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Collective Institutional Entrepreneurship in Emerging Technologiocal Fields

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Abstract

Collective Institutional Entrepreneurship in Emerging Technological Fields
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This paper explores the phenomenon of collective action to shape institutions in emerging technological fields. A number of studies have established the importance of the institutional context in determining the success of failure of new technologies (Van de Ven and Garud, 1993). Garud et.al (2002) emphasize the importance of the institutional space for a technological field and highlight the role of actors in shaping emerging institutions through acts of institutional entrepreneurship (Garud, Jain et al. 2002). Building on the notion of agency in institutional change but recognizing that in complex fields change requires cooperation from many actors with diverse interests, Wijen and Ansari (2007) refer to collective institutional entrepreneurship. Hargrave and Van de Ven (2006) propose a collective action view of institutional change and stress the need of further work in this field. This study aims to improve our understanding of collective action and institutional change by focusing on the forms of power that enable key actors to engage others in collective action to influence the institutional environment and technological trajectory of an emergent field.

The empirical context of this study is the development of the smart grid in the UK. Smart grids require a fundamental technical restructuring of the electricity system and institutional changes will be necessary for their development (Kunneke 2008). Furthermore, no one single actor will be able to drive change at such a scale so collaboration between different stakeholders will be necessary. Publicly available industry information and exploratory interviews with stakeholders were used to build a case study on the advancement of smart grids in the UK, focusing on identifying the most influential groups, their promoters, their sources of power, the objectives and strategies of these groups and the impact of their activities on the institutional environment.

Initial evidence confirms that there are numerous groups being created to support the development and deployment of smart grid technologies at a national, European and international level. Most groups comprise all stakeholders involved in the development of the smart grid including government, regulators, network companies, utilities, technology companies, consumers and academia. These stakeholders have different objectives and motivations.
An interesting insight is that in the UK, the vision of the smart grid that has been developed and promoted is highly influenced by the Government?s environmental objectives for reduction of carbon emissions. The key drivers of this vision are a high penetration of renewable generation technologies and the future electrification of heat and transport, all driven by policy initiatives. This highlights the success of environmental groups in convincing key stakeholders of the importance of this vision and the role of policy-makers in providing the adequate policy environment for its realization. Two forms of power at work in this process are the ?discursive legitimacy? of environmental groups and the ?formal authority? power of Governments.

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Collective Institutional Entrepreneurship in the Promotion of New Technologies

A Case Study of the Development of Smart Grids in the UK

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Collective Institutional Entrepreneurship in the Promotion of New Technologies

Abstract

The institutional context in which new technologies emerge can determine their success or failure. For this purpose actors in a new technological field collaborate to create a supportive institutional environment for their technologies. This often requires institutional change which in complex fields cannot be driven by a single actor but requires collaboration. This study is an initial exploration of the power dynamics around the process of collective action in institutional change. It identifies the diverse sources of power that are relevant during the different processes that lead to the creation of new institutions.

1. Introduction

A number of studies have established the importance of the institutional context in determining the success of failure of new technologies (Van de Ven and Garud, 1993). Garud et.al (2002) emphasize the importance of the institutional space for a technological field and highlight the role of actors in shaping emerging institutions through acts of institutional entrepreneurship (Garud, Jain, & Kumaraswamy, 2002). Building on the notion of agency in institutional change but recognizing that in complex fields change requires cooperation from many actors, Wijen and Ansari (2007) refer to collective institutional entrepreneurship. Hargrave and Van de Ven (2006) propose a collective action view of institutional change and stress the need of further work in this field. Specifically, Hargrave and Van de Ven (2006) argue that theories of institutional change would benefit from a recognition that conflict, power and politics both shape and are shaped by institutions.

This study aims to improve our understanding of collective action and institutional change by focusing on the forms of power that enable key actors to engage others in collective action to influence the institutional environment and technological trajectory of an emergent field. The research question addressed is: **in collective processes of institutional change, what forms of power enable collective action and have the ability to drive institutional change?**

The empirical context of this study is the development of smart grids in the UK. Smart grids require a fundamental technical restructuring of the electricity system and institutional changes will be necessary for their development (Kunneke, 2008). Furthermore, no one single actor will be able to drive change at such a scale so collaboration between different stakeholders will be necessary. Publicly available industry information and exploratory interviews with stakeholders were used to build a case study on the advancement of smart grids in the UK, focusing on identifying the most influential groups, their promoters, their sources of power, the objectives and strategies of these groups and how they try to shape emerging smart grid technologies.

2. Theoretical Framework

2.1. Emerging technologies and institutional change

The literature on technology cycles identifies two distinct phases in the evolution of a product or an industry, an initial formative phase, often referred to as era of ferment, initiated by a technological breakthrough or discontinuity, and a second phase characterised by incremental technological changes and market expansion which starts after the industry settles on a dominant design (Anderson & Tushman, 1990; Utterback & Abernathy, 1975). The era of ferment is marked by technological uncertainty, high rates of experimentation and innovation, competing designs, small markets, low legitimacy of the new

technologies and often an institutional misalignment (Aldrich & Fiol, 1994; Anderson & Tushman, 1990; Freeman & Perez, 1988; Utterback & Abernathy, 1975).

Emerging technological fields, therefore, pose important challenges for companies as they need to be active in the development of new technologies and gain institutional and social support for their designs. Van de Ven and Garud (1989) stress the crucial role of institutional arrangements to either facilitate or hinder the emergence of new technologies and to guide and constrain future technological developments. The significance of the institutional framework in supporting new technological fields drives companies to contend for institutional support (Van de Ven & Garud, 1989). Rival firms often cooperate through industry councils, technical committees and trade associations, to collectively manipulate the institutional environment and gain the legitimacy needed for collective survival (Van de Ven and Garud, 1989). Van de Ven and Garud's (1993) study of the emergence of the cochlear implant industry supports the argument that significant changes in the institutional framework are often required for an invention to develop and highlights that it is in the self-interest of individual actors to work collectively towards the creation of an infrastructure that supports the industry as a whole (Van de Ven & Garud, 1993).

The institutional context and the development of a technological field are closely interrelated and technological changes typically require adjustments in the existing social and institutional framework. Kunneke (2008) studied the interrelation between institutional and technological change in the electricity industry and found that the two co-evolve and it is the interplay between the two that determines the evolution of an industry.

Musiolik and Markard (2011) explored the role of formal networks in creating a supportive institutional environment for an emergent technological field. The context of their study was the stationary fuel cell industry in Germany. They found that organizations join forces in formal networks, such as those formed by strategic alliances, technical committees, working groups or projects, with the purpose of influencing the institutional context to support their technological field (Musiolik & Markard, 2011).

To conclude, institutional change is often required for new technological fields to develop and actors in that field proactively join forces to affect the institutional environment in their interest.

2.2. Agency in institutional change

The study of agency in institutional change has gained momentum in the last decade (Leca, et al., 2008). DiMaggio (1988) introduced the concept of institutional entrepreneurship to refer to organized actors with sufficient resources to drive the creation of new institutions in favour of their interests(Leca, et al., 2008). Institutional entrepreneurs are actors who work towards changing or creating institutions (Perkmann & Spicer, 2007).

Building on the notion of agency in institutional change but recognizing that in complex fields change requires cooperation from many actors with diverse interests, Wijen and Ansari (2007) refer to collective institutional entrepreneurship. Hargrave and Van de Ven (2006) also highlight that institutional entrepreneurs typically don't have the resources, power or legitimacy to produce institutional change by themselves and collaborate with other groups with complementary interests and resources. They propose a collective action model of institutional change that examines the construction of new institutions through the political behaviours of many actors with diverse roles in the organizational field that emerges around a social movement or technical innovation (Hargrave & Van de Ven, 2006).

In this model institutional change involves: ***Framing contests***, in which opposing actors frame the meanings of relevant issues and technologies. ***Construction of networks,*** the creation of cooperative networks to pursue the development and commercialization of a new technology. ***Enactment of institutional arrangements,*** building the institutional infrastructure to realise innovations. ***Collective action processes,*** contested political processes through which new technologies emerge (Hargrave & Van

de Ven, 2006). This model highlights the importance of conflict, power and politics in institutional change (Hargrave & Van de Ven, 2006).

2.3. Power, inter-organizational collaboration and institutional change

Hargrave and Van de Ven (2006) stress that models of institutional change should pay more attention to power dynamics. In this sense it is useful to refer to the work of Phillips, Lawrence and Hardy (2000) which explores the interdependencies between collaboration and institutionalization and highlights the role of power (in different forms) as a link between these two processes (Phillips, et al., 2000).

Phillips, Lawrence and Hardy (2000) identify two processes:

1 - Institutional rules and resources impact collaborative relationships. Institutionalized rules and resources are used in the negotiation of at least three aspects of the collaborative process: the definition of the issue or problem that the collaboration is intended to address; the membership of the collaboration; and the practices utilized in response to the problem (Phillips, et al., 2000).

Hardy and Phillips (1998) argue that three forms of power are key to understanding the dynamics of collaboration: formal authority, the control of critical resources, and discursive legitimacy. ***Formal authority:*** refers to the recognised, legitimate right to make a decision. ***Scarce or critical resources:*** when one organization or groups relies on another for a critical resource, such as money, expertise, equipment, information, the dependent organization is at a power disadvantage. ***Discursive legitimacy:*** some organizations may be able to influence the process of social construction that forms an organizational domain because they have discursive legitimacy. Such actors are understood to be speaking legitimately for issues and organizations affected by the domain (Hardy & Phillips, 1998).

2 - Collaboration affects the structuration of institutional fields. The capacity for organizations to effect change in their institutional contexts will depend on their ability to institutionalize the rules and practices that have been developed in the collaboration. The diffusion of rules and practices from a collaboration to an institutional field will depend on the power of the members of the collaboration in their institutional fields is determined by their ability to effect coercive, mimetic or normative isomorphism (Phillips, et al., 2000). ***Coercive isomorphism.*** Results from formal and informal pressures exerted on organizations by other organizations upon which they are dependent (DiMaggio & Powell, 1983). ***Mimetic processes.*** When technologies are poorly understood, goals are unclear, or when the environment is uncertain, organizations may model themselves on other organizations that they perceive to be more legitimate or successful (DiMaggio & Powell, 1983). ***Normative pressures.*** Stems from professionalization. Professional and **trade associations** are an important vehicle for the definition and promulgation of normative rules about organizational and professional behaviour (DiMaggio & Powell, 1983).

3. An empirical case: the development of smart grids in the UK

3.1. Methodology

3.1.1. Context selection

The empirical context of this study is the development of smart grids in the UK. The unit of analysis is the organizational field emerging around the development of smart grids. This is an interesting context in which to explore the power dynamics in collective action to change institutions for several reasons: (i) the development of smart grids requires both new technologies as well as institutional changes (Kunneke, 2008). (ii) Electricity is a highly institutionalised industry making it an ideal context in which to study institutional change. (iii) Collaboration will be important because no one single actor will be able to drive change at such a scale. (iv) It is a complex field involving numerous stakeholders with diverse goals therefore collective action will be required (Wijen &Ansari 2007).

3.1.2. Data Collection and Analysis

Given the exploratory nature of this study, a case study approach was considered appropriate (Yin, 2009). Archival data and stakeholder interviews have been the two main sources of information. The interviews were analysed using an approach suggested by Saunders et al. (2003). This analytical process involves classifying the data into meaningful categories and "unitising" the data by re-arranging it according to each category. The objective is to facilitate the search for meaning in the data (Saunders et al., 2003).

The case study draws from 21 interviews carried out in the UK between October and December 2011 as well as attendance to the Smart Grids Forum Industry Conference in London on 29th of November 2011 and attendance to the European Smart grid Workshop organised by the UK Energy Research Centre in London December 13th and 14th 2011, involving approximately 50 European experts.

Companies that participated in the interviews:

Organization	Type of Organization	Interviewees
DECC	Government	1
Ofgem	Regulator	1
Ofgem Advisory Board	Policy Advisor	1
The Committee for Climate Change	Policy Advisor	1
UKERC	Research Centre	2
The Grantham Institute for Climate Change	Research Centre	1
National Grid	Networks	1
UK Power Networks	Networks	1
PPA	Consultant	1
Chiltern Power	Consultant	1
EdF Energy	Supplier	1
The Climate Change Group	Environment	1
Sustainability First	Consumerss	1
Elster	Meter Providers	2
Sentec	Technology	2
SmarterGrids	Technology	1
Cable and Wireless	Communications	1
IBM	Business Integrator	1
Total		21

3.2. Data Analysis and Findings

3.2.1. Background: climate change at the centre of energy policy in Europe and the UK

Concerns about climate change have led the European Union (EU) to commit to keeping the expected global mean temperature increase below 2 ºC. Accordingly, highly challenging targets for carbon dioxide (carbon or CO2) emission reductions have been set at20 % from 1990 levels by 2020 and 80% from 1990 levels by 2050. The EU communication "An Energy Policy for Europe" states that acting now on greenhouse gases (GHG) should be at the centre of the new European Energy Policy because CO2 emissions from energy make up 80% of EU GHG emissions. The same communication adds that this commitment means using less energy and using cleaner energy (EC, 2007).

The EU's strategic objective of placing climate change at the centre of the European Energy Policy has resulted in a number of directives designed to meet this challenge. Two of those Directives are particularly relevant to this project:

Renewable Energy Directive, 2008: requires 20% of all energy (heat, electricity, transport) to be from renewable sources by for 2020 (binding target) (EC, 2008).

Energy End-use Efficiency and Energy Services Directive, 2006: requires billing to be on the basis of actual consumption and performed frequently enough to enable customers to regulate their energy consumption. (EC, 2006).

The first Directive is expected to result in a significant increase in electricity generated from renewable sources (RES). The second Directive is an important driver for many EU countries to be currently considering more advanced forms of meters, or smart meters.

In November 2008, the UK's Parliament passed the Climate Change Act (CCA), making the UK the first country in the world to have legally binding carbon budgets with the objective of achieving carbon reductions of 34% by 2020 and at least 80% by 2050 (both below 1990 levels, which implies a 77% reduction by 2050 from 2005 levels) (DECC, 2009a)

As part of the overall climate strategy, in May 2009 the UK announced a major roll-out of electricity and gas smart meters to domestic and small and medium sized businesses throughout the country by 2020. The UK Government believes that accurate real time information on energy consumption will influence consumers' energy related behaviour leading to energy savings and consequently carbon savings (DECC, 2009b).

3.2.2. Commitment to a low carbon society driving the transformation of the electricity system

There is widespread agreement among all the interviewees that in the UK, the low carbon strategy is the key driver of the transformation of the electricity system towards smart grids. The interviewee from the Committee on Climate Change, an independent body created to advice the UK government on setting and meeting carbon reduction targets, emphasized the role of environmental groups in designing the carbon budgets and claim that strong environmental reasons support the UK's low carbon strategy. A few interviewees, however, disagree and believe that the low carbon strategy is primarily driven by energy security objectives.

A comment from an interviewee from a network company is an interesting example of this connection between smart grids and climate change. This informant is active in the development of smart grids in the US and explained that in the US, as doubts around climate change have increased over the past two years, there has been a loss of interest in smart grids.

In the UK, the current electricity supply system consists mainly of large, centralised sources of generation, and networks that enable the electricity to flow one-way from these central power stations fuelled mainly by coal, gas and oil to uncontrolled demand (ENA, 2011). Energy Policy objectives will result in a considerable increase of renewable generation sources. Since the output from renewable generation is intermittent, that is, it depends largely on weather conditions which are, to a certain extent, uncertain and uncontrollable (Gross et al., 2008), managing a system with high penetration of renewable generation is a considerable challenge. Experts agree that additional network flexibility will be needed to integrate intermittent sources of generation, and that control methods, communications and information technologies will be central to achieving this goal (Strbac et al., 2006).

The EU, recognising the need for Europe's electricity grids to evolve in order to integrate all low-carbon generation technologies set up SmartGrids, the European Technology Platform for the Electricity Networks of the Future, with the aim of formulating a vision for the development of the European electricity networks looking towards 2020 and beyond (SmartGrids, 2008). This platform defines a smart grid as "an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both– in order to efficiently deliver sustainable, economic and secure electricity supplies. A smart grid employs innovative products and services together with intelligent monitoring control, communication, and self-healing technologies to:

- better facilitate the connection and operation of generators of all sizes and technologies;
- provide consumers with greater information and choice of supply;
- allow consumers to play a part in optimizing the operation of the system;
- significantly reduce the environmental impact of the whole electricity supply system;
- deliver enhanced levels of reliability and security of supply"(SmartGrids, 2008).

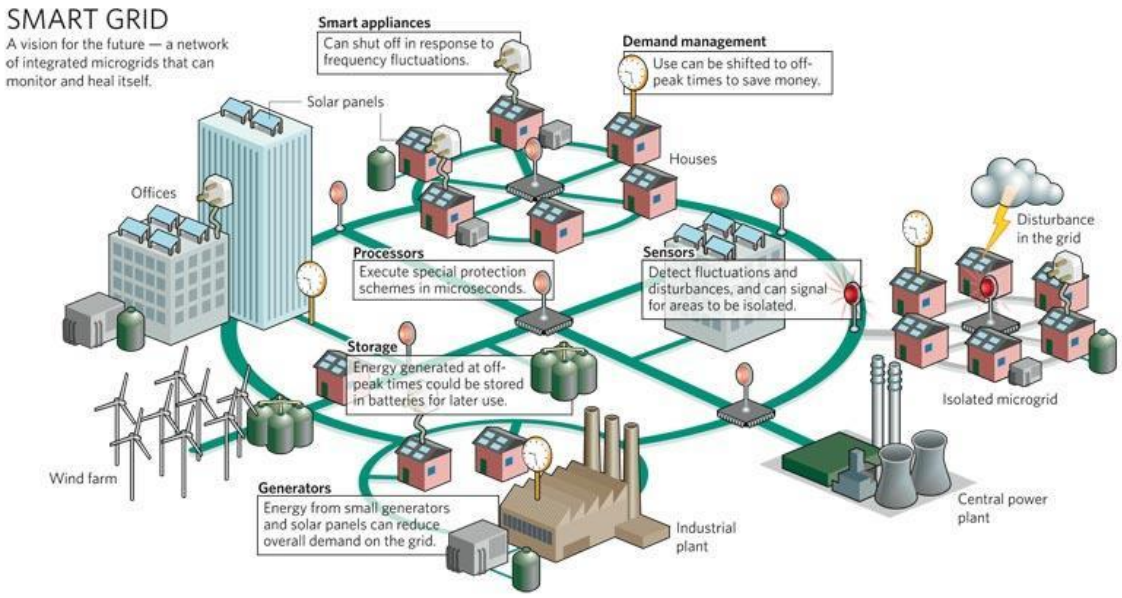

Figure 1: an example of a smart grid concept

3.2.3. The stakeholders' vision of smart grids

"Why do need smart grid? Because we want to decarbonise" Interviewee

Interviews reveal that there is still no single accepted definition of a smart grid, nonetheless the definition put forward by the SmartGrids platform is the one that has been mostly referred to by the interviewees and the one from which government reports draw from. So even despite the lack of a single definition there is an effort towards creating consensus around a common vision.

The name smart grid also originated from the SmartGrids platform. One of our interviewees involved in this platform since it was established in 2005 explained that many other names would be more accurate, and that the term smart grid can sometimes be misleading but it is "neat and clean". Some interviewees have mentioned that they don't like or agree with the name or that it's just a fad. Nonetheless, most

interviewees with this view agreed to continue using the term smart grid as they perceive it to be a brand name, or even a philosophy that reflects a different way of doing things[1]. In fact this is how the vision of smart grids originated. Given the challenge of integrating large amounts of renewable generation as well as distributed generation into the current electricity grids, a group of experts working on the problem believed that there could be a different way of doing things than business as usual (increasing network capacity through reinforcement or new build)[2]

What seems to be clear to most interviewees is that the current electricity system needs to change in order to accommodate the challenges associated with decarbonisation including, connecting and managing low carbon generation sources as well as coping with the considerable increase in demand that the electrification of transport and heat will result in. Smart grids are not an end in themselves but enablers, a solution to a problem. In this sense, smart grids will develop differently in different regions depending on the policy and regulatory framework but also depending on the energy challenges faced in each region and the problems that want to be solved[3].

A smart grid is not a single technology but a mix of technologies necessary to achieve:

Monitoring: the ability to view a wide range of operational indicators in real-time, including where losses are occurring, the condition of equipment, and other technical information (Ofgem 2011).

Control: the ability to manage and optimise the power system to a far greater extent than today. This can include adjusting some demand for electricity according to the supply available, as well as enabling the large scale use of intermittent renewable generation in a controlled manner (Ofgem 2011).

Automation: the ability of the network to make certain automatic demand response decisions. It will also respond to the consequences of power fluctuations or outages by being able to reconfigure itself (Ofgem 2011).

Monitoring, control and automation will require the use of advanced information and communication technology (ICT). National Grid estimates that a full end-to-end smart grid (generation-transmission-distribution-consumption) is still 25 years away. At the moment most technologies are being developed or in trial and demonstration phase. Currently, the only part of the electricity chain that includes a level of smartness is the transmission network which is actively managed and incudes monitoring and control technologies.

3.2.4. Key Actors and their Role in the Smart Grid

This section identifies key stakeholder group, their motivations and their role in the development of a smart grid. It is clear is that the development of smart grids requires more than just the energy sector, parties outside the energy sector will need to get involved for smart grids to develop.

Transmission network (TNOs): National Grid is a regulated monopoly that owns the electricity transmission network in England and Wales and are the transmission network operator in the whole of the UK. As transmission owners they are responsible for the design of the system, engineering and maintenance of the networks and as network operators they are responsible for system planning and operation, facilitating the energy markets and energy trading. Their interest in smart grids is linked to

[1] Personal communication, participant at the European Smart Grids workshop from a Spanish network company.

[2] Personal communication, interviewee involved in the SmartGrids platform.

[3] Personal communication, interviewee from network company.

delivering a low carbon future in a secure, cost-effective, reliable way[4]. In the UK the transmission networks are already quite smart, in the sense that they are dynamic and controllable. They try to shape the evolution of smart grids by being very involved with their stakeholders, participating in groups that they consider relevant and lobbying at the European level[5].

Distribution network operators (DNOs): In the UK distribution network companies are regulated monopolies. Currently there is very little ICT incorporated in the distribution networks and DNOs will need to make large investments in the distribution networks so that they can be actively managed and cope with expected changes in generation (increased micro-generation and distributed generation) and demand (electric vehicles and heat). In turn they stand to benefit from a more efficient operation and deferred or avoided investments in the network. They are identified by most of the interviewees as the key actors in the development of smart grids.

Electricity Suppliers/Retailers: In the UK distribution of electricity is fully unbundled from the sale of electricity. There is full competition in the electricity retail market and in the UK six large companies dominate the market. Suppliers have a role in helping network operators manage the expected changes in the electricity load due to decarbonisation[6].

Generators: Generation of electricity is expected to change significantly due to policy targets so that by 2020 20% of electricity generation needs to come from renewable sources, from approximately 4% at the moment. Furthermore, generation is expected to become more from local. Smart grids should enable the integration of these new generation sources.

Consumers: Are at the receiving end of the electricity grid. End users have traditionally being nodes of consumption and are now expected to become increasingly engaged with the electricity system. Smart meters, a smart grid technology, together with consumer education, tariffs and innovative services are expected to achieve this. Consumers want to improve their energy efficiency, gain greater control over their energy consumption and energy bills. Consumer focus, the UK energy consumer watchdog, wants to ensure that consumers benefit from smart grids, since they are the ones that will be paying for it, be it via tariffs or via taxes (McLeod, 2011).

Goverment: In the UK the responsibility for meeting the energy and environmental targets relies on the Department for Energy and Climate Change (DECC). DECC's interest in smart grids is therefore ensuring that energy and carbon reduction targets are met. DECC has a crucial and complex role in the development of smart grids in the UK by designing the right mix of policies to balance the different objectives and interest of stakeholder groups and making sure technologies are developed.

Regulator: In the UK, Ofgem, the office for gas and electricity markets, is responsible for regulating the energy industry, promoting fair competition and regulating natural monopolies, such as the electricity distribution and transmission networks. Ofgem is independent from the government and has a key role in the development of smart grids in the UK as they influence the behaviour of network companies. In addition Ofgem played an active role in developing the vision for smart grids for Europe and for the UK.

[4] Personal communication, interviewee from network company.

[5] Personal communication, interviewee from network company.

[6] Personal communication, interview with a UK electricity supplier.

Environmental groups: their interest in the smart grid is related to the carbon savings smart grid technologies enable and their role in allowing for integration of renewable generation technologies into the electricity networks.

Telecommunication providers: The communication layer is central to the smart grid. Telecommunication companies will be responsible for the communications platform that will connect renewable and other generation sources, the grid, homes and businesses in a secure, integrated system. Their vision of smart grids is that of a utility internet with an IP-based open communication platform.

Technology providers: This is a large and diverse group comprised by a range of established companies and new entrants. Meter companies, sensor technology providers, demand response technology providers. Their role is to develop many of the new technologies that will be part of a smart grid.

New energy service providers: This group will be responsible for offering new energy services to consumers. They have a key role in engaging the consumer so that they become an active participant in the electricity system.

3.2.5. Collaboration and collective action

In Europe, collaboration activity around the development of smart grids started in 2005 when the EU started funding research projects to develop technologies associated to smart grids which encouraged the formation of R&D consortia. That same year the European Technology Platform SmartGrids was set up to develop a vision of how European networks needed to evolve in order to meet future environmental challenges related to climate change. Collaboration activity around the development of smart grids has increased enormously in the past few years in the UK, in Europe and globally. The interviewees that participated in this study identified the following groups has being the most influential:

At the UK level:

Smart Grids Forum (SGF): This group was established by Ofgem and DECC in April 2011 and it takes over from the Electricity Networks Strategy Group (ENSG) which was responsible for developing a smart grid vision and routemap for the UK. It brings together key opinion formers, experts and stakeholders involved in the development of a smart grid in the UK, with the aim of providing strategic input to help shape Ofgem's and DECC's thinking and leadership in smart grid policy and deployment. It also aims to help provide the network companies and the wider stakeholder community with a common focus in addressing future networks challenges, and to provide drive and direction for the development of smart grids (Ofgem 2011).

Ofgem and DECC invited interested parties to apply for membership and their application as was carefully evaluated. Finally, 20 individuals were selected on the basis of their own personal experience[7]. The group [Group 1st called embedded generation, then ENSG] was formed as a result of a realisation that there was not a group in charge of moving forward the smart grid agenda in the UK[8]. The SGF has a crucial role in the development of smart grids in the UK by making sure that the government develops a policy that has the right balance and fits with network companies, electricity suppliers and consumers[9].

[7] Personal communication, interview with a member of the smart grids forum.

[8] Personal communication, interview with a member of the smart grids forum.

[9] Personal communication, interview with a member of the smart grids forum and UK electricity retailer.

Smart Demand Response: Interviewees have identified all the working groups organised by the Energy Networks Association (ENA) as being important to the development of smart grids in the UK. One of the main working groups organised jointly by ENA and ERA (Energy retail association) is the Smart Demand Response Group. This group brings together network companies and suppliers which is absolutely crucial in the UK given that the regulatory framework places a dual responsibility in these two players.

Smart Grids GB: This group has recently being created (2011) and it is considered relevant mainly because it is endorsed by Ofgem and DECC. Membership is open to all smart grid stakeholders in exchange of a fee. Smaller companies feel disadvantaged by this as their resources are more limited than those of larger established companies[10]. This group describes itself as a stakeholder group[11] but there seems to be some debate around this as other interviewees doubt it is really a stakeholder group and perceive it to be a trade organization. Their objective is to bring together the different stakeholders to share ideas and information regarding the development of smart grids in the UK. They are a sister organisation to the GridWise Alliance in the US and are part of the Global Smart Grid Federation.

At the European level

Smart Grids European Technology Platform: Set up by the European Commission, this platform was instrumental in developing a European vision of smart grids and a research agenda. It was also responsible for coming up with the name smart grids. It is a key forum for discussion and diffusion of activities and technological and institutional developments related to smart grids. It is responsible for the organization of a number of working groups, task forces, initiatives, advisory councils and fora on smart grids at a European level.

At the global level

The International Smart Grid Action Network (ISGAN): The International Smart Grid Action Network launched in July 2010 at the first Clean Energy Ministerial and its focus is to enable governments to collaborate with each other and other stakeholders on advancing the development and deployment of smart grids around the world.

ISGAN is supported by more than 15 national-level governments and its activities cover five areas: policy, standards and regulation; finance and business models; technology and systems development; user and consumer engagement; and workforce skills and knowledge.

Global Smart Grid Federation: The Federation of National Smart Grid Associations launched in September 2010. It is composed of organizations from around the world that represent their countries' national initiatives to create smarter grids.

In addition to a large number of groups, there are numerous demonstration projects in the UK and Europe that represent a collaborative effort among different stakeholders to develop and trial new technologies, and also to challenge and influence the current institutional arrangements[12].

3.2.6. The UK case: unique market structure creates conflict of interests

"The UK's electricity market structure was designed by someone with no knowledge of how electricity supply functions" Interviewee

[10] Personal communication, interview with a new company created to develop smart network technologies.

[11] Personal communication, interview with a high level member of Smart Grids GB.

[12] Personal communication, Project Manager for the Stockholm Royal Seaport Urban Smart Grid project.

In the UK, the electricity value chain (generation-transmission- distribution-retail) is fully unbundled. Competition was introduced in generation and retail while electricity transmission and distribution are regulated monopolies. Although not all European countries have a fully unbundled electricity value chain, European policy is driving them in this direction. What is unique about the UK is that DECC has made retailers responsible for rolling out smart meters as opposed to distribution network companies as is the case in the rest of Europe. The rationale behind this is that retailers are the ones that interact with consumers and DECC believes they are better placed to engage consumers[13].

This government decision has been highly debated and among the interviewees there are those that highly oppose this decision, those that support it and those that did not want to go into the discussion and just took it as a decision "they had to live with"[14]. The key argument of those that are in favour of the a retailer-led smart meter roll-out is that the consumer is central to the concept of smart grid and DNOs would put less emphasis on engaging the consumer and be more focused on increasing the robustness of the network. It is believed that retailers will be more proactive in offering innovative energy services which is important given that DECC estimated that 40% of smart meter benefits will come from consumer engagement[15]. In addition, interviewees mentioned that the long term objectives of reducing carbon emissions will be met easier under these conditions.

Those that oppose the government's decision regarding the smart meter deployment believe that it increases complexity and makes the business case for both smart meters and smart grids less clear. Furthermore, separating smart meters from smart grids[16] creates a complex mix of policies and interests. The responsibility for smart meters and consumer interaction has been placed on retailers yet network companies will be responsible for operating the smart grid. This duality of responsibility has created competing interests, energy suppliers are a trading business, while DNOs are concerned with balancing the grid. It creates a real dichotomy, two different forces that oppose each other: on the one hand, the government is trying to incentivise CO2 reductions through a consumer engagement policy, on the other, the government is trying to incentivise the industry to address weaknesses in the networks[17].

It is also interesting to highlight that some interviewees even question whether a fully unbundled and liberalised electricity system is adequate to deliver smart grids. The electricity system needs to be understood on an end-to end basis and the aim of smart grids is to optimise transmission of energy from source to destination. In the UK, the market has been broken down into different segments and each segment has different interests and policy incentives[18]. In countries where DNOs are responsible for the smart meter roll-out this integration is greater, but this is not the case of the UK where smart meters have been separated from smart grids. Nonetheless, an interviewee highlighted the ongoing collaborative work between DNOs and suppliers and that in UK smart meters will have a smart grid functionality for network operators to use.

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[13] Personal communication, interview with DECC.

[14] Personal communication, interviewee network company.

[15] Personal communication, interview with major UK electricity supplier.

[16] Smart meters are a building block towards smart grids if they have a two-way communications system. Nonetheless, just having smart meters doesn't mean you have a smart grid.

[17] Personal communication, interview with UK electricity supplier.

[18] Personal communication, interview with UK electricity supplier.

A further criticism to the UK smart meter roll out was made by the informant from an environmental group who highlighted that it was precluding third parties to participate. The segmental process that the UK government has chosen makes it very difficult for third parties interested in offering novel energy services to consumers to enter the market. In any case, The UK market structure increases complexity and introduces higher uncertainty in making the business case.

3.2.7. Uncertainty around the business case for smart grids: a key challenge

The majority of interviewees that have participated in this study identified the uncertainty around the business case for smart grids to be a major challenge to their development in the UK. In a personal communication DECC explained that the value of smart grids is driven by assumptions that are highly uncertain, such as the take up of electric vehicles, and that a key objective of the Smart Grid Forum is to develop scenarios and a cost benefit analysis. During the UKERC European smart grid workshop, the participant representing Ofgem also acknowledged that it is unclear where the value of smart grid is.

The value drivers of smart grids in the UK have been identified as: penetration of electric vehicles, penetration of renewable and distributed electricity generation, and penetration of electric heat pumps (Ofgem 2011). These three assumptions depend highly on government policy and on consumer acceptance and adoption of these technologies as well as on the technological developments in those three areas (Ofgem 2011). In addition, understanding the value of demand side response facilitated by some smart grid technologies is important to assess the value of smart grids. However, there is also uncertainty over how responsive customers will be to signals to reduce or shift electricity use (Ofgem 2011).

During the interviews, stakeholders have emphasized the importance of the policy and regulatory framework in establishing the value of smart grids and argue that there is a need for a clear regulatory and policy framework that enables the different players to understand and assess the return on their investment.

This lack of a clear business case increases the other major challenge identified by many interviewees; who will finance the smart grid? DECC has estimated that an investment of £200 million over the next 10 years will be needed to decarbonise the electricity sector. Given the current global economic crisis, it is unclear where the financing for the transition to a low carbon energy system will come from[19].

3.2.8. Innovation; a culture shock for DNOs

The electricity network infrastructure, smart or traditional, is a fundamental requirement of our society and in the UK is considered as one of the elements of Critical National Infrastructure (CNI) (ENA, 2011). Therefore, it must be carefully designed, implemented and operated so that the risks to the proper functioning of the infrastructure are appropriately managed (ENA 2011). For the existing electricity networks Ofgem has set performance standards that must be met by network companies under all conditions (ENA, 2011). Network companies recognise the how critical the infrastructure they own and operate is and their organisational structure, operational systems and business processes have all been designed to ensure the delivery of safe and reliable electricity supply (ENA, 2011). This makes network companies very conservative and highly risk-averse[20].

Many interviewees have noted that DNOs are not very innovative and have highlighted the role of Ofgem in incentivising innovation in the electricity networks. With this aim Ofgem set up the Low Carbon Network Fund (LCNF) which makes 500 million pounds available to network companies between 2010

[19] Personal communication, interview with network company.

[20] Personal communication, interview with network company.

and 2015 for the trial of new network technologies across the UK. This initiative has been praised by most stakeholders although one of our interviewees that is involved in assessing the projects competing for funding criticized the scheme. The informant from a network company that has been awarded funding from Ofgem explained that the LCNF not only promotes innovation but also collaboration with other stakeholders. In addition, Ofgem promotes innovation in the networks innovation promoted through their price regulation mechanism.

Another challenge that network companies will encounter is related to the increased dependence on ICT-based systems that will enable increased monitoring, control and automation as we progress towards the implementation of smarter grids. These ICT systems need to be sufficiently dependable and trusted to not have a negative impact on security of supply (ENA, 2011). In this sense, a number of interviewees have highlighted the enormous cultural differences between IT companies, which are highly dynamic and innovative, and electricity companies which are very conservative. Furthermore, the product lifecycles of IT products and products that typically form part of an electricity network are also very different, which the first become outdated within a few years, the latter are designed to last 40 to 50 years[21].

3.2.9. The consumer; at the centre of the debate

The concept of smart grid in based on an engaged, active consumer and consumer engagement will be important to realise many of the benefits associated with smart grids. However, to what extent consumers will engage, or whether consumers are interested in engaging at all is still very much at the centre of the debate. Some interviewees believe that most consumers just want to have electricity at the time they choose to and as cheap as possible and that current electricity prices are not significant enough to encourage behaviour changes.

The table below, taken from Sarah Darby's presentation at the UKERC European Smart Grids workshop illustrates what practices "active demand" requires.

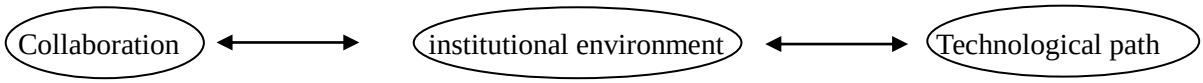
Options for users	Main objectives	Householder activity	Comments
Demand reduction via conservation and efficiency	Better energy management; investment and design for efficiency.	Question and change practices, invest in efficiency, develop energy literacy.	The most conscious and 'active' option. Enabling technology can be very simple.
Static time-of-use tariffs (TOU)	System management to reduce peak load	Choose tariff, and whether utility can control your usage; possible change in practices.	Requires smart metering. Equity and data issues. May assist microgenerators + owners of storage.
Real-time pricing (RTP)	System management to reduce peaks *and* use variable generation efficiently	Choose tariff/ contract, and enabling technologies.	More risky than TOU. Central to idea of the smart grid.
Dynamic demand, smart appliances	Network management to maintain grid frequency	Choose appliances (+ contract with network operator?)	Least problematic option. But needs very reliable technology.

[21] Personal communication, interview with network company and energy research institute.

Engaging the consumer has been identified as one of the key challenges associated with the smart grid and many of the demonstration projects taking place both in the UK and in Europe are trying to gain insights into consumer behaviour and energy use. Some interviewees involved in these trials have highlighted the importance of making energy fun and interesting for the consumer and this was an important topic of debate at the UKERC European smart grid workshop.

4. Discussion

The interest of this study stems from the recognition that new technologies often require changes in the institutional context for their successful development and that actors in a new technological fields collaborate to build a supportive infrastructure for the emerging industry as a whole (Van and Ven & Garud, 1989). The aim of this study is to gain insights into the power dynamics around collective action in institutional change, or what has also been referred to as collective institutional entrepreneurship (Wijen & Ansari 2007). Those actors with the ability to influence aspects of the institutional context such as new regulations, definitions of frameworks and standards and creation of markets are more likely to be able to guide the technological path. Based on the theoretical framework described earlier, two two-way forces can be identified:



In order to recognise the sources of power that enable collaboration, I considered the stakeholders in the organizational domain emerging around smart grids and focused on identifying who has formal authority, who controls key resources and who is able to manage legitimacy discursively (Hardy & Phillips, 1998).

Formal authority or the ability to make decisions regarding the development of smart grids in the UK lies within three key actors. The European Commission responsible for European Energy Policy, a key driver of low carbon energy systems, the Department for Energy and Climate Change (DECC) in the UK, responsible or delivering the UK's low carbon strategy and Ofgem, the regulator of energy network companies.

The control of resources on which others are dependent is another relevant source of power (Pfeffer & Salancik, 1978). In the UK, it lies within the network companies that own and operate the electricity networks and will be responsible for deploying most smart grid technologies. Furthermore, Ofgem's LCNF initiative also gives network companies access to financial resources for the development and trial of new network technologies which forces other stakeholders involved in the industry to collaborate with network companies in order to have access to the funds.

In the UK, utilities own the consumer and can to some extent control their behaviour through price incentives. This is not a significant source of power at this stage but it is expected that it will become increasingly important as the consumer assumes a more active role in the electricity system.

Discursive legitimacy lies within environmental groups which were instrumental in making the environment count in Energy Policy at the EU level. Climate change challenges and environmental goals are mentioned by most interviewees as a key driver of smart grids. The European SmartGrid Technology Platform also used the climate change rhetoric to promote a vision of a sustainable electricity system that is now widely accepted by most interviewees. The energy challenges related to climate change gave a few discerning minds the voice to promote a different way of doing things and challenge existing practices in network companies.

Furthermore, the organizational field of smart grids is forming around the need to decarbonise the energy system, which is in line with Hoffman's (1999) argument that organizational fields are created around one

central issue as opposed to a common technology or a market. The actors around that field are determined around this central issue and therefore, the stakeholders involved in the development of smart grids are not limited to the traditional stakeholders of the energy sector and new entrants needed for the development of new technologies but also include environmental groups, governments and society as a whole, whose focus is the carbon reduction potential of these new technologies.

Many of the groups created around smart grids have the objective of impacting the institutional context through changes in the regulatory framework, definition of standards and technical specifications or new business practices. However following (DiMaggio & Powell, 1983) and (Phillips et al, 2000), influencing the process of institutionalisation of new rules and practices requires the ability to effect coercive, mimetic or normative isomorphism.

Coercive isomorphism: in the UK this power is held by the government (DECC) and the regulator, Ofgem. As an example, in the UK all utilities are rolling out smart meters as a result of a government mandate. Network companies, TSOs and DNOs, because they control key resources can also exert coercive powers over those that depend on them. As an interviewee from a technology company explained, no matter how good a technology is, it's the network company's decision to deploy it or not.

Mimetic processes: a number of companies are beginning to emerge as leaders such as UK Power Networks, EDF Energy, Iberdrola, Fortum or Vattenvall. These companies are very active in demonstration projects in the UK and Europe and have shown leadership in the development of new technologies and frameworks for smart grid technologies. These organizations might be perceived by others as more knowledgeable than the rest and are more likely to be taken as models by other companies that are adopting a "wait and see" attitude until uncertainty regarding technologies, regulation and business case reduces.

Normative pressures: In the UK, the Energy Networks Association (ENA) is a source of normative pressure and going forward, it is likely that this will also be the case of SmartGrids GB if the group succeeds in establishing itself as the referent trade organization for smart grids in the UK.

This initial exploration of the distribution of power in the organizational field emerging around smart grids facilitates a better understanding of the relevant sources of power that come into play during the different processes of collective institutional change. Following Hargrave and Van de Ven (2006) four processes are identified: framing contests, construction of networks, enactment of institutional arrangements and collective action processes.

Discursive legitimacy has proven to be the most important source of power for **framing** the problem that has initiated the process of institutional change. Smart grid technologies are clearly associated with the need to decarbonise our electricity systems. The creation and manipulation of meaning of smart grid technologies has been dominated by the discursive legitimacy of the environmental groups. Even though some interviewees argued that the transition to a low carbon energy system is more related to s desire to reduce energy dependency from conflicting countries such as Russia[22], it is the environmental rhetoric that has predominantly been used by governments to claim the need for change. Once the need for change was established, policy-makers engaged key stakeholders in forming groups dedicated to forming a common vision of these smart grid technologies.

Formal authority and control of critical resources have been the dominant sources of power in the **construction of networks** and mobilizing resources and structures. Cooperative innovation groups have been created mostly around the funds offered by the EU research frameworks or in the UK the Low

[22] Personal communication, informant from research institute.

Carbon Network Fund, which have mobilised stakeholders into forming collaboration groups to develop and demonstrate technologies. Since no one single player has all the capabilities or resources needed to develop smart grids, groups have been formed around combining and leveraging the different specialised capabilities of each player.

This process is critical as collaboration is perceived by stakeholders as an imperative for the development of smart grids in the UK and most interviewees acknowledge that there is a value in dedicating time and resources to groups that are considered relevant. In this sense, in the UK, the groups created by the government, regulator and ENA are perceived by interviewees to have the most authority. The smart grid agenda is moving forward through these collaboration groups which have proven to be important for developing a unified vision and understanding and finding common ground between stakeholders with different and opposing interests.

The development of smart grids is driven mainly by policy and the industry is partly regulated so it is likely that in the process of **enacting institutional arrangements coercive** power as well as the ability to lobby government typically associated with trade organizations (normative power) will be crucial. In this particular industry, governments and regulators might have a higher influence in the institutionalization process that leading companies, so mimetic isomorphism might have less relevance in regulated industries. In this sense, the collaboration groups created or endorsed by the government or regulator are likely to be the most influential ones.

Regarding **collective action processes** which result in institutional change and the legitimisation of a technology or the emergence of a standard, in the smart grid case this process is still ongoing but it is likely to be dominated by **coercive power** since specific groups have been created by the government to define standards. For example, the high level functionality of smart meters has been mandated by government. What remains to be seen is whether these standards will be the ones that the industry will adopt or whether other defacto standards might emerge.

This study contributes to our understanding of the relative importance of the different sources of power that enable institutional change in complex fields where collective action is required. It also identifies which sources of power might dominate in each of the processes that are involved in institutional change.

5. Conclusion

The organizational field of smart grids is emerging around the need to decarbonise the energy system. The concept of smart grid is a social construct that reflects a different way of thinking about how electricity is generated, distributed and consumed in an efficient, secure and sustainable way. The objective of smart grids is to contribute to solving a global environmental problem and it involves new technologies, new institutions, new business models and new consumer practices. It is a complex field in which numerous stakeholders with diverse aims and interests participate. Collaboration is perceived to be crucial to achieving institutional change.

Policy-makers and regulators are the most powerful stakeholders. They have used the discursive legitimacy of environmental groups to initiate the process of institutional change, environmental concerns have enabled governments to define the problem and engage other stakeholders in finding a solution. Policy-makers and regulators have the authority to make decisions that drive the business case for all the other stakeholders. In addition, given that network companies, who control resources, are regulated monopolies, the regulator also has the power to highly influence their behaviour. Finally, in a resource-constrained economic environment, policy-makers and regulators have made funds available for smart grid projects that typically require collaboration.

Many collaboration groups have been created around smart grids to develop technologies, challenge existing regulation, create new business frameworks and standards and influence policy and regulation,

all important aspects of the institutional environment that enable new technologies to develop. The most influential groups are perceived to be those that involve governments, regulators and network companies. There is clear evidence that all stakeholders groups find a value in dedicating time and resources to be part of the many groups that have been created around smart grids. Some of these groups are highly influential and their activities can significantly impact policy and regulation. The smaller players however, feel disadvantaged in the sense that it is difficult for them to get their voice heard given their resource constraints compared to the larger players. In the UK collaborative efforts are particularly important given the market structure and the way that the government has placed the responsibility in key players with opposing interests.

Institutional change in the electricity sector is a complex process where power emanating from discursive legitimacy, formal authority and resource control is needed to drive the process. Understanding the power dynamics around the collaborative process and around the creation of new institutions should be valuable to organisation pursuing institutional change. Different partners might be more valuable in different phases of the process (Phillips, et al., 2000).

Given that the electricity industry is still highly regulated, governments and regulators become key parts of the innovation process. Companies that wish to get involved in a new technological field that involves a regulated industry need to adjust their strategy and understand that politics and lobby groups become important assets and that influential collaboration groups will be centred around policy-makers, regulators and pro-active incumbents involved in demonstration projects. The development of smart girds in the UK is a clear example of how policy and regulation can shape the market and business models.

6. Limitations

This study is an initial exploration of the power dynamics that come into play in the process of institutional change driven by collective action. The preliminary findings are based on a single case study and all the interviews were carried out within three months. Further research is needed to complement these initial findings. In this sense, interviews carried out in different moments in time will be needed to understand the process of institutional change. Furthermore, the UK case is highly driven by policy and regulation, it would be interesting to add a case study of a country where the development of smart grids is driven by market forces.

Regarding the primary data collection, interviews have a number of limitations mainly related to the quality of the data collected, whether it is reliable, biased and whether it is possible make generalisations based on the results. In addition, the competence of the interviewer and the logistics can have an impact on the outcome of the interviews (Saunders et al., 2003). Measures to avoid bias were taken throughout the research process, however, it is acknowledged that some level of bias might be present either in the selection of the interviewees, in the design of the interview themes or/and in the interpretation of the data. Finally, the selection of interviewees intended to represent all stakeholder groups concerned with the development of smart grids however, these do not represent the totality of stakeholder or experts in the field.

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