Low-carbon strategies towards 2050: comparing ex-ante policy evaluation studies and national planning processes in Europe

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Abstract

Both the European Union (EU) and the Member States individually use techno-economic modelling studies to analytically underpin the ex-ante policy evaluation of proposed low-carbon strategies. As these studies vary in depth, focus, and degree of embedment into policy design, we systematically look into the differences by comparing the long-term perspectives toward 2050 for five EU countries (respectively Denmark, France, Germany, the Netherlands and the United Kingdom). The study draws out insights on how ex-ante policy evaluation efforts are mobilised and whether the national approaches are consistent with the long-term European policy objectives for 2050. The comparative analysis consists of a qualitative comparison of (1) the governance of ex-ante policy evaluation in long-term policy planning processes, (2) the distribution of knowledge and skills for ex-ante policy evaluation, and (3) the inclusion of (public) stakeholders. In a second step we conduct a quantitative comparison of national model-based ex-ante policy evaluation studies by assessing (1) their alignment to communicated long-term ambitions and (2) the relative differences. We find a high diversity in national configurations on planning towards 2050, for instance regarding the degree of institutional embedding (e.g. by the presence or lack thereof of climate regulations and monitoring and advising organisations) and the distribution and utilisation of model-based ex-ante policy evaluation efforts. Interestingly, while the national ex-ante policy evaluation studies provided insights into the required domestic action, very little attention was given to the alignment of domestic policies with European or global mitigation ambitions. This study concludes with several areas in which ex-ante policy evaluation could be strengthened.

Keywords: climate and energy policy, decarbonisation strategies, ex-ante policy evaluation, integrated assessment modelling

1 Introduction

In order to track the progress on mitigating greenhouse gas (GHG) emissions, the European Union (EU) has established various regulations and reporting obligations for Member States to monitor current trends (ex-post evaluation) as well as to articulate on prospective trends (ex-ante evaluation) (EC, 2004). Most of these established monitoring and reporting efforts have focused on documenting (national) GHG emissions and the implemention of the Kyoto Protocol (European Union, 2013). However, new challenges for monitoring and reporting have arisen since the adoption of the 'Climate

and Energy package' in 2009 (European Union, 2009a, b, c), which introduced new policies and legally binding legislation related to the GHG and renewable energy targets. For example, the EU Renewable Energy Directive (RED), as one of the new policies in the 'Climate and Energy package', has been translated into various National Renewable Energy Action Plans (NREAPs), which outline the national ambitions for utilising renewable energy by 2020. Likewise, Member States have adopted national (non-binding) commitments for 2020 on total primary or final energy consumption as part of the EU Energy Efficiency Directive (EED) (EEA, 2014). As a result, these specific ambitions and commitments have been monitored for progress over time.

As these targets for 2020 need to be seen in the broader context of meeting long-term ambitions, such as the commitments for 2030 (GHG emission reductions of 40% compared to 1990) (European Commission, 2014), 2050 (GHG emissions reductions of 80%-95% compared to 1990) or the end of the century (well below 2˚C) (European Commission, 2011), greater planning, coordination and documentation efforts of both the EU and the Member States are required. This is acknowledged in the EU 2030 framework (European Commission, 2014), in which the European Commission proposed a new governance scheme that recognises quantitative ex-ante evaluation of national climate and energy plans as an operational element in gaining insight on meeting long-term (supranational) targets (European Commission, 2016). Furthermore, in line with the EU 2030 framework, the EU Energy Union has been established to streamline and integrate a series of policy frameworks into one cohesive strategy. As part of this, Member States are asked to prepare national energy and climate plans with quantified detail towards 2030 and a more in-depth perspective towards 2050. These plans are intended to warrant consistency of national commitments to EU policy objectives (European Commission, 2015).

Given the recent nature of planning towards 2050 on the national level, we present an overview in this paper of the various routes taken by various EU Member States. The main research questions of this study are as follows:

- How are ex-ante evaluation efforts organised in different European countries?
- Are existing representative national scenarios towards 2050 consistent with the long-term European ambitions for 2050?

We focus on five EU Member States (respectively Denmark, France, Germany, The Netherlands and the United Kingdom) which together account for 52% of total GHG emissions in the EU in 2014 (EEA, 2016). As such, the collective movement of these governments is considered important in the light of meeting the EU 2050 objective. Moreover, the sample includes northern European countries who have been drivers of the EU climate policy agenda (Germany, UK) (Jordan and Liefferink, 2004) which provide an experience base in establishing and evaluating long-term policies to which other countries can be compared and contrasted.

2 Methodology

2.1 Qualitative evaluation of national long-term policy planning

Policy makers face several challenges in warranting effective and durable coordination of long-term ambitions. Particularly the adopted lengthy timeframes in climate policies and the experienced volatility in political, social, and technological development pose difficulties in maintaining a stable course over time. Scholars have discussed various potential "coping strategies" to deal with time inconsistencies and the political hurdles over time (see e.g. Hovi et al. (2009) for an overview). Considered coping strategies are, for example, (1) the strengthening of institutions to provide a robust platform for development, (2) the expansion of governmental and non-governmental capacity to draw momentum and resources, and (3) the routinisation of environmental performance reviews which may signal deviations and re-enter issues on the political agenda if necessary (Hovi et al., 2009).

In order to gain insight into how national governments perform in terms of planning for the future, we devise the coping strategies to draw a typology on the national long-term planning processes. The focus of this typology is therefore on (1) the governance and institutional arrangements of long-term ambitions and the ex-ante policy evaluation of long-term ambitions and (2) the distribution of knowledge and skills used to underpin long-term policy choices. Additionally, as the European Union requires the active engagement of (public) stakeholders in national planning processes (principle of subsidiarity) (European Union, 2012), we also consider how participatory processes contribute to ex-ante policy evaluation. Insights are gathered by means of a literature research looking into (a) national and European policy documents, (b) research papers and (c) national regulations. We specifically acquired information on the (i) organisations (legally) involved and (ii) methods and techniques used in ex-ante policy evaluation studies. Additional insights on national policy contexts have been drawn out via an expert workshop, organised in June 2016, inviting national policy makers and experts familiar with exercising ex-ant policy evaluation studies (as documented in van Sluisveld et al. (2016)).

As rich literature is already available on the evolution of national policies over time (see for example Fabra et al. (2015); IEA (2013, 2014); Notenboom et al. (2012)), the qualitative evaluation does not attempt to provide an exhaustive overview of previously or currently implemented policies on the national level. Instead, the analysis attempts to provide a new analytical perspective on *how* long-term planning for climate and energy policy and ex-ante policy evaluation has been embedded within various national contexts and *what* can be learned from a cross-comparison.

2.2 Quantitative evaluation of ex-ante policy evaluation studies

Various tools are available to provide policy-makers with policy decision support, ranging from very simple to advanced and formalized tools. Model-based scenario analysis is a frequently used analytical instrument to quantitatively evaluate long-term climate policies, although literature recognizes other tools and methods in policy assessment (Nilsson et al., 2008).

All the countries under study have proven experience in utilising model-based scenario analysis to underpin policy decisions in the past. To consider whether the selected countries diverge in systematic ways in utilising model-based scenario analysis we compare a variety of existing model-based scenario studies. We distinguish between two types of model-based scenario analyses; those designed by (national) research groups to look into national developments over time (national model-based scenario studies) and those that have been designed to study broader developments throughout Europe as a whole (European model-based scenario studies). The former category represents how

long-term perspectives are investigated in the national context, whereas the latter category is of interest to provide a useful reference for the national model-based studies as they use a consistent method for all European countries. In the following sections we will describe both categories in more detail.

2.2.1 National model-based scenario studies

To understand how model-based scenario analysis is utilised in ex-ante policy evaluation studies, we draw insights from existing model-based ex-ante policy evaluation studies as specific national ex-ante policy evaluation studies as part of the new EU legislation are yet to be submitted to the EU Energy Union. For practical reasons, we have selected one representative national ex-ante policy evaluation study per country, illustrating a number of policy scenarios in line with the EU 2050 ambitions. To warrant the representativeness of the current national policy discourse for long-term planning in these studies, we selected studies that (1) are conducted relatively recent, (2) include a time horizon of up to 2050 (3) include quantitative detail with regard to their respective assumptions and results, and (4) could be regarded as studies with high formal status (authoritative) in each country (see Table 1 for an overview of selected studies).

Table 1 - Overview of resources used and their defining characteristics.

	Denmark	France	Germany	The Netherlands	United Kingdom
Contributing Institute(s)	Danish Energy Agency	ANCRE	Öko-Institut Fraunhofer-ISI	PBL / CPB	UCL / UKERC
Mitigation scenarios [number consistent with EU 2050 goal]	4 [4]	4[4]	2 [2]	4 [2]	5 [2]
Year of publication	2014	2014	2016	2015	2016

For *Denmark*, we have selected the multi-pathway assessment of the Danish Energy Agency (2014). As the Danish Energy Agency (DEA) is a governmental agency, national model-based analyses by the DEA have usually been subjected to approval processes involving the minister and various stakeholders and research institutions, which creates some legitimacy to being representative for the Danish future outlook. Moreover, all the scenarios in this study aim for a fossil-fuel independent energy system, which is consistent with the current policy direction.

For *France*, we focus on four marker scenarios which have been identified during the *National Debate on Energy Transition* in 2013 (Grandjean et al., 2014). These scenarios have been drawn from fifteen pre-existing French national energy scenarios that include an outlook towards 2050, which have been created by multiple private and public research and governmental agencies. The marker scenarios represent four stylised pathways towards meeting the French GHG emission reduction target of 75% in 2050, which differ in focus on how to transform the French energy system (varying in terms of high and low energy demand reduction, and high and low shares for nuclear energy in total power supply).

As a representative *German* national scenario study, we have selected the "*Climate protection scenario 2050*" study (Öko-Institut / Fraunhofer ISI, 2016). Within this study two scenarios are provided that respectively aim for 80% and 95% GHG emission reductions by 2050 relative to 1990 levels, without deploying nuclear energy and carbon capture and storage technologies in power supply. The scenarios have been commissioned by the *Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety* (BMUB), and developed in a research consortium as part of a broader modelling

exercise (see e.g. Öko-Institut / Fraunhofer ISI (2014, 2015, 2016)), linking a variety of different modelling instruments with different focus areas together (Hillebrandt et al., 2015).

As a representative *Dutch* national scenario study we have selected two scenarios from the '*Welvaart en Leefomgeving'* study that align to the EU 2050 ambitions of meeting the 80% GHG emission reductions (*Centraal* and *Decentraal)* (Matthijsen et al., 2015). The scenarios were commissioned by the *Ministry of Economic Affairs* and the *Ministry of Infrastructure and Environment* and provide the analytical underpinning for the Dutch long-term vision as presented in the *Energy Agenda* for 2050 (Ministry of Economic Affairs, 2016a).

For the *United Kingdom* we have selected the scenarios by McGlade et al. (2016) that meet the 80% GHG emission reduction target (respectively *Maintain* and *Maintain (Tech fail)*) as representative national scenarios for this study. These scenarios respect official UK short-term and long-term targets on emission reductions and have been produced by the same model (UKTM) as the one used to inform decisions about the *fifth carbon budget period* (Pye et al., 2015). The scenarios embed explicit assumptions on not allowing new capital construction for coal (*Maintain*) and assuming no commercialisation of carbon capture and storage (CCS) technologies in the near future (*Maintain (tech fail)*). One unpublished additional scenario of the same modelling exercise has been included (*Late catch-up*), representing higher emissions during the *fifth carbon budget period* but higher mitigation efforts after 2035.

2.2.2 European model-based scenario studies

Complementary to the national model-based scenario studies, we also include the outcomes of European model-based scenario studies. European model-based analyses allow us to gain further insights on the relation of cross-border topics to meeting a collective EU objective, such as the trade of electricity and effort sharing. For this study we draw from the multi-model inter-comparison project EMF28 (Weyant et al., 2013); a project by the *Energy Modelling Forum* that specifically focused on the European policy context. Thirteen energy-economy models participated within this project to assess long-term pathways under harmonized assumptions about policy targets and technological availability.

We have selected one scenario that considers optimistic assumptions on technological availability, techno-economic improvements for renewable energy technologies, nuclear power deployment based on merit and cost-performance and an energy intensity improvement of 20% relative to business-as-usual assumptions (denoted as "80% EFF" in Knopf et al. (2013)). The "80% EFF" scenario has been selected for its comparability to the European and national policy directions for the selected countries in *this* study, both in terms of respecting the collective EU GHG emission reduction goal in 2050 (80%) as well as in aligning with considered national low-carbon strategies without foreclosing any specific ones over time (such as nuclear energy and CCS deployment) (Knopf et al., 2013). Differences occurring between the European model-based projections and the depicted national projection could originate from, amongst others, 1) the use of different models, 2) the use of different (national) statistics, 3) different interpretations of specific national policies and 4) differences in assumed long-term national ambitions and international collaboration.

3 Results

3.1 Qualitative evaluation of national policy planning

To consider the governance of ex-ante policy evaluation in long-term planning across a variety of north-western European countries, the following section will focus on the institutional arrangements and the distribution of knowledge and skills used to underpin long-term policy choices. Additional insights are drawn from notable occurrences in which (public) stakeholders have been involved in long-term policy planning processes. The results have been summarised in Table 2.

Table 2 - Overview of national policy planning contexts and ex-ante evaluation configurations per country.

	Denmark	France	Germany	The Netherlands	United Kingdom
	Governance of ex-ante policy evaluation				
2050 policy plan (year of publishing)	Energy Strategy 2050 (2011)	National Low-carbon Strategy (2015)	Climate Plan 2050 (2016)	Energy Agenda (2016)	Carbon Plan (2011)
Institutional arrangements (Year of adoption)	Climate Change Act (2014)	Energy Transition for Green Growth Act (2015)	None (but decisions require inter-ministerial approval)	None (proposed)	Climate Change Act (2008)
Advising body (year of establishment)	CCC (2015)	CETE (2015)	No (but inter-ministerial approval)	No (but part of 'planning agencies')	CCC (2008)
Explicit ex-ante evaluation in policy design	Yes	Yes	Yes	Indicative planning	Yes
	Distribution of ex-ante evaluation knowledge and skills				
Government institutes	Yes	Yes	No	Yes	Yes
Academic institutes	Yes	Yes	Yes	No	Yes
Other institutes	Yes	Yes	Yes	Yes	Yes
	Stakeholder engagement				
Public dialogue (Year)	Yes (2009)	Yes (2013)	Yes (2015)	Yes (2015)	Yes (2011)

3.1.1 Governance of ex-ante policy evaluation

Denmark has a long history in devising model-based scenario analysis as an instrument to underpin long-term strategies, as is demonstrated in the national renewable energy plans (NREAP) (Ministry of Climate and Energy, 2010) and energy efficiency action plans (NEEAP) (DEA, 2014). However, only since the establishment of the *Climate Change Act* (2014), ex-ante policy evaluation has become more formally embedded within the institutional arrangements for long-term national climate policy planning. This is also reflected in the founding of a Danish Council on Climate Change (CCC), which is responsible for the continuous evaluation of the national movements to meeting national climate objectives and international climate commitments. The Danish CCC may also advise on further needed action in meeting the national 2050 objective (Sørensen et al., 2015).

The *French* long-term climate and energy ambition has been embedded in the *POPE-law* since 2005 (75% GHG emission reductions in 2050 compared to 1990, also denoted as "factor 4"). However, only until more recently, additional specific details on the planned course of development have been formally embedded and described in the *Energy Transition for Green Growth Act* (*Loi de Transition*

Énergétique pour la Croissance Verte, LTECV) (Ministry of Ecology Sustainable Development and Energy, 2015a). In preparation of the LTECV, the French national government devised nation-wide stakeholder dialogue sessions to take stock of the visions on long-term development along the "factor 4" objective (DNTE, 2013). Model-based analyses by stakeholders have provided input to these dialogue sessions, and have been found to have influenced the shaping of the LTECV (Argyriou et al., 2016; Mathy et al., 2015; Sartor et al., 2017). As part of the institutional arrangement, the LTECV formalised the establishment of a rotating independent expert committee (*Comité d'experts pour la transition énergétique,* CETE). The CETE is appointed for the course of two years at a time to assess the progress of implementing the national low-carbon strategy (Ministry of Ecology Sustainable Development and Energy, 2015b; n°2015-992, 2015).

In *Germany*, a number of long-term model-based scenario analyses have been commissioned over the years by many different stakeholders, including federal and regional government ministries, environmental NGOs and industry associations (see for an overview Fabra et al. (2015); Hillebrandt et al. (2015)). The recent *Climate plan 2050 (BMUB, 2016a)*, outlining Germany's national low-carbon strategy up to 2050*,* builds on the knowledge of several of these studies (see e.g. Haller et al. (2015)). The "*Climate Protection Scenario 2050*", also selected in this study, most likely played a crucial role in the planning process, as (1) it reports on emissions of energy use and all other GHG sources and (2) respects several normative restrictions to parallel with existing climate policy and ministerial preferences (such as a nuclear phase-out, the availability of carbon removal technologies for process industry alone and limiting the deployment of biomass via the "access rights concept"). Instead of formalising long-term ambitions into law, Germany has appointed one ministry with the responsibility to develop policies along the communicated long-term ambitions, with established inter-ministerial approval procedures to accredit long-term strategic documents.

For *The Netherlands*, ex-ante policy evaluation has not had a formal role in long-term planning processes and the political debate on long-term national low-carbon pathways has been limited. Although the *Ministry of Economic Affairs* has a history in commissioning model-based policy evaluation assessments of current and planned policies (Daniels and Kruitwagen, 2010; Schoots et al., 2016), these perspectives do not stretch out beyond the 2020-2035 period. Some perspective towards 2050 is offered via indicative (linear) pathways describing the leeway between "extended policy" and "additional policy" in 2023 and a 80% GHG emission reduction goal in 2050 (Ministry of Economic Affairs, 2016b). Although national long-term ambitions are not embedded in law, a proposal for a *Climate Change Act* has been submitted to the Dutch parliament in January 2017. The proposed *Climate Change Act* would set binding GHG emission reduction targets for 2030 (55%) and 2050 (95%), while formalising a five-year policy revision cycle and a monitoring authority (Beunderman, 2017).

By enacting the *Climate Change Act* (Climate Change Act 2008 (c. 27), 2008) in 2008, the *United Kingdom* had established an institutional framework that embedded long-term climate ambitions and ex-ante policy evaluation more firmly into law and policy. The *Climate Change Act* required the implementation of a long-term emissions reduction target and a series of carbon budget periods to be legislated by the national administration, following advice from an established Committee on Climate Change (CCC). Hence, to underpin strategic energy and climate policy statements and to quantify the subsequent carbon budgets the UK government has routinely been using model-based scenario analyses. For example, the fourth carbon budget period has been underpinned by six model-based

scenario analyses (DECC, 2011), whereas the fifth carbon budget period is supported by four model-based scenario analyses (DECC, 2015).

3.1.2 Distribution of ex-ante policy evaluation knowledge and skills

Denmark's modelling skills are spread over a wide variety of institutions partaking in the development of national energy scenarios and models, ranging from universities, research institutions, consultancies and governmental agencies (see e.g. Lund et al. (2011); Mathiesen et al. (2015)). Although the ex-ante policy evaluation studies of the Danish Energy Agency are considered the lead contender in informing Danish policy planning processes, other research groups may be consulted, depending on the focus of each individual analysis.

In *France,* various research institutes and universities have been united in the *French National Alliance for Energy Research Coordination* (ANCRE). ANCRE contains a thematic group that embodies modelling and model-based analysis, which has contributed to the planning of national energy strategies in the past. As such, the ANCRE alliance has mostly been responsible for providing the analytical underpinning for policy planning processes since its establishment, such as during the earlier described nation-wide stakeholder dialogue sessions, the *LTECV* and further outlines of the LTECV in policy (ANCRE, 2016; Argyriou et al., 2016).

In *Germany*, model-based analysis is outsourced to external independent bodies which are spread over different scientific institutions (e.g Öko-Institut, Fraunhofer-ISI, DLR German Aerospace Centre), consultancies and academia. The government is in that sense a client, supporting the construct via calls and tenders, allowing for continuity in the field of research regardless of the administration in power. However, through this funding, the government has a certain authority over the direction of the research and modelling being carried out. Although the ambitions presented in the recently published *Climate Plan 2050* is presumably based on a multiplicity of model-based ex-ante policy evaluation studies, they are generally only used for strategic planning.

For t*he Netherlands,* only a limited number of national decarbonisation studies exist that cover the entire energy system. These studies have predominantly been compiled by the Dutch 'planning agencies' (Janssen et al., 2006; Manders and Kool, 2015) or in collaboration with (energy) research institutes as part of broader ex-ante policy evaluation framework looking into the long-term development of the Netherlands (e.g. PBL/ECN (2011)). The national model-based ex-ante evaluation capabilities are currently mostly used to assess the implications of current and planned policies in the near term (up to 2035).

In the *United Kingdom*, many of the ex-ante policy evaluation capabilities are held by academic departments, research networks, governmental departments and consultancies (including former government research institutes) (an overview is given in Strachan (2011a); Strachan (2011b)). Only a few models are routinely used for long-term policy planning in the UK, for which the UK MARKAL family of models has provided the underpinning of insights on long-term low-carbon planning from 2003 to 2013 (Committee on Climate Change, 2016; Pye et al., 2015; Strachan, 2011a). The UK MARKAL model has been succeeded by the UK TIMES model, which has been used to inform the setting of the *fifth carbon budget* period (Anandarajah et al., 2013).

3.1.3 Stakeholder engagement

Denmark has carried out participatory processes with stakeholders in service of the Danish *Energy Strategy 2050* (2011), exploring long-term perspectives based on multiple seminars mobilising over 1600 participants (Lund and Mathiesen, 2009). Although such processes have built social capacity for long-term national low-carbon depictions, they are mainly used for strategic planning and have not had a formal role in policy.

In *France*, the *National Debate on Energy Transition* (DNTE, 2013) had mobilised various stakeholder groups (academia, industry and NGOs) to develop a framework that clustered multiple existing model-based ex-ante policy evaluation studies into four stylised long-term energy transition scenarios. These four scenarios have been subjected to a multi-criteria assessment in a broader participatory process with stakeholders (a council of 112 members from 7 stakeholders groups), which delivered the identification of a preference order for the considered long-term futures. The first-best option of this participatory process has presumably been adopted in the LTECV (Argyriou et al., 2016; Grandjean et al., 2014).

To gain broader societal consensus for the *Climate Plan 2050*, *Germany* had consulted over 500 stakeholders within federal states, municipalities, industry, interest groups and civil society via multiple participatory methods (respectively via various on-site and online dialogue sessions with stakeholders and the public). The broader (public) stakeholder engagement delivered 97 climate action measures in service of the national 2050 decarbonisation ambitions, which have been collected and published in the "*measurements catalogue*" (BMUB, 2016b). The modelling suite used for the "*Climate Protection Scenario 2050*" supported the (governmental) stakeholder sessions by providing quantitative assessment for the proposed measures (BMUB, 2016b). However, the national dialogues have not led to new comprehensive ex-ante evaluation studies or changes to long-term policy planning.

The Netherlands has no formal embedding of civil society or stakeholders in ex-ante policy evaluation studies toward 2050, which remain mostly a product of the Dutch 'planning agencies'. However, the annual report assessing current and planned policies (Schoots et al., 2016) utilises a broad consortium of modellers, policy analysts and experts to come to independent advice. Separate of ex-ante policy evaluation procedures, the Dutch government had initiated the *Energy Debates* in 2016, inviting multiple governmental representatives, businesses, research institutes and network organisations across the country (representing 72 organisations and 3000 people in total) to share possible solutions to meeting long-term ambitions for 2050. The outcomes of these *Energy Debates* are expected to be used in the formulation of the *Energy Agenda* (Dutch Government, 2016).

The *United Kingdom* draws insights from a wider range of sources than the routinely used model-based evaluation tools, such as expert judgments and other types of analysis (CCC, 2016). For example, some stakeholders have developed their own ex-ante policy evaluation studies, such as the *Energy Technologies Institute*, a public-private partnership maintaining the ESME-model, and the National Grid, supported by its own in-house model. Moreover, in 2010, the UK government launched a public engagement programme to open a public dialogue on how the UK should meet its legally binding targets in 2050. The engagement programme resulted into three local deliberative dialogue sessions

utilising the '*2050 Energy Calculator'* tool[1], an online carbon accounting tool developed by the former *Department of Energy and Climate Change* (DECC). Simultaneously, the broader public was engaged via the '*My2050'* serious game interface[2], which engaged over 10.000 participants in using a simplified version of the 2050 calculator. The results have been used to inform policy makers about specific preferences, as well as to inform about patterns in the variation of answers (Comber and Sheikh, 2011).

3.1.4 A quantitative comparison of national ex-ante policy evaluation studies

In this section we compare the actual contents of a selective draw of national representative model-based policy evaluation studies for each Member State. Although the reports written along the selected model-based scenarios vary in style and level of provided quantitative detail, a few common metrics have been identified throughout the studies (respectively greenhouse gas emission reductions, the share of renewable energy in electricity production and total primary energy reductions). These common metrics allow for a cross-comparison between the national studies. To gain additional insights into the considered national developments in a broader European perspective, we portray the representative national model-based scenarios together with the European model-based scenarios (see Figure 7-1).

In relation to total GHG emission reductions, all studies depict an overall similar GHG emission reduction rate for 2030, fluctuating around 50% compared to 1990 levels. The national model-based studies are therefore observed to exceed the EU ambitions (40%) over the near-term, while broadly abiding by the nationally imposed targets. Interestingly, over time the national policy ambitions show to anchor to the EU 2050 ambitions, with a predominant focus on meeting the lower level in the 80%-95% EU 2050 objective. Some exceptions to this rule are found for France (aiming for 75% GHG emission reductions, as described in the LTECV) and Germany (which also explores a pathway towards 95% GHG emission reductions). However, it should be noted that these conclusions can be considered as rather contentious, given our deliberate choice to only select mitigation scenarios aligned with the EU 2050 objective.

[1] http://2050-calculator-tool.decc.gov.uk/
[2] http://my2050.decc.gov.uk/

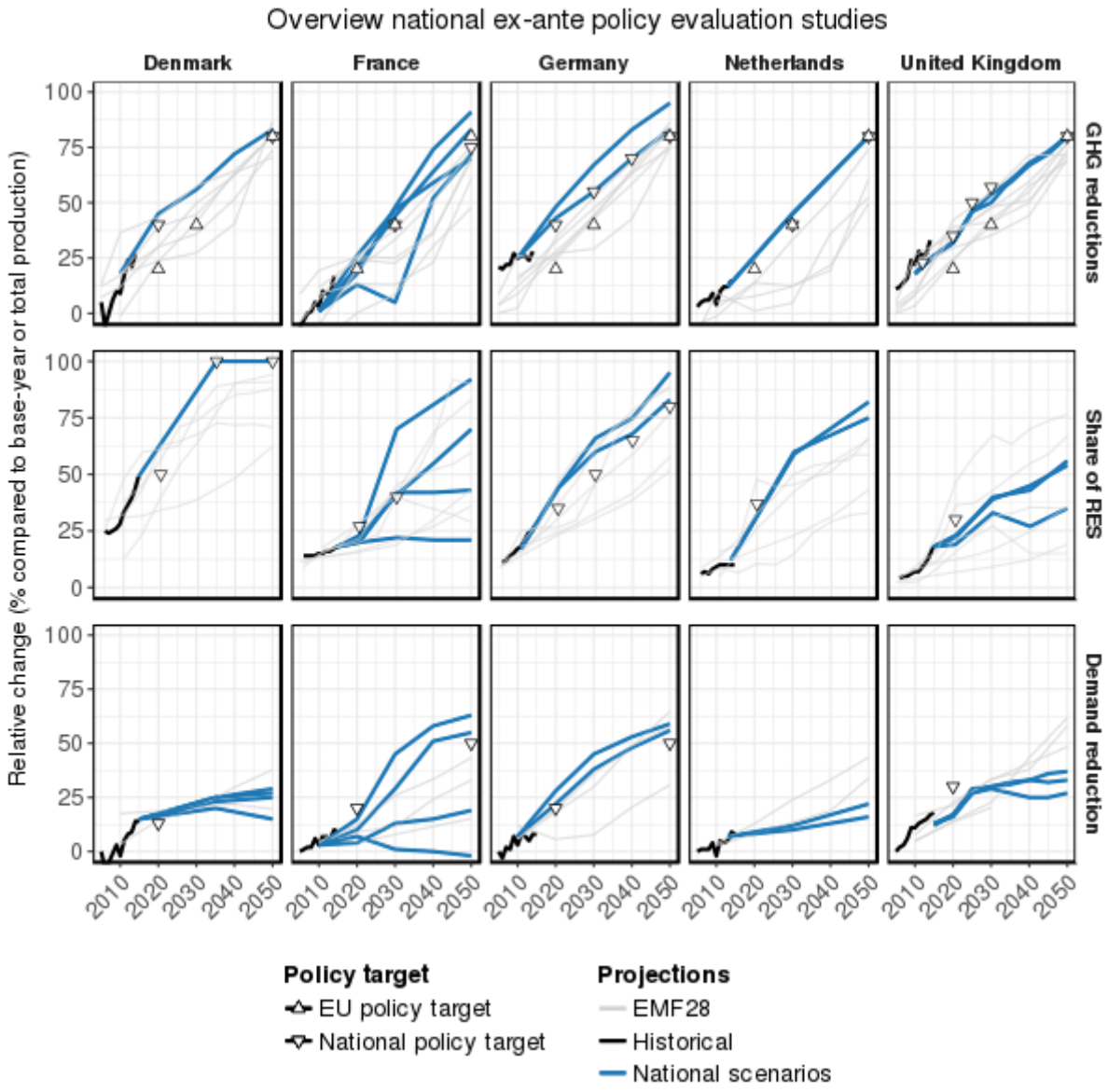

Figure 1- Overview of national low-carbon strategies considered per country, GHG reductions compared to 1990 levels, share of RES represents renewable energy supply in total power generation, demand reduction considers total primary energy demand reduction compared to 2005. Historical references for GHG reductions, renewable energy shares in power production and primary energy reduction retrieved from respectively (Eurostat, 2014a, b, c). Denmark, Germany and Netherlands include GHG emissions of all sectors (excl. LULUCF). Historical reference for France only includes GHG emissions of the energy sector. Historical reference for GHG emissions for the United Kingdom includes all sectors (incl. bunkers), difference with historical data is attributable to differences in accounting and rounding of values. National GHG policy targets for the Netherlands represent the 2030 conditional pledge of 40% (Dutch Government, 2013) and the communicated value for 2050 in the Energy Agenda (Ministry of Economic Affairs, 2016a).

We devise the share of renewable energy in electricity production as a first indicator to draw insights on the overall course of development for the power supply sectors for each country. The selective draw in representative national model-based scenario studies yielded a variety of different perspectives on future power system change. Remarkable for Denmark is that the four included representative national scenarios all reflect similar trajectories towards achieving a full renewable power system by 2035. The study thus represents a discussion on the to-be considered resources towards this objective, describing various combinations of wind power, bioelectricity and hydrogen in the electricity mix. Conversely, the French representative national scenarios show a wide range in

possible low-carbon transition routes, all designed around different considerations for the current nuclear capital stock. The national model-based scenarios have therefore been used to explore a potential switch from nuclear energy to renewable energy technologies (Grandjean et al., 2014). For Germany, as a result of explicitly exempting technologies such as nuclear and carbon removal (CCS) technologies in power generation for all scenarios, shows to depict a relatively strong orientation towards renewable energy technologies in power production. Regardless of the climate objective assumed, the German scenarios show to favour the deployment of wind over solar power by 2050 (Öko-Institut / Fraunhofer ISI, 2015). The Netherlands reflects a similar development trajectory for renewable energy technologies in power production as Germany, though adding more weight to bioelectricity use, CO_2 removal and demand reduction. The UK scenarios depict a lower renewable energy share in power production over time compared to other countries, partly because the contribution from renewables has been historically one of the lowest in the EU. The depicted scenarios mostly reflect combinations of offshore wind and nuclear power generation.

Large differences are also depicted for the primary energy demand reductions between countries and between scenarios, ranging from no reduction in demand for one of the French scenarios to more than 50% reduction in the French and German scenarios. However, the demand reduction projections may be influenced by (1) the way in which the models are structured (as most techno-economic modelling exercises focus on fuel substitution rather than demand reduction – albeit some explicit assumptions on demand reduction are included in the French scenarios) and (2) a statistical artefact in primary energy accounting (which puts intermittent technologies in a more beneficial position than other decarbonisation technologies). Particularly the latter creates major difficulties in comparing primary energy reductions between scenarios with a stronger focus on renewables energy implementation to scenarios that prescribe a greater role to nuclear and CCS.

The EMF28 scenarios provide alternative national perspectives in the light of broader European developments to meeting long-term the EU 2050 objective. Overall the EMF28 scenarios depict wider ranges of national pathways consistent with the (collective) EU commitment for 2050. One reason for this broader range could be that the representative national scenarios do not (fully) devise the option to make use of the EU internal market, which is the case for the participating models in the EMF28 modelling exercise. As a result of effort sharing principles devised in European modelling frameworks, several national-level projections may thus be higher or lower than currently considered within the national context.

4 Discussion

The EU 2030 governance scheme and the long-term national climate and energy plans as requested by the EU Energy Union are intended to provide long-term predictability and certainty to meeting the European objective (European Commission, 2015). However, despite an overall trend of national governments to embrace ambitious policies and legal frameworks, regulatory stability to meeting long-term policy goals provides no guarantee for coherent and consistent policy. This has been relatively recently demonstrated by the UK government, which has shifted the long-term decarbonisation orientation from a focus on all available low-carbon technologies (as was also modelled in an earlier publication of UKERC (2013)) to the prioritisation, at least in the short-term, of nuclear energy and

offshore wind. As model-based ex-ante evaluation exercises can only react to, rather than anticipate on, such change in policy, evaluation studies need to be re-evaluated on a frequent basis.

Moreover, the current study finds that national model-based scenario analyses pay little attention to the developments in (or interaction with) other countries. As explicit identification of regional cooperation opportunities are asked under the EU Energy Union governance scheme (EC (2016), art. 11[2]), this would call for further methodological development of model-based ex-ante policy evaluation practices. Considering how all national scenarios assigned a significant role to intermittent electricity production, this may raise questions about how production is balanced to meet demand if not closely attuned with neighbouring countries (EC (2016), art.19[7]). A similar statement can be formulated for biomass imports (EC (2016), art.18[2]), for which varying assumptions about biomass availability have been used in the different national models.

Furthermore, model-based scenario analysis may be considered to have a vital role in pushing (non)governmental stakeholders in thinking beyond conventional solutions (Voinov and Bousquet, 2010). By expanding the focus to other scientific or policy-relevant concepts, rather than limiting the scope to descriptive scenarios bound by national targets, it would allow for broader learning on the (un)available necessary change and future potential among modellers, decision-makers and stakeholders. Particularly in the light of the observed misalignment of national ambitions with global long-term commitments (Kuramochi et al., 2016; UNEP, 2016) and uncertainties in the depicted large-scale deployment of several technologies in model-based scenarios, this would drive further methodological development and usefulness of ex-ante policy evaluation.

Finally, the combination of model-based scenario analysis with broader stakeholder interaction has yielded notable result in France. As recognised in literature, co-creation via broader stakeholder engagement may allow for mutual learning between modellers and stakeholders, while simultaneously generating legitimacy and social acceptance for specific transition pathways towards 2050 (Kowarsch, 2016; Voinov and Bousquet, 2010). The French example provides evidence that on-site interaction between modellers and the (stakeholder) audience may have been crucial in achieving this, as approaches that offer no direct feed-back, such as the My2050 online platform in the UK, have been considered as rather ineffective (Allen and Chatterton, 2013).

5 Conclusions

In this study we have elaborated on the ex-ante policy evaluation efforts exercised by five EU Member States. In order to deduct insights on the regulatory and institutional arrangements for ex-ante policy evaluation we have systematically looked at (1) the governance of ex-ante policy evaluation efforts, (2) the distribution of knowledge and skills for ex-ante policy evaluation and (3) the involvement of (public) stakeholders. In a subsequent step we quantitatively compared representative national model-based scenarios and European-wide scenarios to assess their (1) alignment to communicated long-term ambitions and (2) the relative differences among the group of EU countries. We draw the following insights and identify the following good practices:

The regulatory and institutional arrangements for long-term planning, including the use of scenario studies, have been organised very differently in the five included Member States

Effective and durable coordination of long-term ambitions over time is considered to be built on (1) strengthened institutions (interpreted as the embedment of long-term ambitions or intermediate targets into laws and regulations on the national level), (2) expanded resources and capacity and (3) frequent ex-ante policy evaluation efforts (Hovi et al., 2009). The research revealed that the studied five Member States have organised their long-term planning and evaluation practices very differently, resulting into varying levels of policy consistency and transparency for planning towards 2050. In regard to ex-ante policy evaluation, the United Kingdom has institutionalised a reoccurring model-based evaluation cycle over time which allows for adaptive policy planning. Alternatively, France mobilised bottom-up research activities and (stakeholder) collaborations, resulting into greater legitimacy for model-based evaluations and a presumable adoption into policy. Denmark is characterised as a country a clear societal preference for a certain transition pathway, which are then reaffirmed and further deepened with model-based analysis. The German government outsources evaluation practices to independent research organisations, yet uses the outcomes mostly for strategic planning. In the Netherlands ex-ante policy evaluation has concentrated only around a few model-based studies, leading to a low frequency in ex-ante policy evaluation efforts and limited transparency in the considered transition pathway towards 2050.

The closed-system approach in national model-based ex-ante policy evaluation excludes perspective on broader European and global developments

The representative national model-based studies revealed that national studies varied in depth, composition, and embedment into policy design. Interestingly, due to the national resolution, all Member States exposed a rather closed-system approach by focusing only on developments on the national level. As such, all studies paid little attention to the developments in (or interactions with) other countries. Further methodological development in ex-ante policy evaluation processes and cross-border collaboration is therefore recommended as to share and react on considered assumptions on, for example, biomass imports and energy market developments. Further work could also consider broadening the research scope, either via (1) including additional (global) objectives next to national objectives to strengthen the analytical understanding of required transformative change over time and (2) participatory modelling exercises with stakeholders as to draw societal capacity and legitimacy for a specific long-term trajectory towards 2050.

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