Constructing Post-Carbon Institutions:

Assessing EU carbon reduction efforts through an institutional risk governance approach

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Abstract

This paper examines three different governance approaches the European Union (EU) and Member States (MS) are relying on to reach a low carbon economy by 2050. Current governance literature explains the operational methods of the EU's new governance approach to reduce carbon emissions. However, the literature neglects to account for the perceived risks that inhibit the roll-out of new low carbon technology. This article, through a novel approach, uses a grounded theoretical framework to reframe traditional risk literature and provides a connection to governance literature in order to assess the ability of EU governance mechanisms to reduce carbon emissions. The empirical research is based on responses from European energy stakeholders who participated in a Delphi method discussion and in semi-structured interviews; these identified three essential requirements for carbon emissions to be reduced to near zero by 2050: 1) an integrated European energy network, 2) carbon pricing, and 3) demand reduction. These features correspond to institutionalized responses by the EU and MS: the Agency for the Cooperation of Energy Regulators (ACER); European Union Emission Trading Scheme (EU ETS) and energy efficiency directives and policies integrated into existing MS institutions. The theoretical and empirical findings suggest that *governance by facilitation* (energy efficiency) fails to induce significant investment and new policy approaches and cannot be relied on to achieve requisite reductions in demand. *Governance by negotiation* (ACER) and *governance by hierarchy* (EU ETS) do reduce risks and may encourage the necessary technological uptake. The term 'risk governance' is used to explain the important role governance plays in reducing risks and advancing new technology and thereby lowering carbon emissions in the energy sector.

Key words: risk governance; energy policy; carbon lock-in

1 Introduction

The European Union (EU) plans to significantly reduce carbon emissions by encouraging the wide deployment of low or zero carbon energy related technologies. The creation of a new EU institutional architecture is at the center of this effort. Between 2005 and 2009 EU institutions and member states (MS) created a new governance structure that is designed to contribute to reducing carbon emissions by 20 percent by 2020 and to further prompt the decarbonization of energy generation by 2050, with overall greenhouse gas emissions dropping to 80 - 95% by 2050 (European Commission 2011). This article will explore three main governance pillars of the EU's carbon reduction effort: The Agency for the Cooperation of Energy Regulators (ACER), The European Union Emission Trading Scheme (EU ETS) and the fulfillment of the Energy Efficiency Directive by MS.

The argument in this paper focuses on two theoretical frameworks: The first concerns itself with previously-identified EU governance methods and their effectiveness; these different methods are connected to three pillars (ACER, EU ETS and energy efficiency) the EU is relying on to reduce carbon emissions. The second framework focuses on risk perceptions and mitigation measures that guide institutional decision making; these affect the deployment of new low carbon energy related technologies. The central intent is to establish how effective new governance structures are at creating coherent stakeholder involvement and action on carbon reductions while reducing risks that inhibit the roll-out of new technologies.

It is proposed that conducting a cross comparison of EU institutions and policy efforts to reduce carbon emissions provides the opportunity to consider the formation of a new low carbon regulatory regime. The Lisbon Treaty of 2009 laid the foundation for EU institutions to ensure energy security of supply and the switch to a sustainable energy system, thereby moving away from a high carbon energy system. This treaty provides a legal foundation suitable for creating a fundamentally different governance structure for the energy sector. The European Energy Commissioner Gunther Oettinger calls the changes in

Europe’s Internal Energy Market a new “institutional architecture” (2011). However, the ‘old’ carbon energy system has a well established stable and predictable regulatory environment. Altering this structure (both in terms of supply and demand) creates a significant amount of uncertainty for all stakeholders, particularly for investors. This means heightened levels of risk may delay or lead to higher costs for new energy projects. This article provides a starting point to assess how new forms of governance can prompt new practices, mitigate risks and induce a wider deployment of carbon reducing technologies, all in a rapid and consistent manner.

The paper first outlines the methods used to elicit feedback from stakeholders. These include: The Delphi technique, 25 semi-structured expert interviews, and the use of secondary sources; the justification for the research is also provided. Reviewed literature on institutional governance (e.g. Eisner 1993; Majone 1997; Knill and Lehmkuhl 2002; Eberlein and Grande, 2005; Bulmer et al. 2007; Eberlein and Newman 2008) is then presented, with strong consideration given to sectoral governance (e.g. Eberlein 2008) and energy sector risk (e.g. Unruh 2000; Unruh 2002; Wiser et al. 2004; Woerdman 2004; Bekkers and Thaens 2005; Jamison, Holt, and Berg 2005; Wiser and Bolinger 2006; Hoffmann, Trautmann, and Hamprecht 2009). Importantly, the examination of risk breaks down the broad term, ‘security of supply’ into short term ‘contractual risks’ and long term ‘regime risks’ which affect the functioning of each governance structure. This section is followed by an examination of interviewee perspectives on the three different EU governance approaches in regard to whether they contribute to reducing carbon emissions. The paper concludes by considering whether new governance structures are able to induce the technological changes necessary to reduce carbon emissions and do so within a stable institutional regulatory regime.

2 Methods

This study relies on a qualitative grounded research approach. The benefit of qualitative methods is they are flexible and heuristic. Also, qualitative methods are, "the best way we have of getting the insider's perspective, the 'actor's definition of the situation'," including complex social phenomena (Punch 1998, 243). The qualitative approach taken in this study relies on the Delphi technique, semi-structured interviews and coding of participant discourse. These methods combine to reveal the importance of governance in technological change.

The original sampling design of this study called for a total of 30 participants. "In-depth information from a small number of people can be very valuable, especially if the cases are information-rich" (Patton 1990, 184). Robson (2002) states that a grounded theory study needs between 20 and 30 participants (Robson 2002, 165). Table 1 provides details on the 34 participants involved in the study, all of whom were actively involved in energy issues in the European Union at the time of participation.

Table 1 Number of interviewees and stakeholder groups represented

	International Institution, government, regulator	Industry or sector Representative	Company	Academic, independent expert	**Total**
Interview participants	**3**	**4**	**12**	**6**	**25**
Delphi discussion participants	**1**		**4**	**4**	**9**
Total	**4**	**4**	**16**	**10**	**34**

2.1 Delphi methodology

The *normative Delphi* process was designed to identify the elements necessary for rolling-out the new technology required to build a post-carbon economy by 2050. This method was chosen to gather expert opinions on defined issues (Lewis-Beck 2004, 245). There were three rounds: The first round consisted of introductions and statements by participants; the second round focused on answering key questions previously developed (appendix a); and the third round focused on identifying areas of agreement from topics of the second round. Using experts to identify key developments corresponds with the assumption that "professionals may be better informed as to potential risks and benefits" (Lewis-Beck 2004, 245). The normative Delphi process and the subsequent interviews drew out direct knowledge gained through stakeholder experience.

The Delphi process relied on a single meeting on April 22, 2009, in Milan, Italy. Nine experts answered an email invitation to a Delphi technique discussion on the Pathways for Carbon Transition project covering transport and energy (Enerdata 2011). The host institution also invited other relevant stakeholders to the discussion. Anonymity was given to participants to facilitate a more open discussion. Selection of the participants, along with the later selected interviewees (detailed below), was done through the use of a large database of 3,000 names assembled by the 11 consortium partners for the PACT project (Enerdata 2011). The second round of expert discussion was guided by a questionnaire that focused on three aspects of transitioning to a post carbon energy system by 2050. The main questions were: 1) How to phase in new technology? 2) What are the priority infrastructures? and 3) what are current and future regulatory and legislative requirements? Each question also focused on associated risks and benefits. In the third session, two overarching conclusions emerged: First, participants attribute an important role to government policies and social acceptance of technology for reducing carbon emissions; second, there is a general perception that current technologies will be utilized, albeit in a more advanced form. As stated by a participant, "We have to use what we have more efficiently up to 2050. The things are there already, it is just a matter of doing things more efficiently" (PACT Discussant B 2009). Currently unknown or unutilized technologies were predicted to be extremely limited in their impact up to 2050. Table 2 identifies general topics discussed and identifies sub-categorizes participants agreed on as being important in moving towards a low or zero carbon energy and transport system. These broad themes indicate the importance of focusing on common EU mechanisms that induce the roll-out of low carbon technology on an EU wide scale by 2050.

Table 2 Roundtable discussion topics

General topics identified	Sub-categories discussed
Security of supply	Risk categories, carbon pricing and gas
Technology	Regulation, taxation, R &D, cost comparison, smart metering, large/small scale, standardization, electricity (backbone for transport and power), existing technology, decentralized, increase efficiency and hydrogen
Generation technology	Renewable, CCS, nuclear, gas, photovoltaic, hydrogen and diverse portfolios
Delivery	Infrastructure (distribution and transmission grid) and smart technology
Public opinion	Response to pricing (carbon) and city design

2.2 Interview methodology

The interview methodology relied on a semi-structured format. The interviews progressed from introductory and general questions to specific probing questions (appendix b). These interviews typically lasted from 45-60 minutes. A post contact sheet summarized each interview, including impressions and follow up questions (Miles and Huberman 1994, 53). Respondents' positionality was important to consider as their answers emerged from their subjective perceptions and position in a network (Miller 2000, 131); this is noted in the analysis.

Selection of interviewees was based on the categories in Table 1. Emphasis was given to involvement in higher level policy and business decision making in the energy sector, with attention paid to their geographic location in the EU. When requested, anonymity was given to interviewees in exchange for frank assessments. A total of 87 people and organizations were identified to represent a balance between new and old EU MS. Participants were approached first by email and then with a telephone call.

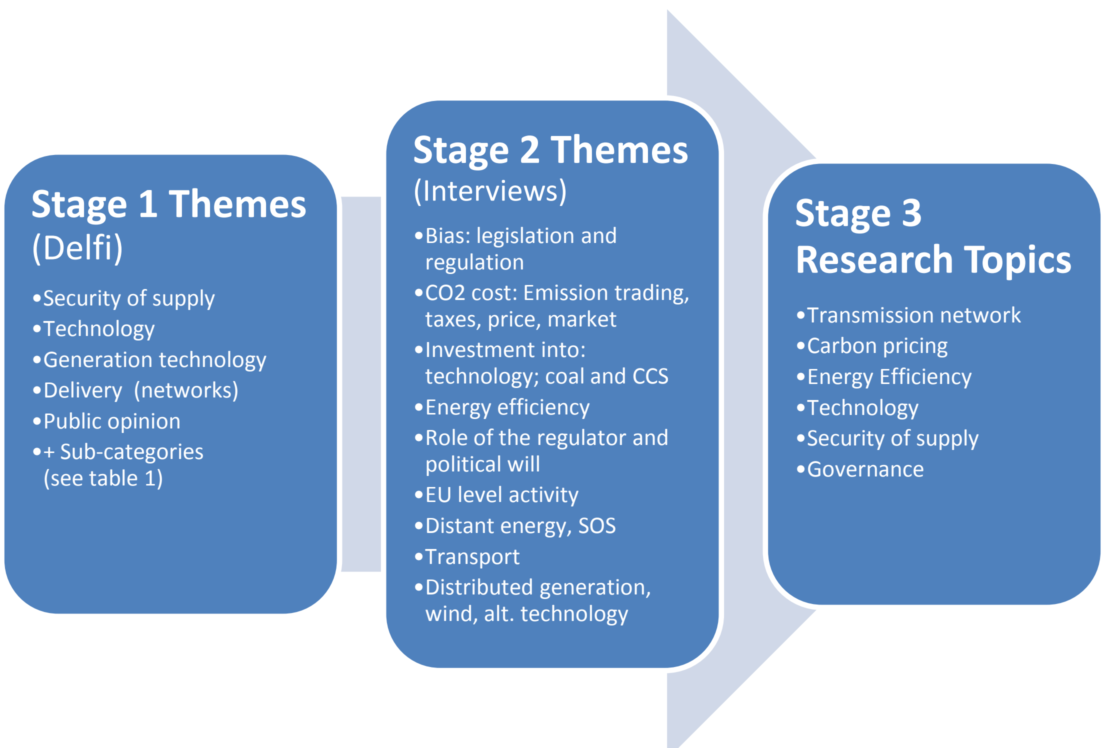
Twenty-five people were interviewed, eight in-person, 16 by telephone and one by email. Additionally, the comments from the nine participants at the Delphi discussion were considered. Nine Interviews were recorded and later transcribed, the remaining interviews were recorded by note taking (this included nine that were typed during the telephone interview with the remainder written), most interviews lasted one hour. In addition, ad-hoc conversations with industry experts in private and at conferences also took place and informed the analysis (these are not included in the participant list). The primary questionnaire is provided in appendix b; this was tailored to each interviewee depending on their sectoral expertise. Open-ended questions were asked to allow each respondent to provide a personal perspective. There were two rounds of interviews conducted. The first round was between May and September, 2009; the second round lasted from January to March 2010. A two round method was chosen due to the reflexivity involved in qualitative research. The break between the rounds enabled data assessment and refinement of questions. The two phase approach is not expected to effect the results, as the time gap was minimal and there were no 'significant' events which could have significantly altered respondents' perceptions.

2.3 Coding methodology

To analyze the data involved two qualitative methods were used: transcription and coding. During the transcription process themes were manually identified. These 'thematic units' (Ryan and Bernard 2000, 780) were either noted in the margins of the texts or highlighted. Over time, a list of themes accumulated. Through coding of more particular words, phrases or thematic units, thirty topical categories were identified. This coding, along with post contact sheets, allowed for data reduction (see

Miles and Huberman 1994; Ryan and Bernard 2000). For the establishment of a category, more than one interviewee needed to address the same topic. These categories inform the structure and analysis of this article. For example, the most often mentioned topics included: bias (in legislation and regulation), emission trading, investment in coal and CCS, energy efficiency, the role of the regulator and political will. Within these categories four to five stakeholders remarked at length on the specified topic. Many of the other categories served as sub-categories of these more popular ones. Figure 1 describes the data reduction flow and the identification of key topics based on the results of the Delphi discussion and interviews.

Figure 1 Data reduction and topic identification



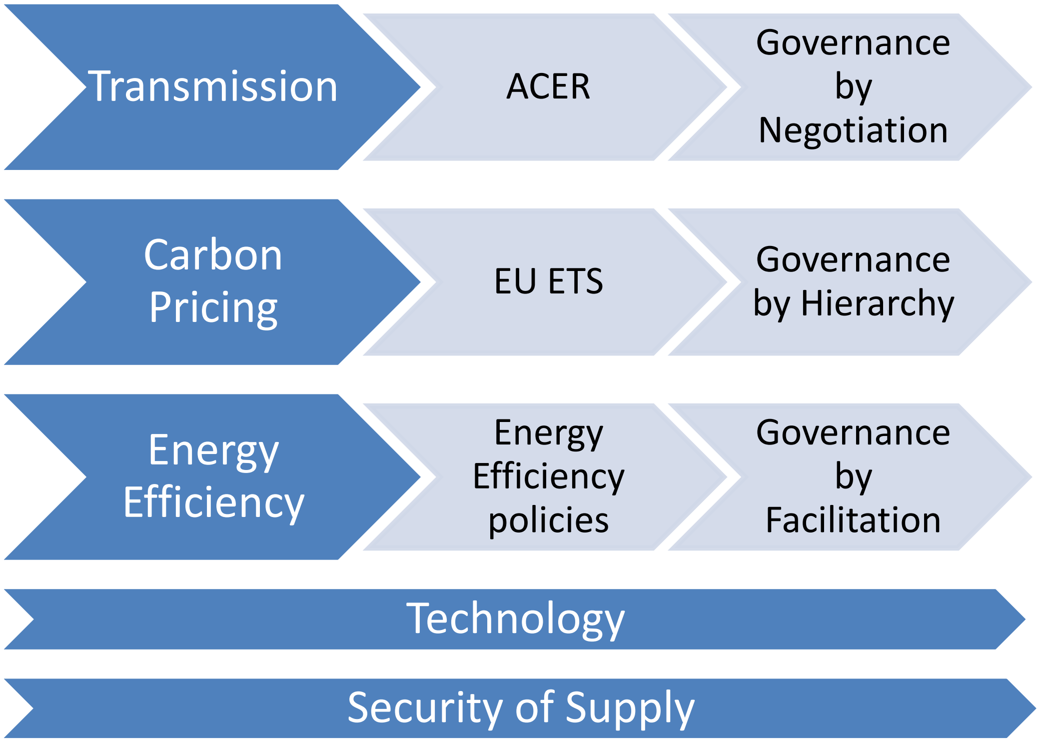
Secondary material was also used to provide additional perspective and place interviewees' perspectives in the wider European debate. Drawing on secondary sources along with governance and risk literature helps to develop a policy studies framework. Different data gathering techniques enables a triangulated approach. The purpose of triangulation is to gain a more accurate reflection of a particular structure by using a range of methodologies. The use of the Delphi technique, semi-structured interviews, secondary sources and a theoretical perspective builds a triangulated perspective (Denzin 1978, 304), boosting validity and revealing governance mechanisms and associated risks.

2.4 Connecting grounded theory to EU energy strategy

Empirical data collection serves as a basis for a grounded theoretical approach. The five final categories (Figure 1) serve as a basis for analyzing how the EU is fostering the energy transition process. This section describes how these five categories connect to the theoretical framework of this article and serve as the basis for further research into the role of governance and risk.

Governance emergences from the data collection phase as a means to represent public, political and sectoral actors in the regulatory and legislative process. As will be explored below, there is a rich theoretical literature on governance in the EU. Three of the six identified topics (Figure 1) correspond with institutionalized responses represented in the EU's new energy architecture: 1) Carbon pricing – the EU Emission Trading Scheme; 2) energy efficiency – the EU Action Plan for Energy Efficiency and EU directives; and 3) transmission networks – the new Agency for the Cooperation of Energy Regulators. Each of these categories corresponds to different forms of governance as identified by Bulmer et al. (2007). Figure 2 demonstrates the connection between the topics identified by stakeholders, EU institutional responses and governance methods.

Figure 2 Connection between empirical topics and theoretical framework



'Technology' and 'security of supply' categories, as discussed next, can be seen as an integrated part of each of these three categories. The roll-out of technology that reduces carbon emissions is the indicator of success for the three governance methods. Security of supply in energy is a critical factor that must be upheld; however, as will be discussed, it can inhibit or motivate the implementation of new technologies and ways of doing business.

2.5 Justification of energy governance

The five categories involved in developing a post-carbon economy have an institutional and legal basis in the European Union. The legal and strategic parameters of each are briefly reviewed here to justify and make connections between the five empirical categories and the EU's governance approach to reducing carbon emissions. Three recent legal documents shape the EU's low carbon institutional architecture: The Lisbon Treaty (2007), the Second Strategic Energy Review (2008) and the Third Energy Package

(2009). Each of these documents is designed to boost security of supply, foster new technologies and create institutional momentum for investment, all in an attempt to reduce carbon emissions.

Transitioning to a new energy system requires investment in new infrastructure in a coordinated regulatory environment; this well-defined path can reduce both short term and long term risks. The Lisbon Treaty, which came into force on December 1, 2009, is central to this effort. The treaty reformed the decision making process of the European Union. There is now a legal basis for a coordinated energy policy in the EU. Article 194 stipulates, among other issues, that EU and MS shall aim to ensure security of energy supply, promote energy efficiency, renewable energy and the interconnection of energy networks (Lisbon Treaty 2007). Subsequently, the treaty has served as the basis for the Third Energy Package and the creation of ACER in July 2009. ACER is now facilitating cross-border cooperation in investment and regulatory issues.

Guiding the policy direction of the EU is the Second Strategic Energy Review. This defines the benefits and means to decarbonize the EU's electricity supply by 2050 (European Commission 2008). Carbon pricing through the EU ETS can influence low-carbon investment decisions, as confirmed by stakeholders (below) and the European Commission (European Commission 2008, 15). The creation of a low carbon future requires the building of a "smart interconnected electricity network" (European Commission 2008, 16). Energy efficiency, in the strategic document, is also seen as having significant long term impacts in reducing energy demand and emissions (European Commission 2008, 16). The EU has identified where carbon emissions in the energy sector can be cut and how to do it. Each of these areas, as discussed below, relies on different approaches to promote investment through a governance mechanism.

Effective governance is necessary to create the environment needed to encourage investment in low carbon technologies. New investments need to overcome traditional risk perceptions embedded in older institutional structures and a carbon based economy. The EU has attempted to remove or mitigate risks by establishing governance procedures that are meant to be inclusive and provide clear guidance for stakeholders. The Lisbon Treaty established the legal foundation and the Second Strategic Energy Review identified the goals and means to accomplish these goals; the Third Energy Package is one of the tools for achieving carbon reductions. However, as discussed next, governance and risk need to be assessed together in order to understand how their combined effects encourage or discourage investments into low carbon technology.

3 Definitions and literature review

3.1 Governance

Institutional architecture influences how policy dissemination and implementation occurs. Both institutional capacity and legal authority affect governance methods, including expected policy outcomes. Through observing operational methods of different governance systems the level of authority and the intent of a regulatory regime can be understood. Identifying different governance styles of institutions lays the foundation to study the broader political-economic environment and for perceiving how policy outcomes influence risk perception. Institutions, through their risk assessments, can influence the pace of deployment for new technologies. In this section, EU governance structures (Bulmer et al. 2007), are matched with three pillars of EU institutional carbon reduction efforts.

The governance process, described here, is seen through an institutionalist perspective. Institutions shape the preferences of actors and structure the policy making process and how policy implementation is carried out (Bulmer et al 2007: 19). Governance, under this view, is state-centric with the emergence of a regulatory state (Majone 1997). Indirect governance mechanisms structure relations between state institutions and private actors (Majone 1997, 143 -147). For example, recent national and EU level regulatory activity is the outcome of privatization and liberalization in the energy sector. The emergence of private actors in a traditionally state controlled sector requires new forms of government oversight.

Broad based embedded interests that shape the actions of private actors amount to a '*regulatory regime.'* The regulatory regime is marked by the "configuration of policies and institutions" structuring relations between social interests, state and economic actors in the economy (Eisner 1999, 1). Resistance to new regulatory regimes emanates from established economic organizations embedded in older institutions; a new regime emerges when "new regulatory policies are initiated in several regulatory issue areas… and [are] combined with significant institutional change" (Eisener 1999, 3). Since the 1990s there has been a new regulatory regime in energy; this is defined by "synergetic relationships, with private and public activities partially reinforcing each other" (Knill and Lehmkuhl 2002, 42). For example, the expansion of privately owned French and German energy companies into new EU MS in the 1990s and 2000s parallels the expansion of the EU, the birth of national energy regulators in Europe, along with regional corporate structures (LaBelle 2009).

The term 'governance' must be broken down to more precisely account for the different activities of institutions and actors. Eberlein (2008) introduces the concept of *sectoral governance* which "denotes policy making by private and/or public actors in sectorally delineated areas outside the legislative arena of democratic politics" (2008, 74). The activities and delegation of responsibilities, particularly in the field of energy regulation, by the European Commission corresponds to such a sectoral form of governance (Eberlein 2008). The Commission has delegated power to 'sectoral governance actors' for two reasons. First, it is a *politically expedient* method that works around cumbersome political decision making, and second, benefits from the *expertise of sectoral actors*. A well functioning market requires key actors to coordinate their activities due to the complexity and 'newness' of the liberalized electricity and gas sectors (Eberlein 2008, 77). *Governance capacity* reflects the social, economic and political support state institutions receive to carry out defined tasks (Knill and Lehmkuhl 2002, 43).

EU policies are effectively transferred and advanced through cooperation and coordination of key actors. This professional interaction is demonstrated by the engagement of energy regulators in regulatory associations (such as ERGEG, the Council of European Energy Regulators (CEER) and the Energy Regulators Regional Association (ERRA) (see LaBelle 2011) and in energy forums which identify best practices (Florence Forum) (see Eberlein 2008).

The three EU carbon reduction pillars, examined in this article, correspond to the theoretical governance categories developed by Bulmer et al (2007). For the authors, "three different patterns of EU governance can be identified, each with distinct institutional characteristics that may be expected to generate a variety of [policy] transfer types" (Bulmer et al. 2007, 19).

- *Governance by negotiation* is policy transfer by consent. The authors identify the Council of Ministers as the primary place where this occurs, but this largely consensual method of governance occurs in ACER (where coercion can be applied due to a lack of institutional authority, along with governance by cooperation). This is a "largely voluntary policy transfer process, but the availability of qualified majority voting may introduce some elements of coercion" (Bulmer et al. 2007, 19).
- *Governance by hierarchy* means considerable power is delegated to supranational institutions. This involves prior negotiations and legislative/treaty activity. It addresses single market and legal based mechanisms (Bulmer et al. 2007, 19).The EU ETS fits within this category because of its institutional and legal basis.
- *Governance by facilitation* describes areas of EU policy making where an "intergovernmental pattern prevails, where the member [state] governments are the most powerful actors, both

> collectively and individually….In this mode of governance policy transfer will take the form of unilateral, voluntary policy transfer facilitated by the EU" (Bulmer et al. 2007, 20). Agreed-upon energy efficiency targets set by MS, are examples of where governments have leeway to develop their own policies and programs. There are no enforceable targets or sanctions.

The influence of technology and globalization is excluded from this model of governance (Bulmer et al. 2007, 12). However, governance and technology are important factors to address together: rolling-out new energy technologies to reduce carbon emissions, as established above, is a core function of new EU institutions. This function is now infused into the EU's energy architecture. Governance structures can effectively induce the deployment of carbon reducing technologies. However, before conducting this assessment, an essential element of energy governance – risk – is defined along with a description of how institutions mitigate risks in security of supply.

3.2 Sectoral Risk

The integration of energy networks in the EU parallels the birth and coordination of energy regulators and carbon reduction policies (Eberlein 2008). This cross border fusion of infrastructure and governance creates mutual dependencies. Electricity system integration increases resilience but to mitigate new risks, requires coordinated planning. System failures can cascade across a weak network (such as happened during the inter-regional black out in the US in 2003 or in Europe in 2006). Interconnected physical and governance networks increase mutual dependency, thereby requiring broader risk mitigation strategies to create resilience (Bekkers and Thaens 2005, 38). In the energy sector "this reinforces the demand for active, forward-looking, even if costly risk management" (Directorate-General for External Policies of the Union, Policy Department 2007, 22-23).

Risk reduction methods attempt to reduce or remove future uncertainty, regardless of future positive or negative outcomes (Wiser et al. 2004, 338). This section describes how risk mitigation practices solidify old ways of doing business and tend to favor the use of particular technologies. New technologies are typically locked-out or marginalized so the result is a decrease of one set of risks and an increase in another set. In addition, more dynamic social, political and economic goals are blocked by entrenched risk reduction practices and perceptions. The solution set forth here is of three parts. First, the often used term 'security of supply' is integrated into a more dynamic assessment of risk to explain how, in the long term, the energy system can become sustainable. Second, two typologies of risk are introduced; these show how institutional (re)action and protection of former investments inhibits the uptake of new technologies. Third, governance structures should incorporate more dynamic and evolutionary risk assessments to address long term security of supply weaknesses.

3.2.1 Risks to Security of Supply

'Security of supply' is a broad based term describing the current and future stability of the energy system. This definition includes risks that affect demand and supply. Figure 2 demonstrates the integrated nature, both empirically and theoretically, of security of supply in the energy system. However, to include long term impacts and to provide a focused definition which accounts for a 2050 timeline, then 'security of supply' needs to be defined further. "*Energy supply security* in fact is very close to the notion of the 'sustainability' of the energy system…. investing in supply security implies to incur current costs in order to avoid greater future cost" (Directorate-General for External Policies of the Union, Policy Department 2007, 22). An effective energy governance system avoids future costs by acting now to mitigate long term risks.

Sectoral governance involves specialized stakeholder communities and activities (Eberlein 2008, 74). In the field of risk management, these groups correspond to *risk regimes.* These regimes define "a policy and intellectual archipelago, a myriad of risk domains isolated from one another…. Each domain has its own risk regulation regime, in which a specific institutional bias is dominant" (Bekkers and Thaens 2005, 42). Emerging from this definition (to align with the discussion here) is the term, *'sectoral risk'* based on islands of expertise and actions. Therefore, bringing the fields of *risk* and *governance* together is facilitated by using the term *risk governance*.

There are two risk typologies that inform risk governance in the energy industry. These sectoral risks are examined next and establish how the effort to create a consistent regulatory environment, conducive to long term investments, may hinder deployment of newer technologies. Management of short term and medium term risks can prevent a more effective transition to a low carbon economy, even within governance structures created to foster a low carbon economy.

3.2.2 Contractual risks

The first type of sectoral risk examined is contractual in nature. Contractual risks, due to clear financial implications, have a more immediate impact on the energy sector. Table 3 describes supply side sectoral risks present in electricity contracts (Wiser et al. 2004). However, as energy supply security involves creating a sustainable energy system, demand side sectoral risks are also defined. As discussed in section 4.3, demand side risks are characterized by unclear long term policy and regulatory signals which, in contrast, are already well defined in the supply side sector.

Table 3 Contractual Risks

Risk		Supply side sectoral risks	Demand side sectoral risks
Contractual risks	**Fuel price risk**	The price of fuel used to generate electricity will exhibit variability, resulting in uncertain costs of generating electricity.	
	Fuel supply risk	Fuel supply to a power plant will be unreliable, resulting in inability to generate electricity in a predictable and dependable manner.	As risks for fuel supply increase, justification and cost of demand side reduction becomes favorable to mitigate higher supply side risks.
	Demand risk	Electricity contracted will not be needed as anticipated or not enough electricity will be available to meet fluctuating demand.	No binding targets to dramatically increase the use of energy efficient measures. New technological or services uptake will not occur and demand will not be reduced. Economies of scale in technologies or services are not realized.
	Performance risk	An electricity generator may not be willing or able to deliver electricity according to contractually prescribed requirements in terms of time and quantity.	A significant amount of energy efficient measures are not implemented. Only the minimum (or least expensive) measures are done for households and industry.
	Environmental compliance risk	The financial risk to which parties to an energy contract are exposed, stemming from both existing environmental regulations and uncertainty over possible future regulations.	

Source: Wiser and Bolinger 2004, 338-339 define supply side risks, the author draws on empirical and secondary data to define demand side risks, as examined below.

3.2.3 Regime Risks

Regime risks are characterized by their long-term impact on the stability of the overall system. As discussed above, the archipelago of sectoral risk contains its own risk regulation regime and particular bias. This bias can impact how the regime's risks are mitigated. As defined in Table 4 the sectoral risks in the European energy sector are characterized by reducing long term future uncertainty to ensure appropriate investments are conducted to reduce short term contractual risks (Table 3). The sectoral risks of demand and supply are addressed together in this chart; the assumption is that an effective risk governance regime will provide the appropriate signals/actions to mitigate both supply and demand risks. The final risk category, geopolitical, is not extensively addressed as it extends beyond the empirical data and institutional activity analyzed here. It is important to remember that geopolitical events and strategies can influence risk regimes.

Table 4 Regime Risks

Medium and long term Risk		Supply side and demand side sectoral risks
Regime risks	**Financial risk**	There are no or a limited amount of commercially available financial instruments offered by banks or large institutions to predictably and dependently finance the upfront costs of low carbon generation, transmission and energy efficient measures.
	Regulatory risk	The risk that future laws, regulations, regulatory reviews or renegotiation of contracts will alter the benefits or burdens of contracts for either party.
	Technological lock-in	Perpetuation of a dominant design that is inferior to newer technology. Industries that have a significant systemic-technological relationship are most susceptible, due to buffered market forces.
	Institutional lock-in	To reduce uncertainty and to provide continuity to past investors regulatory institutions may change only incrementally, thereby relying on older technologies and inhibiting newer technologies.
	Administrative capacity risk	Constrained staffing levels in government institutions prevent a larger policy and regulatory response to prompt the wider uptake of low carbon energy technologies.
	Investment risk	Investments are impacted due to uncertainty in the operational environment. Returns on investments are difficult to predict over a time period. Investments are therefore delayed, not done or completed using less than optimal technology to meet carbon reduction targets. System instability may occur.
Geopolitical risks		Relations with third countries may be altered, threatening a supply source or network route. Reduction in demand can mitigate some risks of supply security.

Understanding the role of technology in the energy governance process (Figure 2) requires an empirical and theoretical approach. This dual examination of the connection between the uptake of new technology and governance methods is essential for building a theoretical framework; this assessment places governance, and the actions of institutions, as an essential part of the architecture in a low carbon energy system.

Three observations can be made in regard to the relation between technological development and governance. First, institutions seek to provide sufficient return on investments for the sunk cost of technologies. Regulations and policies used to initially encourage investments within a buffered regulatory environment, like the energy sector, affect the deployment of newer technologies. Due to the lack of strong market forces and high capital costs in the energy sector (Islas 1997; van der Vleuten and Raven 2006), incremental change becomes the norm and obsolete technologies are ipso facto maintained. The perpetuation of less than optimal technology is called *technological lock-in* (Unruh 2000).

Second, to address how technology is locked-in through institutional action, Unruh (2002; 2000) develops the concept of the Techno-Institutional Complex (TIC) as a means to explain the interlinked nature of technological progress and institutional evolution. State institutions need to continuously ensure the advancement of new technologies. *Institutional lock-in* occurs when institutions fail to encourage this uptake and old inefficient technologies remain the norm (Unruh 2000, 824) (For further discussion on carbon based TIC see Calvert and Simandan 2010). Institutions, to prompt efficient technological change, must have adequate *administrative capacity* to ensure that policies and regulations fulfill public goals that emerge from the dominant regulatory regime.

Third, institutional inaction for encouraging new technologies has a long term impact on the possibilities of reaching a low carbon economy. "Capital investments thus may have long-term implications for GHG

[Green House Gas] emission levels, particularly in the energy sector, where investments are typically long-lived and require long lead times" (Buchner 2007, 13). *Investment risk* therefore becomes an important component to consider and how it influences investments. The definition of investment risk rests on the concept of 'uncertainty', which is explored by Hoffmann, Trautmann, and Hamprecht (2008; 2009), in connection with EU ETS and investment decision making. Regulatory uncertainty, which increase investment risks, may actually prompt investments if a competitive advantage (first-mover) is created, and/or the internal resources of firms are leveraged (Hoffmann, Trautmann, and Hamprecht 2009). However, long-term low-carbon investment projects rely on normative pressures aligning firms with broader social goals (Hoffmann, Trautmann, and Hamprecht 2009, 1247). Long term regime risks (Table 4) and the chosen investments are influenced by normative pressures. Therefore, effective governance structures, as examined next, hold the potential to minimize sectoral risks in transition periods, protect early stage investments, and prompt the continuous roll-out of new technologies over the long term.

4 Results

The EU's carbon reduction strategy significantly rests on ACER, EU ETS and energy efficiency to support the transition to a low carbon economy. This section presents the results of empirical research undertaken with European energy stakeholders (as described in section 2). To create, by 2050, a low or zero carbon energy system, three important components were identified: 1) an integrated European energy network; 2) carbon pricing; and, 3) demand reduction. As explained in Figure 2, these correspond to institutionalized responses by the EU and MS.

The results demonstrate ACER is beginning to fulfill the task of fostering cross-border cooperation between sectoral stakeholders. EU ETS works within an established legal framework but is still moderately dependent on political decision making. Energy Efficiency policies lack the institutional capacity and political support like ACER and EU ETS, therefore demand reduction will fall short of its full potential. More broadly, emerging from this analysis is a message that indicates how efforts to reduce sectoral risks can encourage and discourage investment practices, thereby influencing deployment of low or zero carbon technologies. Identified below is the finding that effective governance structures, which have some institutional and political authority, are becoming more effective at reducing carbon emissions.

4.1 Agency for the Cooperation of Energy Regulators

ACER is the product of the Third Energy Package approved in 2009. The EU Energy Commissioner Oettinger stated at the ACER opening ceremony that the agency is viewed as the "institutional backbone for the legislative measures of the Third Energy Package and as a platform for the cooperation of Europe's energy regulators" (Oettinger 2011). The examination of cross-border infrastructure projects and the development of network codes are the responsibility of ACER; the EU Commission provides powerful support by negotiating on the behalf of ACER with MS. This section will discuss the efforts that ACER is leading to develop, through *sectoral governance* methods, regional electricity and gas markets. How this agency addresses risk mitigation, and encourages the uptake of new technology, will also be discussed.

4.1.1 Governance Considerations

ACER has a direct impact on the sectoral governance of the European energy market - partly through pursuing political objectives and implementing sectoral risk strategies. The initial responsibilities of the agency are modest but serve a purpose - as a regulator stated, "The regulators will have a very strong word in the decisions on network development [through ACER]. They have only been national until now, there needs to be coordination at the regional level plus the EU level" (Sencar 2009).

Electricity and Gas Regional Initiatives are a high priority of the European Commission: the intent is to foster infrastructural and regulatory cooperation. Regional Initiatives were established in 2006, with the governance structure changing in 2011 to include ACER. This "new architecture" (Oettinger 2011) places ACER, the EU Commission and MS political units into a new body called the Regional Steering Committee. This allows for a political and semi-technical committee to guide, and be informed by, the current technical endeavors of national regulatory authorities (NRA) and other stakeholders. Political guidance is now infused into technical decision making (European Commission 2010, 9).

This regionalized regulatory approach may address the concerns of two interviewed stakeholders who stated that there is a disconnect between the regional operation of energy companies and the focus on the national energy markets of regulators. "What we are getting is regional networks, but dominated by corporate interests, rather than [regional] regulatory efforts" (thereby impacting prices) stated a consumer representative (Simpson 2009). Corporate and national interests may conspire to prevent effective regional integration. "National interests are preventing interconnectors from being built; construction is very slow; the ones now are not sufficient. This is why the EU Commission needs more effort to foster regional markets" (Jankauskas 2009). National regulators place their inability to act more authoritatively in a regional manor on conflicting political motives and the limited authority prescribed to them in legislation (Jankauskas 2009; de Jong 2009). Even ACER, according to another former regulator, is a "mouse" and should have more authority (de Jong 2009). From both a consumer and regulatory perspective, greater regional regulatory cooperation is needed and can be fostered at an EU or regional level.

4.1.2 Risk and Technology

External security of supply threats that affect the European energy sector – particularly gas – require action to be taken inside the EU to mitigate supply disruptions. A Hungarian gas expert states efforts at cross border cooperation in the gas sector do not fully address the necessary internal response required to address external supply disruptions. Heavy reliance on Russian gas in Central Eastern Europe, and the lack of a robust interconnected gas network , results in higher contractual risks (e.g. fuel supply and price risks) (Domanovszky 2009).

Interviewees in the CEE region perceive a high security of supply risk (de Jong 2009; Energy Utility Executive A 2009; Domanovszky 2009). This stems from over-reliance on Russian gas. Geopolitical risks are exacerbated by the lack of adequate regional infrastructure to mitigate local fuel supply and performance risks during a crisis. The situation, according to a CEE independent gas expert, is aggravated by different perspectives held by Eastern and Western European governments over whether Russia is a reliable supplier. Long term risks, according to this source, can be mitigated by building gas interconnectors and improving regional cooperation (Domanovszky 2009). ACER can foster greater cross border cooperation for regulators and investors, thereby reducing existing investment and regulatory risk. However, differing political perspectives in terms of the governance process may limit the speed with which ACER moves to encourage regional regulatory cooperation.

Advancing the roll-out of new technology at a regional level is an essential task of ACER. In the opinion of interviewees, the building of a large scale ‘smart grid’ would benefit from a more institutionalized approach (Sencar 2009; de Jong 2009; Palmisano 2009). Going ‘smart’ may even have a local impact through the wide deployment of smart meters. “Smart grids and smart users must go together”; this interaction will result in, “dynamic pricing and dynamic response” by using smart meters (PACT Discussant B 2009).

However, while smart grid technology is exciting, it cannot replace fundamental elements of the EU’s new energy governance structure: energy efficiency and greater regulatory cooperation. First, smart meters are a load balancing method for supply side management, and not for saving consumers money, unlike energy efficiency measures, stated an energy efficiency sector representative (Warren 2009). Second, an effective regulatory design that integrates national markets into regional entities will significantly increase network efficiency; by using methods such as market coupling, cross border interday trading and balancing markets (Energy Utility Official B 2010). These fundamentally important practices were echoed in the responses of other interviewees, regardless of their affiliations; it was stressed that new technologies and increased regulatory cooperation must go together (Chebbo 2010; Palmisano 2009; Sencar 2009).

Overall, it is the scaling up to a regional level, within a new governance structure, that will impact technological roll-out and regulatory cooperation. “Network operations will become more expensive and cross border issues will become more important; this can’t be done on a country by country basis” (de Jong 2009). Greater integration of the EU’s energy system is based on a new governance structure that promotes cooperation, thereby fostering investment into cross border infrastructure and new technologies. This cooperation is also encouraged by another EU institution, the EU ETS, as examined next, which places a price on carbon emissions. Reducing costs through cooperation is an essential element in moving to a low carbon economy.

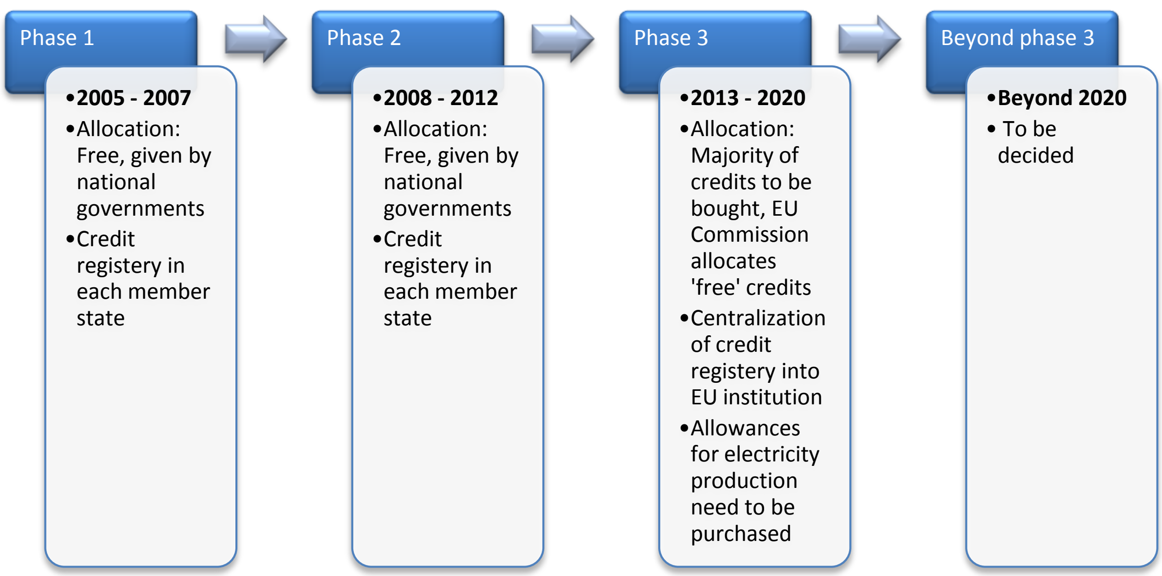
4.2 EU Emission Trading Scheme

The establishment of the EU ETS in 2005 meant that a price was placed on carbon emissions for large emitters; the intent is to encourage carbon reductions in the EU. The credits can be traded between companies. The European Commission and MS are using EU ETS as the main legal pricing instrument for influencing the level of carbon emissions. The first two phases were largely controlled at the national level in allocating industrial allowances, the third phase starting in 2013 builds on previous EU directives and legislative changes and centralizes, through the EU Commission, the allocation and administration of EU ETS. This *governance by hierarchy* approach is more uniform, although the number of free allowances will still largely reflect the outcome of negotiations with MS and stakeholders. Overall, it is envisioned that there will be a 21% drop by 2020 in emissions from participating sectors and a 10% drop for sectors not participating (Europa 2010).

4.2.1 Governance Considerations

The guiding premise of the EU ETS is to place a price on carbon emissions. For the energy sector, this means that greenhouse gas emissions, such as CO2 from power plants, will now have a cost. The program has been in place since 2005 and is proceeding in at least three phases (Figure 3). The third period is marked by a centralization of the credit registry system and allocation of 'free' credits, shifting authority away from MS and towards the EU Commission. As discussed next, there are three reasons for centralization of the EU ETS away from MS.

Figure 3 Evolutionary phases of EU Emission Trading Scheme



First, the competiveness of EU industry can be impacted by carbon pricing. The price has the potential, according to interviewees, to drive out industry from the EU. Carbon intensive industries need to be competitive against non-EU counterparts. A representative of a European financial institution believes that energy intensive industries are already moving outside the EU to be competitive (Kovachev 2009). This perspective is echoed by an energy company representative who stated that the price of CO2, determined by the EU ETS framework, along with labor costs, taxes and regulations, will push some carbon intensive industries out of the EU (Energy Utility Official B 2010). To stem this loss, international agreements and common action inside the EU are needed to protect susceptible industries – all while keeping an eye on World Trade Organization rules (Energy Utility Official C 2010). Centralization of credit allocations by a single EU institution attempts to provide a more rational distribution of credits based on EU competitiveness rather than the favoritism in evidence through EU MS allocation of permits (which has marked the first two phases).

Second, centralization and the restriction of the number of allowances is justified because of a drop in carbon prices due to the previous over-allocation of allowances by MS and the reduced economic output (and emissions) of the recent recession (Guerin and Spencer 2011). The new governance process seeks to limit political involvement in the allowance allocation mechanism, thereby increasing the price. However, due to the haggling that must occur between the European Commission and MS, for third phase allowances, "the price is subject to political decisions". (Energy Utility Official C 2010). This expert stated that clear political decisions made in the near term will give more certainty to the long-term price (Energy Utility Official C 2010).

Third, fluctuations in the price of carbon allowances may increase uncertainty and impact effective long term investments. Therefore, it is important to consider factors that encourage a diverse generation portfolio. Skepticism was expressed by an academic participant about using carbon market pricing to induce technological change: "Markets choose badly, which is the least cost, and may not be the most secure" (Cherp 2009). In addition, echoing this academic perspective but from an industrial point of view: "In Europe they push for dramatic and rapid CO2 targets, but no nuclear, no coal, whatever technological mix is left is costly and will not support European industry" (Energy Utility Executive A 2009), stated an energy utility executive. The centralization of EU ETS may protect, and offer a more rational allocation method for certain energy intensive industries, but market fluctuations may still drive energy intensive industries from the EU and increase cheap short term generation solutions. Longer term solutions (discussed next) may be more expensive but are more effective at reducing carbon emissions; however these may not benefit from fluctuating carbon allowance prices.

4.2.2 Technology and Risk

The shift to a single European allocations mechanism that covers the whole EU will have an impact on investment decisions and short term risk mitigation (see Figure 2). Effective European coordination in the allocation and auctioning of carbon allowances is important if EU ETS is expected to deliver reliable carbon price signals, according to an energy company representative (Palmisano 2009). Auctions "have to be open and transparent, and need to limit pure financial speculation", so prices are not inflated (Palmisano 2009). Representing the views of other industry stakeholders, the perception of accurate pricing will impact investments. Carbon prices influence power generators' "investment strategies and decisions … [and can] facilitate the transition toward a low carbon economy at the least cost" (Palmisano 2009). Short-term contractual risks increase if appropriate market signals do not exist (Table 3, e.g. demand risk, performance risk, and environmental compliance risks), and long-term regime risks can be higher (Table 4, e.g. financial and investment risks).

The price of carbon impacts the roll-out of new technologies. This can be seen in building a near Zero-Emissions Power Plant, which utilizes carbon capture and storage technology (ZEP/CCS). Although not carbon neutral, in Romania, a gas and oil company has plans to build a gas fired power plant that injects CO2 emissions into an existing oil field, which boosts oil output. "We see ZEP/CCS as a very good bridging technology….Critical issues are security and costs of CO2 emitted. If the CO2 price is high, ZEP/CCS will have possibilities," stated a company official (Seidinger 2009). Investments and carbon pricing, under the new EU-ETS, go hand-in-hand.

However, investments in the most efficient technologies must be properly connected to price signals. Echoing other company stakeholders, a utility executive stated that investments in the type of technology which is the most cost efficient and captures the most emissions will be jeopardized if price fluctuations mean they are unable to accurately predict the cost of CO2 abatement technology (Energy Utility Executive A 2009). This can lead to *technological lock-in* of less efficient technologies, and *investment risks* because the price of CO2 is unknown. Newer facilities may be delayed or built using less than optimal abatement technology, and occur if low carbon investments are tied with firms' existing business activities (For the connection between investments and CO2 price see Hoffmann, Trautmann, and Hamprecht 2009). Providing an effective governance structure requires short and long term risk mitigation to ensure appropriate investments occur in the most effective technologies. As discussed next, the lack of a more centralized governance structure may result in less than optimal carbon saving.

4.3 Energy Efficiency

In the EU, shifting from supply side growth to demand side savings is becoming central to meeting climate change goals. EU MS have pledged to cut energy consumption and, as described in the Action Plan for Energy Efficiency (Europa 2008), "The objective of the Action Plan is to control and reduce energy demand … to save 20% of annual consumption of primary energy by 2020" (Europa 2008). The action plan indicates the key areas and methods where energy efficiency savings can be made. The guiding EU Directive 2006/32/EC for energy efficiency stipulates the transposition of non-binding EU standards into domestic legislation and regulations. And despite being specifically mentioned in the Lisbon Treaty, an energy savings target until 2012 (and possibly after) "entails no legally enforceable obligation for Member States to achieve it" (The European Parliament and the Council of the European Union 2006). Energy efficiency relies on a voluntary governance method; this is characteristic of *governance by facilitation*. Discussed next are the governance deficiencies in the current energy efficiency regime that stakeholders identified and the types of risks inherent.

Table 5 EU measures for increasing energy efficiency

Energy Performance	Appliance standards in 14 categories for consumer products. Building standards for new and renovated buildings. Promote 'passive' house design.
Energy Transformation	Electricity generation standards need to rise, the current average yield for power facilities is 40%. Increase use of cogeneration.
Transport	Reduce car emissions and promote alternative cleaner transport. Reduce energy consumption in current transport modes (rail, air and water).
Financing, incentives and fares	Banking sector to offer products for energy efficiency solutions. Increase public-private partnerships in financing projects. Use tax policy as incentives and disincentives for energy efficiency methods.
Change behavior	Educational measures to raise public awareness.

(Source Europa 2008)

4.3.1 Governance considerations

Currently, incentives to reduce energy demand are tied to the price of energy. Most interviewees stated a preference for a significant shift in the governance process so energy demand reduction becomes legally enforceable. Interviewees stated there need to be specific binding goals for energy efficiency and a shift away from the current market orientated approach where the price of energy is the sole inducement for change. In the eyes of a former regulator, the limit has been reached for reducing energy demand with supply side prices. "The next step that is needed are stronger regulatory devices, like performance based standards which can put limits on energy output" (de Jong 2009). However, this would require a shift from current methods of sectoral (voluntary) governance to the roll-out of wide-spread energy efficiency measures.

Reaching higher energy efficiency levels needs sanctioned encouragement by regulatory institutions, and not just voluntary regulatory standards. According to interviewees, regulators need to utilize a 'carrot and stick' approach. An EU parliamentarian stated, "We need to do a lot to improve energy efficiency. We need strong compliance in supply side and demand side policies where energy efficiency plays a central role" (Martins 2009). This political opinion may involve setting quotas for electricity distribution companies to reduce consumption (Martins 2009).

Changing the current regulatory structure so national regulators set benchmarks to reduce demand will require financial inducements or sanctions to ensure compliance by companies, stated the director of the Romanian energy exchange (Palade 2009). This solution may be a self-serving desire for this director, as the energy exchange has the potential to trade in energy efficiency certificates which financially encourage utilities and consumers to reduce demand. However, it is a method used in other countries and is promoted by other stakeholders, even those on the supply side. The director of a gas association stated, "First thing you need to do is stop wasting energy. Whether reducing energy usage or moving to more efficient energy production. [For this to occur] incentives and penalties are essential for change" (Rockall 2009). There was broad agreement among interviewees, even those on the supply side, for the use of financial penalties and incentives to reduce energy demand (Palade 2009; Rockall 2009; Boisen 2009; Energy Utility Executive A 2009; Palmisano 2009). As will be discussed next, the failure of state institutions to take a more active approach, comparable to supply-side sectoral engagement, is resulting in missed opportunities for rolling-out new technologies. This is compounding risks for energy efficiency technologies and policies which are essential for demand reduction.

4.3.2 Technology and Risk

There are a range of risks that are not properly assessed for demand side reduction of energy use. Contractual risks in Table 3 are widely used for energy supply, while regime risks, in Table 4, are traditionally assessed within security of supply. This section identifies, albeit briefly, demand side risks by drawing on stakeholder opinions on the current governance structure. The chosen decentralized governance approach to energy efficiency means different types of risk for quickly rolling out new technologies are compared to those approaches utilized for ACER and EU-ETS. There are three main factors that expose these risks: institutional capacity, energy efficiency standards, and evolving technology.

First, *institutional capacity* is necessary to ensure policies and regulations encourage investment in energy efficient projects: state institutions must have sufficient knowledge, operational means, staff, and experience. Institutional capacity is the institutional know-how that exists in state institutions and the private sector; it is the backbone for preparing access to financing and implementing energy efficiency projects, stated an official from an international institution (Kovachev 2009). Effective carbon reduction programs are dependent on administrative capacity and experience; within *governance by facilitation* there are deficiencies that ensure existing legislative requirements or EU directives are not properly implemented. Without adequate institutional capacity, there is an increased risk that institutional lock-in will occur, thereby preventing a wider dissemination of newer technologies.

Second, *energy efficiency standards* differ. There is a disconnect between EU level energy efficiency standards and actions taken within MS. This exacerbates a range of risks such as environmental compliance, demand, regulatory and performance risks. For example, within the EU 20/20 standard there is a planned reduction target of 20% for energy consumption from lighting. However, for one lighting and electronics manufacture executive, there are marked differences between the EU and local level. “The EU regulatory framework is good but the local certainly needs to catch up” (Electronics Manufacturer Executive A 2009). As an example, this executive cites Hungary, where lighting performance standards have not been updated to match this EU level goal. In Hungary there is “practically no new standard for energy consumption,” (Electronics Manufacturer Executive A 2009). This is a lost opportunity, stated this executive, to reduce energy consumption in the commercial and industrial sectors, as a significant reduction in electricity demand can be made by moving from luminous lighting standards to energy consumption standards.

The connection to energy consumption standards is important because, for another interviewee, higher emission standards may result in lower efficiency. For power plants and in transport, “Tougher emission demands often mean reduced efficiency," stated a natural gas vehicle representative (Boisen 2009). This impact was not widely noted by other interviewees, but using a technology like carbon capture and storage does result in lower efficiency in power plants (see Rubin, Chen, and Rao 2007). Therefore, while new technologies can reduce the amount of CO2 and other harmful gas emissions, efficiency may be reduced, thereby increasing the amount of energy consumed. The resulting long term regime risks need to be properly weighed in assessing these technologies.

Third, reflecting technological change and the efficiency debate, *evolving technology* means rigid standards need to be adjusted in a timely manner, so newer technologies are not hindered from being deployed. "Technological developments mean that legislative action is like shooting at a moving target. Evaluations of energy efficiency are extremely complex and must be open for perpetual reviews and adjustments" (Boisen 2009). This moving target can foster uncertainty over the chosen technology and expected financial returns (e.g. investment and financial risks), thereby affecting the financing of energy efficiency projects. This complexity can be compounded by the price of energy and the cost of technology, along with the policy and regulatory environment.

"Overall, energy efficiency is the lowest hanging fruit" (Seidinger 2009) and while this may be the case, the current voluntary governance approach has not fostered an equally institutionalized response to regional cooperation (ACER) or for carbon pricing (EU-ETS). The voluntary and facilitating role that EU institutions play in ensuring energy efficiency measures reduce carbon emissions appears to be faltering for some countries. "New member states in the CEE region are inefficient economies and are not moving fast enough to reduce energy consumption, [while the] targets are not strong enough" stated a former regulator (Jankauskas 2009). The failure to engage in a clear form of governance that reduces uncertainty is liable to compound risks (e.g. environmental compliance risk or performance risks). The lack of institutional capacity to provide effective guidelines or programs inhibits the wider uptake of newer technologies that can reduce energy demand and/or carbon emissions.

5 Discussion

5.1 Bridging the gap

The emergence of a low carbon regulatory regime requires an interconnected assessment of major EU and MS institutional efforts to reduce carbon emissions. Existing governance literature does not fully examine the connection between deploying low carbon technologies and institutional practices. The three different governance mechanisms, examined here, demonstrate the diverse institutional methods the European Union is relying on to reach a post-carbon economy by 2050. Governance literature (Bulmer et al. 2007), when applied here, describes well the institutional methods used to reduce carbon emissions, but the literature does not fully account for the influence of older technological regimes and the associated risks inhibiting the uptake of newer technologies. However, for example, institutional ambiguity in the third phase of the EU ETS may also prompt investments (Hoffmann, Trautmann, and Hamprecht 2009), but not necessarily in the most efficient, low carbon technologies.

Stakeholders sought clearer investment conditions. Interviewees identified key areas where institutional means are necessary to roll-out low carbon technology; under the assumption that removing uncertainty may prompt further investments. This article examines the deployment of new technology within the current EU energy governance architecture. It also refines and reframes the definition of security of supply and traditional risk assessments to improve the insight of governance literature.

The identified energy goals in the Lisbon Treaty (2009) and in the EU Energy Strategy (2008) provide a direction for European governments and industry. The new governance architecture the EU and MS have established partially reduces the medium and long-term risks associated with the transition to a new energy system. However, short term risks remain due to political uncertainty. Governance by facilitation, used for energy efficiency, by relying on voluntary measures fails to induce significant investment and new policy approaches and is not predicted to achieve its demand reduction goal. Technological uptake is encouraged by governance by negotiation and hierarchy, not by facilitation. The theoretical framework of risk governance highlights the important role governance plays in advancing new technologies and implementing carbon reduction policies in the energy sector.

5.2 Governance, risk and technology

It is important to recognize the differences between the three approaches. ACER and EU ETS attempt to accomplish their goals through an institutional governance system that works within a legally centralized mandate. Governance by negotiation is the decision making mandate for ACER, while EU ETS, particularly in the third period, will function through a strong legal and hierarchical governance structure. The two institutional approaches for ACER and EU ETS do accommodate for differences. By considering regional and sectoral differences, such as regional markets and additional free carbon allowances for energy intensive industries, they demonstrate flexibility.

Governance by facilitation for energy efficiency is the loosest of the three approaches. It remains to be seen whether voluntary efforts will work, while it is clear that the decentralization of policies and regulations weaken the impact of policy making. It is important to note that governance by facilitation is not indicative of success. “The low level of institutionalization in facilitation, it is hypothesized, means that policy transfer will be restricted to influence, with a relatively high incidence of abortive transfer” (Bulmer et al. 2007, 24).

There are two factors that make ACER and EU ETS effective at inducing technological change (these are lacking in the field of energy efficiency): 1) The new low carbon regulatory regime places these two institutions in the EU governance system; and, 2) the rise of sectoral governance in energy brings in all specialized stakeholders to work together to create effective solutions which mitigate risks of rolling-out new technologies. Energy efficiency measures, due to the lack of governance capacity, are still firmly subordinate to institutions operating in an older carbon based regulatory regime – where risk assessments have difficulty accommodating, or encouraging, new low carbon technology. Sectoral governance (as in the cooperation surrounding ACER) demonstrates the high level of technical coordination that must occur between stakeholders to induce a significant uptake of new technology. Sectoral governance in the field of energy efficiency remains weak and thereby locks-in older technology. Established institutions which deal with energy efficiency standards lack the governance capacity to make necessary adjustments or develop new programs that encourage a significant uptake of evolving technology.

The chosen form of governance, as I have discussed, demonstrates how embedded institutional risk assessments influence the roll-out of low carbon technology. In addition, the chosen institutional structure impacts how quickly specific sectors transition to low carbon technologies. The findings indicate that, in the short term, implementation of each of the three governance approaches may increase uncertainty and contractual risks. However, for stronger governance regimes, the likely impact over the medium and long term is that regime risks will be reduced and supply security will increase. Table 6 outlines both the governance structures and the most apparent risks that are present in each of the institutional and policy fields. These three forms of governance, in order to successfully achieve their mandates, must achieve a high level of policy transfer to foster a regulatory regime shift away from carbon based energy sources and towards low carbon policies and technologies.

Table 6 Risk governance, institutions and policy impact

EU institution and policy area	**ACER**	**EU ETS**	**Energy Efficiency**
Governance	Governance by negotiation	Governance by hierarchy	Governance by facilitation
Characteristics of Governance method	EU Commission sets policy direction; national regulars cooperate to implement technical solutions. Limited power of agency, decision making is done by consent.	Legally binding and enforceable actions. Centralization of authority – away from MS. Input from governments important for final decisions.	Policies and standards established by EU, no binding targets. MS choose how and whether to implement or enforce energy savings measures.
Mitigation of Contractual Risks	Regional integration with regulatory oversight may increase the ability to trade electricity across borders. System stability may increase and interdependency should also increase. Contractual risks should drop compared to current system.	Pricing uncertainty may increase contractual risks. Sustained higher prices may prompt new technological investments. Special allowances to energy intensive industries may mitigate uncertainty.	Pricing signals affect the extent that energy efficient measures are employed. Measures taken are usually focused on short term risk/price mitigation. National regulations and enforcement are necessary to increase energy savings measures and technologies.
Mitigation of Regime Risk	Pushed policy and regulatory convergence may see internal and cross-border infrastructure built to provide long-term investment signals, thereby affecting the pace of technological adaption.	Sustained higher prices for CO2 may enable investors and stakeholders to build infrastructure for low carbon energy sector. Sustained uncertainty over price may influence the type of technological investments.	Current voluntary measures may fail to send signal to prompt long term investment and new business models. Non-binding and decentralized approach has resulted in action due to energy prices. Limited mitigation of long term risks.

Risk governance emerges as an initial but integrated framework which provides a structure to merge the actions of institutions with the inherent 'institutionalized' aversion to risk. Investment into low carbon technology is influenced by risk perceptions and practices within institutions. Governance structures, within an established regulatory regime may willingly or not, protect carbon based technology. The evolution of more dynamic institutional risk assessment approaches appears to be essential for promoting new technologies. ACER and EU ETS - because they are new institutions characterized by strong institutional mandates to roll-out new technology, represent a more dynamic method of mitigating sectoral risk. Energy efficiency, in contrast, relies on older state institutions which employ less dynamic risk mitigation techniques; these risk assessments are focused on protecting past investments or providing long term investment stability rather than introducing new technology. The development of a risk governance typology, as exemplified in Table 6, demonstrates the institutional lock-in of past practices that emphasize low energy prices and the lack of an institutional mandate to reduce energy consumption.

5.3 Limitations

There are four limitations to this risk governance theoretical framework. First, a limitation of the methodology emerges by not identifying beforehand, companies, groups or organizations not supportive of EU level activity towards carbon reduction. The diversity of interviewees was expected to yield diverging opinions, rather than reveal a common willingness for EU action. The division of opinions among interviewees is mainly about the level of EU involvement necessary to prompt the roll-out of new technology.

Second, there is a narrow focus on the interrelationship between governance, regulation, policy and investments. Societal considerations are not fully taken into account (nor how they impact policy making decisions and the implementation of technological solutions). Expanding on this area is important as it would also extend the risk framework and integrate public participation into energy governance. Because of this narrow focus, geopolitical influences are not fully considered, although external influences significantly impact energy policies.

Third, this higher level policy analysis of governance structures does not account for many of the policies, regulations, and subsidy programs that are occurring at the national level which are actively reducing carbon emissions. Green certificates or feed-in tariffs do have a big impact on the deployment of renewable energy technology. The variability of these national approaches makes it difficult for this article to fully assess their impact while providing an assessment of the higher level institutional carbon reduction efforts across the EU. An examination of national approaches within these governance approaches would be beneficial particularly in the topic of energy efficiency.

Fourth, sectoral governance is meant to be an inclusive process. However, established stakeholders may have extensive interests to protect and may stymie efforts by new stakeholders (those possessing new technologies) from greater participation. By highlighting the technological alternatives to today's carbon based economy I have attempted to pay some attention to alternative forms of ways-of-doing-business. Nonetheless, further analysis of the 'black-box' of policy making within these three sectoral governance areas should be able to provide a clearer analysis of decision making and interest representation in the carbon reduction regime. By developing risk governance, an attempt is made to consider alternative governance structures that a carbon based regulatory regime may be suppressing.

6 Conclusion

Institutional structures matter. The components of an effective carbon reduction regime must be embedded in effective governance structures. Stakeholder action, orientated to develop low or zero carbon energy solutions, produces the necessary inertia to break away from carbon based technology. It is too early to predict the level of success or achievements of ACER and EU ETS; however, the perception of stakeholders is that these governance mechanisms are on the right path to build a low carbon economy. The lack of an effective governance mechanism for energy efficiency, with coherent stakeholder participation, prevents building the necessary momentum required to break from the carbon based regulatory regime.

Risk assessments reveal the hurdles that new technology must overcome. The current carbon based regulatory regime works by providing long-term stability to investments and rolling-out new technology at a gradual – evolutionary – speed. In the tight regulatory atmosphere of the energy sector, security of supply and monopolistic market practices constrain innovation and market pressures. However, as this article demonstrates, governance structures need to practice dynamic and evolutionary risk assessment. Reducing carbon emissions fulfills wider social, economic and environmental goals. An effective risk governance approach will utilize this broad dynamic to implement technological change to mitigate future risks, thereby creating a sustainable and secure energy system.

This article extends the connection between governance and technological change. Previous literature (Eisner 1993; Unruh 2000; Knill and Lehmkuhl 2002; Unruh 2002) examines the relationship between regulations, policy making and technology; the emergence of sectoral governance in the EU requires a deeper understanding of how specific governance structures encourage the roll-out of low carbon technologies. While this article informs and extends the governance framework developed by Bulmer et al. (2007), further research and analysis is necessary to relate specific governance activity with developing a low carbon economy and society by 2050.

Risk assessments for the supply side of the energy sector are established in risk literature (Wiser et al. 2004; Bekkers and Thaens 2005; Wiser and Bolinger 2006; Jamison, Holt, and Berg 2005; Hoffmann, Trautmann, and Schneider 2008; Hoffmann, Trautmann, and Hamprecht 2009). These are based on contractual and regulatory assessments. Demand side risks, and how to mitigate these, are less well understood. There is a direct connection between reducing energy demand and reducing carbon emissions. A typology of demand side risks, to match those on the supply side, is less developed; this can prevent a fuller assessment of risk mitigation measures and how to encourage a more effective roll-out of energy efficiency technologies. The findings in this article should prompt further development of a demand side risk typology that is just as rigorous as the supply side.

The goals for carbon reduction are set: By 2050 the EU aims to have zero carbon emissions from electricity generation. Broader goals for significant energy demand reduction and more efficient energy networks require effective governance structures. The EU’s new institutional architecture will shape how these carbon reductions are achieved up to and beyond 2050. Greater emphasis should be given to understanding how risk perceptions and governance processes can reduce carbon emissions. By examining deeper institutional practices, answers and solutions emerge; these will contribute to reaching a post-carbon economy by 2050.

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Appendix a

6.1 Questions for the Delphi 'round table' discussion, April 22, 2009.

Energy

1. How will new technological energy systems be phased in by 2050? What experience will producers and consumers have with the introduction of new energy systems?
    a. What are the risks and benefits associated with implementation of new energy technologies on stakeholders?
2. What priority energy infrastructure (networks) needs to be built to achieve an effective transition towards carbon neutral energy systems?
    a. What are the risks and benefits associated with the building of new infrastructure on stakeholders?
3. Which elements in current and future regulatory and legislative requirements are effective in providing stability and predictability during the transition towards carbon neutral systems?

Appendix b

6.2 Interview questions for PACT Work Package 4.2

1. How will businesses change in the medium and long-term to meet carbon reduction goals?
2. How should regulatory efforts and strategies change to improve electricity and gas networks during the transition towards a carbon free energy system?
3. There are strong efforts by the EU and national institutions to create regional markets in electricity and gas. Do you see the current policy and actions sufficient to help foster more efficient regional markets? And how do you see it progressing in the future?
4. Do you believe the broad regulatory and policy changes that are being made at the EU and national levels are sufficient enough to create a path towards reduced carbon energy systems?
5. Energy efficiency is a key component for the EU to meet its carbon reduction goals, do you believe effective regulations and policies will be put in place to ensure these goals are met?
6. How can economic incentive be structured over the medium and long term to encourage the private sector to increase investments in new technologies which contribute to the reduction of CO_2 energy sources?
7. Extra generation capacity will be built to replace existing capacity and to meet future demand do you believe sufficient regulations and policies are in place to promote low carbon energy sources to fill this gap?
8. An example of technology that is being relied upon before its technological abilities are proven is Carbon Capture and Storage, could you describe your opinion on this and how regulations and legislations could be enacted to see this as a viable part of the future energy mix?
9. The development of large renewable wind and solar projects may mean electricity will be transported over large distances, such as from Africa and gas from Central Asia and the Middle East, do you believe, in the long term (towards 2050), the energy mix of the EU will be significantly reliant on distant energy sources?
    a. How would distant energy sources impact on the EU's security of supply?