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How should grid operators govern smart grid innovation projects? An embedded case study approach

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HIGHLIGHTS

- Smart grids require collaboration between grid operators and other actors.
- We contrast transactional and relational governance of smart grid projects.
- Long-term relations produce more incentives for smart grid collaboration.
- Non-financial incentives are more important in long-term relations.
- Policy makers should stimulate long-term relations to stimulate smart grids.

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ABSTRACT

Grid operators increasingly have to collaborate with other actors in order to realize smart grid innovations. For routine maintenance, grid operators typically acquire technologies in one-off transactions, but the innovative nature of smart grid projects may require more collaborate relationships. This paper studies how a transactional versus relational approach to governing smart grid innovation projects affects incentives for other actors to collaborate. We analyse 34 cases of smart grid innovation projects based on extensive archival data as well as interviews. We find that projects relying on relational governance are more likely to provide incentives for collaboration. Especially non-financial incentives such as reputational benefits and shared intellectual property rights are more likely to be found in projects relying on relational governance. Policy makers that wish to stimulate smart grid innovation projects should consider stimulating long-term relationships between grid operators and third parties, because such relationships are more likely to produce incentives for collaboration.

1. Introduction

Smart grids are generally seen as important enablers of more transparent, reliable and sustainable energy supply (Morgan et al., 2009). Smart grids are changing how grid operators deal with other actors in the energy industry (Agrell et al., 2013; Giordano and Fulli, 2012). For regular maintenance of the electricity grid, grid operators typically purchase technologies and other resources in one-off transactions. However, smart grid innovation is no routine activity and requires continuous learning and experimentation (Sagar and van der Zwaan, 2006). Therefore, grid operators may have to engage in joint technology development in long-term relationships rather than one-off transactions. In other words, grid operators may have to move from transactional towards relational governance in their dealing with third parties (cf., Uzzi, 1997).

Smart grid innovation projects can be framed as collective action situations since smart grids cannot be realized by one single actor (Oliver et al., 1985; Olson, 1971). Grid operators depend on energy producers, energy providers and technology providers for access to technologies and other resources. Since smart grid pilots often take place in a specific region, regional governments and citizen associations also need to be involved. Collective action theory is specifically useful to understand the position of grid operators since it deals with issues of governance (Ostrom, 2000; Salisbury, 1969) as well as how to incentivize collaboration (Olson, 1971). However, collective action theory has not yet been applied to the case of smart grid innovation projects.

This paper aims to analyse how a transactional versus relational approach to governing smart grid innovation projects affects incentives for other actors to collaborate. We do so through an embedded case study (Yin, 2003) on the major Dutch grid

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operator Alliander. We analyse 34 sub-cases of smart grid innovation projects in which the grid operator participated (2007–2013). Our case data is derived from a unique dataset comprising extensive internal documentation on smart grid innovation projects. Findings are corroborated through a set of interviews with project participants. The embedded case study design provides high internal validity since all embedded cases have similar market and institutional conditions.

Smart grids is a term without a unique single meaning (Morgan et al., 2009). According to the European Commission, a smart grid is 'an electricity network that can cost-efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety' (European Commission, 2011). As such, smart grids contain digital technologies to mediate communication between electricity providers and consumers, in order to enable energy savings, increased reliability and increased efficiency of the grid. Smart grids also enable grid operators to limit the copper lines that need to be installed through smart planning (Verzijlbergh et al., 2012).

The paper contributes to policy making in the field of smart grids. For policy makers that intend to foster smart grid innovation, the findings provide important implications on how to shape government-funded R&D projects in the area of smart grids, and which incentives for collaboration are used in which types of governance forms. For grid operators, the paper shows how to make trade-offs between transactional and relational governance in their innovation projects with other actors..

This paper proceeds as follows. Section 2 develops the theoretical framework for the study, building on governance as well as collective action theories. Based on the theory, hypotheses are developed. Section 3 details the case study method, including the case selection, data sources and measurement instrument. Next, results are presented in Section 4. Section 5 discusses results and concludes the paper with recommendations for policy makers as well as grid operators.

2. Background

This section provides a theoretical background on governance (Section 2.1) as well as collective action theory (Section 2.2). In Section 2.3, we develop hypotheses that will be tested in the remainder of the paper.

2.1. Transactional and relational governance

Governance has been discussed both from a wide range of perspectives, ranging from economics to sociology and innovation management (see for an overview De Reuver, 2009). In economic literature, especially transaction costs theory deals extensively with governance. A specific concern is whether to organize economic activities within or between organizations (Hennart, 1993; Williamson, 1979). In its traditional form, transaction costs theory distinguishes market and hierarchy governance (Williamson, 1979). Hierarchy governance is used to organize activities within the organization, using mechanisms such as power and authority structures. Market governance is used to organize activities with other organizations, using mechanisms such as price and legal contracts. The assumption is that economic exchange in the market is typically done in one-off transactions in which opportunistic behaviour has to be countered.

In sociological literature, it is typically argued that transactions are embedded in social relationships. Relational approaches to governance took off with the classical work by Granovetter (1985), who argues that most economic models, including transaction costs theory, tend to underestimate the fact that transactions are embedded in social networks. As such, the behaviour and outcomes can only be understood when embeddedness is taken into account. For instance, Uzzi (1997) finds that organizations that are embedded in long-term relationships do not pursue their own interests in a calculative manner, but rather act trying to benefit the long-term collaboration. In other words, the long-term relation is considered more important than the individual transaction. Such benevolent behaviour may even occur if a relationship is about to end. Ring and Van de Ven (1994) argue that organizations often take the interest of other organizations into account when managers feel they are indebted to do so.

Besides these social drivers, another driver for relational governance may be that long-term relations create value rather than pose costs (Tsang, 2000; Zajac and Olsen, 1993). For instance, Dyer and Singh (1998) argue that long-term relationships may create benefits that could not be achieved when organizations would act alone as they require long-term collaboration. In their view, market governance could harm these relational rents as they involve contracting, monitoring, adaptation and renegotiation costs. Organizations should rather use self-enforced arrangements like financial co-investments, goodwill, trust and reputation.

Another driver for relational governance is that organizations often find themselves as being part of a broader network. As Gulati et al. (2000, p. 203) argue, being embedded in networks leads to reputational concerns. Not adhering to agreements with partners can damage the reputation of an organization. Moreover, being embedded in a broader network makes it easier for trust to develop, to acquire knowledge about capabilities of partners and to sanction opportunistic behaviour. Jones et al. (1997) advance the concept of network governance to reflect how embeddedness affects governance between organizations. They argue that organizations in network do not need to make legal but social and implicit contracts, which allow more flexibly adapting to changing circumstances..

ICT innovations like smart grids make it more likely for organizations to be embedded in networks of relationships. In traditional manufacturing-oriented industries, economic activities are typically organized in a linear fashion, see Porter (1985). However, this assumption does not hold for service industries (Stabell and Fjeldstad 1998). Moreover, ICT and liberalization of markets has led to convergence between previously separate industry sectors as illustrated by Li and Whalley (2002). Consequently, organizations are increasingly embedded in networks, which make relational governance more likely to emerge.

Importantly, transactional and relational governance are to be seen as ideal types. In reality, organizations often use a mix of governance modes as has been shown by Lowndes and Skelcher (1998).

2.2. Collective action theory

Collective action theory, first developed by Olson (1971), explains how groups of individuals may collaborate for a common goal even if the incentives to do so are smaller than not collaborating. In other words, the theory seeks to explain the conditions under which individuals, or organizations, collaborate with each other to accomplish a common goal (Markus et al., 2006). The theory has been widely applied to study collaboration for a common goal in different fields of sociology, politics and management of natural resources. Recently, collection action has also been adapted to studying collaboration for innovation projects (e.g., De Reuver et al., 2015).

Collective action emerges when group members share a common goal and have strong motives for cooperation (Monge et al., 1998). Organizational motives for collective action can stem from finding new business opportunities, like being visible in a market or extending activities to emerging domains (Contractor and Lorange, 1988; Hagedoorn, 1993). Other organizational motives may include strategic issues, for example status and reputation (Lopes et al., 2009), and networking issues, for example to enlarge networks or explore new cooperation opportunities (Contractor and Lorange, 1988).

The classical problem of collective action is that 'rational, self-interested individuals will not act to achieve their common or group interests' and they tend to free-ride on contributions of others (Olson, 1971). Therefore, when it is not possible to exclude others, rational individuals are better off to benefit from it without contributing any resources for provision of that. However, if every individual in a group behaves like that, the collective good will not be provided and everyone would be damaged (Kollock, 1998). The free-rider issue, which is an inhibitor, will sabotage the efforts for collective action in two ways: either everyone would be tempted to free-ride and behave rationally or would lose motivation to cooperate because of fear that others might free ride. This will lead to the 'start-up dilemma', i.e. how to start-up cooperation?

As the intrinsic motives for engaging in collective action may not be sufficient, 'selective incentives' may be deployed (Knoke, 1988; Oliver, 1980). Selective incentives can be positive (e.g. awards or private benefits for those contributing to the common goal) or negative (e.g. penalties and punishments for those not contributing) (Oliver, 1980). Positive incentives may be material (e.g. subsidies, funding) or immaterial (e.g. status, reputation, support) (Clark and Wilson, 1961).

Typically, deploying selective incentives requires a central authority to impose rewards and punishments (Olson, 1971; Salisbury, 1969). Salisbury (1969) defines leaders as those who invest capital to create a set of benefits (i.e., selective incentives) for potential members to join a group. He argues that if the benefits fail or costs exceed the benefits for both potential members and leaders, the group will collapse.

2.3. Hypotheses

To conclude this section, we build hypotheses on how transactional versus relational governance affects the selective incentives for collective action in smart grid innovation projects.

Consistent with Clark and Wilson (1961), we differentiate material and non-material selective incentives for collective action. Given that transactional governance is based on mechanisms of price, we hypothesize that financial selective incentives are mostly likely to be present in projects relying on transactional governance.

H1. : Financial selective incentives are most likely to be found in projects relying on transactional governance.

As part of the non-material selective incentives, we argue that reputation-related incentives are important, following Lopes et al. (2009). Especially as smart grids are an emerging area, having reputable partners is valuable as an incentive to participate in projects. As reputation is an important mechanism in embedded relationships (Gulati et al., 2000), we hypothesize that reputation-related incentives are most likely to be present in projects relying on relational governance.

H2. : Reputation-related selective incentives are most likely to be found in projects relying on relational governance.

We further argue that the technological nature of smart grid projects implies that access to enabling technologies can be considered an incentive for collaboration. For instance, access to the core of the grid, smart meter interfaces or data from the grid can be an incentive for third parties to collaborate with a grid operator. Since access to enabling technologies is especially relevant when persistent over a longer period of time, we hypothesize that relational governance is most likely to produce technology-related selective incentives.

H3. : Technology-related selective incentives are most likely to be found in projects relying on relational governance.

Finally, given the innovative nature of smart grid innovation projects, intellectual property rights (IPR) gained from a project will be an important incentive for actors to collaborate. When projects partners become the (partial) owner of IPR produced in a project, this can be an important incentive to participate. Such joint IPR will especially arise when technologies are developed jointly by grid operators and other actors. Therefore, we hypothesize that:

H4. : IPR-related selective incentives are most likely to be found in projects relying on relational governance.

Hypotheses are visualized in Fig. 1.

3. Methodology

To test the hypotheses from Section 2, an embedded multiple case study is conducted. We analyse the smart grid innovation project portfolio of Alliander, the largest grid operator in the Netherlands, distributing electricity to more than 3 million customers and gas to more than 2.5 million customers in the Netherlands. Alliander is extensively engaged in smart grid innovation and hosts a knowledge centre for technical innovations for the distribution of electricity and gas as well as social innovations providing customers with better insight in their energy consumption. Alliander is especially suitable for our research purposes as it has largely relied on transactional governance in the past and is now slowly moving towards more long-term relations with other actors in the energy industry and beyond.

We follow an embedded case study design (Yin, 2003), which implies that multiple cases of smart grid innovation are studied which are all governed by the same grid operator, Alliander. The advantage of the embedded case approach is that we can control for external factors affecting governance and selective incentives, such as market and institutional conditions. Moreover, by studying 34 cases, we are able to make statistical inferences on the association between governance and selective incentives for collective action.

We use content analysis as a tool to analyse a rich set of data on the cases. Case material was sourced from extensive internal documentation (e.g. progress reports, project management reports) and complemented with a series of interviews with project participants. Based on the data, two observers filled out a coding protocol.

3.1. Background on Alliander

For specifying our measurement instrument and interpreting the findings, we first explored the context in which Alliander engages in smart grid innovation. We did so through various informal talks with three key informants in Alliander, who are decision makers from asset management, innovation and subcontracting departments. Informal talks took place between 2011 and 2013, i.e. both before data collection to specify our measurement instrument and after the data collection for aiding in interpreting findings. We conducted a follow-up interview with the

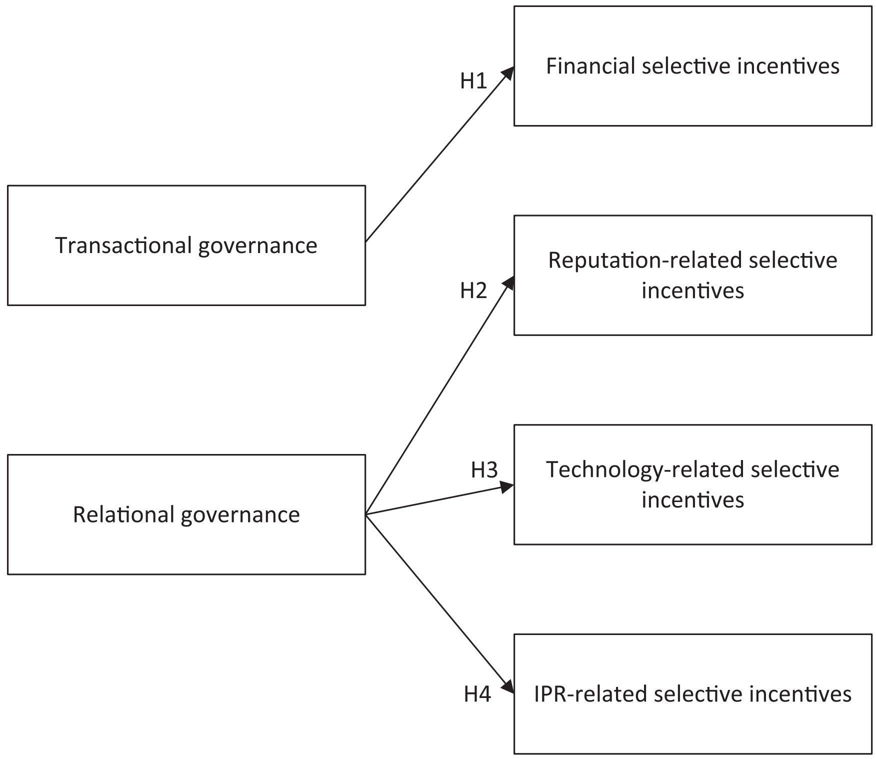

Fig. 1. Hypotheses.

managers of subcontracting and innovation departments in January 2016, allowing a more reflective perspective on the observed period. These informal talks and follow-up interview served to sketch the context of the cases, and were not used for the actual data collection.

Strategic drivers to engage in smart grid innovation projects are diverse, according to our key informants. While the main strategic goal of grid operators is to achieve operational excellence by reducing costs, innovation and customer intimacy are becoming increasingly important. However, smart grid innovation may, in the long run, reduce operational risk, for instance as real-time information on loads can reduce redundancies in grid planning. As such, innovation is not only a nice-to-have but also directly contributes to reaching efficiency gains in the long run. Another reason to engage in smart grid innovation is from a responsibility and legitimacy perspective. Due to the separation between grid operations and energy provisioning, grid operators do not have a direct relation with end-users. However, end-users do have to pay a mandatory fee for the grid operations, which sometimes raises legitimacy concerns. A typical pattern is that grid operators try to sustain their legitimacy by engaging in innovation projects.

According to our key informants, the object of innovation in smart grid projects ranges from pure technology development towards testing, demonstration and roll-out, see also Section 3.2. As such, the most relevant manifestation of transactional versus relational governance is on how technologies are developed with third parties. On the extreme ends, technology innovation is either achieved through subcontracting to third parties in one-off transactions (i.e. transactional governance) or through long-term open-ended collaboration projects (i.e. relational governance). In those open-ended collaboration projects, Alliander attempts to share gains from innovation projects. For instance, smart grid projects can lead to less redundancy in grid layouts which imply less turnover in the future for subcontractors. In these cases, Alliander allows subcontractors to increase their margins in order to compensate for turnover reduction.

The cultural and strategic context plays an important role in how to govern smart grid innovation projects, according to our key informants. The main performance criteria of a grid operator are transmission continuity and voltage quality, which form the core of benchmarks among grid operators in Europe (CEER, 2012). Consequently, there are strong incentives for the grid operator to control operational risks in innovation projects. A risk-averse culture is at odds with the open-ended, non-formalized nature of relational governance. At the same time, key informants point out that the risk-averse culture has changed in the past years.

3.2. Cases

We identified cases of smart grid innovation projects by exploring internal project management databases as well as interviewing informants within Alliander, see Section 3.2. Initially, we identified 124 cases in which Alliander cooperated with external parties in a project on smart grid innovation. From this initial set, 34 cases were selected that contained sufficiently rich information to analyse governance forms and collective action incentives.

The projects ran between 2007 and 2013. Projects ran between 5 and 69 months, with an average of 23 months. Projects were generally large with an average budget per project of 6.2 million euros. Government subsidies were part of the budget for 37% of the projects, with an average amount of subsidies equaling half a million euros. Almost half of the projects had a clear regional focus (47%).

The main focus of the projects was to enable home energy management or smart meters (33%), local energy production (12%), energy savings for consumers (9%), energy storage (6%), CO_2 reduction (6%), (bio)gas (6%), e-mobility (3%), or the smart grid and smart cities in general (26%).

The nature of projects was diverse, in terms of technology-orientation and maturity of the solutions. Six projects explicitly aim at technology development only, for instance exploring and developing solutions for energy storage, for self-sustaining decentralized energy production by citizens without a connection to the grid. Other examples of technology development are exploring wireless technologies as a backup communication channel for smart grids. Five projects aimed at testing technological solutions in practice, for instance a technology for storing locally produced energy from farmers or a tool for offering dynamic energy pricing to citizens. In seven projects, readily developed technological solutions were rolled out in practice. These implementation projects range from simple projects (e.g. rolling out a smart meter) towards complex integrative projects (e.g. building a new city district without carbon emissions). At least three projects were explicitly aiming to improve acceptance from the general public for smart meters, for instance by offering personal advice on potential energy savings or even an energy savings contest among primary school children. In four other projects, the aim was to induce behavioural change (i.e. reducing energy consumption) from citizens or workers, for instance by providing insights into energy consumption from smart meters.

The grid operator participated in the projects for multiple non-exclusive goals, according to formal project documentation: developing strategic relationships (82%), realizing the smart grid (74%), costs reduction (71%), showcase demonstration (38%), facilitating transition to sustainable energy production (38%), learning about smart grid innovations (21%), testing smart meters in practice (12%), promoting the brand name of the grid operator (6%), demonstrating societal and regional involvement (3%) and promotion of smart meters (3%).

On average, 6.6 partners were involved per project, ranging from two to eighteen partners. Typical roles of project partners are energy producer such as a power-plant (present in 82% of all projects), citizen association (76%), energy providers who deliver energy to end-users (71%), knowledge institutes (59%), government agency (44%) and technology providers (32%). In 80% of the projects, some or all of the partners had already collaborated earlier.

The data sources provided limited information regarding the ultimate outcomes of the projects. For 53% of the projects, conclusions on the outcomes could not be drawn by the observers because such information was not available in the project management databases or it was too early to conclude. 18% of the projects clearly met the stated objectives. 12% of the projects did not meet the stated objectives but produced lessons learned, especially on the feasibility of technological solutions, while another 6% of the projects did not meet the stated objectives due to conflicts between partners. 12% of the projects were terminated before reaching the end of the projects, for instance because project partners did no longer wish to participate in the projects.

3.3. Data sources

For each case, three main sources of data were consulted. First, for factual information on project goals, milestones, involved external partners, involved personnel and starting dates, an internal knowledge management system was consulted. Second, a rich and extensive amount of project management information was sourced from an internal file sharing database. This database contained the following types of documents:

- Project initiation documents: Following a formal project management method, such documents contain a management summary, context, goals and scope of the project, involved external partners, relationships with other projects, projected results, projected budgets, business case and project risks. The depth of information in the project initiation documents differed per case: especially for larger and more risky projects, more information is being stored.
- Project plans: A document made in collaboration with project partners. Compared to the project initiation documents, the project plan also contains the division of responsibilities, costs and benefits between the partners, the overall project planning, and anticipated meetings and reviews.
- Collaboration contract: For some cases, a collaboration contract was found that states the mutual agreements between project partners. Such contracts formally define the goal of the project and the division of responsibilities, costs and benefits between partners. The collaboration contracts also detail IPR procedures in the project and describe how the collaboration can be terminated.
- Progress reports: For 16 cases, progress reports were found. Progress reports evaluate on a monthly basis whether the project meets the planning, budgeting and scope of the project. The reports also describe whether project risks are acceptable, resources being available and quality conditions are being met. The progress reports also describe the most important problems as well as milestones that have been achieved.

As a third source of data, seven semi-structured interviews were conducted with informants from the grid operator. Although the internal documentation described above provided rich and extensive insights, interviews were conducted to probe deeper into more subtle issues of governance and collective action. The interviews thus aimed to corroborate and complement the findings from the documentation. Interviewees were selected by a primary informant working at the grid operator, based on the list of 34 analyzed projects. All prospective interviewees agreed to participate. All interviews were recorded and interview reports were created and fed back to interviewees for validation. See Table 1 for overview.

3.4. Measurement instrument

A qualitative coding protocol was defined that specifies the theoretical concepts from Section 2. For the relational and transactional governance concepts, we focused on technology development since this occurs in most of the cases (see Section 3.2). At the extreme form, transactional governance refers to acquiring technology or subcontracting a predefined standardized task to a third party. An example would be acquiring a smart meter from a device manufacturer. The extreme form of relational governance involves fully open-ended, long-term collaboration aimed at jointly developing and owning the technology. An example would be jointly developing a dynamic pricing system with an energy provider. Regarding reputational selective incentives, the measure focused on the participation of reputable partners in the project.

Table 1
Interviewees.

Interviewee	Role in company	Role in analyzed projects
1	Innovation consultant	Participated in several smart meter related projects as advisor
2	Program manager	Manages program overseeing multiple pilot projects on smart grids
3	Senior innovation manager	Involved in several pilot projects smart grids
4	Internal consultant regulatory affairs	Regulatory advisor on several projects
5	Consultant and program manager	Manages program overseeing innovation projects in Amsterdam area
6	Project manager	Involved in projects on gas transmission
7	Innovation and strategy consultant	Involved in projects on energy storage

Table 2
Operationalization of measurement instrument.

Theoretical concept	Operationalization	Scale
Transactional governance	Does the grid operator buy technology, systems or other components from the other party/parties?	No / To some extent / Yes
Relational governance	Are systems or technologies developed jointly?	No / To some extent / Yes
Selective incentives: Financial	Does the project involve selective material incentives (e.g. subsidies or venture capital)?	Yes/No
Selective incentives: Reputation	Does the project involve collaboration with able and visible partners?	Yes/No
Selective incentives: Technologies	Does the project involve facilitating technologies for third parties (e.g. offering open application programming interfaces on technologies platforms)?	Yes/No
Selective incentives: IPR policies	Does the project involve IPR policies to stimulate innovation by third parties?	Yes/No

Since Alliander participated in all projects, we focused specifically on the reputation of the other partners in the project.

This qualitative open-ended protocol was pretested on ten cases by two coders. After refining the protocol using the ten cases, a quantitative closed protocol was defined to analyse all cases. An overview of the relevant codes is given in Table 2.

Quantitative coding was executed by two coders in order to increase reliability. Prior to coding a case, both coders jointly collected and shared documents and relevant interview excerpts, to ensure coding was done using the same data points. Next, the two coders independently read the information and filled out the protocol. Generally, each coder went over the case material twice to assign the coding. Only after all cases were coded, the results were compared across the coders, using intercoder reliability metrics. For each variable, percent agreement and Cohen's Kappa were computed, as the latter corrects percent agreement for chance (Cohen, 1960). Intercoder reliability can be found in Table 3, showing acceptable levels of both metrics.

4. Results

4.1. Descriptive statistics

Before testing the hypotheses, we first explore the results in a descriptive manner. We illustrate the descriptive statistics derived from the case database with the main qualitative findings from the interviews.

We find that transactional governance is the prominent mechanism in 47% of the cases, while relational governance is present in 53% of the cases. This pattern is corroborated in the interviews, as interviewees explain that several innovation projects are maintained through transaction-oriented buyer-supplier relationships. Interviewees argue that such transactional relations often lead to lack of mutual understanding and trust between the grid operator and other organizations. Interviewees also argue that a transactional focus typically leads to strict planning of activities, which can be cumbersome in innovation projects where outcomes and processes cannot be fully foreseen up-front.

Table 3
Intercoder reliability.

Variable	Percent agreement (%)	Cohen's Kappa	*P*-value
Transactional governance	85.3	0.69	0.000
Relational governance	76.5	0.51	0.001
Selective incentives: Financial	85.3	0.71	0.000
Selective incentives: Reputation	82.4	0.60	0.000
Selective incentives: Technologies	82.4	0.63	0.000
Selective incentives: IPR policies	85.3	0.70	0.000

The most prominent incentives found in the cases are technology-related (73.5%) selective incentives. In the qualitative interviews, various interviewees explained that other organizations often collaborate with Alliander because they need to access the energy grid for developing smart grid innovations. Another prominent incentive is related to reputational benefits (61.8%). Our interviewees explained that Alliander's strong brand and financial solvency are important reasons for other organizations to collaborate. The strong reputation of the grid operator is especially important incentives for knowledge institutes. Financial selective incentives were present in half the cases (50.0%). Several interviewees argued that other organizations often collaborate with Alliander in order to receive financial investments for their innovation projects, either directly from the grid operator or through joint grant proposals to the European or national government. On the other hand, interviewees argued that financial incentives are rarely a sufficient reason to start collaborating and that the importance of financial incentives differs between public and private organizations. IPR-related selective incentives were least prominent (41.2%), and they are mostly present in larger or externally funded projects. Our interviewees explained that they are not used to dealing with IPR. In practice, IPR is often hardly being dealt with. One interviewee shared an anecdote in which the grid operator had to license-in a technological innovation that was developed in a project in which they had invested in themselves. Interviewees provided several reasons for not handling IPR properly, for instance lacking expertise, high costs of maintaining IPR or unwillingness to formalize agreements in general. Others provided more strategic reasons for not handling IPR, arguing that IPR should not be a main interest for a public organization and be retained by commercial partners.

The selective incentives are not fully independent. Selective incentives related to reputation often appear in the same cases with selective incentives related to technology ($\chi2(1)=8.10$, $p=0.007$)) and IPR policies ($\chi2(1)=5.78$, $p=0.018$). Apparently, non-financial selective incentives are more likely to be present jointly or not at all in the cases.

4.2. Hypotheses testing

We test the hypotheses by evaluating the association between collective action incentives and governance forms. Table 4 presents the results of chi-square tests on the associations.

Regarding selective incentives, we find that financial selective incentives are not associated with either of the relationship types. Therefore, we conclude that:

H1: Financial selective incentives are most likely to be found in projects relying on transactional governance– NOT SUPPORTED
Selective incentives related to reputation of project participants are associated positively with relational governance ($\chi2(2)=$

Table 4
Interaction effects between governance and selective incentives for collective action.

	Selective incentives: Financial	Selective incentives: Reputation	Selective incentives: Technologies	Selective incentives: IPR policies
Transactional	n.s.[a]	n.s.	Negative association ($\chi2(2)=6.00$, $p=0.050$))	n.s.
Relational	n.s.	Positive association ($\chi2(2)=7.96$, $p=0.019$))	n.s.	Positive association ($\chi2(1)=6.29$, $p=0.043$))

[a] n.s. = non-significant association.

7.96, $p=0.019$)). Therefore, we conclude that:

H2: Reputation-related selective incentives are most likely to be found in projects relying on relational governance – SUPPORTED

For technology-related selective incentives, we expected that they would be mostly present in projects relying on relational governance. We find, however, that these types of incentives are not significantly associated to relational governance. Technology-selective incentives are *negatively* associated to transactional governance ($\chi2(2)=6.00$, $p=0.050$)). Apparently, even though technology-related selective incentives are not more common in relationally governed projects, engaging in transactional governance has a negative effect. As such, we find the hypothesis not supported.

H3: Technology-related selective incentives are most likely to be found in projects relying on relational governance – NOT SUPPORTED

Selective incentives related to favourable IPR policies are more common in projects governed through relational governance ($\chi2(2)=6.29$, $p=0.043$)). Therefore, we conclude that:

H4: IPR-related selective incentives are most likely to be found in projects relying on relational governance – SUPPORTED

5. Conclusions and policy implications

This paper explored how smart grid projects are governed by grid operators, and how this affects collective action with other actors. We found that selective incentives that promote collective action are more likely to be found in projects relying on relational than on transactional governance. Specifically, in projects where technologies are developed jointly in a long-term relationship, it is more common to find incentives related to reputational benefits and shared intellectual property rights. Financial incentives such as fees or subsidies are similarly common in transactional and relational governed projects. Technological incentives were not associated to relationally governed projects. We did find that technological incentives were less present in transactional governed projects. As such, although our hypothesis was not supported, technological incentives are at least not found in one-off deals.

A limitation of this paper is that we did not measure the ultimate success of innovation projects. While we set out to collect such performance metrics, the case information proved insufficient to reach reliable conclusions. However, collective action theory does stipulate that the selective incentives included in our study ultimately have a positive effect on project performance. Moreover, from an innovation perspective, financial performance is not the only relevant criterion since also lessons learned are relevant, and since the ultimate success can involve different aspects from the different partners. Another limitation is that we only interviewed Alliander representatives rather than their partners. However, in our primary data source of project management documents, input from partners is taken into account. As such, the analysis does cover the perceptions of the project partners to some extent.

As the analysis has been done on the project portfolio of one specific Dutch grid operator, internal validity is high as disturbing effects of institutional and market conditions are limited. On the other hand, generalization to other settings should be done with care. Generalizability is difficult to assess since benchmarks on grid operators, nationally and internationally, only focus on continuity of supply, voltage quality and commercial quality (CEER, 2012). Since benchmarks indicate performance of Dutch grid operators is similar, one might argue that the patterns will be similar. However, innovation capacity, collaboration modes and selective incentives for project partners are not included in benchmarks or comparison studies.

Our findings contribute to policy-making in the area of smart grids. Innovations in the energy domain increasingly require organizations to collaborate with others. As our case analysis shows, such collaboration often extends beyond the boundaries of the energy industry as technology providers and even citizen associations are often involved. Our informal discussions with grid operators in the Netherlands indicate that they face a challenge on how to deal with those other actors during the course of innovation projects. While grid operators have been used to dominate interactions with other actors through price-based one-off transactions, grid operators increasingly consider long-term partnerships to achieve their objectives. Our findings show that such a shift from transactional to relational governance significantly affects selective incentives for collective action. More specifically, our findings support the idea that grid operators may not just offer financial incentives through one-off transactions but provide more intangible types of benefits in long-term relationships. When joint development is done with a long-term horizon, non-financial incentives for collaboration such as sharing intellectual property rights or reputational benefits play an important role. The findings also suggest that, within such projects relying on relational governance, grid operators should consider a broader range of incentives beyond the mere financially driven ones.

For policy makers, our findings show how a move from transactional to relational governance can produce positive effects for smart grid innovation projects. In the Netherlands, regulation does not strictly prohibit the shift in collaboration modus. However, the societal trend towards price-driven, elaborate tendering procedures may hinder the move towards relational governance. A helpful development might be the recently announced new vision on subcontracting between government agencies and construction sector stipulates transparency, shared goals, shared risks and rewarding of learnings from projects (Schultz van Haegen, 2016). We recommend that policy makers further stimulate relational ways of innovation for smart grids, for instance by steering the public debate.

For innovation policy making, the findings are relevant since smart grid innovation projects are often subsidized by national or regional governments. Typically, such subsidies are given to consortia of organizations that work in a networked project setting. In terms of the conceptualization employed in this paper, such subsidies are a form of financial selective incentives that may stimulate collective action between actors. However, our findings indicate that if grid operators work jointly with partners in a long-term relationship, other selective incentives are created as well. Partners benefit from sharing intellectual property rights over the inventions produced in the project as well as from the reputation of working together with a large grid operator. As such, policy makers should consider how to optimize the conditions for such non-financial selective incentives rather than merely offering subsidies. For instance, requiring joint IPR arrangements where both grid operators and other parties benefit and stimulating dissemination about high-profile projects may be just as effective to convince organizations to work on smart grid projects. Policy makers that wish to stimulate smart grid innovation projects should consider stimulating long-term relationships between grid operators and third parties, because such relationships are more likely to produce incentives for collaboration.

Finally, we provide a policy recommendation by reflecting on the lack of benchmarking information for our study. Grid operators are still largely benchmarked and evaluated based on their operational performance, i.e. continuity of supply, voltage quality and customer interaction (CEER, 2012). As grid operators have a responsibility to support or even drive the transition towards smart grids and renewables, we argue that other performance criteria should be added. Modes of collaboration, innovation impacts and selective incentives for third parties to engage in smart grid innovation should be added as performance and benchmarking criteria. Our measurement instrument may be a starting point for such benchmarking instrument, as this paper has shown it can reliably measure selective incentives even if only based on formally documented project information.

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References

Agrell, P.J., Bogetoft, P., Mikkers, M., 2013. Smart-grid investments, regulation and organization. Energy Policy 52, 656–666. http://dx.doi.org/10.1016/j.enpol.2012.10.026.

CEER, 2012. 5th CEER Benchmarking Report on the Quality of Electricity Supply 2011. CEER, Brussels.

Clark, P.B., Wilson, J.Q., 1961. Incentive systems: a theory of organizations. Adm. Sci. Q 6, 129–166. http://dx.doi.org/10.2307/2390752.

Cohen, J., 1960. A coefficient of agreement of nominal scales. Educ. Psychol. Meas. 20, 37–46. http://dx.doi.org/10.1177/001316446002000104.

Contractor, F., Lorange, P., 1988. Cooperative Strategies in International Business. Lexington Books, Lexington, MA.

De Reuver, M., Verschuur, E., Nikayin, F., Cerpa, N., Bouwman, H., 2015. Collective action for mobile payment platforms: a case study on collaboration issues between banks and telecom operators. Electron. Commer. Res. Appl. 14 (5), 331–344.

De Reuver, M., 2009. Governing Mobile Service innovation in Co-evolving value Networks. Doctoral Dissertation. Delft University Of Technology, Delft.

Dyer, J.H., Singh, H., 1998. The relational view: cooperative strategy and sources of interorganizational competitive advantage. Acad. Manag. Rev. 23, 660–679. http://dx.doi.org/10.5465/AMR.1998.1255632.

European Commission, 2011. Mandate M/490, March 2011.

Giordano, V., Fulli, G., 2012. A business case for smart grid technologies: a systemic perspective. Energy Policy 40, 252–259. http://dx.doi.org/10.1016/j.enpol.2011.09.066.

Granovetter, M., 1985. Economic action and social structure: the problem of embeddedness. Am. J. Sociol. 91 (3), 481–510.

Gulati, R., Nohria, N., Zaheer, A., Nitin, Nohria, 2000. Strategic networks. Strateg. Manag. J. 21, 203–215. http://dx.doi.org/10.2307/3094185.

Hagedoorn, J., 1993. Understanding the rationale of strategic technology partnering : interorganizational modes of cooperation and sectoral differences. Strateg. Manag. J. 14, 371–385. http://dx.doi.org/10.1002/smj.4250140505.

Hennart, J.-F., 1993. explaining the swollen middle: why most transactions are a mix of "market" and "hierarchy". Organ. Sci. . http://dx.doi.org/10.1287/orsc.4.4.529

Jones, C., Hesterly, W.S., Borgatti, S.P., 1997. A general theory of network governance: exchange conditions and social mechanisms. Acad. Manag. Rev. . http://dx.doi.org/10.2307/259249

Knoke, D., 1988. Incentives in collective action organizations. Am. Sociol. Rev. 53 (3), 311–329. http://dx.doi.org/10.2307/2095641.

Kollock, P., 1998. Social dilemmas: the anatomy of cooperation. Annu. Rev. Sociol. 24, 183–214.

Li, F., Whalley, J., 2002. Deconstruction of the telecommunications industry: from value chains to value networks. Telecommun. Policy 26. http://dx.doi.org/10.1016/S0308-5961(02)00056-3.

Lopes, H., Santos, A.C., Teles, N., 2009. The motives for cooperation in work organizations. J. Inst. Econ. . http://dx.doi.org/10.1017/S1744137409990038

Lowndes, V., Skelcher, C., 1998. The dynamics of multi-organizational partnerships: an analysis of changing modes of governance. Public Adm. 76, 313–333. http://dx.doi.org/10.1111/1467–9299.00103.

Markus, M.L., Steinfield, C.W., Wigand, R.T., Minton, G., 2006. Industry-wide information systems standardization as collective action: the case of the U.S. residential mortgage industry. MIS Q 30, 439–465. http://dx.doi.org/10.2307/25148768.

Monge, P.R., Fulk, J., Kalman, M.E., Flanagin, A.J., Parnassa, C., Rumsey, S., 1998. Production of collective action in alliance-based interorganizational communication and information systems. Organ. Sci. . http://dx.doi.org/10.1287/orsc.9.3.411

Morgan, M.G., Apt, J., Lave, L.B., Ilic, M.D., Sirbu, M., Peha, J.M., 2009. The many meanings of "Smart Grid. Carnegie Mellon Engineering.

Oliver, P., 1980. Rewards and punishments as selective incentives for collective action: theoretical investigations. Am. J. Sociol. 85, 1356–1375. http://dx.doi.org/10.1086/227168.

Oliver, P., Marwell, G., Teixeira, R., 1985. A theory of the critical mass. I. interdependence, group heterogeneity, and the production of collective action. Am. J. Sociol. . http://dx.doi.org/10.1086/228313

Olson, M., 1971. The Logic of Collective Action: Public Goods and the Theory of Groups, Revised edition.,. Harward University Press, Massachusett.

Ostrom, E., 2000. Collective action and the evolution of social norms. J. Econ. Perspect. 14 (3), 137–158. http://dx.doi.org/10.1257/jep.14.3.137.

Porter, M.E., 1985. Competitive Advantage; creating and Sustaining Superior Performance. Free Press, New York.

Ring, P.S., Van de Ven, A.H., 1994. Developmental processes of cooperative interorganisational relationships. Acad. Manag. Rev. 19, 90–118. http://dx.doi.org/10.5465/AMR.1994.9410122009.

Sagar, A.D., van der Zwaan, B., 2006. Technological innovation in the energy sector: R&D, deployment, and learning-by-doing. Energy Policy 34, 2601–2608. http://dx.doi.org/10.1016/j.enpol.2005.04.012.

Salisbury, R.H., 1969. An exchange theory of interest groups. Midwest J. Polit. Sci. 13, 1–32. http://dx.doi.org/10.2307/2110212.

Schultz van Haegen, M., 2016. Marktvisie Rijkswaterstaat en bouwsector. Ministry Of Infrastructure And The Environment, The Hague.

Stabell, C.B., Fjeldstad, Ø.D, 1998. Configuring value for competitive advantage: on chains, shops, and networks. Strat. Manag. J. 19, 413–437. http://dx.doi.org/10.1002/(SICI)1097-0266(199805)19:5 < 413::AID-SMJ946 > 3.0.CO;2-C.

Tsang, E.W.K., 2000. Transaction cost and resource-based explanations of joint ventures: a comparison and synthesis. Organ. Stud. 21, 215–242. http://dx.doi.org/10.1177/0170840600211004.

Uzzi, B., 1997. Social structure and competition in interfirm networks: the paradox of embeddedness. Adm. Sci. Q 42, 35–67. http://dx.doi.org/10.2307/2393808.

Verzijlbergh, R.A., Grond, M.O.W., Lukszo, Z., Slootweg, J.G., Ilic, M.D., 2012. Network impacts and cost savings of controlled EV charging. IEEE Trans. Smart Grid 3 (3), 1203–1212.

Williamson, O.E., 1979. Transaction-cost economics: the governance of contractual relations. J. Law Econ. http://dxdoi.org/10.1086/466942

R.K., Yin, 2003. Case study research: design and methods, applied social research methods series.

Zajac, E.J., Olsen, C.P., 1993. From transaction cost to transactional value analysis: Implications for the study of interorganizational strategies. J. Manag. Stud. 30. http://dx.doi.org/10.1111/j.1467–6486.1993.tb00298.x.