 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 ban, 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 further below). 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 [34,35].

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 energy-users in their own energy provision [20]. 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 [20]). The Decree allows for an exemption of maximum ten years. However, a first official evaluation of results regarding the above mentioned purposes is carried out after four years. For details on the background and content of this Experimentation Decree see Section 6 in [34]; in this article we focus on the chosen modes of governance under this Decree.

Regarding the requirements for governance, the Experimentation Decree applies to projects operated by associations, meaning owners' associations and energy associations [36,37]. 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(1)j [20]), but members decide on the organisation, progress and distribution of costs of a project (Decree Article 7(1) [20]). This governance choice to not include DSOs and energy suppliers seems to be influenced by the undesired dominant position of these two actors in the IPIN 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(1)m [20]). Hence, in order 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 [20]). Additionally, the association has to finance the entire project (Decree Article 7(1)l [20]). 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. Secondly, for 'project grids' associations have the

option to take over the responsibilities, and in consequence the powers, of current DSOs and energy supply companies.

To conclude, the current legal framework of the electricity sector establishes modes of governance which are inadequate for dealing with the transition of the electricity system. Experimental legislation 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 new modes of governance exactly result from the Decree, and whether these are suitable for DG of RES outside of an experimental setting, i.e., in real-life projects. To address this question, we combine legal and governance research.

3. Method

The analysis undertaken in this article integrates the two fields of law and governance. Especially for legal experimentation, which shapes modes of governance, both disciplines are closely interrelated. Answering the research question of this article hence requires an interdisciplinary approach between governance and legal research. This combined approach is reflected in the two steps of our analysis, whereby the first steps is closer related to law, and the second step focusses more on governance.

First, legal research shows how legislation shapes governance of the energy sector. This is undertaken by identifying which new modes of governance emerge through the Experimentation Decree compared to those established by the current legal framework. The analysis focusses on generation/collective generation, supply/peer-to-peer supply, and system operation; the core components of the electricity supply chain. The analysis mainly refers to the Electricity Act of The Netherlands as the projects are carried out in The Netherlands, yet most of the provisions stem from EU legislation on the electricity sector and therefore are also valid in a broader context within the EU.

The analysis of the legal grounding of the Dutch Electricity Act vis-à-vis the Experimentation Decree shows which modes of governance are specified in the Decree. As stated in the introduction, facilitating future energy systems requires new modes of governance. Therefore, with the second step, we take a deeper look into the projects that were granted an exemption in order to identify which modes of governance were actually implemented. To define governance we follow Bevir [38] who refers to it 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” (p. 2).

Our analysis through the lens of governance includes all nine projects that were granted an exemption via the Experimentation Decree. Four of these projects derive from the first tender procedure of 2015, and additional five projects resulted from the second tender procedure of 2016 (for details on these projects see [39]). The data was collected from publicly available material in a twofold way. Firstly, we reviewed the official project applications, and consulted the official acceptance letters. Secondly, in order to enhance and corroborate the data from the official sources, where available, we examined the projects’ websites and news material. Based on these two steps we can determine which lessons can be learned from experimentally acquired results regarding new modes of governance for decentralized electricity systems.

4. Design and Implementation of the Experimentation Decree

The identification of the modes of governance that derive from legal experimentation calls for the analysis of both the design and the implementation of the Experimentation Decree. Therefore, Section 4.1 sets the Dutch Electricity Act vis-à-vis the Experimentation Decree and shows which modes of governance are legally possible. Following this, Section 4.2 takes a look at the modes of governance that emerge in the nine projects under the Experimentation Decree. This analysis prepares for the discussion on the lessons learned regarding new modes of governance for a decentralized electricity system outside of experimental settings.

4.1. Envisaged Modes of Governance in the Experimentation Decree

This section addresses the chosen modes of governance of 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 modes of governance they are set against the current rules on these activities, as specified in the methods section.

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 [40].

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 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 next sub-section.

4.1.2. Peer-to-Peer Supply

Under current electricity sector legislation, electricity suppliers for domestic customers need to have a license for supply (Dutch Electricity Act 1998, Article 95a [41]), which is granted by the Dutch National Regulatory Authority (NRA) [42]. 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 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 [20]). Additionally, associations can determine their own local (dynamic) electricity tariffs (Decree Article 12 [20]), 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.

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 modes for 'project grids' and for 'large grid' projects, respectively. For the latter one, the regional DSO remains in charge [20]. More rigorous is the chosen mode of governance for 'project grids', which allows for the option to not designate the regional DSO as system operator, but to include system operation as task of the association. Thereby 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. Considering however that connected customers are themselves part of the project as being a member of the association, it is doubtful whether they decide to choose another

supplier. In that sense, the governance mode not only re-bundles generation, system operation, and supply, but also includes the customers.

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 implement 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 by actors. For this reason, we investigate in the next section which modes of governance were implemented in the individual experiments.

4.2. Implemented Modes of Governance in the Projects

The nine projects that were granted an exemption under the Experimentation Decree in 2015 (projects one to four, see Table 1) and 2016 (projects five to nine, see Table 1), respectively, reveal specific modes of governance. Our 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’ in Bodegraven-Reeuwijk are large grid projects in which the DSO remains in charge). Table 1 provides details on all nine projects.

Table 1. Overview of the nine individual projects.

	Name	Location	Applicant		Main Stakeholder	Technologies
			OA	EC		
1	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
2	Blackjack (the project was officially discontinued and excluded from participation under the Experimentation Decree in August 2016.)	Amsterdam	x		JansZon B.V. (solar PV company)	PV panels, CHP, p2p, energy management via ICT
3	Endona	Heeten and Raalte		x	Energy association Escozon	PV panels (park with 7.200 panels) biodigester, p2p, energy management via ICT
4	Greenparq	Reeuwijk	x		Real estate company Green Real Estate B.V.	PV panels on the roofs of common facilities, heat pumps, p2p
5	Schoonschip	Amsterdam	x		Research center CWI	PV panels, heat pumps, solar thermal collectors, home batteries, p2p, energy management via ICT
6	Noordstraat 11 Tilburg	Tilburg	x		Starlight B.V. (project developer)	PV panels (3000 Wp), solar thermal collectors, energy management via ICT
7	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
8	Aardehuizen	Olst	x		Owners' association Aardehuizen Olst	PV panels, collective battery, energy management via ICT, p2p, dynamic electricity tariffs
9	Kringloopgemeenschap	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

OA = owners' association; EC = energy cooperation; p2p = peer-to-peer supply.

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, and in three cases an energy cooperative 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 new modes of governance, which are not exactly those that are envisaged by the Experimentation Decree, as the following two sub-sections show.

4.2.1. More Efficient Use of Grid Infrastructure and Involvement of Consumers

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 [20]). This is generally referred to as energy management, and involves ICT for remote-control, i.e., smart grid technology [43]. Energy management can simply include the remote-control of appliances in individual households; moreover it can involve peer-to-peer supply of electricity, as six of the projects explicitly stated. Three of the five projects from the 2016 tender also mention energy management with batteries as storage units, an aspect that is not defined in the Decree. Technologically speaking, this energy management with peer-to-peer supply and storage enables a more efficient use of the electricity grid infrastructure; the second goal of the Experimentation Decree. However, decreasing peak loads and, thereby, using the grid infrastructure more efficiently depend strongly on the involvement of single grid users [44]. Dynamic electricity tariffs can facilitate consumer engagement and behaviour change in form of shifting demand [45]. Yet, in the projects that fall under the Experimentation Decree, dynamic electricity tariffs are only mentioned in three cases. This shows that the Experimentation Decree’s third goal of increasing consumer involvement is likely to only be achieved partially, as little incentives for consumer involvement exist. Associations must be entirely controlled by their members, which establishes another entrance point for consumer involvement. This type of involvement might however only be passive for many consumers, e.g., voting at annual general members meetings. Additionally, Section 4.2.2 shows that associations are not in control in all projects, but other stakeholders are in the lead; another sign for a rather passive involvement of the associations’ members.

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. 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. Taking a look at the leading stakeholders in the individual projects thus 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 supply companies 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 ‘Schoonship’. Of course, security and technical standards need to be preserved; nevertheless, sufficient space needs to be provided for new modes of governance to develop. In such

new modes of governance a balance must exist between safety and professional expertise in electricity provision; this can be facilitated if associations have the possibility to become part of this professional level playing field.

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 low-voltage grid. Experimenting with law and governance for the distribution grid is a well-chosen focus. On the one hand, increasing DG and demand can pose challenges for the low-voltage grid [46], on the other hand the local level can play an important role in local climate policy and action [47]. As the current legislation of the electricity sector is shaped to centralized production and transmission, searching for specific modes of governance for activities emerging at the distribution level is useful. Yet, the aim of this article is to assess the above outlined findings of envisaged and implemented governance modes in the projects regarding the question whether those can serve as new modes of governance applicable to real-life settings. In the following we discuss three main lessons of the experimentally acquired results on new modes of governance: Re-bundling, the role of new actors and emerging activities, and consumer involvement.

5.1. Re-Bundling of Activities

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 mode 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 Section 2.2 above). Subsequently, one recommendation of the IPIN projects included to allow for 'flexible system operation', 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 modes, as no other form than 'bundling' is thought of and implemented. Outside of experimental settings, this chosen governance mode 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 perceived as unlikely that members will choose another supplier than their own association. Yet, the case that associations will change in the course of time and members might decide to leave the project for various reasons can threaten the integrity of the project, as the whole objective of the projects is built upon the integrated governance structures; a conclusion in line with [48].

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: actors from outside the electricity sector, and 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 [18]. 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. Hereby, one might think of the following two examples regarding managing supply and demand in the low-voltage grid. Firstly, a new type of actors could be aggregators who manage flexibility of grid users (generators and consumers) on a larger scale, as specified in [49]. Secondly, related to this, storage could be a

new commercial activity in the electricity sector, which leads to the emergence of operators of storage facilities. As [50] points out conflicting interests in regard to storage, regulating this activity is essential.

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 [44], and “marks a major shift in the nature of electricity systems and their governance” [51] (p. 767). Verbong et al. [52] summarize three main barriers for active consumer involvement in the Dutch electricity sector, as identified by [53]: (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: on the one hand, collective generation and peer-to-peer supply are possible and, on the other hand, the transmission grid is not being utilized. Dynamic tariffs, however, lack in the majority of the nine projects. This lack of financial incentives puts a limit on upscaling. Involving consumers actively is crucial as they play an important role at the low-voltage level in form of purchasing generation or storage technologies, providing access to their data and allowing the remote-control of their appliances [52]. Additionally, ‘project grid’ projects are limited to 500 connected users, an immediate cap to upscaling for at least the next ten years, i.e., the maximum duration of the experiments. Thus, it is doubtful whether the European trend towards more interest in consumer engagement in (smart) DG projects [15] 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 modes of governance that it specifies. This hinders not only the upscaling of these experiments, but already manifests itself in the projects that fall under the Decree. As the restrictions derive mainly from the exclusion of (potential) stakeholders, we want to emphasize the message of [34] that in experimentation legal safeguards are needed to ensure the inclusion stakeholders, as “these safeguards may well prove to foster not only the yield of experimentation, but also the potential for up-scaling” (p. 13).

6. Conclusions

This article addressed the research question of which lessons can be learned from experimentally-acquired results regarding new modes of governance for a decentralized electricity system? The Dutch Experimentation Decree for decentralized renewable electricity generation was established to investigate in how far local projects can contribute to increasing DG, foster the efficient use of the grid infrastructure, and improve consumer involvement. Comparing the modes of governance envisaged in this Decree to those established by the current legal framework shows that for ‘project grids’ one main actor has to carry out all tasks in the electricity supply chain: associations (i.e., owners associations and energy associations). These associations can engage in collective generation, peer-to-peer supply and system operation. In the nine projects that fall under the Decree, these new modes of governance have been implemented to different extents. In several projects it was not associations, but actors from other sectors, that took the lead, and consumers were not actively involved in energy management. Based on these experimentally-acquired governance results, we can draw three main lessons that show that the Experimentation Decree is too restricted regarding new modes of governance for a decentralized electricity system in real-life settings. Firstly, bundling all activities in the local electricity supply chain through associations does not allow to experiment with other modes of governance. Secondly, this restriction prevents the involvement of new actors and emerging activities that could be central to accommodate current developments in the distribution grid. A third lesson is that active consumer involvement is limited in the implemented projects, even though dynamic electricity and network tariffs are possible.

Overall, as current electricity sector legislation is shaped to centralized production and transmission, allowing experimentation with new modes of governance is a wise idea in light of the transitioning structure of electricity generation. It could very well be that in our future electricity

system, functionalities and modes of governance differ depending on the voltage-part of the grid. However, to find new, suitable modes of governance for a decentralized energy system, a restricted design of experiments is not beneficial. At the same time, parallel, similar developments at the EU level might cause the risk of establishing different or even clashing modes of governance. Most recently, in November 2016, the EU Commission published several proposals for legislation in the energy sector, titled “Clean Energy for All Europeans”. The focus therein is inter alia on developments such as distributed generation and new services, and places customers at the core of the sector. Therefore, on the one hand, further research is needed in regard to new, not-too-restricted modes of governance for decentralized energy systems. On the other hand, it is paramount to investigate the coordination of national and EU-level developments, in order to learn from each other, but also to prevent undesired unequal developments.

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