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EU 2050 LOW-CARBON ENERGY FUTURE:
VISIONS AND STRATEGIES

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Abstract

The aim of this paper is to identify the main challenges regarding the achievement of a low-carbon energy system in the EU by 2050. We analyze the visions presented by stakeholders and existing strategies of member state to achieve this transition. The five main challenges identified are the following: 1// energy efficiency - to ensure ambitious energy savings; 2// GHG emissions - to go towards a nearly zero-carbon electricity system; 3// renewable energy - to push effective technologies into the market; 4// energy infrastructure - to ensure timely investment in the electricity transmission grid capacity across borders; 5// energy markets - to guarantee timely investment in electricity generation back-up capacity. We also find that member states are already pursuing different strategies in dealing with these challenges. This creates risks for a European energy policy fragmentation. It also opens new opportunities for cooperation among member states so that the European Commission could demonstrate how to produce European added value.

Keywords

Climate change, decarbonization, EU energy policy, 2050 energy system

Introduction[1]

The European Commission has announced to come out with a 2050 energy roadmap by the end of 2011, following the recently released roadmap for a low carbon economy by 2050 (EC, 2011). The role of the EU in the transition towards a low carbon energy future is increasingly debated (Jones and Glachant, 2010). This debate is taking place in a context where various visions of the path to follow have been presented by stakeholders, while several member states already started implementing policies to guide the transition. The main contribution of this paper is then to analyze these existing visions and strategies to identify new risks of member states moving in different directions ("policy fragmentation") and new opportunities for member states cooperation and European added value.

The visions that we analyze are recently released energy roadmaps presenting specific values for Europe. They are from a European electricity industry association (Eurelectric, 2010), representatives of the European gas industry (EGAF, 2011), the European Climate Foundation (ECF, 2010), the intergovernmental International Energy Agency (IEA, 2010), and a non-governmental organization (Greenpeace, 2010)[2]. The member states' strategies that have been included in our analysis have already defined low carbon energy policies beyond 2020. They are Denmark, France, Finland, Ireland, Germany and the UK.

The paper is organized into 2 sections. Section 1 introduces the stakeholder visions and derives from these visions the main policy challenges. They are in policy areas where the EU is already active in the 2020 context: energy efficiency, GHG emissions, renewable energy, energy infrastructures and energy markets. Section 2 then looks at how pioneering member states are already dealing with these challenges. We indentify the actual risks of policy fragmentation and the new opportunities for member state cooperation and European added value.

1. Stakeholder visions of a low carbon energy system

In this section, we introduce the stakeholder visions of a low carbon energy system. We first discuss their views on how costly it will be, and then continue with the identification of the main policy challenges that need to be addressed to achieve these visions.

1.1 Transition cost

Stakeholders have presented alternative pathways towards a low carbon energy system in 2050 with a slightly different geographic scope and GHG emissions' reduction targets (Table 1). The visions have in common the assumption that population in Europe is going to stabilize at about 575 million people by 2030. The main differences in assumptions are: 1// economic growth; 2// fuel prices; and 3// technology development.

Regarding economic growth, the stakeholders have in common that they assume the economic growth slow and stable after 2030, but the values used to report the assumed economic growth before and after 2030 are not the same so that it is not straightforward to compare assumptions. Primarily, there is a difference regarding the currency used in the different studies. Moreover, there is a difference in the indicators used to quantify growth. The ECF and EGAF studies only present an average annual growth for the whole transition period, while the others present the expected value for GDP or GDP per capita.

[1] The research for this paper has been conducted in the framework of the FP7 funded project THINK. The authors have benefited from comments by Ronnie Belmans, Erik Delarue, William D'haeseleer, Helen Donoghue, Serge Galant, Adrian Gault, Luis Olmos, Sophia Ruester, Peter Taylor, Christian von Hirschhausen, and the participants of the THINK expert hearing, March 2011, held in Brussels.

For the assumed fuel prices (Annex 1), IEA presents low fuel prices, which are based on the reference scenario in IEA (2009), but it is considered that the fuel prices will decrease significantly towards 2050 as a result of decreasing fuel consumption. ECF fuel prices are a bit higher based on the low carbon scenario included in IEA (2009)[2]. EGAF uses the same assumptions on fuel prices as ECF, except for gas where it has two scenarios: a high gas price scenario with the same gas prices as ECF and a low gas price scenario where it assumes that gas prices remain low up to 2050. The Eurelectric fuel prices based on own calculations using the Prometheus model are higher. Greenpeace has the highest assumed fuel prices based on the high price sensitivity scenario in IEA (2009).

Looking at the assumed technology development, not every stakeholder considers every technology and, for the technologies considered, the assumed cost evolution also differs. For instance, ECF considers that Carbon Capture and Storage (CCS) technologies will be commercially available from 2020, while Eurelectric and EGAF consider that they will be only available after 2030, and IEA projects that CCS will be available between 2015 and 2025, depending on the support that this technology will receive. Greenpeace does not consider these technologies. For renewable energy technologies, stakeholders do not report the same indicators. For instance, Eurelectric presents levelized cost and Greenpeace the evolution of investment and operation and maintenance costs, while IEA, ECF and EGAF studies present the learning rates of the different technologies.

Table 1 – Stakeholder visions

Stakeholder	Vision	Europe	GHG Target*
Eurelectric	Power Choices	EU 27	75%
European Gas Advocacy Group (EGAF)	Low gas price	EU 27 + Switzerland and Norway	80%
	High gas price		80%
	Low gas price and constrained nuclear***		80%
International Energy Agency (IEA)	BLUE Map	OECD Europe**	75%
European Climate Forum (ECF)	Roadmap 40% RES	EU 27 + Switzerland and Norway	80%
	Roadmap 60% RES		80%
	Roadmap 80% RES		80%
Greenpeace	Energy [R]evolution	OECD Europe**	80%

* GHG emissions reduction relative to 1990 level.
** OECD Europe consists of 19 EU Member States plus Iceland, Norway, Switzerland and Turkey.
*** Nuclear capacity constrained at 30GW by 2030.

Despite the differences in the assumptions among the different visions, their outcomes concerning the overall cost of the transition are considerably similar. Eurelectric's low carbon vision can be achieved at a lower long-term total energy cost than their baseline scenario. IEA's vision is that the additional investments are lower than the cumulative fuel savings, compared to the baseline scenario. ECF's vision is that the cost of energy in their de-carbonized pathways declines by 20-30% over the period, relative to the baseline. ECF also reports that GDP growth will be slightly higher than the baseline as a result of this improvement in productivity. EGAF argues that the ECF pathways are costly and risky, while their vision is cheaper. The Greenpeace study reports an annual cost of electricity supply that is

[2] This low carbon scenario assumed the stabilization of the concentration of greenhouse gases in the atmosphere at 450 ppm CO_2-eq, limiting the rise in global temperature in 2^0C (IEA, 2009).

below that in their baseline scenario. In other words, the view seems to be that the fuel cost savings will compensate in cumulative terms the massive investments needed.

Some stakeholders have also argued that their findings are robust by showing that they also hold under different assumptions. For instance, Eurelectric performed four sensitivity analyses in order to study the impact of changing their main assumptions, including the delay on CCS technologies development, the change in nuclear phase out policies, the stricter restrictions regarding on-shore wind installation and the inexistence of additional energy efficiency policies. The overall result is that in general there are no significant changes, neither on the target achieved nor in the overall costs of the transition[3]. IEA also performed some sensitivity analysis regarding assumptions in the different economic sectors (electricity, buildings, industry and transports) in order to guarantee the robustness of their conclusions. Within the ECF study there is a sensitivity analysis, but the main goal has been to show that the power system can sustain a high share of renewable energy sources, even when considering extreme weather conditions and/or reductions on interconnections (among other changes in the system).

1.2 Main policy challenges

In this section, we identify the main challenges for policy when trying to achieve the stakeholder visions in each of the following policy areas: 1// energy efficiency; 2// GHG emissions; 3// renewable energy; 4// energy infrastructure; 5// energy market.

First, in the policy area of energy efficiency, the main challenge reported by stakeholders is to achieve ambitious energy savings. The ambition desired is not always comparable among the different studies since they do not present the necessary energy efficiency improvements using the same indicators. Indeed, Eurelectric and Greenpeace report the primary energy savings that need to be achieved in their visions relative to a baseline, i.e. the reference scenario in IEA (2009), while the others refer to the role of energy efficiency on the GHG emissions' reduction. The savings that need to be achieved are 20% in the case of Eurelectric, and 40% in the case of Greenpeace. IEA reports that energy efficiency improvements in its vision reduce GHG emissions by 30%. ECF reports separate numbers for the building and the transport sectors, where 45% and 20% of GHG reductions are expected to be achieved, respectively.

Second, in the policy area of GHG emissions, the main challenge reported by stakeholders is to achieve a nearly zero-carbon electricity sector[4]. The vision is to generate electricity mainly with low-carbon energy technologies, i.e. using renewable energy sources, nuclear, or fossil fuels equipped with Carbon Capture and Storage (CCS) so that electricity can play an important role in decreasing also the emissions of the transport and heating sectors. Eurelectric considers the highest level of electrification for both sectors, followed by the ECF visions, while Greenpeace and IEA consider the highest direct use of renewable energy sources and a lower use of electricity[5].

Third, in the policy area of renewable energy, the main challenge reported by stakeholders is to push strategic technologies into the market. There is an agreement that the use of renewable energy sources needs to continue to increase, both directly and indirectly (through the use of electricity and heat generated from renewable energy sources). Concerning the use of renewable sources in electricity generation, the importance ranges from 30-34% (EGAF) up to almost 100% (Greenpeace) of

[3] The inexistence of additional energy efficiency policies is the one with the highest impact both on the targets and on the costs, -7% and additional 3552 billion euro's, respectively.

[4] See also Delarue et al. (2011).

[5] The relatively high level of electrification of the heating and cooling sector can partially be explained by the decarbonization of the power sector (which makes electricity a carbon-free energy vector) but also by the existence of certain constrains concerning the modelling of certain heating and cooling technologies (such as passive solar and free cooling, e.g.).

electricity generation in 2050. ECF presents three different visions with different shares on the use of renewable sources within the power sector, ranging from 40% to 80%. IEA envisages that 50% of the electricity is produced from renewable energy sources.

Fourth, in the policy area of energy infrastructures, the main challenge reported by stakeholders is to organize timely investments in electricity transmission grid capacity across borders. The importance of the electricity transmission grid, and especially the expansion of connections across borders, is emphasized in all visions. The expansion of interconnections that needs to be achieved in the different studies ranges from a 40% to more than 90% increase compared to today's capacities. The focus on cross-border connections and on the creation of a Pan-European electricity transmission grid requires cooperative planning and investment. In this specific case, the similarities concerning the focus on the expansion of the transmission network do not necessarily imply that this is the only challenge within the match of demand and supply[6] and the network expansion is indeed the most effective way of achieve a appropriate functioning of the energy system. All the visions analyzed are based on modeled representation of the possible energy system and some of the options for matching supply and demand (such as demand response and storage) cannot be easily input into these models, constraining the possible options presented by the visions.

Fifth, in the policy area of energy markets, the main challenge reported by almost all stakeholders is to ensure timely investments in electricity generation back-up capacity. Depending on the visions, the increase in generation capacity ranges from 50% (Eurelectric) to 164% (ECF 80%RES) of the today's generation capacity. This raises concerns for timely investments, especially concerning back-up capacity in a context of a generation mix that will be increasingly based on intermittent renewable energy sources. ECF reports that, even if the electricity transmission grid is expanded to reduce the need for back-up, the back-up capacity needs to be significantly increased comparing to today's values, i.e. between 170 to 270 GW of back-up capacity (equivalent to 22 and 35% of the today's installed capacity) in its visions of 40% up to 80% electricity generation based on renewable energy sources. EGAF reports a generation portfolio with more CCS so that less back-up capacity is needed. As the amount of back-up capacity that will be needed is uncertain, depending on the generation mix and the electricity transmission grid expansion, there are concerns that the market will not deliver in time.

Table 2 – Main policy challenges

Energy efficiency	GHG emissions	Renewable energy	Energy infrastructure	Energy market
Ambitious energy savings	Nearly zero-carbon electricity sector	Push strategic technologies into the market	Timely investment in electricity transmission capacity across borders	Timely investment in electricity generation back-up capacity

[6] Generally, there are four different components of the solution to deal with the matching of electricity demand and supply: back-up capacity, grid expansion, storage capacity and demand response. All these components are needed to a perfect operation of the power system, but there are some trade-offs among them. In all the reports, the focus is on the grid expansion (especially for what concerns cross-border connection) but the importance given to the other options differs from study to study, which leads also to different requirements in terms of grid expansion. For instance, back-up capacity is mentioned by Eurelectric and ECF. ECF also studied the impact of achieving certain levels of demand response (through smart-grids and flexible demand) on grid expansion and back-up power requirements.

2. Emerging low carbon energy policies at member state level

In this section, we explore the low carbon energy policies that are emerging in pioneering EU member states. We first compare the status of the policy production process. We then compare what these member states are doing to indentify new risks of policy fragmentation and new opportunities for member state cooperation or European added value.

2.1 Status of the political process

In what follows, we discuss the status of the political process of member states that are already mobilized towards a low-carbon energy future beyond 2020 in terms of 1// exploring policy options; 2// legal commitment; and 3// implementation (Table 3).

The first step to develop low carbon energy policies is the exploration of the political, economic and technological options. The Danish government established the Commission on Climate Change Policy in 2008 to develop proposals to decarbonize and to become independent of imported fossil fuels. This commission consisted of 10 independent experts, who published their recommendations in 2010 (DCCCP, 2010). In France, the government initiated a debate with different stakeholders (including local authorities, trade unions, business, NGOs) on ecological and sustainable development in 2007, i.e. the “Grenelle de l'environnement”, which has resulted in a set of recommendations (Tuot, 2007). In Finland, the Government approved in 2008 the “Long-term Climate and Energy Strategy” (GOF, 2008), with detailed proposals on climate and energy policy measures up to 2020, and suggestions up to 2050. In 2009, the government has published the “Foresight Report on Long-term Climate and Energy Policy” (PMO, 2009) to supplement the 2008 strategy. It sets GHG targets up to 2050 and outlines longer-term climate policies. This report is based on a set of studies commissioned by the government to expert groups and on public consultations of stakeholders, experts and citizens. The German government has developed its low carbon energy policy, i.e. “Energiekonzept” (FMET, 2010) based on a study that models different scenarios on the future of the German energy sector (Prognos et al., 2010). In Ireland, the previous government last year has released a Climate Change bill with the goal of legally establishing a target of 80% GHG reduction by 2050 (MEHLG, 2010). The bill also provides for creating an Expert Advisory Body that, with the support of the Irish Environmental Protection Agency, should give the Minister of the Environment the political, economic and technological advise necessary to define the specify policy measures to reach the target. In the UK, the climate policy with a 2050 target started with the previous government that established the Committee on Climate Change and used its advice (CCC, 2008) to develop a low carbon energy system transition plan (HMG, 2009).

Secondly, there is the need for a legal commitment. This step has not yet been achieved by all the member states referred to in this paper. In Denmark the recommendations of the Commission on Climate Change have not yet been translated into legal commitments and in Ireland the Climate Change bill is still pending[7]. In Finland, the “Long-term Climate and Energy Strategy 2008” was endorsed by the Parliament on June 2009 and the government is considering the possibility of supporting a Climate Change Act similar to UK. In Germany, the law corresponding to the “Energiekonzept” has also not yet been enacted but it is expected to be voted in 2011. In France, the “Grenelle de l'environnement” initiative has already led to two legal commitments, i.e. “Grenelle I”, enacted in 2009, that sets the general policy without practical implementation or funding, and “Grenelle II”, released in 2010, which defines specific targets and actions. In the UK, a first legislative action has already been accomplished in 2008 with the Climate Change Act, mandating to cut GHG emissions with 80% by 2050 relative to 1990. This act also officially established the Committee on Climate Change as an independent advisory body. The Committee recommends the level of carbon

7 In Ireland, after the election in February 2011 a new coalition leads the government, which did not yet define its climate policy at the time of our analysis, which is why Ireland is not discussed in the next section.

budget, which is the maximum level of GHG allowed in UK, on a five years period to the government, which in turn must propose a budget before Parliament. In the first report in 2008 (CCC, 2008) the CCC recommended the level of the first three budgets, covering the period up to 2022 and parliament subsequently legislated in line with its recommendations. In December 2010 the CCC published recommendations for the fourth budget (CCC, 2010b), covering the years 2023-27, based on which the government will propose further legislation in spring 2011. Furthermore, an additional law, the Energy Act, was voted in April 2010 in order to implement part of the transition plan prepared by the government. After the election in May 2010, the government has changed, but also the new conservative-liberal coalition has a set of measures on its agenda to fulfill the ambitious low carbon targets put in place under the previous government. The measures seem to be largely in line with the policies of the previous government, but there are also new elements[8]. The new government has started a series of consultations for a wide reform of the electricity market in the context of climate change[9]. New legislative proposals are expected in 2011.

The third step is the implementation of the defined measures/policies. In Denmark, since there has not yet been a legal commitment, the recommendations of the Commission on Climate Change have also not yet been implemented. Similarly, in Germany this step has not yet been accomplished but it is foreseen that the government will need to monitor and report on progress every three years. In Ireland if Climate Change bill will pass, the Expert Advisory Body shall prepare an annual report to the government on progress made in implementing the low carbon policies. In France, 201 decrees need to be implemented for the laws to become effective (CDD, 2010), foreseen for 2012, and the government will need to report on the status of the implementation of this policy on a yearly basis. In Finland, an initial report on the implementation of the new measures defined in the Foresight Report will be drawn up during the current government. In the UK, the Committee on Climate Change is realizing yearly progress reports and it has already published the first two (CCC, 2009; CCC, 2010a) advocating that even stronger measures need to be taken, such as the introduction of a carbon floor price. In addition, the Energy Act 2010 requires the government to present regular reports on the progress of decarbonization policies.

8 See: http://www.cabinetoffice.gov.uk/sites/default/files/resources/coalition_programme_for_government.pdf

9 See: http://www.decc.gov.uk/en/content/cms/consultations/emr/emr.aspx.

Table 3 – Status of the political process

Member State	Exploring policy options	Legal commitment	Implementation
Denmark	Commission on Climate Change	/	/
Finland	Long-term Climate and Energy Strategy (GOF 2008) Foresight Report on Long-term Climate and Energy Policy (PMO, 2009)	In 2009 the parliament endorsed the Long-term Climate and Energy Strategy	Expected report by government
France	Grenelle de l'environnement	Grenelle law I 2009 Grenelle law II 2010	201 pending decrees Annual status report by government
Ireland	Expert Advisory Body*	/	Annual report by the Expert Advisory Body
Germany	Energieszenarien für ein Energiekonzept der Bundesregierung (Prognos et al., 2010)	Foreseen in 2011	Expected status report by government every three years
UK	Committee on Climate Change Electricity Market Reform Project (EMR, 2010)	Climate Change Act 2008 Energy Act 2010 Additional legislation foreseen in 2011	Annual Progress report by the Commission on Climate Change Annual status report by government

* Defined in the Climate Change Bill 2010, which has not yet been enacted (MEHLG, 2010).

2.2 Strategies to deal with the main policy challenges

Each of the policy challenges indentified in the previous section has now to be analyzed: 1// achieving ambitious energy savings; 2// decarbonizing the electricity sector; 3// pushing effective technologies into the market; 4// ensuring timely investment in electricity transmission capacity across borders; 5// ensuring timely investments in electricity generation back-up capacity.

What are the existing member state strategies to deal with these challenges? Can we already indentify new risks of policy fragmentation and new opportunities for member state cooperation and European added value?

To achieve ambitious energy savings, all countries consider the building sector to be the one with the highest potential for reductions, and they all propose important policy changes in order to lever the efficiency improvement in this sector. The Danish strategy focuses on building efficiency through the development of a certification scheme for builders in cooperation with the construction industry, including development of energy consumption benchmarking within relevant sub-sectors (e.g. supermarkets, office buildings, etc) based on the reporting by energy retailers. In Finland after 2012 energy standards for new building will be amended to facilitate a gradual transition to passive houses. In France, the increase of buildings' efficiency is considered as the measure with the highest potential, even when considering other policy areas. Indeed, the French target is to achieve 38% reduction of the overall energy consumption within the building sector by 2020 and, in order to achieve this, they intend to develop stricter building's regulations for both new and refurbished buildings, defining minimum performance standards and minimum annual refurbishment rates. In Germany, the target is to reduce the overall energy consumption by 20% by 2020 and 50% by 2050 relative to 2008 levels and this strategy relies on the establishment of a special fund to subsidize a wide range of measures for consumers, industries and local communities to increase energy efficiency, including buildings. As in France, also in Germany the intention is to develop stricter building regulations for both new and existing building stock. Also in the UK, the priority regarding energy savings is to improve energy efficiency in homes, businesses and public buildings. Besides improving buildings' efficiency, the member states we analyzed also consider relevant the increase of energy efficiency in other sectors, such as the transport sector. Germany has a target to reduce energy consumption in transportation of 10% by 2020 and 40% by 2050. France for instance wants to expand public transportation in order to reduce energy consumption in the sector. We do see that the building sector is strongly targeted by low-carbon energy policies at member state level, but the approaches seem to diverge substantially.

Regarding decarbonization of the electricity sector, all the countries have in common that they only consider low-carbon electricity generation technologies for 2050. Nonetheless, the technology strategies are quite different from country to country. For instance, Denmark and Germany do not consider nuclear as an option, while in France a large share of its electricity generation is still expected to come from nuclear power plants. The French electricity sector is expected to be already almost decarbonized by 2020, considering that it achieves the 20% national renewable energy target for 2020. In Germany, the government aims to use renewables as its major sources for electricity generation, corresponding to 50% of the electricity consumed in 2030, going up to 65% in 2040, and 80% in 2050. Finland and UK fully support renewable energy technologies but do not have long term targets for them because they are also open to develop other low carbon technologies, namely CCS and nuclear. As a result, pioneering member states strongly differ in the low-carbon electricity generation options they intend to rely on to decarbonize their electricity sectors.

Because of the different views on the generation portfolio that each country intends to develop by 2050, the countries have different policies on strategic technology. In Denmark, biomass and wind-power are considered as the strategic technologies that need to be pushed and the Commission on Climate Change suggests continuing to rely on the current national support scheme. Also Germany intends to continue to rely on the existing national support scheme to push its strategic renewable energy technologies, but nuclear will play an important role in the short and midterm as a bridging technology (through the delay of nuclear phase out). About CCS two demonstration projects eligible for EU funding are expected to be built by 2020, these tests will be important for the government to decide future implementation. In the UK, the government wants to push renewable energy as well as CCS, and also nuclear is considered a valid low carbon option[10]. Renewable generation technologies will continue to receive support via the existing Renewables Obligation Certificate scheme, but feed-in tariffs will also be introduced. Concerning CCS, the Energy Act 2010 has introduced incentives to support the construction of four commercial-scale CCS demonstration projects, and the new government wants to establish an emissions performance standard to make new coal-fired power stations equipped with sufficient CCS to meet the emissions performance standard. In Finland the government supports all low carbon technologies, including nuclear with the Olkiluoto Nuclear Power Plant under construction. It will use feed-in tariffs to increase renewable energies and it supports the construction of new nuclear power plants in the near future. Consequently member states that are already on the path towards a low-carbon future beyond 2020 have different views on what are the key technologies to be supported, and how to support them.

[10] About nuclear there was a change of policy in UK. The previous government supported nuclear technology while in the new government the Liberal Democrats have long opposed any new nuclear constructions. According to the program of the new government new nuclear constructions will be possible but without public subsidy.

Regarding the timely investment in electricity transmission capacity across borders, important actions are foreseen in the different countries. The Danish strategy is based on further integration of its electricity grid into Europe and especially into the northern European grid. Also the German strategy is to take the initiative of developing an integrated Europe-wide grid. In the UK, the Energy Act 2010 redefines the role of the regulator to prompt initiatives to tackle climate change. In 2010, the national regulatory authority for electricity and gas, OFGEM, defined a new regulatory framework designed to promote grid smartness, i.e. the so-called RIIO model, replacing the RPI-X model (OFGEM, 2010).[11] Today, pioneering member states are willing to further integrate their electricity transmission grids to enable their low-carbon energy strategies.

To ensure timely investments in electricity generation back-up capacity, the main strategy considered by member states is to further integrate the national electricity markets. The Danish strategy is based on a further integration of its electricity market into Europe and especially into the northern European region. Also the German strategy is to support integration of the electricity (and gas) markets. In the UK low carbon energy policies have triggered an electricity market reform process. The study that supports the ongoing public consultation (EMF, 2010) argues that an electricity generation capacity mechanism needs to be reintroduced in the UK to mitigate the security of supply risk. The study considers two options, i.e. a capacity payment for all, or a targeted capacity tender. Both would increase capacity margins and reduce risks to security of supply, but the study suggests that the tendering is the most appropriate option; one of the main reason is that the alternative would imply a radical change that may create obstacles for the future integration of the GB market with the rest of Europe. That case of UK illustrates that low-carbon energy policies may push fragmentation and become a risk for the unacheived electricity market integration in Europe.

Conclusion

The studies by stakeholders show different visions of a low carbon energy system. However they have in common that the projected fuel cost savings should compensate for the massive investments needed. They also agree on the challenges regarding five main energy-related policy areas: 1// energy efficiency - to achieve ambitious energy savings; 2// GHG emissions - to go towards a nearly zero-carbon electricity sector; 3// renewable energy - to push effective technologies into the market; 4// energy infrastructure - to ensure timely investment in the electricity transmission grid capacity across borders; 5// energy market - to ensure timely investment in electricity generation back-up capacity.

Several member states have already started to address these policy challenges. Denmark and Finland explored the main options to achieve a low-carbon energy system by 2050. Germany and Ireland made government proposals and for Germany a legislative initiative is foreseen to be approved in 2011. France established a legislative commitment which is expected to become implemented in 2011. The UK is the most advanced among the analyzed Member States, facing already the implementation phase of its strategy and having the first monitoring report published.

These different strategies emerging at member state level also bring new risks for policy fragmentation, e.g. the ongoing electricity market reform process in the UK. They also open new opportunities for cooperation among member state and European added value, e.g. the development of a Pan-European electricity transmission grid. This is why and where the EU role in the transition towards a low carbon energy future needs to be considered. It will be the next step of our research.

[11] See: http://www.decc.gov.uk/en/content/cms/consultations/emr/emr.aspx

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Annex 1: Assumed fuel prices

	EGAF Low Gas Price Scen. *		IEA-WEO Reference Scen.		Eurelectric Power Choices		IEA-ETP BLUE Map		ECF Low Carbon Scen.		Greenpeace E[R]	
	Year	**Price**	**Year**	**Price**	**Year**	**Price**	**Year**	**Price**	**Year**	**Price**	**Year**	**Price**
Oil (US$/bbl)	2009	59	2008	97.2	2010	71.9	2008	97	2009	59	2015	110.6
	2015	87	2020	100	2020	88.4	2020	-	2015	87	2020	130
	2030	115	2030	115	2030	105.9	2030	90	2030	115	2030	150
	2040	115	2040	-	2040	116.2	2040	-	2040	115	2040	150
	2050	115	2050	-	2050	126.8	2050	70	2050	115	2050	150
Gas (US$/GJ)	2010	7.9	2008	10.3	2010	8.12	2008	10.9	2009	9.39	2010	11.0
	2015	7.9	2020	12.1	2020	10.7	2020	-	2015	11.1	2020	16.6
	2030	7.9	2030	14.2	2030	13.2	2030	11.6	2030	15.0	2030	19.3
	2040	7.9	2040	-	2040	14.96	2040	-	2040	15.0	2040	22
	2050	7.9	2050	-	2050	16.94	2050	9.1	2050	15.0	2050	26.0
Coal (US$/ton)	2009	70	2010	120.6	2010	95.5	2008	121	2009	70	2010	120.6
	2015	91	2020	104.2	2020	129.8	2020	-	2015	91	2020	135.4
	2030	109	2030	109.0	2030	141.8	2030	65	2030	109	2030	142.7
	2040	109	2040	-	2040	141.2	2040	-	2040	109	2040	160
	2050	109	2050	-	2050	146.1	2050	58	2050	109	2050	172.3

*For the high gas price scenario, the gas prices are the same than in ECF.

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