Grid Resilience Governance of the Future: Analyzing the Role of Associations in Experimental Smart Grid Projects in The Netherlands

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Abstract. Local generation decentralizes urban grids. Soon new actors, such as associations, might enter the traditional energy domain. As electrical grids are critical for society, new actors will need to collaborate with other city-level stakeholders to ensure proper grid functioning in times of crisis. Little research has been done about how this collaboration could look like for smart grid projects. This short paper presents for discussion initial analysis on how associations as new actors might approach establishing such collaborations to improve grid resilience. We focus on advances in Dutch governance related to local energy planning projects. First, we outline which stakeholders are currently concerned with grid resilience in the Netherlands. Then, we introduce how innovative smart grid projects can be organized and describe the role of associations within them. Finally, we apply the Institutional Analysis and Development Framework (IAD) to point out what associations might consider to improve grid resilience.

Keywords: Grid resilience · Planning · Governance · Institutional Analysis and Development Framework · Associations · DSO · Security regions

1 Introduction

Ensuring electricity supply to important city-level consumers, such as hospitals, is a task that demands devising plans how a grid should operate in case of blackouts. Collective decision-making might account for how to distribute electricity as a scarce resource during disasters. For this, grid stakeholders can devise ‘islanding’ strategies [1] to isolate a part of the grid from the main electricity supply and ensure that sufficient local generation is provided [2]. However, it is unclear how smart grid actors can structure their collaboration. This challenge is exacerbated as future grids will see new actors emerge. Specifically, actors like associations that can take over the DSO’s role in smart grid projects, as recently introduced for experimental electricity systems in The Netherlands [3]. Based on this, there are questions that have yet to be solved, including defining the

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specific roles of possible future actors, and how they can structure their interactions with other stakeholders.

The Institutional Analysis and Development (IAD) Framework can help to address these questions [4]. While the Framework is mainly used to study common pool resource (CPR) problems like irrigation systems or fishing grounds [5], it has been applied to understanding energy transitions [6] and kWh can be seen as CPRs [7].

To define electricity grid resilience governance, this paper describes current stakeholders in grid resilience, as well as a new actor (associations) that was introduced by a Dutch Crown Decree to enable experiments for future grids. Afterwards, we present for discussion our analysis on how associations can structure their collaboration with other stakeholders. For this analysis we use constructs from the IAD Framework. Overall, this paper aims to inform researchers about which actors might have a stake in a common grid planning process according to Dutch practices, as well as to show how stakeholders can interact in the future.

2 Background

Ensuring continuity of electricity supply to critical consumers is essential for smart cities of the future. Recently, [2] developed a Collaborative Framework to suggest how urban grid resilience can be improved. This framework deals with threat analysis (e.g., [8, 9]) and the identification of stakeholders. Based on vulnerability and criticality assessments, the stakeholders are to come up with a disaster response plan for establishing a small ‘island’ of electricity. However, ways in which stakeholders can structure their collaborations as regards resilience have not been specified in the literature yet. Such a structure can help to structure interactions between stakeholders.

This paper provides initial analysis on how future collaborations can be arranged by taking Dutch practices as an example. To do so, this section overviews actors related to grid resilience, outlines a new actor (associations), and describes the Institutional Analysis and Development Framework that will be used for the analysis.

2.1 Actors Concerned with Grid Resilience in the Netherlands

Distribution system operators (DSOs) are responsible for connecting all consumers to the electricity grid and transporting electricity to them (according to Dutch Electricity Act 1998[1]). They should ensure the safe use of energy and prevent, limit, and fight events that can impact the grid [10]. DSOs work in close connection to the *TSO* (transmission system operator) and *Netbeheer Nederland (*the umbrella organization of all Dutch DSOs) which signs agreements with the *police* and *security regions* to ensure robustness and resilience of the electricity grid.

25 *Security Regions* (in Dutch: veiligheidsregio’s) are in charge of reacting to large-scale undesirable events and responsible for protecting critical infrastructure (CIs), with

[1] Elektriciteitswet 1998 Wet van 2 Juli 1998, houdende regels met betrekking tot de productie, het transport en de levering van elektriciteit, Stb. 1998, 427, art. 1(g).

special attention to the sectors of electricity, portable water, and surface water [11]. Hereby they are responsible for initiating collaboration between critical sectors in the region, establishing relevant contracts and networks, and reaching agreements with CI operators over communication, information, and measures [11].

Besides the *police, NCTV* is a specialized organization that handles safety on the national level and works together with security regions, if pandemics, terrorist attacks, or, e.g., a blackout in a telecommunication network occur [12]. Additionally, *industry* is an important actor in connection to national safety, as they control about 80% of CI. Thus, collaboration between security regions and the industry is essential [13].

The preferred policy instrument of the Dutch government are covenants between stakeholders [14]. These agreements between actors are important for addressing robustness and resilience issues of the electricity grid. For instance, in the Brabant-Noord region in The Netherlands a covenant was signed by (i.) security region Brabant-Noord; (ii.) the police of Oost-Brabant; (iii.) the DSOs Endinet, Enexis, Liander; (iv.) the TSO TenneT and Gasunie [15]. These four classes of actors indicate stakeholders particularly concerned with grid resilience nowadays.

2.2 Associations as a New Grid Resilience Actor

As decentralized renewable electricity generation continues to change the (previously) centralized electricity grid, it can be expected that the future actor landscape will change in line with it. In the effort to shape future grid-related governance, on April 1, 2015 The Netherlands introduced the Crown Decree 'Besluit experimenten decentrale duurzame elektriciteitsopwekking' (short: Experimentation Decree) [3]. This Decree lifts the ban that no one can take over the tasks of DSOs. Thus, new actors – under specific conditions – are allowed to experiment with the local generation, distribution and sale of renewable energy.

The Decree grants exemptions to *associations,* i.e. owners' associations and energy associations. Associations take over the responsibilities and powers of a *DSO.* They have to comply with DSO-related requirements, including reliability, safety, security of supply, consumer and environmental protection, and technical standards.

Following the two tenders of 2015 and 2016, nine projects were granted an exemption and thus allowed to start smart grid projects (see Table 1).

Seven of the listed projects are defined as 'project grid' (maximum 500 connected consumers), and two others ('Aardehuizen' and 'Kringloopgemeenschap') are 'large grid projects' (up to 10.000 connected entities, 80% of them consumers) in which the DSO remains responsible. For more details see [16].

As these listed projects are rather innovative, the way in which associations might structure their interaction with other stakeholders is not yet clear, especially in regard to disaster response. Analyzing this relation, e.g. with the help of relevant governance frameworks, can be useful to approach the task.

Table 1. List of projects under the Dutch Experimentation Decree

Type of project	Project name (location)	Details
Apartment building complex	Noordstraat 11 Tilburg (Tilburg)	Three apartments with PV panels, solar thermal collectors, ICT
	Villa de Verademing (The Hague)	Apartments with heat pumps, solar thermal collectors, PV panels, small wind turbine, storage, ICT, peer-to-peer supply (p2p)
	Blackjack[a] (Amsterdam)	High-rise apartment complex with PV panels, combined heat and power (CHP), p2p, ICT
	Zwijsen Veghel (Veghel)	115 apartments with PV panels, CHP, ICT, dynamic electricity tariff
Residential area	Endona (Heeten & Raalte)	Solar park with 7.200 PV panels, bio-digester, p2p, ICT
	Green-parq (Reeuwijk)	Recreational homes with PV panels on the roofs of common facilities, heat pumps, p2p
	Schoonschip (Amsterdam)	46 water-homes with PV panels, heat pumps, solar thermal collectors, storage, p2p, ICT
	Aardehuizen (Olst)	Houses with PV panels, collective battery, ICT, p2p, dynamic electricity tariffs
	Kringloopgemeenschap (Bodegraven & Reeuwijk)	2.500 households connected to 2,3 MW wind turbine, 16.000 PV panels, dynamic electricity tariffs

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

2.3 Rules-in-Use as a Structure to Analyze Stakeholder Interactions

The Institutional Analysis and Development Framework can be employed to analyze interactions between stakeholders for grid resilience. The IAD Framework [4, 5] was developed to find institutional arrangements for the governance of common pool resources. Thus, its aims to overcome the ‘tragedy of the commons’ [17]. Seven variables (*rules-in-use)* are core elements of the IAD: position, boundary, choice, aggregation, information, payoff, and scope rules (see Table 2). We apply these rules to analyze possible future interrelations between grid resilience stakeholders.

Table 2. An overview of IAD's rules-in-use (based on [4, 18, 19])

Rules-in-use	Definition
Position rules	What positions exist (initiator of meetings, chair, agenda-setter)?
Boundary rules	Which actors need to be involved? Who and how many units withdraw kwh?
Choice rules	Which sets of actions do actors may, must, or must not take?
Aggregation rules	Are decisions made collectively, individually or automated?
Information rules	How much information do actors need? Who shares which information?
Payoff rules	Which costs and benefits do specific actions entail? Is compensation needed?
Scope rules	Which geographic region is affected?

3 Associations as a Grid Resilience Actor: Analysis and Discussions

The rules-in-use can be used to structure stakeholder interactions as follows:

Position rule: In the novel smart grid projects, associations take over the responsibilities of DSOs and energy supply companies in 'project grids', including security. Thus, associations will be responsible for disaster response plans, and will need to organize meetings, establish networks, and initiate contracts.

Boundary rule: Associations might plan how to reduce the impact of electricity supply interruptions, e.g., to perform grid islanding. As developing a disaster response requires knowledge of state-of-the-art solutions and perhaps technical expertise, other parties might need be involved, such as specialized developers or research centers. Thus, similarly to the current Dutch practice, covenants need to be established for public safety in smart grid experiments, e.g. associations might sign agreements with a security region, police, DSO, and TSO (similar to the Brabant-Noord covenant).

Choice rules have to be outlined next. For example, whether an association can decide on behalf of all its members or whether it might need the permission of its members for certain actions. Next, the actors have to specify how they will make agreements (*aggregation rule*), as clear decision-making processes are needed to effectively work together in crisis situations. The agreements have to include: (1) *information rules* (e.g. communications with critical infrastructure operators and citizens); and (2) *payoff rules* related to costs and benefits of certain actions (e.g., withdrawing energy from a private or collective battery can lead to a compensation).

Scope rule: Currently, smart grid projects are rather small and span from one individual building up to the grid of one or two municipalities. In this way, a security region might need to have a number of special agreements within the area concerned. Establishing a significant amount of covenants may lead not only to increased complexity, but might also require additional efforts to coordinate. To counter this, several projects could form a group, which leads to complex stakeholder interactions.

Altogether, the Crown Decree introduces a new actor (associations) into the Dutch electricity production and distribution system. This actor will be an important stakeholder in connection to how electricity should be prioritized in case of black-outs. On the one hand, this might result in easier and faster decision-making, provided that negative outcomes would not strongly interfere with interests of nation-level stakeholders outlined in the document. On the other hand, associations might be inexperienced and lack expertise of DSOs and energy suppliers. To sum up, structuring future stakeholder interactions can be challenging, but devising specific rules-in-use can help to reduce at least part of the governance complexity.

This paper aspires to initiate a discussion. It overviews grid resilience actors in The Netherlands and introduces for the first time (to the authors' best knowledge) how the IAD framework can structure interactions between grid resilience stakeholders. Several future actions can benefit this line of research, including performing additional analysis in from of empirical case studies, overviewing status of resilience governance and trends in other countries, and obtaining feedback from practitioners.

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