Master Thesis

Linking Regulative and Normative Forces with Innovation Performance: the moderating role of Media Presence of Social Movement Organisations in the Energy Storage Systems Industry

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Contents

Abstract

The continuously growing amount of renewable energy on the European grid is becoming increasingly difficult to manage. In response to these problems the energy storage systems industry is emerging. Based on data from ten European countries for the period 2004 – 2015, the impact of regulatory pressure, normative forces and media presence of social movement organisations (SMO) on innovation performance in the energy storage systems (ESS) industry was assessed. This study theorises that SMO media presence strengthens the positive effect of regulatory pressure through the promotion of technologies. Additionally, a normative force, market-based incentives in this study, exerts isomorphic pressures on the organisational field lowering the diversification, competition and ultimately innovation performance. SMO media presence interferes between normative forces and innovation performance through challenging the taken-for-grantedness in the organisational field by encouraging the development of alternative technologies, thereby, weakening the negative effect of market-based incentives in innovation performance. Through a clustered ordinary least squares regression with robust standard errors, evidence was found for direct effects of SMO ESS media presence and market-based incentives on innovation performance in ESS industry. Furthermore, evidence was found for a moderating effect of SMO ESS media presence, weakening the negative relation of market-based incentives. The results contribute to institutional theory by stressing the negative impact normative forces can have on innovation performance. Furthermore, social movement theory is enriched by showing that not only entrepreneurial activity is positively influenced by SMO but innovation performance as well. Moreover, a new moderator effect of social movements is introduced which shows that besides economic factors, normative factors may also be moderated by SMO. These finding have practical implications for managers and policy makers in the field of renewable energy and energy storage. Lastly, future research in the other empirical settings, e.g. developing countries or other industries, is encouraged to provide a deeper understanding of the implications of the findings.

Keywords: *Social movement organisations; media presence; institutional theory; regulatory pressure; normative forces; market-based incentives; innovation performance; energy storage; clean technology; European Union*

1. Introduction

In 2009 the European Commission set the 2020 objective of achieving 20% of the total energy consumption through renewable energy. The objective meant that each European Union (EU) member state had to create its own national action plan with regards to the promotion of renewable energy. The cumulative efforts of the EU countries have led to a 17% share of renewable energy in 2015. The European Commission has already announced more ambitious targets for both 2030 and 2050 in terms of renewable energy and decarbonisation (European Commission, 2016a).

Due to the weather dependency of two of the largest renewable energy providing technologies, wind and solar energy, the EU faces various grid issues. One of the key issues of renewable energy for the grid is its variability, meaning that the supply of energy cannot be controlled. Consequently, backup energy supplies are required. Furthermore, renewable energy can have large peaks. When the weather is windy and sunny at the same time, it can be difficult for grid operators to deal with these peak energy supplies. Moreover, in contrast with large conventional power plants, with renewable energy there are many smaller power plants that provide different amounts of energy. This makes it complicated for grid operators to control the distribution of energy and the frequency of the network (Denholm, Ela, Kirby, & Milligan, 2010).

These issues give rise to a new clean technology industry which provides remedies for the problems that high amounts of renewable energy cause, the energy storage systems industry (also referred to as ESS industry). Energy storage in the electricity network can be defined as (European Commission, 2016b, p. 2): *"the act of deferring an amount of the energy that was generated to the moment of use, either as final energy or converted into another energy carrier"*. There are many different types of energy storage system technologies, sizes and applications (Hameer & van Niekerk, 2015; Rastler, 2010). The only technology that is currently widely applied is pumped-hydro energy storage. However, this technology is strongly restricted to geographical location and often categorised differently than the technologies that are currently commercialising with the rise of renewable energy, such as, batteries and compressed air storage.

As renewable energy in the EU continues to grow, so does the need for energy storage. Previous studies in the clean technology industry have shown that social movements could have a particular influence on the ESS industry. Schneiberg, King, and Smith (2008) were among the first to identify the moderating effect social movements can have on economic forces in an industry. Sine and Lee (2009) extended this theory with a study in the US wind energy sector. They found that social movement organisations (henceforth SMO) moderated the influence of resource availability on entrepreneurial activity. Other scholars found positive direct effects of SMO on the clean technology industry as well (Hiatt, Sine, & Tolbert, 2009; Pacheco, York, & Hargrave, 2014; Vasi, 2009).

Besides social movements, institutional forces are known to influence clean technology industries as well. Among scholars there is considerable debate about the influence of regulatory forces on the organisational field (Ambec, Cohen, Elgie, & Lanoie, 2013). One particular aspect of this debate is the influence on innovation. While Porter and Van der Linde (1995) argue that regulation creates pressures that incite innovation and Jaffe and Palmer (1997) show that regulation leads to more innovation activity, others find other explanations for this relation or fail to provide strong evidence (Brunnermeier & Cohen, 2003; Ford, Steen, & Verreynne, 2014). Normative institutional forces are also known to influence industries. By exerting isomorphic pressures, normative forces reduce variation of policies, lead to similar performance and reduce organisational independence in an industry (Heugens & Lander, 2009; Hoffman & Ventresca, 2002).

Although the importance of energy storage in Europe is growing, the industry is still in its commercialisation phase. Therefore, a lot of research and development is being done on various energy storage technologies. However, research into influences of SMO and institutional forces that might influence energy storage innovation is limited. Although social movement theorists have found positive influences of SMO on factors, such as, entrepreneurial activity and industry emergence, e.g. Pacheco et al., 2014; Schneiberg et al., 2008; Sine and Lee, 2009, no studies have been done on the influence of SMO on innovation, despite the potential of SMO to moderate or directly impact the organisational field. When it comes to regulative institutional forces, some studies have been done on the influence of regulation on innovation. However, contrasting results have been found and the debate remains open. With regards to normative forces, it is known that they may lead to similar organisational outcomes and reduce industry diversification (Heugens & Lander, 2009). Yet, the influence of normative forces on innovation has been neglected in literature.

As SMO and institutional forces may have an important influence on the innovation of energy storage technologies, which may shape the future of the European electricity network, this study aims to explore the relations between SMO, regulative pressure, normative forces and innovation performance.

Research question

The preceding introduction leads to the following research question: *How does the media presence of social movement organisations moderate the relationships between regulative pressure, normative forces and innovation performance in the energy storage systems industry between 2004 and 2015?*

Methods

To answer the research question this study examines the energy storage systems industry for ten European countries between 2004 and 2015. Panel data were gathered to measure regulatory pressure, normative force through market-based incentives, SMO ESS media presence and innovation performance. Regulatory pressure was measured by looking at regulation within three EU directives that directly impacts the ESS industry. The normative force was measured through fixed-price incentives for renewable energy. Furthermore, the influence of SMO was examined by looking at their presence in the media in combination with energy storage, SMO ESS media presence. SMO ESS media presence was measured through counting media publications that refer to energy storage of five environmental organisations, three international and two national organisations. Lastly, the dependent variable innovation performance was measured by looking at energy storage related patent applications by country and year. To analyse the data an ordinary least squares (OLS) regression with clustered standard errors was used to estimate the conceptual model. Further elaboration on the methods is provided in the methodology chapter.

Contributions

This study contributes to institutional and social movement theory. Firstly, contribution are made to institutional theory by finding a negative relation between market-based incentives and innovation performance. This builds on previous studies by showing that a normative force, through isomorphism, does not only reduce organisational independence, the availability of organisational choices and diversification in the industry; but it reduces innovation performance as well (DiMaggio & Powell, 1983; Heugens & Lander, 2009; Hoffman & Ventresca, 2002).

Secondly, contributions to social movement theory are made through the positive direct effect of SMO ESS media presence on innovation performance in the ESS industry. This result underscores previous scholars by providing evidence for the positive influence of SMO on the organisational field in a clean technology context (Pacheco et al., 2014; Sine & Lee, 2009; Vasi, 2009). However, the results extent previous studies by showing the effect on innovation performance. This shows that SMO do not only influence entrepreneurial activity but innovation as well. Furthermore, the moderating effect of SMO ESS media presence shows that the negative influence of normative forces is weakened by SMO media presence. This contributes to Schneiberg et al. (2008) and Sine and Lee (2009) by showing that besides economic forces (e.g. resource availability) normative forces are also moderated by social movements. Lastly, results of this study shed a different light on the coevolutionary model of Pacheco et al. (2014) as it shows that when media presence and SMO are combined the effects can provide alternative explanations.

Structure

The remainder of this report consists of theoretical background including hypotheses, where the theoretical foundation for this research is explained and hypotheses are drawn. This section is followed by the methodology chapter which provides insights into the empirical setting, databases, operationalisation and regression strategy. Then, the outcomes of the analysis are provided in the results chapter. The final chapter consists of the discussion, theoretical and practical implications, limitations of this study and directions for future research.

2. Theory

This chapter first outlines the institutional perspective from which this study derives. Then, the relation between regulatory pressure and innovation is stressed. Next, the influence of normative forces and market-based incentives on innovation performance is explained. Furthermore, the role of SMO and media presence with regards to regulatory pressure, normative forces and innovation performance is outlined. Finally, a conceptual model with hypothesised relations is provided.

2.1. The institutional perspective

Institutional theory is associated with groups and organisations establishing legitimacy through compliance with rules and norms of the institutional context (Bruton, Ahlstrom, & Li, 2010). An institution can, according to Bruton et al. (2010, p. 422), be referred to as a: “formal rule sets, ex ante agreements, less formal shared interaction sequences, and taken-for-granted assumptions that organizations and individuals are expected to follow”. Institutions create frameworks for organisations that clarify which actions are appropriate (Powell & DiMaggio, 2012). These frameworks can then be divided into different aspects.

In institutional theory thee different pillars can be identified: the regulative pillar, the normative pillar and the cognitive pillar (Scott, 1995). The first is concerned with regulations, coercive measures and compliance. Institutions direct behaviour by creating a regulative context in which one must behave. This pillar is mainly shaped by, governments, industrial agreement and standards. The second pillar is the normative one which relates to social, organisational and individual values which prohibit or encourage certain behaviour. This is accomplished by defining what is expected in a social or business context. The main driver of behaviour in this pillar is social pressure to conform with grounded social values (Olsen & March, 1989). The final institutional pillar is the cognitive pillar, which describes an individual’s behaviour based on personal rules that have often developed over time. These rules influence a person’s beliefs and actions and can be in contrast with values from the other pillars (Scott, 1995).

Each institutional pillar can provide a basis of legitimacy. The term legitimacy can be defined as (Suchman, 1995, p. 574): “a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions.” As legitimacy is a perception it is an individual’s subjective opinion, however, all individual opinions combined form general objective legitimacy which an organisation can obtain or lose. Thus, an organisation can lose legitimacy in the eyes of one or a few individuals while retaining overall legitimacy (Suchman, 1995).

It has been widely agreed that the institutional setting affects the process of establishing legitimacy, which is important to the acceptance of technologies. Innovation performance often depends on the legitimacy of the technology. This is, for instance, shown by Geels and Verhees (2011) who show the creation of legitimacy enhances innovation while a lack of legitimacy decreases it. Markard, Wirth, and Truffer (2016) studied the role of institutional dynamics in technology legitimacy in the German biogas industry. They found that in the biogas industry legitimacy increased due to regulations, however, over time the industry lost legitimacy through institutional conflict. Furthermore, a meta-analysis shows that when organisations conform to institutional norms and, therefore, obtain legitimacy it enhances organisational performance (Heugens & Lander, 2009). In short, innovation performance depends on legitimacy and institutions are used to obtain this legitimacy.

2.2. Regulatory pressure and innovation

The institutional setting is important to innovation as it can either promote or constrain innovation performance through legitimacy (King et al., 1994). Regulative institutions can have a dual role with regards to their influence on innovation. On the one hand, regulative institutions promote innovation performance by, for instance, directing innovation on certain technologies or defining standards for innovation. On the other hand, regulatory institutions limit innovation through various rules which increase the complexity in innovation and limit the freedom of innovators (King et al., 1994; Porter & Van der Linde, 1995).

This dual and inconclusive nature is also shown in the debate regarding the Porter Hypothesis which was introduced by Michael Porter (1991, p. 168). The Porter Hypothesis reads as follows: "Strict environmental regulations do not inevitably hinder competitive advantage against rivals; indeed, they often enhance it." Porter's statement went against incumbent industry logic that (environmental) regulations limit opportunities and that if profitable opportunities that support the environment would exist, they would already be exploited by ventures. Many studies have been done in pursuit of the hypothesis, but throughout the years evidence both in favour of and against the hypothesis has been found (Ambec et al., 2013).

One specific aspect of this debate is the effect of (environmental) regulations on innovation. Porter and Van der Linde (1995) argue that regulation points companies towards resource inefficiencies and, therefore, technological improvements. Furthermore, regulations may reduce uncertainty to investors and may create pressure that motivates innovation. Moreover, other studies have provided evidence in favour of the positive relation between (environmental) regulations and innovations. For instance, empirical evidence from a longitudinal study was provided by Jaffe and Palmer (1997) who found a positive relation between environmental stringency and innovation activity in the US. Furthermore, public policy changes in the renewable energy industry have shown to increase the amount of patent applications. Also, effects on patent applications seem to differ by policy type (Johnstone, Haščič, & Popp, 2010). Moreover, in a working paper Calel and Dechezlepretre (2016) provide evidence for the effectiveness of the European carbon trading scheme on innovation.

There are also studies that show that the relation is not straight-forward. Some studies find an initial positive effect of regulation. However, they have to nuance their findings due to small effect sizes, alternative explanations or significance for only one or a few of the regulatory indicators (Brunnermeier & Cohen, 2003; Ford et al., 2014). In addition, a study on the environmental management systems certification in Germany did not provide clear statistical evidence for the relation between the certification or any other form of regulation in the study, and environmental innovation (Frondel, Horbach, & Rennings, 2008). Although the majority of the evidence on the relation between (environmental) regulations and innovation points towards a positive one, literature reviews tend to keep the debate open as contrasting evidence is still found (Ambec et al., 2013; Costantini & Mazzanti, 2012).

As shown by the previously mentioned studies embedded in clean technology context, regulative institutions in clean technology industries do seem to play a significant and positive role. Research in the independent power sector of the US between 1980 and 1992 indicates that regulations have a stronger positive effect on the green energy industry than on the conventional energy industry (Sine, Haveman, & Tolbert, 2005). Moreover, Markard et al. (2016) have provided additional support for the influence of regulatory institutions in the renewable energy industry by analysing technological innovation in the biogas sector.

To conclude, there seems to be a discussion between institutional scholars on the role of regulatory institutions on innovation. This is exemplified by the ongoing Porter Hypothesis debate, but beyond this discussion as well. Given that the majority of the studies find a positive relation between regulations and innovation performance, especially in a clean technology context, the following hypothesis was drawn:

H1: There is a positive relationship between regulatory pressure and innovation performance in the ESS industry.

2.3. Normative forces and market-based incentives

Besides regulative pressure, normative forces can influence innovation performance as well. Normative forces are concerned with norms, according to Scott (1995, pp. 37-38):

> Norms specify how things should be done; they define legitimate means to pursue valued ends. Normative systems define goals or objectives (e.g., winning the game or making a profit) but also designate the appropriate ways to pursue them (e.g., conceptions of fair business practices).

Norms may impose constraints on organisational behaviour as they are internalised. Therefore, institutional actors could use normative forces to guide innovation behaviour in an industry. When norms are widely internalised in the organisational field it leads to increased isomorphism (Scott, 1995).

Isomorphism is the increase in homogeneity in an organisational field as a result of institutional forces, in other words, organisations in an institutional environment tend to become similar through their pursuit of legitimacy (DiMaggio & Powell, 1983). Isomorphism may leave organisations unwilling to pursue opportunities due to organisational inertia, escalation of commitment and risk-averse behaviour (Hannan & Freeman, 1984; Kondra & Hinings, 1998; Staw, 1976). This ultimately limits the independence of organisations, their available choices, and leads to similar performances (Heugens & Lander, 2009; Hoffman & Ventresca, 2002).

Innovation performance is influenced by normative forces through isomorphism. With isomorphism an organisation becomes more reluctant to move beyond the norms of the industry. This is for instance shown by Benders, Batenburg, and Van der Blonk (2006), who through a case study show that a Dutch publishing company refrains from differentiation due to isomorphic pressures. Furthermore, performances in an industry become more similar and competition reduces (Kondra & Hinings, 1998). Consequently, increased normative force may lead to decreased diversification in an organisational field.

Market-based incentives are a normative force often seen in a clean technology context. Market-based incentives are policies which encourage organisational behaviour through market signals instead of coercive measures (Stavins, 2003). For example, the renewable energy industry in Europe has used feed-in tariffs to promote the development of renewable energy infrastructure. By providing renewable energy suppliers with a financial incentive, governments indicate how they would like to achieve their renewable energy targets. These measures support the established and incumbent technologies. Because market-based incentives designate legitimate ways for organisations to achieve the valued goals of the issuing institution, they exert a normative force on the industry.

Market-based incentives in renewable energy industry can reduce innovation performance in the ESS industry. In the renewable energy industry market-based incentives specify how and which incumbent technologies are eligible for financial support. This means that, through isomorphism, market-based incentives may lead to similar performances, limited organisational independence and less diversification. Therefore, renewable energy market-based incentives can reduce innovation performance in the ESS industry. Hence, the following hypothesis was formulated:

H2: There is a negative relationship between renewable energy market-based incentives and innovation performance in the ESS industry.

2.4. Social movement organisations and media presence

Throughout history social movements have always impacted industries. Many organisations that are taken for granted in contemporary society have evolved from or in fact still are social movements, for instance, the various protestant churches or political parties (Snow, Soule, & Kriesi, 2004). Social movement is collective behaviour towards a certain goal by two or more people. It is well established that social movements are concerned with change, which can either be to promote change or prevent change. Social movements are often involved with change in institutions, which can be at a regulatory, normative or cognitive level (Snow et al., 2004).

To manage the required resources for the collective action and to achieve the collective goals, social movements organise themselves in social movement organisations. SMO can be defined as (McCarthy & Zald, 1977, p. 1218): "*A complex, or formal, organization which identifies its goals with the preferences of a social movement or a countermovement and attempts to implement those goals*".

SMO are known to impact organisational fields. Traditionally scholars focussed on the indirect effects of social movements on industries, mostly through political pressures. However, newer studies have also identified more direct impacts of SMO on industries (King & Pearce, 2010). For instance, SMO directly appeal to the companies in pursuit of new market offerings (Hiatt et al., 2009). Alternatively, SMO may direct their focus towards consumers to fundamentally change consumer preferences and behaviour (Kozinets & Handelman, 2004). In short, SMO appeal to industries advocating for alternative industry practices or market offerings in line with their values.

One aspect of the organisational field that SMO affect is innovation performance. Innovation performance can be influenced though the legitimation by SMO of industry practices and technologies (King & Pearce, 2010). Because legitimacy is often required for the adoption of new technologies, SMO aim to legitimise technologies that they endorse (Markard et al., 2016; Pinch & Bijker, 1984). As SMO endorse new technologies and innovations they challenge the taken-for-granted assumptions in an industry by introducing alternatives. Thus, through legitimisation SMO may influence the development of technologies they are concerned with.

Various studies have shown that SMO can both encourage and discourage technology development and industry practises. An example of a negative influence can be found in the United Kingdom, where the anti-genetic engineering social movement put a halt to the genetic engineering industry (Schurman & Munro, 2009). A similar thing happened to the biotechnology industry in Germany, where an anti-biotechnology movement put such pressure on biotechnology firms that the firms discontinued their domestic biotechnology projects (Weber, Rao, & Thomas, 2009). On the contrary, a positive impact can be seen in the grass-fed meat and dairy industry where social movement supported market creation (Weber, Heinze, & DeSoucey, 2008). Furthermore, studies in the renewable energy sector show that SMO positively influence the outcomes of an industry (Doblinger & Soppe, 2013; Pacheco et al., 2014; Sine & Lee, 2009). These examples show that legitimacy through SMO could influence innovation performance.

One of the methods SMO use for legitimisation is media attention. Media attention is used by SMO to pursue their goals as it draws interest from the public and ultimately support for their cause

(Koopmans, 2004). SMO use the media to communicate and shape the norms with regards to markets and technologies, thereby legitimising and influencing company behaviour, research efforts and the development of industries (Hoffman & Ocasio, 2001).

Partially through media attention, SMO have been known to influence the clean technology industries. In a quantitative analysis Vasi (2009) shows how environmental movements have influenced the wind energy development. He concludes that the industry develops quickest in countries with a high density of SMO, a favourable public policy and sufficient natural resources. Pacheco et al. (2014) have studied the growth of the wind energy in the US between 1999 and 2008 and found that SMO influence both institutions and industries. Sine and Lee (2009) also looked at SMO in the US wind energy industry but this research examined data from 1978 to 1992. They found statistical evidence for the positive influence of SMO on the relationship between the material-resource environment and entrepreneurial activity. Other studies have underlined the importance of the social movements and their influence on technology in clean technology industries as well, for instance Doblinger and Soppe (2013) and Markard et al. (2016). The above suggests that in a clean technology context, SMO generally seem to support and positively influence the development of the organisational field.

Previous studies have emphasised the influence of SMO on technology and industry development in a clean technology context. However, the impact that SMO could have on innovation performance remains largely neglected in literature. This should be addressed because through media presence SMO can have the ability to challenge assumptions within an organisational field that have been taken for granted. This SMO support legitimises new technology development and encourages innovation. Consequently, the following hypothesis was drawn:

H3: There is a positive relationship between SMO media presence and innovation performance in the ESS industry.

In addition to hypothesis 3 another role of SMO ESS media presence could be possible, namely that of a moderator variable. Social movement research has shown that social forces, like SMO, can moderate between economic factors and organisational outcomes, such as technology development or market creation (Schneiberg et al., 2008). Through challenging existing industry arrangements, standards, organisational forms and legitimacy SMO do not merely interact with economic forces but they could also affect normative and regulative institutional forces.

SMO can influence the effect of regulative pressure on innovation performance. This could happen when regulative forces interact with the influence that SMO exert on the organisational field. In a clean technology context previous studies already show the positive effects of SMO and regulative forces on the organisational field (Sine & Lee, 2009). However, as Schneiberg et al. (2008) show, SMO can moderate by generating institutional support. In other words, they can encourage the forces that regulative pressure exerts on the organisational field.

In view of hypothesis 1, this might mean that when SMO are actively promoting technologies in an industry, they could increase the legitimacy of the industry. Thereby increasing the effect of regulative pressure on innovation performance. This means that more media presence of SMO would increase the regulatory pressure experienced by the industry, thereby, interfering with hypothesised positive effect of regulatory pressure. Consequently, the following hypothesis was made:

H3a: The positive relationship between regulatory pressure and innovation performance in the ESS industry is stronger when energy storage related SMO media presence is higher.

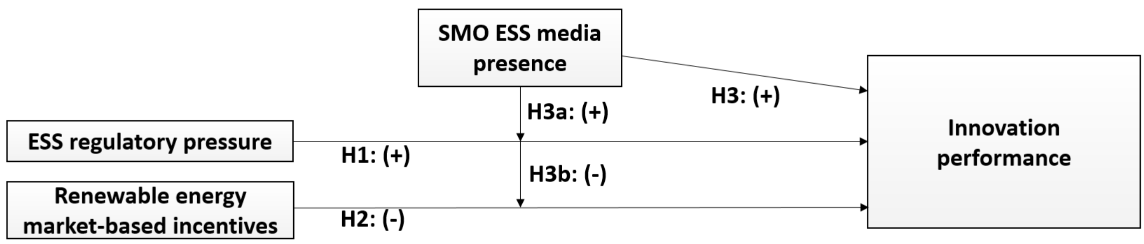
Besides regulative forces, SMO could also influence normative forces. In hypothesis 2 normative forces, in the form of market-based incentives, are expected to lower the diversification and lead to similar performances in an industry through isomorphism (Heugens & Lander, 2009). SMO are known to challenge the taken for granted assumptions in an industry and can provide legitimacy for new alternative technologies (King & Pearce, 2010). Thus, SMO might interact with the effects normative forces on innovation performance.

In a clean technology context this would mean that market-based incentives for renewable energy lead to less diversification and similar industry outcomes, thus, leading to less innovation in the ESS industry. However, through media presence SMO can promote new technological development in the ESS industry, in other words, advocate diversification and diverse industry outcomes. This would weaken the negative effect of market-based incentives on innovation performance as innovation is discouraged through normative forces but encouraged through SMO media presence. Hence, the following hypothesis was drawn:

H3b: The negative relationship between renewable energy market-based incentives and innovation performance in the ESS industry is weaker when energy storage related SMO media presence is higher.

2.5. Conceptual model

The theoretical discussion has led to a conceptual model showing the relationships between regulative, normative and SMO factors and innovation performance between 2004 and 2015. Figure 1 shows five hypothesised relations. Firstly, the positive direct effect of ESS regulative pressure on innovation performance. In hypothesis 3a the moderator variable SMO ESS media presence is introduced which is expected to strengthen the relationship of hypothesis 1. A negative effect is expected for hypothesis 2 which means higher renewable energy market-based incentives lead to lower innovation performance. Hypothesis 3b expects a weakening moderating effect of SMO ESS media presence between market-based incentives and innovation performance. Hypothesis 3 includes SMO ESS media presence as an independent variable hypothesising a positive relationship with innovation performance. Lastly, four control variables are included in the conceptual model which are explained in-depth in the methodology chapter.



Control variables:

- Renewable energy production capacity
- Share of (intermittent) renewable energy in total energy generation
- Private funding to energy storage projects
- Year

Figure 1 – Conceptual model

3. Methodology

The methodology chapter explains how the conceptual model shown in Figure 1 is measured and tested. This chapter first outlines the research paradigm in which this study is embedded. This is followed by the empirical setting. Then, the operationalisation and data collection of the variables is discussed. Lastly, the regression strategy is outlined.

3.1. Research paradigm

This research is embedded in the postpositivistic research paradigm. This paradigm is on many aspects similar to the commonly used research paradigm in quantitative studies, positivism. However, postpositivism allows for the use of some aspects of the qualitative research paradigm, constructivism. With regard to the methodology, postpositivism allows for the introduction of qualitative measures on method-level. In the view of this research the research paradigm is still quantitative but it tolerates qualitative data collection methods. The reason for this is that true objectivity cannot be guaranteed in postpositivistic research, therefore, data collection from different sources could get one closer to the truth (Guba, 1990).

According to Guba (1990, pp. 21-22) postpositivism addresses four methodologic imbalances that occur when using either positivism or constructivism. The first is the imbalance between rigor and relevance, which is caused when a research has high internal validity but low external validity or vice versa. Postpositivism allows the researcher to balance control and generalisability, meaning that relevant results can be made without losing significant control over the study. Secondly, the imbalance between precision and richness, which is concerned with the balance between accuracy of pure quantitative research and the depth of qualitative research. The allowance of qualitative methods in postpositivism lets researchers rectify the imbalance. The third imbalance relates the discrepancy between elegance and applicability. Positivism emphasises the need to predict and control in research, leading elaborate theories. However, these theories often prove to be impractical to use, therefore, postpositivism allows for the grounding of the theory in local or natural settings. The final imbalance is between discovery and verification. Verification, or falsification, is concerned with the testing of a prior theory. Solely seeing verification as a justified method seems strange since many great theories have been based on discovery. Therefore, postpositivism allows for both verification and discovery.

Although this research stays close to positivism, it is ultimately embedded in the postpositivistic research paradigm. The main reason for adopting postpositivism are the qualitative aspects required in this research. The majority of the data is purely quantitative, however, some variables required qualitative interpretation before they were be quantified. Although the subsequent paragraphs of this chapter will provide details on this, innovation performance, regulative pressure and SMO ESS media presence required a certain degree of interpretation from the researcher. As postpositivism dictates this influence was kept at an absolute minimum, but it was is required to get the desired richness in the analysis.

Other aspects of this research such as the deductive nature and quantitative data stick more closely to positivistic principles. However, in the end the postpositivism allows this research to make better contributions to institutional and social movement theory by allowing the researcher to increase the applicability of the theory, the richness of the data and relevance of results.

3.2. Empirical setting

The dataset in this study is based on the ten European countries examined between 2004 and 2015. The EU is used as the empirical setting because all EU member states have to work within the same European regulatory framework but have the freedom to implement European rules as they see fit. Therefore, differences in adoptions between European countries can be assessed. The country sample was taken based on two conditions. Firstly, the availability of useable data. Secondly, the ability to translate texts of the various European languages. Table 1 displays the EU countries included in the study.

The timespan of this research is between 2004 and 2015. The reason for this twelve-year time span is that since 2004 the renewable energy market in Europe started to become significant. This increased the need for energy storage opportunities. Furthermore, from 2004 onward most EU countries started to implement renewable incentive systems (Held et al., 2014).

Austria	**Belgium**
Denmark	**France**
Germany	**Ireland**
Italy	**The Netherlands**
Spain	**The United Kingdom**

Table 1 – Country selection

3.3. Dependent variable

The dependent variable in this study is innovation performance, which was measured through energy storage patents. Patents have been widely used in literature as indicators of innovation. For example, an OECD study by Jaumotte and Pain (2005) argues for the use of patents as a dependent variable. Furthermore, Johnstone et al. (2010) used patents as an indicator of technological innovation in the renewable energy industry. Table 2 provides an overview of the indicator.

Variable name	Full name	Explanation
PATENTS	Corrected energy storage patents	Total amount of energy storage patents divided by total patents

Table 2 – Energy storage patents variables

The data for this indicator was collected from Espacenet. This patent database is built in cooperation with the European Patent Office and holds over 90 million (inter)national patents. To derive the amount of patents per country the national databases were searched using the national abbreviations in the application codes (e.g. NL2004123 for the Netherlands, GBR2004123 for the United Kingdom).

This study used energy storage related keywords to derive the number of energy storage patents. In Appendix – I Table 10 and Table 11 show the English keywords, translations into other languages and the Boolean search terms used to identify the patents. To collect the correct patents various actions were undertaken. Firstly, industry reports were used to derive the set of keywords to search the databases. As can be seen in Table 11, the keywords consist of various energy storage technologies. Next, the keywords were translated to the non-English languages included in the study: Dutch, German, Danish, French, Italian and Spanish. An initial translation was done by the researcher with the help of energy storage industry reports and translation programs. Then, these initial translations were checked, reviewed and improved in collaboration with native or bilingual speakers of the respective languages. From these translations Boolean search terms were created to find the energy storage patents with minimal incorrect results. For each non-English speaking country an additional English keyword search was done to check for patents that included English terminology. All the search results were checked on relevance to energy storage before they were included as an energy storage patent. Furthermore, doubles that arose from having to do multiple searches for each year were filtered out. The year that was used to match the patents to the years in the study was the application year as it indicates best when the actual invention was made. For all countries except France and Germany the keyword searches were based on the patent title, for France and Germany Espacenet did not allow a sole title search which meant all text in the patent was searched. This could lead to results of up to 2,000 patents per search which had to be filtered on relevance. Therefore, for France and Germany, the first 500 were reviewed on relevance for three years: 2004, 2009 and 2015. The average percentage of relevant patents to search results was taken to estimate the total amount of relevant patents.

Once the total count of energy storage patents had been established, data for the total number of general patents were derived from Eurostat to correct for sizes of national patents offices. The energy storage patents have been divided by the general patents to create a corrected variable for the model, *PATENTS (Eurostat, 2017b).* An overview of the missing data for *PATENTS* and the other variables can be found in Appendix I – Table 14.

3.4. Independent variables

The first independent variable included in the model is ESS regulatory pressure. An overview of the variable can be found in Table 3. Furthermore, an explanation of the data collection and operationalisation is provided.

Variable name	Full name	Explanation
REGULATION	Corrected energy storage regulations	Total amount of energy storage regulations divided by total national transpositions

Table 3 – Regulatory pressure variables

The data for ESS regulatory pressure was collected through the European portal for legislation, Eur-Lex, this portal which is provided by the European Union and includes European and national legislation. Furthermore, it provides a database of national legislation linked to European directives. This particular feature was used for the data collection.

This study operationalised ESS regulatory pressure as the count national energy storage policies that influence energy storage. Due to the limited amount of energy storage legislation, regulations that directly impact the energy storage industry have also been used to measure ESS regulatory pressure. To systematically count the energy storage regulations European directives were used to identify regulations. A European directive is a piece of legislation which requires member states to move towards a certain goal without specifying exactly how. This means that differences among member states can arise on national transpositions or implementations of the directive. In this study three European directives that could influence energy storage were analysed: the Electricity Directive (2009/72/EC), the Renewable Energy Directive (2009/28/EC) and the Energy Efficiency Directive (2012/27/EU) (EUR-Lex, 2017). The national legislation linked to the directives was examined and assessed for its influence on energy storage. If the legislation had an impact on energy storage it was included in the count. This resulted in two counts, a total amount of national transpositions of the directives and a count of energy storage related national transpositions. After filtering out double counted regulations, the counts of the directives were accumulated. Next, to account for differences between legal systems and time the energy storage regulations were divided by the total national transpositions of the directives. This resulted in the final variable *REGULATION* (exemplified in Table 4).

REGULATION measures energy storage regulatory pressure as it filters out the energy storage regulations that are used to implement EU directives. For instance, to achieve a certain directive´s goal Belgium might use a policy that influences energy storage. While France in pursuit of the same goal might use a measure that does not impact energy storage development. This means that the directives are used as a tool to systemically examine relevant legislation but the extent to which a directive is implemented is not measured. Instead the pressure of energy storage impacting regulations is measured within the boundaries of the three directives.

Country_Year	***REGULATION***	**Total national transpositions in directives**	**Total energy storages legislation in directives**
BEL_2012	.29	24	7
BEL_2013	.18	28	5
BEL_2014	.24	34	8
BEL_2015	.22	9	2

Table 4 – Example of REGULATION variable for Belgium

The second independent variable is market-based incentives indicated by renewable energy fixed-price incentives. In Table 5 an overview of the variable is provided and below further details on the data collection and operationalisation are given.

Variable name	**Full name**	**Explanation**
INCENTIVE	Renewable energy fixed-price incentive in natural logarithm	The natural logarithm of the sum of average onshore wind and solar photovoltaic fixed-price incentives in euros per kWh

Table 5 – Renewable energy incentive variable

The majority of the data were derived from the RES-legal archive, the IEA & IRENA joint policy and measures database and national legal databases (International Energy Agency, 2017; RES-LEGAL, 2017). Through these databases overviews of historical renewable energy incentive tables were accessed.

This study operationalises market-based incentives through renewable energy fixed-price incentives as it is widely applied market-based incentive. The renewable energy fixed-price incentives variable*, INCENTIVE*, is the total sum of euros per kWh of onshore wind and solar photovoltaic energy in a given year. The solar and wind incentives were summated to indicate the combined renewable energy incentive. The renewable energy incentives used in this study were fixed-price incentives. In the EU fixed-price incentives have been around since the nineties, over time various forms and levels of fixed-price incentives have had varying results. Although fixed-price incentives can have various forms, the two main forms found in Europe are, feed-in tariffs and feed-in premiums. Feed-in tariffs are power purchase agreements which allow the supplier to sell renewable energy for a fixed price over 10 to 25 years. Feed-in premiums take market conditions into account and promise a premium price above the market price as an incentive (Couture, Cory, Kreycik, & Williams, 2010). The exact implementation of feed-in premiums and can differ per country.

Two renewable energy technologies are most interesting from an energy storage perspective, wind energy and solar photovoltaic (PV) energy. Many offshore wind parks are incentivised through a tender system; therefore, only onshore wind energy incentives were included in this study. In Europe different incentives are provided for different installation sizes. This means that a 10 MW installation will get a different amount of euros per kWh than a residential installation. Various countries can have various size categories; therefore, the average amount of €/kWh has been taken from all available categories for onshore wind and solar PV.

For some countries a slightly different approach had to be taken to acquire the data. For Germany not all historical data could be retrieved. Therefore, a consistent and comparable alternative measure was used. The amount of fixed-price incentive paid per kWh instead of the amount offered for new installations. An initial comparison check with incentive trajectories of other countries in the dataset shows that the data used for Germany do not show a strange trajectory. Therefore, the measure is deemed an appropriate indicator of the German renewable energy fixed-price incentives. Moreover, renewable energy policy of Belgium slightly departs from a fixed-price scheme; instead Belgium has used a certificate trading system to promote renewable energy. This means that for every MWh of energy a green certificate is issued which can be sold on the market. The average transaction prices have been used as an indicator to compensate for the absence of feed-in tariffs or premiums. These average transaction prices are backed by minimum prices. Because this still provides secure electricity prices they are comparable to feed-in tariffs and premiums. The data for these prices was derived from the Flemish gas and electricity market regulator. Additionally, the incentives of the United Kingdom were provided in their local currency. To account for this the average exchange rates, extracted from OFX.com, for 2004 to 2015 were used to level this difference (OFX, 2017). Lastly, some countries have at a certain point used feed-in premiums which were added on top of the market price. For these data points the average wholesale electricity price were added to the premium to make them comparable to feed-in tariffs. The wholesale electricity price data were collected through Eurostat, all wholesale electricity data were downloaded and then averaged over each year and consumption category (Eurostat, 2017a).

Once all solar and onshore wind fixed-price incentives data were collected and summated, the data were corrected for skewness and kurtosis using a natural logarithm resulting in the variable *INCENTIVE*.

3.5. Independent and moderator variable

SMO ESS media presence is both moderator and independent variable in this study, Table 6 shows a variable overview and additional information on the operationalisation and data collection is provided below.

Variable name	Full name	Explanation
MEDIA	Corrected count of SMO media presence in relation to energy storage in natural logarithm	Count of total amount of media presence of selected SMO in combination with energy storage corrected for database coverage and transformed in natural logarithm

Table 6 – SMO media presence variable

SMO ESS media presence was measured by looking at a sample of SMO in each country and analysing the amount of media publications they appear in within an energy storage context. These data were derived by reviewing environmental movements in each country for their support of energy storage. This lead to two national environmental movements for each country and three international environmental movements. The selection of the SMO was based on two conditions: the support for energy storage technologies and their media coverage. First, an initial check was done to ascertain that the environmental movement favours energy storage. Then, a publication check was done to assess whether the environmental movement supports energy storage in the media and the extent of coverage. The international environmental movements were, Greenpeace, the World Wide Fund for Nature and Friends of the Earth. The latter sometimes operates as national organisation under a different name. Appendix I – Table 12 shows a complete list of organisations included in the study for each country. To ensure that the environmental movements are positive towards energy storage, the strategic orientation and publications of the organisations were assessed before inclusion in the study. The two aspects, SMO selection and news article analysis, have also been used by Pacheco et al. (2014), but they used it to measure SMO and news articles separately. This study combines these two measures by looking at the coverage of SMO in combination with energy storage in the media.

The media database LexisNexis has been used to derive the data for each country and year. Based on the keywords in Table 11 and the organisations in Table 12 search terms were created to provide a set of news articles for each year. Then, these articles were individually assessed on whether they truly include a message about energy storage by a social movement organisation. If true, the article was added to the count of the respective country and year. Pumped-hydro energy storage was not taken into consideration because, although it is an energy storage technology, it is a technology which has been used as a generation technology for decades and is part of the major electricity production sources of Europe. Furthermore, initial examination of the search results in the Dutch media showed that the inclusion of pumped hydro as a keyword heavily influenced the outcomes (LexisNexis Academia, 2017).

To correct for LexisNexis' coverage of the different countries, the amount of national media sources included in the database were used to correct for these differences. However, due to limitations of database a slightly different measure had to be used for France, Germany and the United Kingdom. For these countries, instead of all sources, only media sources that included articles from the searches were included. These counts media source counts were used to divide the count of relevant news articles. Then, these data were transformed through a natural logarithm to correct for kurtosis and skewness to create the variable *MEDIA*.

3.6. Control variables

Besides the independent variables, four other factors which could also influence innovation performance have been added to the model: the cumulative amount of intermittent renewable energy production capacity, the share of wind and solar energy in the total electricity generation, the amount of private funding and the time variable *YEAR*. These were all used as control variables. This is summarised in Table 7.

Variable name	Full name	Explanation
REPC	Renewable energy production capacity	The total accumulated amount of production capacity of all wind and solar photovoltaic installations in megawatts
SHARE_RE	Share of intermittent renewable energy in total energy generation	The fraction of wind and solar energy as part of the total energy generation in a country
FUND	Private funding for energy storage projects corrected for gross domestic product (GDP) and transformed through natural logarithm	The amount of funding to smart grid/energy storage projects in euros corrected for GDP and transformed through natural logarithm
YEAR	Years included in the study	Time variable indicting the year for each country ranging from 2004 to 2015

Table 7 – Control variables overview

Renewable energy indicators are required to control the variation of the overall model due to the link between intermittent renewable energy and energy storage. High amounts of intermittent energy can cause various issues to local or national electricity networks and energy storage is an important remedy for these problems. Hence, higher levels of intermittent renewable energy could affect innovation performance and SMO media presence related to energy storage. Therefore, it is important to include the effect of intermittent renewable energy in the model (Auer & Haas, 2016).

The first renewable energy indicator is the cumulative amount of renewable energy production capacity, *REPC*. As many energy storage installations can be coupled with wind and solar installations the renewable energy production capacity indicates both the potential and the need for energy storage. Because of this *REPC* could influence energy storage innovation performance, which is why it was included as a control variable. Furthermore, the impact of renewable energy on the grid is indicated by the share of intermittent renewable energy generation, *SHARE_RE*. Generally, the higher the SHARE_RE is the larger the grid issues in a country which means the more need for energy storage innovations. Therefore, *SHARE_RE* was included as a control variable.

Both *REPC* and *SHARE_RE* data are collected from the European Commission's periodically issued energy datasheet which includes various energy statistics for all European countries from 1990 to 2015. This study used the version dated 16 March 2017.

The amount of private funding in million euros with regards to smart grid research and demonstration projects in Europe was used as a control variable as well. As exact funding data on energy storage was not available a broader concept was used which includes energy storage, smart grids. These data were derived from the Joint Research Centre´s database and smart grid projects outlook 2017 report (Gangale, Vasiljevska, Mengolini, & Fuli, 2017). The JRC database consists of smart grid data in the European Union. Although it must be acknowledged that smart grids and energy storage are not completely similar, they show much overlap. The proposed official EU definition of a smart grid is: *"any equipment or installation, both at transmission and medium voltage distribution level, aiming at two way digital communication, real-time or close to real-time, interactive and intelligent monitoring and management of electricity generation, transmission, distribution and consumption within an electricity network"* (Giodano, Vitiello, & Vasiljevska, 2014, p. 4). The definition mentions the intelligent management of electricity generation, transmission and distribution which points towards energy storage and its applications. The connection between a smart grid and energy storage is exemplified by the Leighton Buzzard project in the United Kingdom which is classified as a smart grid project but revolves around a large energy storage installation[1].

The energy storage private funding indicates the investment in energy storage research and development which means it might explain some of the variance caused in energy storage innovation performance. The GDP for each year and country was used to correct for differences between countries. GDP data derived from Eurostat were used to divide private funding. Once the funding was corrected a descriptive analysis showed that a natural logarithm was required to achieve the desired skewness and kurtosis which led to final variable FUND indicating the amount of energy storage funding divided by GDP and transformed using a natural logarithm.

Lastly, the control variable YEAR is added to the model. This controls for aggregate trend effects, meaning that data values could naturally increase through time which could bias results.

[1] Project Summary Leighton Buzzard: https://www.ofgem.gov.uk/ofgem-publications/46102/sns-original-submission-appendices-redacted.pdf

3.7. Regression strategy

A common way to perform a regression analysis is to use an ordinary least squares (OLS) regression. However, this relies on the premise that the residuals are independent and normally distributed while in real world data this could possibly not be the case, especially in panel datasets. Petersen (2009) sampled 45 panel data studies and found that 22% of them used Rogers standard errors. Rogers standard errors are based on White/Huber their robust estimator of standard error. However, Rogers' standard error relaxes the independence assumptions of OLS by allowing to specify clusters (Rogers, 1994; Williams, 2000). The method assumes that standard errors are uncorrelated across clusters, while correlated within clusters. An OLS regression is used in various panel data studies, for instance, Pacheco et al. (2014) used OLS regression to estimates parts of their coevolutionary model. Furthermore, Jaffe and Palmer (1997) used an OLS regression to test the influence of environmental government regulatory expenditure on patents and R&D expenditure. The statistical package Stata was used to estimate the conceptual model through a clustered OLS. The Stata command to run this regression is *regress [variables], vce (cluster [clusterid])*.

An initial paired correlation coefficients table showed a particular high correlation between *MEDIA* and *REPC*, over 0.7. This indicates multicollinearity between the independent and the control variable, especially in models with smaller statistical power (Hair, Black, Babin, Anderson, & Tatham, 1998). A reason for this correlation between renewable energy production capacity and SMO media presence might be that energy storage in combination with SMO would often be mentioned in the context of renewable energy in a country, as more renewable energy increases the need for energy storage systems. Thus, more renewable energy could increase the SMO media presence. This potential multicollinearity is likely to introduce bias to the conceptual model with the risk of reducing the significance. Therefore, to reduce type II error the *REPC* variable is removed from the model. By having an additional indicator for renewable energy in a country, *SHARE_RE,* the influence of renewable energy is still accounted for in the model.

Another finding from the initial correlation tests shows that the renewable energy fixed-priced incentives seem to positively correlate with innovation performance, which contrasts the hypothesis. However, a positive effect may imply a negative relation of a hypothesis. Because of this, the *INCENTIVE* variable was reserve coded to improve the interpretability of the results.

Ultimately, seven models were run to test the hypotheses. The first model, model 0, is the null model which consists solely of control variables. Model 1 adds the first independent variable, *REGULATION,* indicating ESS regulatory pressure. Model 2 takes the null model and adds the second independent variable, *INCENTIVE.* Model 3 is the null model plus the SMO ESS media presence variable, *MEDIA*. Then, model 4 and 5 take all control and independent variables and add each interaction term. Firstly model 4 with MEDIA**REGULATION* and then model 5 with MEDIA**INCENTIVE*. Model 6 is the full model including all previously mentioned variables.

With the alterations based on initial analyses the exact variables that were included in the model are summarised in Appendix I - Table 13.

4. Results

Table 8 reports the descriptive statistics and paired correlations and Table 9 shows the outcomes of the regression analysis. In short, for three out of five hypotheses some statistical evidence was found.

Model 0 shows that the control variables in the model do not have a significant influence on innovation performance. This indicates that the share of renewable energy and the amount of private funding do not affect the amount of ESS patents applications. Furthermore, the insignificance of *YEAR* indicates that aggregate trend effects do not seem to influence innovation performance.

Model 1 shows that no significant effect was found between *REGULATION* and *PATENTS*. In other words, contrary to hypothesis 1 no evidence was found that the ESS regulatory pressure directly influences innovation performance. However, model 2 does show significant results. The variable *INCENTIVE* shows a significant ($p = .006$) negative relationship with *PATENTS*, underlining hypothesis 2. Through model 3 the third hypothesis is supported, as a significant ($p = .018$) positive relationship is shown for the independent variable *MEDIA*.

In model 4 where the interaction term MEDIA**REGULATION* is added to the model no significant effects were found other than *INCENTIVE.* This shows that there seems to be no interaction between *REGULATION* and *MEDIA* with regards to *PATENTS*. Thus, no support was found for hypothesis 3a. In model 5 there were significant results. First and foremost, some statistical evidence was found for the existence of an interaction effect between renewable energy fixed price incentives and SMO ESS media presence on innovation performance. The relationship of the interaction term *MEDIA*INCENTIVE* is positive with a weak statistical significance of $p = .06$. Furthermore, model 5 shows significant results for *INCENTIVE* and *MEDIA* with p-values of .034 and .035 respectively. These findings underline hypothesis 3b with weak significance and improve the robustness for hypothesis 2 and 3.

Lastly, the full model 6 was tested. The results show that again no significant results were shown for *REGULATION* and *MEDIA*REGULATION* meaning that in none of the models statistical evidence was found for hypothesis 1 and 3a. Model 6 does show a significant relationship for *INCENTIVE* at a p-value lower than .05. For both the *MEDIA* variable and the interaction term *MEDIA*INCENTIVE* no strong statistical evidence was found. However, weak statistical significance ($p < .1$) was found for *MEDIA* and *MEDIA*INCENTIVE*. It seems that adding *MEDIA*REGULATION* to the model reduces the significance of both these variables. This could be due to *MEDIA*REGULATION* and *MEDIA*INCENTIVE* both being partially based on *MEDIA*. This means the variables share some of the variance which could have influenced the significance levels in the full model.

The overall significance of the model examines whether the proportion of explained variance (r-squared) differs significantly from 0. When looking at the F-statistics and associated p-values for the overall models, every model that shows a significant result has an overall model significance of $p < .01$, except for model 3. The overall p-value of model 3 is .128, which means it is not significant. Therefore, there is cause to doubt the relation between MEDIA and PATENTS specified in hypothesis 3. However, in the other models MEDIA shows significant results and in a robustness check where the PATENTS variable was lagged with one year model 3 did show significant results for the overall model and MEDIA. Therefore, caution is required in the interpretation the effect of MEDIA on PATENTS but the majority of statistical models do point towards some statistical significance.

Overall, the most consistent statistically significant evidence was found for *INCENTIVE*, which showed significance levels of p < .05 in three models and p < .1 in model 4. *MEDIA* shows reasonable statistical significance with a p-value less than .05 in model 3 and 5 and a weak statistical evidence in the full model. The interaction term *MEDIA*INCENTIVE* shows statistical weak significance in all the models it was included in.

Examining the proportion of explained variance, r-squared, shows that the full model explains about 27% of the variance in *PATENTS.* Looking at the variance of the most significant model (5), it underlines that the addition of the interaction term *MEDIA*REGULATION* explains little variance. Furthermore, based on the Aikeke information criterion (AIC) statistic, model 5 seems to be favourable compared to model 4 and 6 as it holds the lowest value (-1062), also preferring the absence of *MEDIA*REGULATION*. However, just as with r-squared, the differences are small.

Looking at the interaction term it can be noticed that *MEDIA*INCENTIVE* weakens the relation between renewable energy fixed-price incentives and innovation performance. This effect is illustrated by Figure 2, in which the interaction graph shows the negative relation between *INCENTIVE* and *PATENTS*. When *INCENTIVE* is constant, high levels of *MEDIA* are associated with higher PATENTS scores. This indicates the positive influence of *MEDIA* on the negative effect of *INCENTIVE*. Thus, the negative effect of renewable energy fixed-price incentives on innovation performance is weaker under higher levels of SMO ESS media presence.

Table 8 – Descriptive statistics and correlations

Descriptive statistics and correlations

	Variable	N	Mean	S.D.	1	2	3	4	5	6	7	8
1	PATENTS	120	.003	.003								
2	INCENTIVE	120	-.251	.169	-.341**							
3	REGULATION	120	.314	.285	-.043	.138						
4	REGULATION*MEDIA	120	.030	.070	.207*	-.116	.488**					
5	MEDIA	120	.089	.101	.370**	-.257**	.067	.691**				
6	INCENTIVE*MEDIA	120	-.027	.050	-.385**	.550**	-.035	-.620**	-.855**			
7	YEAR	120	2009.5	3.467	.161	.075	-.045	.081	.278**	-.174		
8	FUND	120	1.860	1.376	.143	.027	.054	-.005	-.038	.029	.540**	
9	SHARE_RE	120	.086	.089	.183*	.237**	-.068	.021	.101	-.027	.500**	.337**

** Significant at .05 level ** significant at .01 level*
Note: Paired correlations coefficients are based on full model

Results of the analysis							
				Model			
Variable	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Constant	-.211	-.2076	-.1119	.06063	.07414	.06752	.07778
Independent variables							
REGULATION		-.00039			.00022	-8.2E-05	.0002
INCENTIVE†			-.00757***		-.00591*	-.00728**	-.00717**
MEDIA†				.01232**	.01105	.01398**	.015*
Interaction terms							
MEDIA*REGULATION					-.00359		-.00274
MEDIA*INCENTIVE						.01241*	.01155*
Control variables							
YEAR	5.50E-05	5.30E-05	4.20E-05	-.0001	-8.50E-05	-8.3E-05	-9.1E-05
FUND†	.00015	.00016	.00011	.00039	.00032	.00031	.00032
SHARE_RE	.00466	.00457	.00855	.00504	.00803	.00836	.00839
N	120	120	120	120	120	120	120
r2	.04298	.04421	.1952	.1773	.2657	.2693	.2704
aic	-1038	-1036	-1057	-1054	-1062	-1062	-1060

legend: *p < .1; ** p < .05; *** p < .01
† natural logarithmic transformation

Table 9 – Regression results

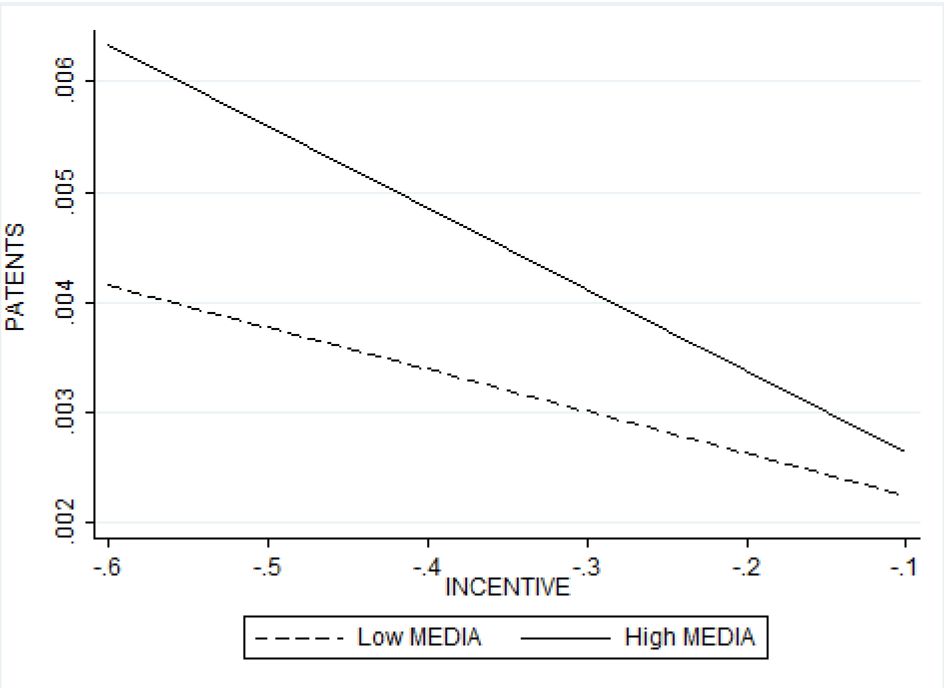


Figure 2 – Interaction graph of INCENTIVE, MEDIA and PATENTS

A clustered OLS regression with robust standard errors was used in order to derive the results. This method accounts for differences between countries but does not account for within cluster correlation of standard errors. The control variables were added to account for the potential error which might exist in the model. An assumption for using the robust clustering method is that the number of clusters should approach infinity. Although the data have only 10 clusters, the total number of observations was 120. According to Rogers (1994) the method is most accurate when cluster sizes are no larger than about 5% of the sample. This study has cluster sizes of 10% of the total sample. Therefore, the cluster sizes in this study do not fully approach infinity and the standard errors might have a slight bias. This often means that the relative standard error increases leading to less significant results and increased the type II error (Cameron & Miller, 2015).

Lastly, the analytic method used is already concerned with robust standard errors, which implies a certain level of robustness of the results. However, one could argue that the effect of renewable energy fixed-price incentives or SMO ESS media presence will not affect innovation performance in the same year. It may take time before these effects influence the number of patents applications. Therefore, as robustness check the *PATENTS* variable was lagged with one year and the models were rerun. A similar robustness check was performed by Dezsö and Ross (2012) in a strategic management context. This method also reduces the chance of reversed causality, but from a conceptual point of view this was already unlikely. The result of the lagged model mostly underline the results in Table 9. Small changes in the significance levels of the results could be seen with lower significances for *INCENTIVE* in some of the models. This is however, unsurprising as the number of observations was reduced by lagging the *PATENTS*.

Based on the results of the regression analysis the model shown in Figure 3 is adopted. With regard to the conceptual model, ESS regulatory pressure and the moderating effect of SMO ESS media pressure, represented by hypothesis 1 and 3a, have been taken out due to insignificance.

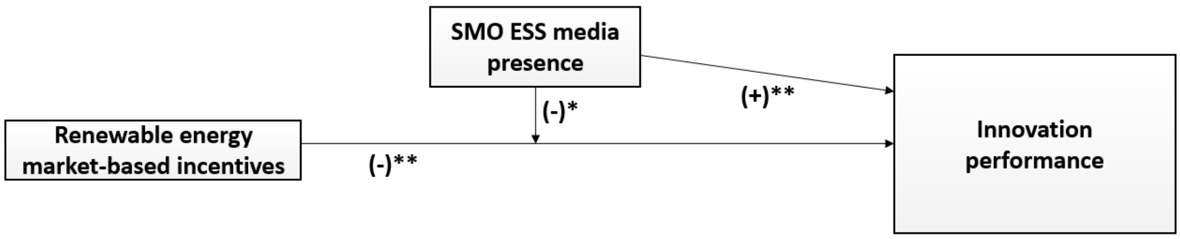


Figure 3 – Adopted model
**: weak significance (p < .1)*
***: significant at p < .05 in multiple models*

5. Discussion

As the EU pushes its renewable energy and decarbonisation targets the need for energy storage increases as different energy storage applications remedy various renewable energy related issues, for instance, high peak powers or variability of energy supply. In recent years an increasing amount of energy storage related research has been conducted, both in technical and business studies. This study finds that both SMO ESS media presence and renewable energy fixed-price incentives directly influence innovation performance in the energy storage systems industry. Furthermore, SMO ESS media presence moderates the effect between renewable energy fixed-price incentives and innovation performance.

With reference to the original research question: *"How does the media presence of social movement organisations moderate the relationships between regulative pressure, normative forces and innovation performance in the energy storage systems industry between 2004 and 2015?"* This study provides support for the negative effect of normative forces and the positive effect of SMO media presence on innovation performance. Moreover, this study shows that SMO media presence moderates the negative effect of normative forces on innovation performance by weakening it.

The findings suggest that market-based incentives exert a normative force on the organisational field which, through isomorphism, leads to lower innovation performance. Additionally, through media presence social movement organisations challenge the taken-for-grantedness of industries, thereby, legitimatising and encouraging the development of new technologies and inducing innovation performance. Moreover, because SMO promote new technological development their media presence interferes with the normative forces from market-based incentives. Hence, the results show that SMO media presence also weakens the negative relation between normative forces and innovation performance.

Similarly to previous studies, findings of this study stress the relation between institutional and social movement theory as it shows factors from both theories can interact with the organisational field (Pacheco et al., 2014; Schneiberg et al., 2008; Sine & Lee, 2009). Hence contributions are made to both institutional and social movement theory.

Contributions to institutional theory

This study contributes to institutional theory by providing empirical evidence for the debate among (institutional) scholars on the influence of regulatory forces on the innovation. This is exemplified by the ongoing discussion surrounding the Porter Hypothesis (Ambec et al., 2013). Initial evidence for the positive relation between regulatory factors and innovation was expected to be gathered from examining the influence of regulatory pressure in the ESS industry. However, empirical evidence from this study suggests that no significant relationships exist between regulatory pressure and innovation performance in the ESS industry. This could be interpreted as evidence for the rejection of the Porter Hypothesis, as regulatory pressure does not seem to influence innovation performance in the ESS industry. This would underline previous studies which failed to find strong statistical evidence for a positive relation between regulation and innovation (Brunnermeier & Cohen, 2003; Ford et al., 2014; Frondel et al., 2008).

However, the majority of studies on this issue conclude the opposite and provide evidence for a positive relation (Ambec et al., 2013; Costantini & Mazzanti, 2012; Jaffe & Palmer, 1997). Other factors might explain the absence of evidence for a positive effect of regulatory pressure in this study. An explanation might be found in the level of impact that the regulations included in the study have on energy storage. As mentioned in the chapter on methodology, there is no European wide distinct policy for the use of energy storage. Therefore, regulation from EU directives that shape and influence the energy storage market were assessed and the relevant legislation included. In hindsight this indicator might not have explained the necessary variation in innovation performance to have a significant impact. This would actually underline the recent cries for regulation from the energy storage industry towards governments (The Fuel Cell and Hydrogen Joint Undertaking, 2015; van der Vegte, van Melzen, & van der Spek, 2016). In short, the examination of ESS regulatory pressure does not provide evidence in favour of a positive relation with innovation performance. However, the insignificant results of regulatory pressure in the ESS industry do underscore an industry wide call for more and better regulation.

With regards to normative forces, significant evidence was found for the influence of market-based incentives on innovation performance. This builds on institutional theory by showing that normative forces reduce innovation performance. Previous studies show that normative forces, through isomorphism, lead to limited organisational independence, available choices and competition (DiMaggio & Powell, 1983; Heugens & Lander, 2009; Hoffman & Ventresca, 2002). This study extents these theories by showing that normative forces reduce the need for new innovations as well. Moreover, the findings show that by specifying how and which technologies should be implemented, renewable energy fixed-price incentives exert a normative force on the clean technology industry. This reduces the organisational field's need for innovation in new technologies, such energy storage. Thus, when renewable fixed-price incentives increase innovation performance in the ESS industry decreases.

Contributions to social movement theory

This study contributes to social movement theory through both the direct effect of SMO ESS media presence on innovation performance and the moderating effect of SMO ESS media presence on the relation between renewable energy fixed-price incentives and innovation performance. Both effects build on previous social movement studies in a clean technology context (Pacheco et al., 2014; Sine & Lee, 2009; Vasi, 2009).

Underscoring these previous studies, the direct effect shows the positive influence of SMO on the clean technology industry. This study contributes to social movement theory by not focussing on the influence of SMO on industry emergence or entrepreneurial activity but on innovation performance, something previously neglected in literature. Furthermore, the use of SMO ESS media presence to examine the influence of SMO provides a richer measurement as it specifies the how SMO directly challenge the industry's taken-for-grantedness by promoting and encouraging energy storage in the media.

Schneiberg et al. (2008) show that social movements moderate the effect of economic forces on the organisational field. The moderating effect of SMO media presence found in this study builds upon these findings by showing that besides economic forces, normative forces can also be moderated by SMO. This study shows that the negative effect of renewable energy fixed-price incentives on energy storage innovation performance is weakened by SMO ESS media presence. This underlines Schneiberg et al. (2008) by showing that SMO can make innovation performance less dependent on normative forces. Furthermore, the moderating effect found in this study extents Sine and Lee (2009), they showed that when limited resources are available SMO can moderate resource availability stimulating entrepreneurial activity in a clean technology industry. In this study the isomorphic forces exerted by market-based incentive on the industry are weakened as SMO media presence challenges the taken for granted assumptions in the industry, thereby, advocating for diversification in the organisational field, thus, weakening the isomorphic pressures from market-based incentives on innovation performance in the ESS industry.

With regard to Pacheco et al. (2014) the results suggest alternative explanations to parts of their coevolutionary model, which model shows that technology orientated SMO membership figures influence both public awareness and market-based incentives which in their turn influence industry emergence. Findings from this study show that when public awareness and technology promoting SMO are combined that market-based incentives effects on innovation performance are moderated by the SMO media presence.

In brief, this research contributes to social movement theory by showing that SMO advocacy of alternative technologies may lead to higher innovation performance. Furthermore, the previously neglected moderating role of social movements has been identified, between normative forces and innovation performance. Lastly, the study has shown that when media presence and SMO are combined, rather than media attention and SMO strength measured separately, alternative outcomes can be found.

Practical implications

The results of this study have some implications for practitioners in the field of energy storage and more generally the clean technology industry. Firstly, the effect of renewable energy fixed-price incentives on innovation performance in the energy storage industry shows that forces from the renewable energy sector may influence outcomes in the energy storage industry. This means that organisations that want to benefit from innovations in the energy storage industry would do best to consider countries with low or no renewable energy incentives as this encourages energy storage innovation. However, if there are still renewable energy incentives, one could examine the involvement of social movements in the energy storage industry as they might mitigate the negative effects of renewable energy incentives. In brief, if one looks for a climate that supports energy storage innovation, low renewable energy incentives and high SMO involvement should be considered. Furthermore, the insignificance of regulatory pressure on innovation performance in the ESS industry provides additional evidence for the energy storage lobby, showing that current regulatory frameworks do not impact the energy storage sector and that revision of European-wide legislation is required. Lastly, this study provides evidence for the link between the renewable energy and the energy storage industry which means that policy makers in either industry should consider the other industry as decisions which are made in the one could have potential implications in the other.

Limitations

Although the contributions to literature are all based on statistically significant findings there is some degree of caution required in the interpretation of some of the findings. As already highlighted in the results section most of the relationships found are fairly significant. However, for the moderating effect of SMO ESS media presence a weaker level of statistical significance has to be taken into account. Furthermore, in the regression analysis only the standard errors were clustered, which means that the correlation coefficients are not determined on country specific trajectories but European wide. Consequently, effects could differ in individual countries.

Although the bias in this study was kept at a minimum it cannot be completely ruled out. The regression assumption based on cluster amounts was slightly violated which introduces a potential bias to the results. Furthermore, the renewable energy fixed-price incentive measurement for Germany and Belgium was slightly different due to data availability. The alternative measurement can be deemed a comparable indicator, but it still introduces some bias. For these reasons a future study with larger time span and country sample, is expected to underline the findings with larger statistical power. Additionally, a fixed-effects method did not provide statistically significant evidence for the hypothesised effects. However, the measure that was used, clustered standard errors is also a common method in panel data as recent studies point out (Diestre & Rajagopalan, 2012; Marcel, Barr, &

Duhaime, 2011). This method can show alternative explanations for panel data analyses to fixed-effect methods, which in the view of this study it did.

Lastly, due to limited data on energy storage funding smart grid funding was used to approximate the *FUND* variable. Although the differences are slim, it does provide a less accurate control variable. Moreover, none of the control variables included in the study have given significant effects on innovation performance. This means that their impact was limited. However, looking at the r-squared of around 27% this study cannot rule out that factors outside this study explain some of the unexplained variance.

Future research

The findings from this study have indicated some new areas of research on which future studies could be based. Firstly, as already mentioned the regulative pressure variable did not show any significant results. However, this might be due to the nature of the energy storage industry. Therefore, future studies of regulatory pressure in other clean technology industries might show effects expected in this study. Additionally, this study assessed SMO through media presence. A future study might widen the scope on activities of SMO by adding others, for instance lobbying efforts. Moreover, this study used renewable energy fixed-price incentives as a measure for normative force, in future studies other normative measures could be included to widen the perspective of normative pressures in the renewable energy industry and its relation with the ESS industry. Moreover, this study focused on the European Union and most previous studies, though not all, have focussed on the US. Future studies in other geographical areas might provide interesting insights, for instance, developing countries where energy storage solutions could be incorporated in the initial design of the energy networks instead of changes to long established grids which occur in developed countries. Lastly, this study was embedded in the clean technology industry and future research could ascertain whether the results found in this context hold in other industries.

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Appendix

Appendix I – Methodology tables

Austria	Language	Search number	Search terms:
	German	1	(Energiespeich*) OR (Batteriespeich*) OR (Wasserstoffspeich*) OR (Schwungrad* AND Speicher)
	German	2	(Wärmespeicher*) OR (Druckluftspeicher*) OR (Supraleitende AND magnetisch*) OR (Superkondensator)
	English	1	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	2	(Compressed AND air AND storage) OR (superconduct* AND magnet* AND storage) OR (super AND capacitors) OR supercapacitor
Denmark	**Language**	**Search number**	**Search terms:**
	Danish	1	(energilag*) OR (lag* AND energi) OR (energiopbevar*) OR (opbevar* AND energi) OR (batterilag*) OR (hydrogenlager*) OR (lag* AND hydrogen)
	Danish	2	brint OR Svinghjul OR (lager* AND terminsk) OR (lager AND varm*) OR (Varmeenergilag*) OR (varmelager*) OR Trykluftlager* OR (superledende AND magn*) OR superkondensator
	English	1	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	2	(Compressed AND air AND storage) OR (superconduct* AND magnet* AND storage) OR (super AND capacitors) OR supercapacitor
Germany	**Language**	**Search number**	**Search terms:**
	German	1	(Energiespeich*) OR (batteriespeich*) OR (Wasserstoffspeich*) OR (Schwungrad* AND Speicher) NOT (Verbrennung* OR Fahrzeug)
	German	2	(Wärmespeicher*) OR (Druckluftspeicher*) OR (Supraleitende AND magnetisch*) OR (Superkondensator) NOT (Verbrennung* OR Fahrzeug)
	English	1	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	2	Compressed AND air AND storage) OR (superconduct* AND magnet* AND storage) OR (super AND capacitors) OR supercapacitor
Italy	**Language**	**Search number**	**Search terms:**
	Italian	1	(Immagazz* OR accumul* OR Stoccaggio) AND (energia OR Idrogeno OR batter* OR termic* OR calor* OR (aria AND compress*))
	Italian	2	(magnet* AND superconduttiv*) OR (supercondensator*)
	English	1	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	2	(Compressed AND air AND storage) OR (superconduct* AND magnet* AND storage) OR (super AND capacitors) OR supercapacitor
Spain	**Language**	**Search number**	**Search terms:**
	Spanish	1	(almacen* AND energía) OR (Almacen* AND Batería) OR (Almacen* AND hidrógeno) OR (Volante AND inercia)
	Spanish	2	(Almacen* AND térmico) OR (Almacen* AND aire AND comprimido) OR (Magnética AND superconducción) OR Super condensadores
	English	3	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	4	(Compressed AND air AND storage) OR (superconduct* AND magnet* AND storage) OR (super AND capacitors) OR supercapacitor

Belgium	Language	Search number	Search terms:
	Dutch	1	(energie AND opslag) OR energieopslag OR batterij OR waterstof OR vliegwiel OR (thermische AND opslag) OR warmteopslag
	Dutch	2	(gecomprimeerde AND lucht) OR (supergeleid AND magneet) OR supercondensatoren
	English	3	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	4	(Compressed AND air) OR (superconduct* AND magnet*) OR (super AND capacitors)
	French	5	((stockage OR accumul*) AND (Batteri OR Pile OR accumulateur OR hydrogène)) OR (Volant AND inertie)
	French	6	((stockage OR accumule*) AND (thermique OR chaleur OR (air AND comprimé)))
	French	7	(magnétique AND supraconductrice) OR ((aimen* AND magnet*) AND supraconducteurs) OR Supercondensateur
France	**Language**	**Search number**	**Search terms:**
	French	1	((stockage OR accumul*) AND (Batteri OR Pile OR accumulateur OR hydrogène)) OR (Volant AND inertie) NOT (vehicule OR combustion)
	French	2	((stockage OR accumule*) AND (thermique OR chaleur OR (air AND comprimé))) OR CAES NOT (vehicule OR combustion)
	French	3	(magnétique AND supraconductrice) OR ((aimen* AND magnet*) AND supraconducteurs) OR Supercondensateur NOT (vehicule OR combustion)
	English	1	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	2	(Compressed AND air AND storage) OR (superconduct* AND magnet* AND storage) OR (super AND capacitors) OR supercapacitor
Ireland	**Language**	**Search number**	**Search terms:**
	English	1	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	2	(Compressed AND air AND storage) OR (superconduct* AND magnet* AND storage) OR (super AND capacitors) OR supercapacitor
The Netherlands	**Language**	**Search number**	**Search terms:**
	Dutch	1	(energie AND opslag) OR energieopslag OR batterij OR waterstof OR vliegwiel OR (thermische AND opslag) OR warmteopslag
	Dutch	2	(gecomprimeerde AND lucht) OR (supergeleid AND magneet) OR supercondensatoren
	English	3	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	4	(Compressed AND air) OR (superconduct* AND magnet*) OR (super AND capacitors)
	Language	**Search number**	**Search terms:**
United Kingdom	English	1	(energy AND storage) OR (battery AND storage) OR (hydrogen AND storage) OR (flywheel AND storage) OR (thermal AND storage)
	English	2	(Compressed AND air AND storage) OR (superconduct* AND magnet* AND storage) OR (super AND capacitors) OR supercapacitor

Table 10 – Search terms for patent data

English	Danish	Dutch	French	German	Italian	Spanish
Energy storage	Energilagring	Energieopslag	stockage d'Energie	*Energiespeicher*	Immagazzinamento dell'energia	Almacenamiento de energía
Storage	Lagering	Opslag	Accumuler	Speicher	Accumulare	Almacenar
					Immagazzinare	
Battery	Batteri	Batterij	Batteri	*Batterie*	Batteria	Batería
			Pile		Batterie	
			Accumulateur			
Smart grid	Smart grid	Slimme netwerken	Réseau intelligent	Intelligentes Stromnetz	Reti Intelligenti	Red eléctrica inteligente (REI)
Hydrogen	Brint	Waterstof	Hydrogène	*Wasserstoff*	Idrogeno	Hidrógeno
	Hydrogen					
Flywheel	Svinghjul	Vliegwiel	Volant d'inertie	*Schwungrad*	Volano	Volante de inercia
Thermal energy storage	Termisk	Thermische opslag	Termique	*Wärme*	Termico	Almacenamiento térmico
Heat energy storage	Varmelager	Warmteopslag	Chaleur	*Wärme*	Calore	Almacenamiento de calor
	Varmeenergilagring					
Compressed air energy storage	Trykluft	Gecomprimeerde lucht	Air comprimé	*Druckluft*	(Immagazzinamento d')aria compressa	(Almacenamiento de energía de)aire comprimido
Superconducting magnets	Superledende magnitisk	Supergeleidende Magneet	magnétique supraconductrice	*Supraleitende magnetische (Energiespeicher)*	Magneti Superconduttivi	Imanes Superconductores
			Supraconducteurs		Supercondensatori	Energía magnética por superconducción
Super Capacitors	Superkondensator	Supercondensatoren	Supercondensateur	*Superkondensator*		Super condensadores

Table 11 – Keywords in different languages
Note: Not all initial keywords were included in the search terms in Table 10 as not all keywords provided results

Geography	Organisation
International	World Wide Fund for Nature (WWF)
	Greenpeace
	Friends of Earth (FoE)
Austria	global2000 (FoE)
	Umweltberatung
	Österreichische Gesellschaft für Umwelt und Technik (ÖGUT)
Denmark	NOAH (FoE)
	Danmarks Naturfredningsforening
	CONCITO
Germany	Bund für Umwelt und Naturschutz Deutschland (BUND)
	Deutsche Umwelthilfe (DUH)
	Naturschutzbund Deutschland (NABU) (FoE)
Italy	Amici della Terra (FoE)
	Legambiente
	Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)
Spain	AMIGOS DE LA TIERRA (FoE)
	FONDO MUNDIAL PARA LA NATURALEZA (WWF)
	Ecologistas en Acción
	Equo
Belgium	Les Amis de la Terre (FoE)
	Climaxi
	Bond Beter Leefmilieu
	Fédération Inter-Environnement Wallonie
France	Les Amis de la Terre France
	la Fondation Nicolas Hulot
	France Nature Environnement
Ireland	Friends of the Earth (FoE)
	The environmental pillar
	FRIENDS OF THE IRISH ENVIRONMENT
The Netherlands	Milieudefensie (FoE)
	Urgenda
	Natuur & Milieu
United Kingdom	ClientEarth
	Friends of the Earth
	Green Alliance

Table 12 – Overview of environmental movements included in study
Note: the organisations with (FoE) behind them are national organisations associated with Friends of the Earth

1. Innovation Performance	
PATENTS	Corrected energy storage patents
2. ESS regulatory pressure	
REGULATION	Corrected energy storage regulations
3. Renewable energy market-based incentives	
INCENTIVE	Renewable energy fixed-price incentive in reversed natural logarithm
4. SMO ESS media presence	
MEDIA	Corrected count of SMO media presence in relation to energy storage in natural logarithm
5. Interaction terms	
*REGULATION*MEDIA*	Interaction term between REGULATION and MEDIA
*INCENTIVE*MEDIA*	Interaction term between INCENTIVE and MEDIA
6. Control variables	
SHARE_RE	Share of intermittent renewable energy in total energy generation
FUND	Private funding for energy storage projects corrected with GDP in natural logarithm
YEAR	Time indicator for each country ranging from 2004 to 2015

Table 13 – Variables used in model

Variable	Missing data
PATENTS	No data missing for the energy storage patents count, however Eurostat had no total overall patent data for 2015. Therefore, the data for 2015 for all countries was approximated through extrapolation of 2012, 2013, and 2014.
REGULATION	No missing data
INCENTIVE	No missing data
REPC	No missing data
SHARE_RE	No missing data
FUND	No missing data
YEAR	No missing data

Table 14 – Missing data table