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Realizing innovative public waterworks: Aligning administrative capacities in collaborative innovation processes

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ABSTRACT

The importance of government support for innovation is widely acknowledged, but the way governments support innovation is changing. We discern three trends: local innovation policies are gaining importance; governments increasingly choose a bottom-up, tailor-made approach to support specific innovations; and there is more collaboration between public and private actors. We analyse these trends and investigate how modern governments employ their administrative capacities to support innovation. We conduct a comparative case study of four attempts to realize integrated energy and waterworks, combining water safety and sustainable energy generation. Despite broad support, attempts to realize such innovative, multifunctional works in The Netherlands have had varying degrees of success. We examine the governmental support for these attempts and assess how governments' actions affect the innovation process. We conclude that all governmental administrative capacities have to be employed, and that public alignment is crucial for a synchronized endeavour. We elucidate the growing importance and special role of local authorities in innovation and demonstrate how modern governments spur innovation with tailor-made support in close collaboration with the private sector. We further conclude that 'encouraging interaction' is an insufficient public contribution to innovation and that expectations must be carefully managed to avoid role confusion in public–private innovation.

1. Trends in governmental support for innovation

It has become common practice to understand innovation as a result not solely of a private firm's research and technology activities (Smith, 2000), but also of the complex interaction between private producers, public policy, consumers, research and education, politics and infrastructure (Lundvall, 2010). The important role of governmental action in the generation, diffusion and adoption of innovation is widely acknowledged (Etzkowitz, 2003). This role is changing however. Different trends can be discerned in the way governments support innovation.

First, there is a gradual dispersal of innovation policy away from the national government towards regional and transnational (European) authorities, leading to a more multi-level setting (Partzsch, 2009: 986). Public research, technology and innovation are no longer exclusively in the hands of national authorities (Kuhlmann, 2001: 953). Reacting to the perceived failure of national governments to address environmental challenges, local governments are for example implementing their own policies to support innovation for sustainability, in a 'rebirth of regionalism' (Garret-Jones, 2004: 3). The emergence of 'smart' cities is one example (Cohen and Amorós, 2014). Local governments are seeking to attract the creative class, establish innovation districts and profit from the job creation that innovation brings (Cohen and Amorós, 2014; Doh and Kim, 2014). The local environment is an important determinant of a private firm's capacity to innovate, and research shows that R&D intensity and innovation activity vary more across regions than across national states (Oughton et al., 2002).

Related to this trend towards localization is the trend towards more applied, tailor-made governmental support for innovation. Increasingly, policy measures are developed in interaction with industry and universities (Etzkowitz and Klofsten, 2005). This results in 'smart regulation, a new type of negotiated settlement in which improved procedures allow for better, institutionally assured cooperation, more ambitious goals and limited administrative costs' (Partzsch, 2009: 985). Instead of 'sponsoring grand technology citadels', governments increasingly choose a more bottom-up approach, aimed at establishing local clusters, knowledge hubs and innovation districts (Garret-Jones, 2004: 3).

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The third trend is the focus on collaborative governance and a more coordinating role for governments. Modern governments increasingly rely on collaboration to realize their policy goals. A host of non-governmental actors, public and private, are mobilized to solve today's 'wicked' public problems (Salamon, 2000; Klijn and Koppenjan, 2016). This also applies to the field of environmental innovation policymaking. Now that the state's capacity to deal with environmental challenges is diminishing, 'other actors and institutional arrangements are stepping in' (Francesch-Huidobro, 2015: 11). The role of the government in innovation processes shifts to 'encouraging interaction and cooperation between institutional spheres' (Lundberg, 2013: 213; Etzkowitz, 2003). A result of this trend towards collaborative governance is the blending of public and private innovation. Governments often involve private actors to address (traditionally) public problems. They try, for example, to increase private investments in innovation in the water sector (World Bank, 2004).

The vast literature on government support for innovation generally distinguishes between supply-oriented and demand-oriented policy instruments (Aschhoff and Wolfgang, 2009; Guerzoni and Raiteri, 2015). The former stimulate the supply side of innovation, for example by providing subsidies to private firms to support their R&D activities. Demand-side instruments stimulate the market for innovative products and services, for example by public procurement or mandatory standards. Many studies test the effectiveness of a specific policy instrument for innovation, for example public procurement (Uyarra et al., 2014) or R&D project subsidies (Kang and Park, 2012). Recently, growing attention has been given to the combined effect of various policy instruments (Rogge and Reichardt, 2013). The term *policy mix* is used to refer to the 'set of different and complementary policy instruments to address the problems identified' (Borrás and Edquist, 2013: 1514). The current literature, however, still focuses predominantly on traditional governmental support for innovation. There is a dearth of research exploring how local governments support innovation (Mazzarol et al., 2014) and, although innovation in the public and the private sector are melding, the literature on public and the literature on private innovation are still largely separated. There are, in other words, few studies that cover the new ways in which governments support innovation and the capacities they employ in doing this. Therefore we formulated the research question: What capacities are employed by public authorities to support public–private innovation and with what consequences?

To answer this question, we analyse four cases that reflect the trends in governmental support for innovation. We compare four regional projects in which public and private actors collaborate to add innovative techniques for sustainable energy generation (tidal energy, salinity gradient power) to public waterworks. Not only are these techniques innovative. Also the fact that public waterworks are used for commercial goals is novel, as is the way in which public and private actors have to collaborate to realize the implementation of the innovative techniques.

Transnational, national and local governments are involved in the projects, and their role differs per case. We unravel how the authorities contribute to the innovation processes by mobilizing different administrative capacities. We do not focus on the support of one sole government or policy instrument, but rather analyse the actual mix of different instruments and resources in a multi-level and multi-actor setting, thereby zooming in on a tailor-made form of governmental support for specific innovation projects. We investigate what extra activities authorities undertake to spur the adoption of innovations, in addition to the institutional framework of policies, rules and regulations at national level. Instead of comparing national systems, we thereby analyse variation within one such system to determine whether different mixes of employed capacities result into different outcomes. In Section 2, we further elaborate the public–private nature of integrated energy and waterworks and the special position of authorities in realizing them.

2. Our research: integrated energy and waterworks as public–private innovation

Innovation can be defined as 'the successful exploration of new ideas' (Francis and Bessant, 2005: 171) or, more elaborately, as 'the recognition of opportunities for profitable change and the pursuit of those opportunities all the way through to their adoption in practice' (Baumol, 2002). The technologies used in our cases, such as the turbines that generate tidal energy and the membranes for osmotic energy, are typical, private sector innovations developed by private firms for 'cost reduction, market expansion and profit maximization' (Schumpeter, 1934; Stoneman, 1983). These techniques are implemented, however, in public infrastructure, in dams, sluices, levees and dikes that normally are used only for flood risk safety and water management. As these waterworks are publically owned and managed, realizing integrated energy and waterworks thus inevitably has a public component. Such works could therefore be called public–private innovations.

In the water sector governmental support is of great importance to achieve innovation, because, compared to other sectors, the R&D intensity and innovation rate is relatively low (Ipektsidis et al., 2014). Innovation in the water sector is driven predominantly by regulatory developments and social and environmental factors and much less by market demand and competitiveness (European Commission, 2014: 275). The relatively low profitability is one of the reasons for the lagging private investments in water innovation (World Bank, 2004). The same holds for the renewable energy sector; technology development for renewable power generation is largely driven by governmental support (Cantner et al., 2014).

To realize integrated energy & waterworks besides the cooperation of public asset managers is essential. Their cooperation is not straightforward however, because the infrastructure used in energy and waterworks is vital for flood protection and the supply of fresh water. Dutch water management, anchored in laws and regulations, focuses on risk avoidance, and public asset managers have a strict, monofunctional task orientation (Van Buuren et al., 2013; Roovers and Van Buuren, 2014). It is therefore not easy to accommodate other functions at waterworks, as required in integrated energy and waterworks.

Governments generally promote innovation because it fosters economic growth (Smith, 2000: 75; Aschhoff and Wolfgang, 2009: 1235). Innovation is believed to increase competition, create jobs and generate wealth for individuals and the nation (Michael and Pearce, 2009: 285). These objectives also apply to governments' support for integrated energy and waterworks. In addition however, the realization of such works contributes to climate adaptation, sustainability and the transformation towards a green economy; and local governments hope that the innovative constructions will attract tourists and international businesses to their region.

The factors described combine into a complex position for authorities in the realization of integrated energy and waterworks. In our study, we take a closer look at this special position and investigate how authorities' contributions influence the attempts to realize such works. In Section 3, we discuss the literature on the different capacities governmental actors can employ to support innovation.

3. Administrative capacities to support innovation

3.1. Administrative capacities of the modern state

There is a huge literature on organizations' capacities and capabilities. Most authors take a resource-based view (Nelson and Winter, 1982), wherein institutional capacities are considered the core competences of organizations, built up over a long period of interaction and collaboration in which actors develop routines and competences that are essential for their joint effectiveness (Spekkink, 2013; Wehn de Montalvo and Alaerts, 2013). We focus solely on the level of government organizations and take a more instrumental view on capacities as the resources and instruments an organization uses to realize its ambitions.

To investigate the extra activities undertaken by governments to support the realization of integrated energy and waterworks, we use Lodge and Wegrich's (2014) theoretical framework on the administrative capacities of the modern state. Lodge and Wegrich's administrative capacities relate to the four principal governing resources: treasure, nodality, organization and authority (Hood, 1986; Howlett, 2000). In line with Lodge and Wegrich, we define administrative capacities as the *sets of skills and competencies that authorities employ to address today's governance challenges*, distinguishing between delivery capacity, analytical capacity, coordination capacity and regulatory capacity. In the rest of this section, we further define these four capacities and how they are used by authorities to support the adoption innovation.

3.2. Delivery capacity to support innovation

Delivery capacity is an authority's capability to make things happen; it consists of the resources that governments use to perform their primary tasks at the policy frontline (Lodge and Wegrich, 2014). A state's delivery capacity relates to its treasure; it includes for example grants and loans and, in modern times, research funding (Hood, 1986; Howlett, 2000: 420). Government funding is an important stimulus for innovation (Guerzoni and Raiteri, 2015; Hyytinen and Toivanen, 2005). In collaborative innovation processes, access to resources is one of the fundamental conditions brought in by governmental actors (Sørensen and Torfing, 2012: 8). Authorities use their delivery capacity to spur innovation by providing ‘funds, human resources (…) risk capital and base capital’ (Moon and Bretschneider, 1997: 61). With their delivery capacity, they can support both the supply side of innovation, e.g. with R&D subsidies, and the demand site, by purchasing innovative products in public procurement procedures (Caerteling et al., 2008; Cantner et al., 2014).

3.3. Analytical capacity to support innovation

Authorities' analytical capacity is based on the information that authorities have at their disposal and use to make policy choices; it is the knowledge that informs decision making. This form of capacity ‘addresses demands on forecasting and intelligence that informs policy making under conditions of uncertainty’ (Lodge and Wegrich, 2014: 14). Analytical capacity relates to the governing resource nodality and stems for example from the state's access to networks of expertise. Examples of nodality-based policy instruments are advice and training, education and information provision (Hood, 1986; Howlett, 2000).

Governments can use their analytical capacity to support innovation by providing knowledge and information. This can be done in an indirect way by financing universities that generate knowledge spill-overs to the private market (Moon and Bretschneider, 1997; Aschhoff and Wolfgang, 2009: 1237) or in more direct ways by bringing data into innovation processes. In collaborative innovation, one of the roles of governmental actors is to bring ‘new knowledge into play (⋯) and encourage transformative learning and out of the box thinking’ (Sørensen and Torfing, 2012: 8). In the case of integrated energy and waterworks, access to governmental data on water streams and environmental conditions is essential for successful realization.

3.4. Coordination capacity to support innovation

Coordination capacity is the capacity to ‘bring the necessary actors together to achieve problem-solving’ (Lodge and Wegrich, 2014: 13). Besides being one of the participants in collaborative governance, government can act as the organizer or facilitator of the process, bringing participants together and ‘aligning organizations from different backgrounds under often tricky conditions’ (Lodge and Wegrich, 2014: 13). Salamon (2000: 1638) speaks of the ‘new government's orchestration skills'. In modern times, governments do not ‘play all the instruments alone’ and they cannot depend on ‘control and demand’; instead, they use their coordination capacity to enable the orchestra's performance.

In innovation the government's role as network manager, boundary spanner, broker and intermediary is also gaining importance (Gregersen, 1992; Howells, 2006; Partzsch, 2009). Modern governments promote innovation by encouraging interaction among institutional spheres (Lundberg, 2013: 213; Etzkowitz, 2003). Authorities have to ‘create, institutionalize, and manage open and flexible arenas for collaborative interaction with other relevant and affected actors’ to make innovation possible (Sørensen and Torfing, 2011: 16; Nambisan, 2008).

3.5. Regulatory capacity to support innovation

Regulatory capacity (Lodge and Wegrich, 2014: 11) is the modern state's capacity to prohibit or permit and refers to the government's power to constrain economic and social activities. Regulatory capacity is based on the governing resource, authority; associated policy instruments are regulations and licences, and in modern states, labelling, treaties and political agreements (Hood, 1986; Howlett, 2000: 420).

Authorities can use their regulatory capacity to spur innovation by adding, improving or removing regulation (Gregersen, 1992; Aschhoff and Wolfgang, 2009; Cohen and Amorós, 2014). The literature on innovation often identifies rules and regulations as a hindrance to innovation (Sørensen and Torfing, 2012). One function of regulations is to eliminate risk, whereas the acceptance of risk is a precondition for innovation (Brown and Osborne, 2013). Rules can, however, also be necessary to make innovation possible. In the case of integrated energy and waterworks, there is on the one hand an overload of rules; there are many, often conflicting, laws and regulations concerning water safety, energy generation and nature conservation. On the other hand however, there is an institutional vacuum, there are no rules yet specifically aimed at integrated energy and waterworks. Governments can thus stimulate innovation by using their regulatory capacity to abolish or adjust rules or draft new ones, for example in the form of new ‘organizational or juridical arrangement, additional contracts, temporary permissions or bilateral agreements or new policy rules’ (Van Buuren et al., 2013: 694).

4. Methodology

4.1. Case selection

The cases selected are The New Afsluitdijk, Tidal Power Plant

Brouwersdam, Oosterscheldekering and Testing Centre Grevelingendam. As stated, these cases were selected because they display the three trends in governmental support for innovation discerned from the literature. The technologies used, the membranes and tidal turbines, are private sector innovations. Their implementation in public waterworks, that are essential for flood protection and are managed by water authorities with a monofunctional task orientation, is as much as an innovation however. We can learn much from these cases because they can be considered as most extreme cases in water innovation (Seawright and Gerring, 2008). On the one hand, there is a strong shared belief that the Dutch have to invest in their world-leading position with regard to innovative delta technology. Both the national government (with innovation policies aimed at stimulating innovation in a couple of top sectors, including water) and the regional authorities emphasize the importance of making the Dutch Delta the worldwide window of innovative delta solutions. At the same time-as elaborated in Section 2-the collaboration of the responsible water authority is indispensable to realize this kind of innovation because it necessitates the use of public waterworks. That makes these cases very relevant from this article's perspective, as these innovation processes necessitate the employment of different administrative capacities by various public actors with different and even conflicting interests.

The national authorities involved are the same in all four cases and the other authorities involved have comparable capacities. Although the resources and administrative capacities that could be employed by the authorities thus do not differ significantly, the capacities that they employ in reality do differ. The cases further differ with regard to their (tentative) success, making them suitable for exploring the relation between administrative capacities employed and innovation success. Much research on innovation is biased towards best practices; by selecting cases with different levels of success we avoid this (Borins, 2001).

Because of our research design, our results cannot be directly generalized to all processes of (water) innovation. Innovation processes all have ‘their own dynamisms and are influenced by, among other things, the features of technologies, the specific organizational and institutional settings, legal frameworks etc.’ (Meijer, 2014: 206). Although our research does not lead to generalized empirical knowledge, it does enhance our understanding of the role of public authorities in water innovations and leads to a detailed understanding of the relation between the capacities they employ and the success of innovations. Our case studies thus can contribute to further theory development on this topic (Walton, 1992).

4.2. Data collection

We gathered data by in-depth semi-structured interviews, document analysis and observations. We studied relevant documents such as newspaper articles, governmental policy briefs and notes, agreements between actors, permit and subsidy applications and allocations. This document analysis was used to reconstruct the planning process, the relevant actions of involved actors and their formal agenda. We attended several public meetings where stake- and shareholders discussed specific issues concerning the projects (such as the business case or the contract arrangement).

Between February and December 2014, we conducted 17 interviews. We also made use of the transcripts of 23 more interviews conducted by master students writing their theses. The interviews were equally distributed among the cases. We interviewed all key players in the four cases: public professionals of national and local authorities, directors of the private firms involved and representatives from other public organizations. The interviews were used to deepen our understanding of the process and the agenda of the actors involved, the perception of the authorities' contribution to that process and actors' perceptions about the relative impact of this contribution. Finally, our reconstruction of capacities and their impact was checked by one key representative per case (in all cases a public policy official).

4.3. Operationalization and measurement

On the basis of the literature on administrative capacities and innovation policy, we constructed Table 1 containing possible public contributions to energy and waterworks. We use this table to determine the capacities employed by the public authorities in our cases.

To assess the extent to which these capacities are actually employed, we make a distinction between low, medium or high use, which we define as follows.

- Low: Almost no elements of this type of capacity are employed;
- Medium: Various elements of this type of capacity are employed;
- High: (Almost) all different elements of this type of capacity are employed.

We are interested in the effect of the capacities employed on the success of the attempt to realize energy and waterworks. We acknowledge that success is subjective, difficult to define and hard to assess, even more so because the attempts in our study are ongoing. We define success as the realization of an integrated energy and waterworks and we take into account interim results, such as permits granted, subsidies obtained or construction started. These are milestones on the way to full realization. We distinguish between four aspects of success: (perceived) progress, feasibility, institutional fit and legitimacy. We define feasibility as the availability of (financial) resources to realize the innovative works, and progress as the satisfaction of the involved actors about how fast the project is proceeding. Institutional fit stands for the fit of the project within the institutional framework and organizational values of public authorities involved, and legitimacy is the support the project receives from authorities, other stakeholders and the general public.

5. Case description: four attempts to realize integrated energy and waterworks

In this section, we briefly summarize the four attempts to realize integrated energy and waterworks in The Netherlands. Table 2 gives an overview of the main characteristics of the cases, followed by a narrative description of the stimulus, the involved actors' interests, and dependences and progress in all four cases.

5.1. The New Afsluitdijk

The Afsluitdijk (Enclosure Dam) was constructed in 1927–1933; the dam is essential for water safety, and the adjacent lake is an important source of fresh water. The dam no longer meets the safety criteria and needs extensive renovation. The asset manager, the national Department of Waterways and Public Works (Rijkswaterstaat, RWS) is in charge of this renovation. The national government decided to focus solely on water safety and finance only essential renovation. Complementary ambitions, e.g. in relation to nature development, tourism and sustainable energy generation, are left to local authorities and private actors. For them, the complementary plans are very important because it is believed that they will generate a much needed boost to the local economy.

Local governments and private firms therefore hope to seize the

Table 1
Possible governmental support for integrated energy and waterworks ordered by administrative capacities.

Administrative capacity	Government support for innovation	Indicators. Authorities' actions
Delivery capacity	Financial support, subsidy and funding schemes, risk and base capital, R&D support, public procurement, organizational and human resources	- Provide R&D subsidies, grants or research funding - Act as launching customer - Stand surety for loan - Adjust assets for multifunctional use
Analytical capacity	Information provision, advice, training, public networks of expertise, policy analyses, cost-benefit and impact analyses, open data	- Commission studies -Share public information and expertise -Supply information for permit application -Support subsidy or grant application -Investigate possibilities for innovation -Conduct market consultation
Coordination capacity	Network management, bringing actors together, boundary spanning, initiating and maintaining intermediary platforms	-Organize workshops and meetings -Involve relevant actors -Maintain relations with actors involved -Negotiate and lobby -Ease entrance to organization for private initiators (e.g. by 1 single window) -Synchronize actions and collaborate with other authorities involved
Regulatory capacity	Constrain economic and social activities, prohibit and permit via regulations and licences, labelling, treaties, political agreements	-Abolish, adjust and/or develop policy, rules and regulations to support innovation -Sign agreements -Give (temporary) permissions, accept risks

Table 2
Main characteristics of the cases.

	The New Afsluitdijk	Tidal Power Plant Brouwersdam	Oosterscheldekering	Testing Centre Grevelingendam
Water work	32 km-long dam, north Netherlands	6.5 km-long dam, southwest Netherlands	8 km storm surge barrier, southwest Netherlands	6 km-long inland dam, southwest Netherlands
Project content	15–25 turbines in 8–12 shafts + blue energy pilot installation	Large number of turbines in 100 m-long breach in dam	3–5 turbines in 1–2 shafts	Test location for tidal turbines
Estimated power	~2–3 MW[a]	~5–45 MW	~1 MW	Varying
Estimated costs for realization	~€20–25 m[a]	~€60–250 m[b]	~€9 m	~€10–30 m
Stimulus	Renovation dam for water safety	Breach in dam for water quality	Need for turbine showcase	Reopening sluice for water quality
Initiator	Private actors and local governments	National and local governments	Private actors	Local governments
Asset manager	Focuses on renovation, facilitates private initiatives	Actively investigates possibilities of power plant	Facilitates private initiatives	Invests in reopening sluice
Local governments	Support private initiatives	Act alongside national asset manager	Support private initiatives	Initiated, aims to facilitate private initiative
Private actors	Initiated projects	Participate in market consultation	Initiated projects	Some take initiative, some wait-and-see
Public–private collaboration	Local governments support, national government facilitates private initiative	Market consultation, private actors wait-and-see	Local governments support, national government facilitates private initiative	Governments want to facilitate, private actors wait-and-see
Drivers	Ambition and support local governments	Broad-mindedness asset manager	Public subsidy, support local governments	Perseverance public and private initiators
Barriers	Energy projects small re renovation, no integration	High costs, dependence on other local developments	No private investors	Little interest from private investors and costumers
Progress (August 2016)	Tender renovation, 2 energy projects realized, 1 working on business case	Market consultation closed, tender in preparation	1 of 2 initiated projects realized	Private consortium works on business case and permits

[a] Tidal energy Den Oever, tidal energy Kornwerderzand and *blue energy* together.
[b] Additional costs for tidal plant in breach, range for different options.

opportunity of the renovation to realize and expand pilot installations for sustainable energy generation. The asset owner, the Ministry of Infrastructure and Environment, has a somewhat ambiguous attitude towards the energy projects. It prescribes (and solely pays for) essential renovation but, at the same time, the minister is enthusiastic about the Afsluitdijk becoming an integrated energy and waterworks. Therefore, RWS feels unofficially obliged to support the local ambitions and has agreed to help the private actors and local authorities to implement their plans.

Since 2008, a turbine constructor has been operating a pilot installation in one of the shafts of an outlet sluice. In 2015, partly financed by public subsidies, the firm expanded its installation with three more turbines. Together with the local authorities, it wants to realize a second pilot installation. There have been talks with different possible investors and participants, but to date (August 2016) without success. In 2014, another private firm opened a pilot installation for the generation of *blue energy*, using the difference in salinity between fresh and salt water, at the Afsluitdijk. Realizing the installation was a shared ambition of the local authorities, and the firm received subsidies from national and local authorities.

5.2. Tidal Power Plant Brouwersdam

The Brouwersdam, constructed in 1971, encloses a saltwater inlet of the North Sea, creating the lake Grevelingenmeer. Since the enclosure, the water oxygen level has gone down, damaging nature and the local economy. Therefore, the public authorities developed plans to breach the Brouwersdam to restore estuarine dynamics and improve the water quality in the Grevelingenmeer. With this plan, the idea emerged to realize a tidal power plant in the breach. The authorities hoped that the alteration to the dam, a very costly undertaking, could be financed with the revenues from energy generation. In 2013, local authorities and RWS set up a project bureau to investigate the feasibility of a power plant in the Brouwersdam. They conducted an extensive market consultation and joint fact-finding with market actors to investigate different options and costs. They concluded that it was not possible to finance the renovation with the revenues from energy generation; rather, the realization of a power plant would entail additional costs.

The local authorities nevertheless see great benefits in the realization of a power plant. They expect great benefits for local employment, the knowledge economy and attracting visitors to the region. They have small budgets, however, and are willing nor able to make large financial investments in a power plant. RWS advocates for a power plant but is also unable to make extensive financial contributions. RWS is now (August 2016) preparing a concession-based tender in which the realization and the exploitation of the power plant are combined. The private actors in this case have a somewhat wait-and-see attitude. They consider the power plant a public ambition and hope to be given the job to build the plant at public expense.

5.3. Oosterscheldekering

The Oosterscheldekering (Eastern Scheldt storm surge barrier) is part of the delta works in the southwest of The Netherlands, built after a flood in 1953 as protection from the North Sea. In 2008, a consultancy firm and a turbine constructor both took the initiative to install tidal turbines in one of the breaches in the dam. Their primary goal is to create a showcase for potential customers. Both firms applied to RWS for a permit and for several local, national and European subsidies. The Province of Zeeland is an enthusiastic advocate and promoter of tidal energy. The region is known worldwide for its innovative delta works. Zeeland now hopes to update this status by combining the waterworks with sustainable energy generation. The Province expects many financial and social spin-offs for the region. RWS aims to contribute to the multifunctional use of infrastructure, sustainability and technology development. Therefore, RWS decided to deliberate jointly with the firms and help them to formulate a viable permit application. In an intensive, collaborative process, the private firms and RWS came to an agreement about the terms and conditions under which the firms could install their installations and generate energy at the dam. Both projects received several public subsidies but had a hard time finding additional private investors. Consequently, the project was postponed multiple times. The two initiatives merged, and in September 2015 the turbine constructor and partners successfully realized one of the projects by installing five turbines in one of the dam's breaches. It is uncertain whether it will also realize the second project. In 2016 the firm applied for an additional €2 m in subsidies to expand the project.

5.4. Testing Centre Grevelingendam

The Grevelingendam is a 6 km-long dam in the southwest of The Netherlands, built in 1958 as part of the delta works. The Grevelingendam is not a primary flood defence and its water safety function is no longer clear. The dam has a road connection and several recreational functions. Because the water quality in the adjacent lake, the Grevelingenmeer, is low since its enclosure, plans were developed to reopen the sluice in the dam to restore estuarine dynamics in the lake. With this plan to reopen the sluice, the idea emerged to realize a testing centre for tidal turbines in the sluice. The local authorities see great benefits in establishing a testing centre. The region aims to become ‘the home of the tidal energy industry’, and a testing centre would contribute to this ambition. They are unwilling, however, to realize (and finance) such a centre themselves. The Province of Zeeland therefore took the initiative to find private initiators. It funded engineering and a consultancy firm to organize a series of workshops to bring together interested actors. The local authorities hoped that private firms and knowledge institutes would unite in these workshops to realize the test location without governmental participation, but the workshops did not have the hoped-for result. One obstacle is that it is unclear whether there is any need for a test location on the private market. The asset owner, the Ministry of Infrastructure and Environment, is willing to reopen the sluice earlier than planned to facilitate the realization of a tidal testing centre. The work has been put out to tender, and the reopening of the sluice is planned in 2017. The consultancy firm formed a consortium of private partners that is now (August 2016) trying to obtain the necessary permits and public and private funding.

6. Analysis

We now take a closer look at the public authorities' contributions to the four attempts to realize the integrated energy and waterworks. We categorize the capacities used and indicate to what element of the innovation processes (feasibility, progress, institutional fit or legitimacy) the authorities contributed (see Tables 3–10).

6.1. The administrative capacities employed per case

6.1.1. The New Afsluitdijk

In The New Afsluitdijk case, the local authorities employ a wide range of administrative capacities to contribute to the sustainable energy projects (see Table 3). The effectiveness of their effort, however, often proves insufficient. The innovation process is very time-consuming, and the realization of the various projects is uncertain. To a certain extent, there is public alignment between the different authorities involved; the national asset manager and the local authorities have regular contact and keep one another informed about their activities, but they fail to synchronize their activities in such a way that the implementation of the local agenda is connected to the national government's renovation work. Furthermore, despite requests from the local authorities, RWS is not willing to complement the capacities that the local authorities lack. These include, for example, more delivery capacity (in the form of directly purchasing the generated electricity) and regulatory capacity. An important barrier is the fact that RWS is not willing to adjust its rules with regard to the planning or the scope of the dam renovation. Table 4 gives an overview of the administrative capacities employed by the different authorities involved.

6.1.2. Tidal Power Plant Brouwersdam

In this case, there has been great public alignment. RWS and the local authorities, united in a project bureau, employed a lot of analytical and coordination capacity researching the possibilities and feasibility of a power plant (see Table 5). The authorities worked closely with private actors, and the employment of their

Table 3
Public authorities' contributions to innovation process The New Afsluitdijk.

Public authority	Authorities' action contributing to energy and waterworks	Administrative capacity	Positively contributed to
Ministry Economic Affairs	Subsidy for projects, per amount of energy generated	Delivery	Feasibility
Ministry I&M	€20 m (total) financial contribution to local sustainability projects	Delivery	Feasibility
Asset manager RWS	Established 1 single window for all requests from the region	Coordination	Progress, institutional fit
	Participates in multiple local deliberative bodies	Coordination	Progress
	Supported private initiators to formulate admissible permit application	Analytical	Institutional fit
	Negotiated with private initiators about permit requirements and adjusted standard requirements	Regulatory	Institutional fit
	Informed local actors about its own activities, advised local actors about theirs	Coordination	Progress, institutional fit
	Offered opportunity to include local projects in tender for renovation	Coordination	Progress, institutional fit
	Obliges the renovation contractor to take into account the local project plans	Regulatory	Institutional fit
Local authorities (united in project bureau)	Support private project initiators in finding financial investors	Coordination	Progress, feasibility
	Support private projects initiators to formulate admissible subsidy applications	Analytical	Institutional fit, feasibility
	Lobbied asset manager to purchase generated energy directly from initiators	Coordination	Feasibility
	Contributed financially to projects through local funds	Delivery	Feasibility
	Stand surety/pre-finance projects, thereby taking financial risks	Delivery	Progress
	Negotiated with asset manager about conditions for including projects in renovation tender	Coordination	Progress, institutional fit
	Secure coherence/relation between individual projects	Coordination	Progress

Table 4
Overview of administrative capacities employed in The New Afsluitdijk case.

	Delivery capacity	Analytical capacity	Coordination capacity	Regulatory capacity
EU/national government	Medium	Low	Low	Low
National asset manager	Low	Medium	Medium	Medium
Local authorities	Medium	Medium	Medium	Low

Table 5
Public authorities' contributions to innovation process Tidal Power Plant Brouwersdam.

Public authority	Authorities' action contributing to energy and waterworks	Administrative capacity	Positively contributed to
Asset manager RWS	Entered collaboration with local authorities, became member of project bureau	Coordination	Progress, legitimacy
	Will give initiators the chance to realize an energy plant in waterworks	Regulatory, delivery	Institutional fit
	Prepared innovative integrated tender for realization and exploitation of power plant	Regulatory	Feasibility
Local governments (united in project bureau)	Researched financial, technical and social feasibility and affordability of different power plants	Analytical	Feasibility, institutional fit, progress
	Organized meetings with potential stake- and shareholders	Coordination	Legitimacy
	Conducted market consultation, joint fact-finding and red flag analysis	Analytical	Institutional fit, progress
	Lobbied Ministry of Economic Affairs to financially contribute	Coordination	Feasibility
Province Zuid-Holland	Suggested the idea of a power plant	Coordination	Progress
	Set realization of power plant as condition for financial contribution to renovation for water quality	Coordination	Progress, feasibility
Province Zeeland	Willing to contribute financially to power plant	Delivery	Feasibility

administrative capacities has been fine-tuned in order to fit the private ambitions. It is too early to conclude whether the authorities' effort will be successful; the exploration of the feasibility of a tidal energy plant is ongoing. Currently (August 2016), RWS is exploring how it can employ its coordination and regulatory capacity with an innovative, integrated tender in which the realization and the exploitation of the power plant are combined. Much effort is being made to align what the public authorities can further

Table 6
Overview of administrative capacities employed in the Tidal Power Plant Brouwersdam case.

	Delivery capacity	Analytical capacity	Coordination capacity	Regulatory capacity
National asset manager	Low	High	High	Medium
Local authorities	Low	High	High	Low

Table 7
Public authorities' contributions to innovation process Oosterscheldekering.

Public authority	Authorities' action contributing to energy and waterworks	Administrative capacity	Positively contributed to
EU	€3,250,000 subsidy for regional development	Delivery	Feasibility
Ministry Economic Affairs	€1,750,000 subsidy	Delivery	Feasibility
	Subsidy, per amount of energy generated	Delivery	Feasibility
Ministry I&M	Gave RWS permission to support the privately initiated projects	Delivery	Institutional fit
Asset manager RWS	Actively investigated possibilities for privately initiated projects	Analytical	Institutional fit
	Supplied information necessary for permit application	Analytical	Progress, institutional fit
	Had monthly talks with initiators, helped them to formulate admissible permit application	Analytical	Institutional fit
	Negotiated with initiators about permit requirements and adjusted standard requirements	Regulatory	Progress, institutional fit
	Extended standard permit period to improve private business case	Regulatory	Feasibility
	Granted a provisional permit before all necessary research was conducted	Regulatory	Progress, feasibility
	Accepted (financial and safety) risk of damage to the waterworks	Regulatory	Institutional fit
	Extended monitoring programme for new infrastructure (costs for private initiator)	Regulatory	Institutional fit
Province Zeeland	€500,000 subsidy	Delivery	Feasibility
	Compensated potential objectors to prevent notice of objection procedure	Coordination	Legitimacy, progress
	Lobbied other authorities to support the initiatives	Coordination	Legitimacy

contribute to realization, but it is uncertain whether the necessary public funds will become available. The employment of delivery capacity in the form of a substantial public financial contribution will be essential for realization but it is uncertain if this becomes available. Table 6 gives an overview of the administrative capacities employed in this case.

6.1.3. Oosterscheldekering

Table 7 contains all the public contributions made to the Oosterscheldekering project. In this case, there was effective alignment between the public authorities involved; Table 8 shows that together they employed all four capacities. RWS employed its analytical and regulatory capacity in a very explorative mode, deliberating with the initiators and adjusting its permitting rules. The Province of Zeeland acted as network manager and applied a lot of coordination capacity to achieve public alignment and broad public support. Zeeland closely monitored the barriers in the innovation process, employed the capacities that were missing and removed obstacles for the private initiators. All levels of government employed their delivery capacity; this resulted in large subsidies. This case is therefore relatively successful: in September 2015 one of the two privately initiated projects was realized; five tidal turbines have been installed in the dam.

6.1.4. Testing Centre Grevelingendam

In this case, the local authorities, especially the Province of Zeeland, employed a lot of coordination capacity (see Table 9), thereby hoping to bring together private actors who then together would take the initiative to realize a testing centre, but the sole employment of coordination capacity proved an insufficient public contribution. Only after substantial financial support is a private consortium now making an attempt to realize a testing centre. RWS has limited its contribution to renovating and reopening the sluice. It has not been necessary to employ regulatory capacity because there have been no permit applications yet. Table 10 gives an overview of the administrative capacities employed in this case.

6.2. Case comparison

Table 11 gives an overview of the capacities employed and the success of the four cases. To date (August 2016), the Oosterscheldekering case is the most successful; one of the two initiated projects has been realized. In this case, all administrative capacities have been employed. Several authorities have made substantial financial contributions, and the province employed a lot of coordination capacity to ensure public alignment and broad support. The asset manager employed its analytical and regulatory capacity to support the private initiatives. In the other cases, one or more of these success factors are missing, resulting in moderate to no success (yet).

6.2.1. Delivery capacity in the innovation process

The employment of delivery capacity, in the form of financial contributions, is an important stimulus for innovation (Guerzoni and Raiteri, 2015; Hyytinen and Toivanen, 2005); our cases confirm this. Public funding is, at least at the current stage of technology development, essential to realize integrated energy and waterworks. The availability of a large subsidy was a driver of success in the Oosterscheldekering case, and the absence of public funding is an important barrier in the other cases. Allowing public

Table 8
Overview of administrative capacities employed in the Oosterscheldekering case.

	Delivery capacity	Analytical capacity	Coordination capacity	Regulatory capacity
EU/national government	High	Low	Low	Low
National asset manager	Low	High	Low	High
Local authorities	High	Low	High	Low

Table 9
Public authorities' contributions to innovation process Testing Centre Grevelingendam.

Public authority	Authorities' action contributing to energy and waterworks	Administrative capacity	Positively contributed to
Asset manager RWS	Renovated and reopened sluice to make testing centre possible (estimated costs €8,300,000, commissioned by Ministry I&M).	Delivery	Institutional fit
Province Zeeland	Searched for private initiators	Coordination	Legitimacy, progress
	Paid €100,000 to draw up programme of requirements	Delivery, analytical	Institutional fit, progress
	Made testing centre part of EU research project, paid for workshops to support realization of the test centre	Delivery, coordination	Legitimacy, progress
	Financed €100,000 revolving fund for private initiators to start up project	Delivery	Feasibility, progress

Table 10
Overview of administrative capacities employed in the Testing Centre Grevelingendam case.

	Delivery capacity	Analytical capacity	Coordination capacity	Regulatory capacity
National asset manager	Medium	Low	Low	Low
Local authorities	Medium	Low	High	Low

Table 11
Comparison of the administrative capacities employed in the four cases.

	Delivery capacity	Analytical capacity	Coordination capacity	Regulatory capacity	Success
The New Afsluitdijk	Medium	Medium	Medium	Medium	Moderately successful, all capacities employed, little public alignment, insufficient feasibility, moderate institutional fit
Tidal Power Plant Brouwersdam	Low	High	High	Medium	Relatively promising, low feasibility, slow but steady progress, moderate institutional fit, high legitimacy
Oosterschelde-kering	High	High	High	High	Successful, high feasibility, slow but steady progress, moderate institutional fit, high legitimacy.
Testing Centre Grevelingendam	Medium	Low	High	Low	Moderate success, low feasibility, slow progress, moderate institutional fit, high legitimacy.

infrastructure to be used by external actors is another, essential form of employing delivery capacity to enable this public–private innovation. The financial contributions made by the authorities in our cases are all one-time contributions. Governments are hesitant to make long-term investments and become partners in these projects. Neither are they willing to act as launching customers to support the demand side of this innovation (Gregersen, 1992; Aschhoff and Wolfgang, 2009). The Oosterscheldekering case shows that this does not necessarily have to be a problem; the works can successfully be initiated, owned and run by private actors. This, however, must be clear from the beginning of the innovation process. In the Grevelingendam case, public authorities incessantly expressed their ambition for a testing centre. This left the private actors in a wait-and-see position; they expected the public authorities to take the lead and supply the necessary resources. The authorities' failure to do so led to deadlock.

6.2.2. Analytical capacity in the innovation process

In the Oosterscheldekering case, the asset manager's willingness to share governmental data on water streams and environmental conditions with the private initiators and pro-actively deliberate jointly about the possibilities was an important success factor. In The New Afsluitdijk, the asset manager is more hesitant to share information and work together with the private initiators. In the Brouwersdam case, the asset manager and the regional authorities not only shared information, but also went a step further by conducting research to generate new information from which private partners in the innovation process could benefit.

6.2.3. Coordination capacity in the innovation process

Our analysis illustrates that the role of the government as network manager and boundary spanner in innovation is essential (Etzkowitz, 2003; Howells, 2006; Partzsch, 2009). To realize integrated energy and waterworks, the authorities' coordination capacity proved especially important to ensure public alignment and shared ambitions. For the Tidal Power Plant Brouwersdam, the national and local authorities worked closely together in a project bureau, and this led to broad support. In the Afsluitdijk case, the lack of alignment between national and local authorities is a barrier to success. Innovation processes benefit from public authorities that work together, know one another's capacities and are willing to step in when others cannot deliver. Coordination capacity is also important to involve possible share- and stakeholders, keep track of the process and eliminate possible obstacles, as the Province of Zeeland did in the Oosterscheldekering and Grevelingendam cases. The Grevelingendam case, however, also shows that the sole employment of coordination capacity, bringing relevant actors together and facilitating their collaboration, is an insufficient public contribution to realize innovation.

6.2.4. Regulatory capacity in the innovation process

The initiators of integrated energy and waterworks have to work with different legal frameworks concerning water safety, energy generation, technology development and regional development. Besides the rules and regulations, dominant values such as efficiency, effectiveness and risk aversion can form a barrier to innovation. To realize integrated energy and waterworks, organizational fit has to be created between the dominant institutional framework and the aimed-for innovations (Van Buuren et al., 2013). To do this, public authorities have to employ their regulatory capacity to abolish or adjust existing rules and draw up new ones (Gregersen, 1992; Moon and Bretschneider, 1997; Aschhoff and Wolfgang, 2009). However, in our cases, this capacity is hardly employed. To realize energy and waterworks, customization of organizational rules and tailor-made agreements are essential. As with the employment of analytical capacity, it is important that public authorities use their regulatory capacity in a positive, open and learning way. Only when the asset manager is willing to collaborate with initiators and exchange wishes and ideas is it possible to come to arrangements that safeguard public values and enable innovation. This is in line with the literature on innovation, which states that regulation created in interaction with relevant actors leads to ‘a negotiated settlement of smart regulation’ (Partzsch, 2009: 985; Lundberg, 2013).

Because of the low number of cases, it is not possible to discern clear patterns in the various capacity mixes and related success rates. In all four cases however, it proved crucial for the authorities to be able to combine their capacities in such a way that an optimal mix was formed that enabled realization of the innovations. The national asset manager had an important role in organizing the formal opportunity, providing access to the infrastructure and supplying the necessary information about on-site physical conditions. The local authorities provided the necessary network facilities and could give access to the (much needed) public funds. The Oosterscheldekering case shows how the asset manager and local authorities align their efforts and together successfully support the realization of an innovation. The national asset owner and the Ministry of Economic Affairs, however, are nearly absent in the cases. This is unfortunate, as the first has the regulatory capacity essential for multifunctional use of public infrastructure and the latter has the delivery capacity crucial to enable this kind of innovation. The aloofness of these two authorities makes it difficult for the other actors to achieve successful innovation, as they have to deal with quite restrictive conditions.

7. Conclusion

The importance of governmental support for innovation is widely acknowledged. In the water sector, the involvement of authorities in the innovation process is of even greater importance (Krozer et al., 2010). The way governments support innovation is changing however. Local innovation policies are gaining importance (Cohen and Amorós, 2014); governments increasingly choose a bottom-up, tailor-made approach to support specific innovations (Garret-Jones, 2004); and public and private actors collaborate more, leading to a blend of public and private sector innovation (Francesch-Huidobro, 2015). We analyse these trends and investigate how modern governments employ their administrative capacities to support innovation by adjusting their own routines and by facilitating private actors to implement their innovative techniques.

Our study shows the combined effect of various policy mixes (Borrás and Edquist, 2013). For complex, public–private innovations such as integrated energy and waterworks to succeed, no single policy instrument can do the job. The authorities have to employ all their capacities: regulatory capacity to adjust their own policies and regulations; delivery capacity for to enhance the feasibility of implementing techniques currently not fully developed; analytical capacity to provide the necessary information about possible consequences and impacts; and coordination capacity to reach public alignment and build a strong public–private coalition. The four capacities, however, do not have to be employed by one and the same public actor; ideally, authorities complement one another. The authorities all employ their capacities in a way that fits their own procedures and ambitions, but public alignment is crucial. Public–private innovation necessitates the synchronized deployment of authorities' capacities in a contextualized, dedicated way because each situation is unique (even when the same technological innovation is pursued). The framework of Lodge and Wegrich (2014) can help authorities to make an inventory of the available and the necessary administrative capacities.

Our analysis confirms the growing importance and special role of local authorities in innovation support (Kuhlmann, 2001). Local authorities foresee great benefits of innovation for their region and develop tailor-made support for regional innovative industries (Doh and Kim, 2014). Local authorities' capacities are limited, but they are an important actor in the innovation process. With their coordination capacity, they act as network managers, bringing together relevant share- and stakeholders, achieving public alignment and public support. They work in close collaboration with private project initiators, keep track of potential barriers and smooth the innovation process.

Our study shows the extra activities that modern governments can undertake to spur innovation, in addition to the existing national framework of policies, rules and regulations. The authorities employ their capacities to support specific innovation projects. Through interaction and negotiation, public and private partners achieve tailor-made solutions and successful public–private innovation in these projects. Our study further shows how the government's role as pacer in innovation, ‘encouraging interaction and cooperation between institutional spheres’ (Lundberg, 2013: 213), works out in practice. Bringing the relevant actors together and subsequently facilitating their collaboration are tasks that modern governments are very keen to undertake. We find, however, that often this is too small a public contribution for innovation to succeed. A substantial financial contribution, for example, is often needed.

Our study demonstrates another pitfall of collaborative public–private innovation. Authorities tend to express great ambitions, even when they do not intend to take a prominent role in the innovation process or to act as launching customer. Deadlock can occur when articulated public ambitions do not match their actual ability or willingness to act. When authorities are trying to activate the private sector with their enthusiasm and support and arrange a series of interactions, they can unintentionally accomplish the opposite: a wait-and-see private sector that expects the government to take the lead. To avoid this role confusion, managing expectations is crucial. There has to be clarity about actors' aspirations, the capacities they are willing to employ and their expectations of other, public and private, actors. Integrated energy and waterworks are realized under challenging conditions. In general, public–private collaboration for innovation is a sensitive process, an ongoing search in which the actors involved continuously have to exchange wishes and opportunities to reach solutions that are acceptable for all.

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