PBL Netherlands Environmental Assessment Agency

AN ESSAY ON THE COLOURFUL SCENE OF EUROPE'S ENERGY TRANSITION

Modernising the energy system under the pressures of supply and competitiveness concerns and the growing urgency to decarbonise

Policy Brief

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Modernizing the energy system under pressure of supply and competitiveness concerns and the growing urgency to decarbonize

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'Tackling climate change requires thinking over a long period of time, and there's always risk, for any government, and always a temptation, for any government, to think about very short time periods and the immediate, very real, political and other pressures of the current day (Matthew Bell, UK Committee on Climate Change) [1]'.

KEY FINDINGS

In the light of Europe's ambition to substantially reduce its greenhouse gas emissions towards 2050, this essay provides a helicopter view of national climate and energy policies in the EU-28. The essay is written to support the efforts by the Social and Economic Council of the Netherlands (SER) to share experiences with cooperation and public support for energy transition in European member states.

National energy and climate policies play a substantial role in the transition towards a low-carbon energy system. We considered these policies with respect to their ambitions, goals, and driving forces, also taking the structure of the current energy system into account, which led to the following main findings:

- Energy security, affordability and competitiveness are the dominant issues in most national policies. Climate change mitigation and substantial reductions in greenhouse gas emissions (decarbonisation) are seen as important but are seldom the key drivers.

- The EU climate and energy package for 2020 has a considerable impact on the national policies of all Members States. The most striking aspect is the growth in renewable energy across the EU-28. However, this growth is not necessarily associated with a reduction in greenhouse gas emissions.

- Renewable energy has a broader support base, it contributes to the reduction in fossil fuel imports, provides new opportunities for regional economic development, and is a trigger for innovation and for new business models. The growth in renewable energy is perceived very differently by the various actors across the EU-28. Some consider renewable energy an essential part of an economic modernisation strategy, while others emphasise the related high subsidy costs and stress the need for a careful approach.

- Countries who started early with reforming their energy systems, mostly by combining renewable deployment and energy efficiency improvements, did this against relatively high costs. This, nevertheless, has not seemed to have hurt their economy.

- In not a single Member State has national energy and climate policy as yet developed into a coherent long-term decarbonisation strategy. If the energy transition is understood to be the structural change of the current energy system towards a low-emission energy system, then the conclusion must be that this transition apparently is still in its infancy. Some Member States have started this process, but most have yet to begin.

- The EU 2020 policy framework has greatly impacted energy and climate policies in most Member States. The 2020 approach has strong top-down elements, the most evident being the EU-determined national targets for renewable energy. The policy framework will change, post-2020, towards a system with stronger bottom-up elements, giving Member States greater flexibility. Whether the post-2020 framework will deliver the EU decarbonisation goals for 2030 and 2050, depends on the collective efforts by the Member States. The post-2020 framework shows the promise of cross-sector integrated energy and climate policies, with a clear long-term orientation and clarity, and greater collaboration between Member States, but this is not self-evident.

1 Introduction

Europe has the ambition to reduce its greenhouse gas emission substantially towards 2050. The EU has agreed on a reduction of 80% to 95% by 2050 and on intermediate goals of 20% by 2020 and 40% by 2030, all relative to 1990. The international climate agreement of Paris has lent support to this reduction pathway and even stronger reduction efforts may be required, in order to limit global warming to well below 2 °C and to enter into a post-2050 carbon-neutral world.

Such a reduction in greenhouse gas emissions requires structural changes to the way our energy systems function and are organised. The transformation of the current energy system into a low-emission system, here, is called the 'energy transition'.

Energy policies traditionally aim for secure and affordable energy. The awareness of climate change and the task to reduce greenhouse gas emissions is an additional dimension of these policies. Energy transition introduces structural directional change in energy policies needed over a long period of time. It introduces new sources of uncertainty with impact on investment and planning certainty. However, energy transition is also associated with economic opportunities and has the potential to be an innovation-based economic modernisation approach.

Actually, all EU Member States are at the beginning of their energy transformation process, with some lagging more behind than others. Energy policy in the European Union is an area of shared competences between Member States and European institutions. Consequently, national policies are an important component of the set of policies that shape the structural change aimed at the decarbonisation of Europe.

Within the scope of this essay, we will outline the structure of energy and climate policies across the EU-28. Our emphasis will be on targets and underlying considerations, preferences and driving forces. Given the many countries and the complexity of policies and debates on energy and climate, this essay can be nothing more than a snapshot. It aims to increase understanding of the different approaches and positions of Member States.[1]

Our focus here is on the following set of questions:

- What do national energy transition strategies look like, with regard to the integration of climate in energy policy, ambitions, preferences and targets?
- What common challenges can be identified?
- What can we learn from each other and how can we collaborate?

[1] The vast and very relevant area of policy instruments, their design, implementation, efficiency and effectiveness will remain largely out of the scope of this paper. Although we have sincerely tried to look at all relevant developments in EU Member States, due to limitations in our knowledge and ability to access national policy documents there is an emphasis on north-western European countries. We apologize for this bias in description, but think overall conclusions are valid for all Member States.

2 Current situation

Member States greatly differ in the structure of their energy systems and other economic, political and social circumstances. Such differences affect the choices they have made in their energy and climate policies and the success of these policies towards the energy transition.

In 2013, fossil fuels supplied more than 70% of the EU-28's energy consumption, of which 33.4% in oil products, 23.2% in natural gas and 17.2% in solid fossil fuels. The share of nuclear heat was 13.6% and renewable energy accounted for 11.8%. The most evident trends since 1990 are a decrease in the share of solid fuels (hard coal and lignite) and an increase in that of renewable energy and natural gas [2].

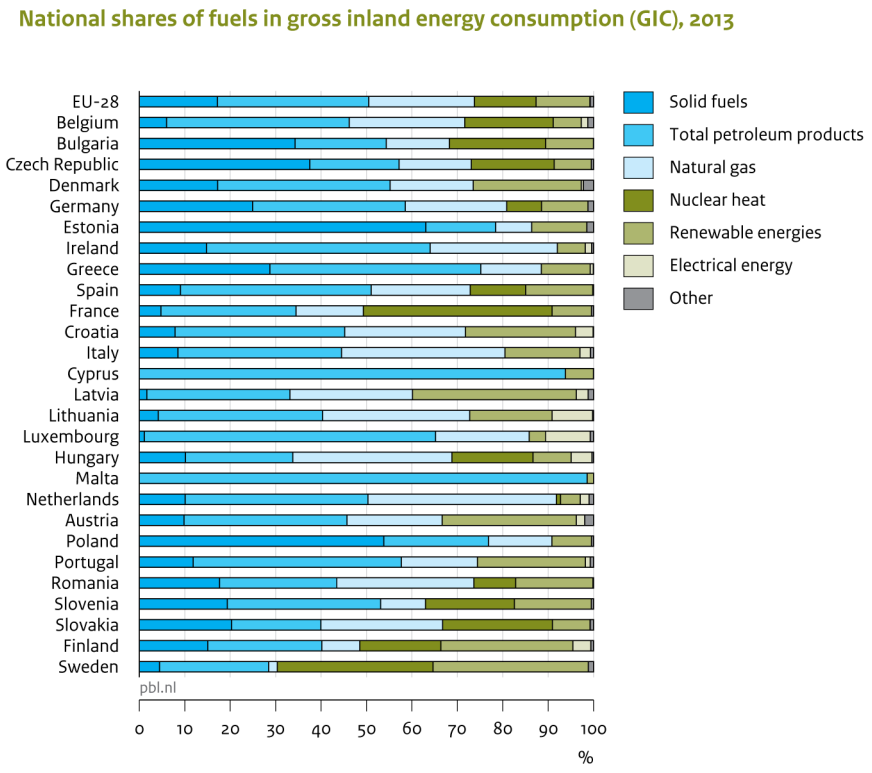

Figure 1 Fuel mix across the EU-28. Source: Eurostat

The composition of the current fuel mix of the EU Member States differs considerable (Figure 1). Solid fossil fuels covered the national energy consumption above EU-28 average in Estonia, Poland, Czech Republic, Bulgaria, Greece, Germany, Slovakia, Slovenia, Romania, United Kingdom and Denmark. The biggest share of oil products in gross domestic energy consumption are seen in Malta, Cyprus and Luxembourg. Natural gas has a share of over 30% in the Netherlands, Italy, Hungary, United Kingdom and Romania. Nuclear power is part of the domestic energy mix in 14 EU Member States, France has the largest share, followed by Sweden. Renewable energy covered more than 20% of the domestic energy consumption in Sweden, Latvia, Austria, Denmark, Finland, and Portugal.

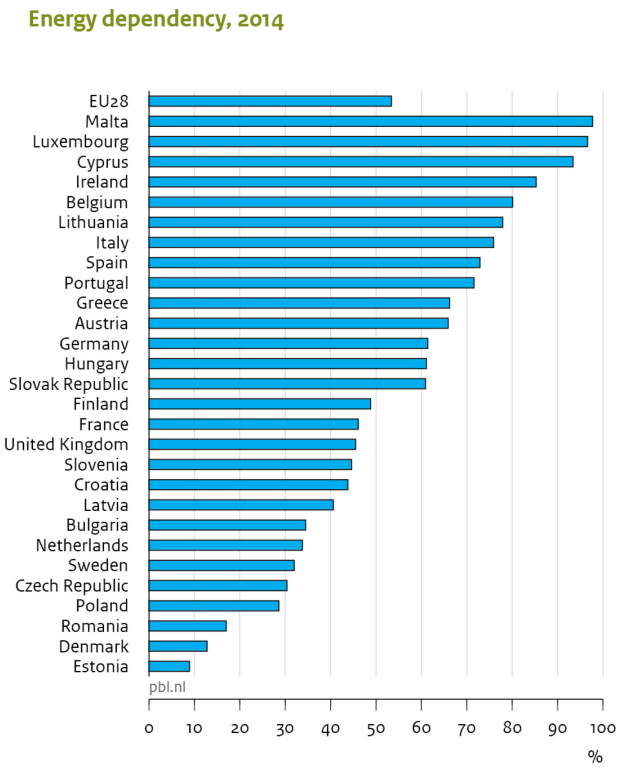

Figure 2 Energy dependence across the EU-28 (net imports divided by the sum of gross domestic energy consumption plus bunkers). Source: Eurostat

Over the past decade the primary energy production in the EU is decreasing, with the consequence that the EU is now relying more on imports for its energy supply. Differences in energy dependency between Member States, however, are large; Malta, Luxembourg, Cyprus and Ireland depend on imports for more than 80% of their domestic energy consumption, in Romania, Denmark and Estonia this is less than 20% (Figure 2).

Only few Member States have substantial domestic energy resources. The United Kingdom and the Netherlands have the highest production levels of natural gas, but these levels are diminishing. Germany, Poland and the Czech Republic have the highest production level of hard coal and lignite. Nuclear heat is produced by half of the 28 EU Member States. France has by far the largest nuclear energy production, other countries with relatively high levels of production are Belgium, Germany, Spain, Sweden and the United Kingdom. Countries with a renewable energy (including hydropower) production that recorded double digit production levels (in Mtoe) in 2013 were Germany, Italy, France, Spain and Sweden. Low energy dependency countries, such as, Romania, Denmark and Estonia, combine a relatively small consumption with domestic production from two or more resources.

The most remarkable development in energy supply within the EU-28 is the growth in renewable energy, in particular since 2000 (solar, wind, biomass, water, geothermal). In the majority of Member States this is visible, above all, in the increasing amount of renewable electricity in the energy system. Renewable heat (biomass) is relatively well developed in

Sweden, Finland and the Baltic States. The penetration of renewable energy in the transport sector remains rather low in all Member States (Figure 3).

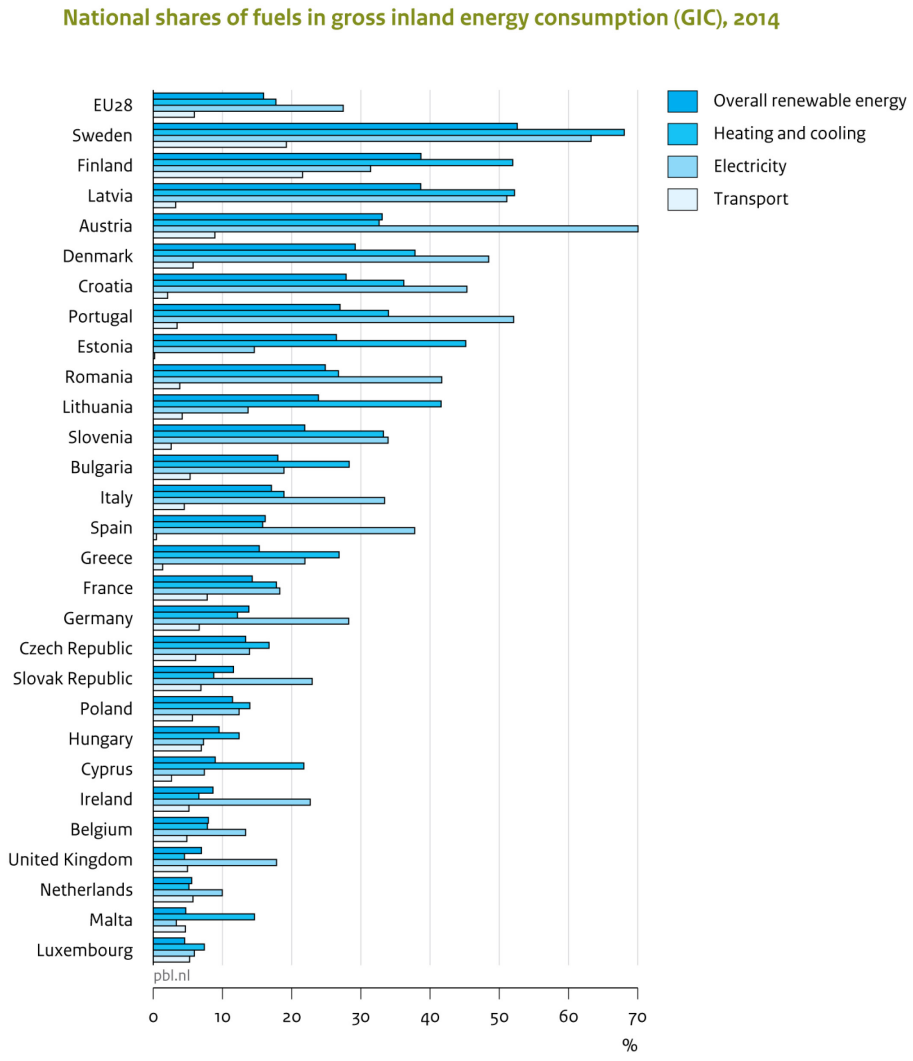

Figure 3 Renewable energy shares across the EU-28 (percentage of renewable energy in gross final energy consumption). Source: Eurostat Shares

The gross domestic energy consumption in the EU-28 was relatively stable during the 1990–2010 period, with a strong decrease in 2009 as a result of the financial and economic crises. In 2009, gross domestic energy consumption decreased by 5.7%, compared with 2008. There was a recovery in 2010, when it increased by 3.8%, followed by consecutive decreases in 2011, 2012 and 2013, so gross domestic consumption in 2013 was just below the level recorded in 2009 [2]. Within the EU-28, large differences in per-capita energy consumption are observed, depending on structure and activity of the economy, climate conditions, and energy efficiencies (Figure 4).

In 2012, greenhouse gas emissions (including international aviation, but excluding LULUCF), in the EU-28, were 17.9% below 1990 levels. From 1999 to 2006, greenhouse gas emission levels

within the EU-28 hardly changed. They began to decrease, at a modest pace, between 2006 and 2008. The year 2009 saw a sharp drop in emissions (7.3% in just one year) as a result of the global financial and economic crisis and the resulting reduced industrial activity. Emissions rose again in 2010 and decreased in 2011 and 2012 [2].

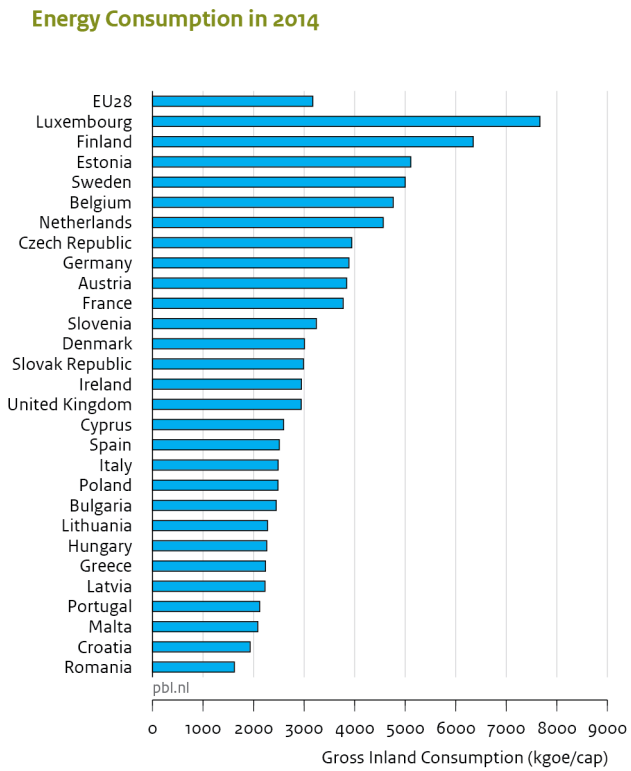

Figure 4 Energy consumption per capita across the EU-28 (all fuels). Source: Eurostat (PBL calculations)

Across the EU-28, in 2012, greenhouse gas emission levels were the highest in Germany (20.6% of the EU-28 total), while the United Kingdom (13.1%), France (10.8%) and Italy (10.0%) were the only other Member States to record double-digit shares. In 2012, the biggest decreases compared to 1990 were reported for several central and eastern Member States: Latvia (- 57.1%), Lithuania (- 55.6%), Estonia (- 52.6%), Romania (- 52.0%), Bulgaria (- 44.1%), Slovakia (- 41.3%), Hungary (- 36.3%) and the Czech Republic (- 32.7%). The combined share in the EU total of these countries in 2012 is about 10%, i.e. their substantial relative reductions contributed little to the overall EU emissions. In 2012 the greatest increase in greenhouse gas emissions compared to 1990 were reported for Malta (+ 57.3%), Cyprus (+ 47.7%), Spain (+ 22.5%), Portugal (+ 14.9%), Ireland (+ 7.0%) and Greece (+ 5.7%). These six Member States together accounted for about 13% of the total EU greenhouse gas emissions in 2012 (Figure 5).

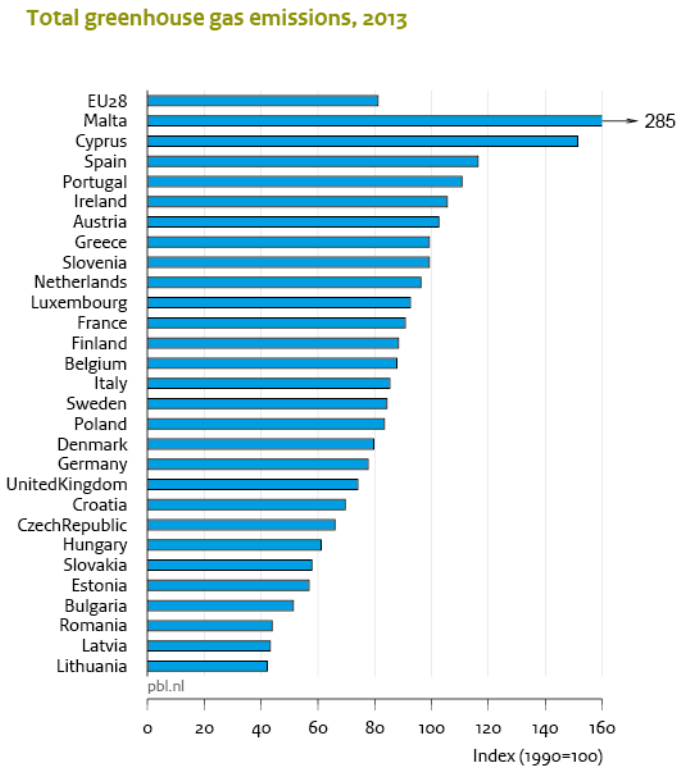

Figure 5 Total greenhouse gas emission across the EU-28 indexed (total greenhouse gas emissions, including international aviation and excluding LULUCF and indirect CO_2). Source: EEA based on UNFCCC

3 Targets for the energy transition

This section outlines the ambitions and goals of national energy and climate policies. The structure of national policies is the result of national debates, preferences and initial conditions. Policies build on path dependencies (e.g. domestic reserves of natural gas, lignite or hard coal), the structure of the energy system (e.g. energy mix and infrastructure) and of the economy (e.g. strong industrial base or infrastructure hub function). Political constellations and ideologies are different between Member States and this shaped the content and structure of their energy and climate policies as well.

Security of supply, affordability and safety are traditionally key issues in all national energy policies. Concerns about climate change increased in the 1990s and gradually became an element in energy and other policies in most Member States. The main tension has always been between affordability and sustainability (climate change); security of supply has been the most basic policy objective.

In 2008 the EU Member States agreed upon a climate and energy package for 2020 aiming for the reduction in greenhouse gases, deployment of renewable energies and improvement of energy efficiency. This translated into EU 2020 targets for the Member States on greenhouse gas emission reduction for the sectors not covered by the Europeans emission trading system (non-ETS), for the share of renewable energy and for energy efficiency. Member States are given flexibility in their plans for achieving their targets enabling them to take account of the national context. In the majority of the 28 EU Member States the energy transition is guided by country-specific 2020 targets and underlying legislation, in addition to EU-wide instruments, such as the Ecodesign Directive, vehicle emission standards and most of all, the EU Emission Trading System.

The 2020 climate and energy package has from the beginning be accompanied by an intense discourse on policy effectiveness and justification of policy interventions [3]. Some consider a greenhouse gas reduction target alone as sufficient to support a transition towards a low carbon energy system. This thinking is based on the assumption that policy intervention is justified because of the negative externalities from greenhouse gas emissions. With a proper pricing of CO_2 these externalities are taken into account in investment decisions [4]. Others recognize in addition to greenhouse gas emissions two additional market failures. First, underinvestment in energy-efficiency improvement mainly due to a lack of information, split incentives and high upfront costs. And two, underinvestment in low-carbon innovation due to knowledge spillovers and high upfront costs[5].

In the designs of national policies Members States should take conformity with the EU state aid rules into consideration, an issue of scrutiny by the European Commission.

A few Members States, mostly in north-western Europe, decided on national targets that go beyond the ambition level and detail of those decided on EU level (Table 1). Most of them also have targets for the period post-2020 and up to 2050, reflecting a long-term policy orientation.

Table 1. Schematic overview of quantitative national targets in energy and climate policies on top of the EU-2020 targets. The country code indicate that in the national policy of the Member State a quantitative target has been established for the issue mentioned

Issue ↓	**2020**	**2022/ 2023**	**2025**	**2028**	**2030**	**2035**	**2040**	**2045**	**2050**
General targets									
Greenhouse gas reduction	DE DK FR SE UK				DE FR UK		DE		DE FI FR UK
Renewable energy	DK IT SE	NL			DE FR	DE		DE	DE
Energy efficiency	DE DK FR NL SE								DE FR
Sector targets									
Power	DE			FR	DK FR	DE		DE	DE FR
Heating and cooling	DE			FR	DK				DE FR
Transport				FR	NL SE				DK FR NL
Industry				FR					FR
Agriculture and forestry				FR					FR
Technology targets									
Wind power	DK NL								
Solar power									
Nuclear energy		DE	FR						
Miscellaneous									
Additional energy related jobs	NL								
Reduction in fossil fuel consumption	FR				FR DK				DK

Note: Targets indicated in this table have a formal status, either by being included in legislation or as part of a political (coalition) agreement. Based on [6–14]
Member State codes: DE: Germany; DK: Denmark; FI: Finland; FR: France; IT: Italy; NL: Netherlands; SE: Sweden; UK: United Kingdom

3.1 National climate targets

The majority of Member States have aligned their climate policies with the EU goal of 20% greenhouse gas reduction by 2020 and have focused their efforts on achieving their targets established in the Effort Sharing Directive (ESD) for sectors not covered by the EU ETS. According to the latest progress report by the European Environment Agency [15], almost all Members States are on track to realise their ESD targets; progress of Belgium, Austria and Ireland is lagging slightly behind.

Few Member States have domestic greenhouse gas reduction targets in place for 2020 and beyond covering all sectors of their economy (excluding aviation and shipping). The United Kingdom, Finland and France have established climate targets for 2050 in legislation; for the United Kingdom and Finland it is a greenhouse gas reduction of at least 80%, for France it is at least 75%, all relative to 1990. In Germany climate objectives are part of a cross party coalition agreement [16]. Denmark has broad political agreement on 40% greenhouse gas emission reduction in 2020 (relative to 1990) and has put in place a Climate Change Act as a strategic framework giving guidance to the transition towards a low-carbon society in 2050 [17]. Providing guidance on the planning system for climate change policy is in fact the main element of Finland's Climate Change Act as well [14].

The UK Climate Change Act requires the Government to set legally binding 'carbon budgets'. France has recently followed a similar approach. A carbon budget is a cap on the amount of greenhouse gases over a five-year period and therefore less sensitive to cyclical fluctuations (mild or tough winters, price fluctuations of fossil fuels, *etcetera*). The United Kingdom has its first four carbon budgets put into legislation running up to 2027. France has defined its first three budgets running up to 2028. Carbon budgets provide a systematic approach to define, adjust, and evaluate decarbonisation trajectories, taking technological, economic and other relevant developments into account. By establishing carbon budgets clearly in advance, economic actors can take account of them in investment decisions.

The UK Committee on Climate Change advises the Government on emissions targets, and reports to Parliament on progress made in reducing greenhouse gas emissions. The Committee provides advice on the appropriate level of each carbon budget which is designed to reflect a cost effective path to achieving the long terms objectives [10]. In France an expert committee has given similar tasks [12]. Because France already has a high degree of decarbonisation of its power generation focus is more than elsewhere on other sectors: transport, buildings, agriculture and forestry, industry and waste.

The German coalition agreement comprises, like Denmark, a 40% overall greenhouse gas reduction target in 2020, relative to 1990. This is clearly more ambitious than the 20% target for the EU as a whole. In addition, the objectives for the German 'Energiewende' define a decarbonisation trajectory for Germany by setting targets for 2030 (55%), 2040 (70%) and 2050 (80-95%) [6].

3.2 Deployment of renewable energy

Part of the EU energy and climate package 2020 is the deployment of renewable energy technologies. The EU goal is to have 20% of its final energy consumption covered by renewable sources in 2020. The Renewable Energy Directive (RED) sets a target for each Member State as a share of gross final energy consumption to be covered by renewables in 2020. This pull policy certainly appeared to have driven the growth of renewable energies in Europe by creating a market for these niche technologies [3]. Although the EU as a whole seems to be on track to achieve the 2020 renewable energy target, differences between Member States are considerable. The latest biannual progress report by the European Commission [18] shows that in particularly France, Luxembourg, Malta, the Netherlands and the United Kingdom have difficulties to achieve their RED targets. On the other hand a number of countries may even exceed their RED target considerably, among others, Austria, Estonia, Denmark, Germany, Italy, Lithuania, Romania and Sweden.

A small group of Member States have ambitious renewable energy policies beyond the extent of the EU ambitions. Denmark aims to power the entire country with renewables by 2050. Germany pursuits a growing role of renewables to the energy supply the next decades. According to the German Energy Concept [19], renewables should cover 60% of the final energy consumption and 80% of the power generation in 2050. In the German Renewable Energy Act 2015 roll-out trajectories for different renewable energy technologies are established.

Recently France set in its 'Energy Transition for Green Growth Act' a goal of 32% of renewable energy in the final energy consumption in 2030 (40% in the electricity production). Italy has a target to reach the total share of renewable energies to 19 or 20% in 2020 [13].

The RED provides Member States freedom of choice to develop national instruments to promote deployment of renewable energy. This has resulted in a patchwork of not harmonized national remuneration schemes and support mechanisms across the EU-28. Renewable energy policies have appeared to be agile. Roughly a more or less converging trend is discerned from support mechanisms based on a price guarantee towards a more market oriented approach through application of feed-in-premiums, contracts-for-difference or a level of support determined by bidding procedures [20].

The growth in renewable energy in the EU has opened a profound debate on economic and technical issues related to electricity systems with high shares of intermittent wind and solar power. The debate has many dimensions. It extends to the economic position of coal and gas power plants in a market with growing amounts of renewables supported by policies. It directs to the need to make the power system more flexible in order to improve integration of the variable production of power from solar panels and wind turbines under constraints of reliability. But last but not least it reveals structural design features in the market. Current electricity markets are based on the principle of marginal cost pricing and are designed to reflect and optimize the cost structures of conventional technologies (centralized production dominated by coal, gas and nuclear plants). They are not suited for a low-carbon power system dominated by technologies that require high investment costs but operate with low marginal

cost. At this stage there is no consensus yet on the way forward on this complicated issue [21-23].

3.3 Energy efficiency

At EU level a target of improving energy efficiency by 20% in 2020 has been agreed. Member States are required to set their own indicative 2020 target in order to contribute to the achievement of the EU target; the Energy Efficiency Directive (EED) provides a common legislative framework. The EED gives Member States quit some flexibility in approach making a comparison rather complicated. In its annual progress report the European Environment Agency [15] concluded that there is an apparent overall lack of ambition in the primary energy targets which the Member States have taken on under the EED. Latest information from the Member States shows that their primary energy in absolute terms will remain 3% higher than the EU target up to 2020. For final energy it seems that the overall EU target will be achieved [15].

For energy efficiency a clear distinction of national targets going further in ambition of what has been agreed upon in the EU for 2020 is difficult to make due to different ways of calculation and measurement. Some Member States have in their national energy and climate policies explicitly mentioned the importance of improving energy efficiency. This has been translated into national targets for 2020.

Germany and France have various national efficiency targets. Germany possesses 2050-targets for primary energy (-50% relative to 2008), final energy (-40% relative to 2005), power consumption (-25% relative to 2008) and space heating (-80% relative to 2008). France wants to reduce its final energy consumption by 50% in 2050, and diminish its fossil fuel consumption by 30% in 2030 (compared to 2012). The Dutch Energy Agreement has for 2020 an additional 100 petajoule saving target for final energy.

3.4 Technology choices

Regarding technology preferences, some Member States have made clear choices which have been translated into specific targets. One of the obvious choices is the decision by the German Government to phase-out nuclear power. Although this is a low-carbon technology, Germany sees no future in it, because safety risks are considered too high, cost too uncertain and the nuclear waste problem yet unsolved. After having been surrounded by controversy for a long time, nuclear power is currently a technology that is not widely supported by German society. In Germany, the official shutdown of all nuclear reactors is now scheduled to take place during the period up to 2023.

France put a cap of 63.2 gigawatts (today's capacity) on installed nuclear capacity and aims to reduce its role in the power mix from about 74% now to 50% in 2025 (a phase-out plan to guide such a transition has not been made public). Belgium wants to phase-out nuclear power over time but recently decided for life-time extensions because of concerns regarding security of supply. Other countries, such as the United Kingdom, Poland, Czech Republic, Slovakia and

Hungary see a clear or increasing role for nuclear power in their future power mix although this has not been translated into specific targets.

Some countries recognize an important role of specific renewable technologies. In Denmark this is wind (on- and offshore) and biomass, in Germany it is wind (on- and offshore) and solar. For the United Kingdom and the Netherlands it is offshore wind. Often such preferences translate into strategic objectives in their energy policies, such as the 4,450 megawatts offshore wind target for 2023 in the Netherlands.

In general, specific technologies have been recognized as strategic objective because Member States see a particular national interest in it, whether having a high potential in their territories, having an attractive cost reduction potential, or offering opportunities for their economies or regional development.

Countries advocating technical neutrality in their energy policies see an important role for the market to decide which technologies are economically most interesting to invest. Therefore, the United Kingdom, theoretically, is open to all types of low-carbon technology, whether it is renewable energy, nuclear energy, or carbon capture and storage (CCS). In the Czech Republic and Poland, concerns of energy security and dependency dominate their energy policies; as a result, there is room for all technologies (including nuclear energy) that contribute in a positive way to these aspects. Also the exploration of domestic energy resources, such as coal, lignite and shale gas, fits into this focus [24,25].

The United Kingdom recognises an important role for nuclear energy in the decarbonisation of their energy system. The UK Government, however, is faced with a market that considers the investment risks too high. Under current market conditions (e.g. low wholesale prices, low CO_2 prices), investors are only willing to consider investing in nuclear power plants under government guarantees. For the nuclear power plant project, Hinkley Point C, the government guaranteed in a contract for difference a strike price set at £92.50/MWh for 35 years, fully indexed to inflation. Despite the offered contract, no final investment decision has been made yet by the consortium of companies interested in the project [26]. CCS technology is an important option, both in the United Kingdom and in the Netherlands, but a substantial British subsidy has been withdrawn [27], and the Netherlands already has been waiting for quite some time for investors to take a decision about one CCS demonstration project in Rotterdam.

3.5 Focus on sectors

Some countries have allocated strategic energy and climate goals to specific sectors. The sector receiving most attention is the power sector. First, because in most countries this sector is the largest source of greenhouse gas emissions – particularly in those with a strong coal and lignite base (Germany, Poland, Czech Republic, Greece). Second, it is also linked to nuclear controversies (Germany, France, Spain) and, therefore, is at the centre of political and social considerations. Third, compared with other sectors, there are various ways of producing zero- to low-carbon electricity, from nuclear to various renewable energy technologies, each with its advantages and limitations [28]. Fourth, decarbonising other sectors is even more challenging

and, therefore, CO_2-free energy is an important fuel for decarbonised transport and in the heating and cooling sectors [29].

This focus on the power sector has been translated into strategic goals, in some countries. Most prominently, in Germany, with targets for renewable energy for the next decades of, ultimately 80% by 2050. France strives for 40% renewable energy by 2030 and Denmark for 100% by 2035.

In the energy transition of some countries, in addition to the power sector, special attention is also given to the heating and transport sectors. These two sectors are responsible for relatively large shares of greenhouse gas emissions. Germany has efficiency targets for the space heating sector (-20% by 2020 and -80% by 2050, relative to 2008). Denmark wants to phase-out oil and coal for heat production, by 2030, and for the transport sector the renewable energy target by 2050 is 100%. The Dutch Energy Agreement mentions long-term green house gas reduction targets in particular for the transport sector (-17% by 2030 and -60% by 2050, relative to 1990). Few countries (Germany, Italy, the Netherlands) have set targets for the number of electric vehicles.

In its recent low-carbon strategy, France [12] has established decarbonisation goals for all sectors. These should steer sector actions in accordance with the general greenhouse gas reduction goals. France has formulated a carbon budget approach comparable to that of the United Kingdom.

3.6 Economic growth and jobs

In the Member States' energy policy debates, economic opportunities and risks, business opportunities and the creation of jobs associated with the energy transition are frequently discussed issues. The debates can be observed to roughly take two different directions. In the first, the energy transition is regarded as a strategy for economic modernisation, new business and employment (often framed as 'greening the economy'). The second direction considers the energy transition as a risky and costly enterprise, driving up energy costs and reducing competitiveness, endangering employment. Both schools of thinking can be recognised in national debates, and the difference between them is rather gradual.

A few Member States intend to link their energy and climate policies with strategies pursuing new economic chances and employment. For example, France recently adopted a law on 'energy transition and green growth' and the Netherlands has a broad 'agreement on energy for sustainable growth', including a target for an additional 15,000 jobs by 2020. In Denmark, energy policy is strongly framed as an opportunity for Danish clean technology companies; 'State of Green. Join the Future. Think Denmark' (see [30]). In Germany, the 'Energiewende' is seen not only as a trigger for innovation, industrial opportunities and new employment, but also as a threat for existing economic structures associated with lignite mining and power production, which are deeply entrenched in certain German regions [31]. Similar concerns can be seen in Poland and the Czech Republic [25].

4 Drivers behind national energy and climate policies

This section briefly mentions the different backgrounds and rationales (drivers) in the energy and climate policies of the EU Member States.

Affordability is an important consideration in the energy and climate policies of all Member States. It is in fact an important constraint for all policies and therefore a primary driver.

Security of supply is figuring high on the energy policy agenda of the majority of Member States. Deep concerns about energy dependency and security are recognizable notably in the energy policies of many central European Member States (Table 2).

The energy transition is in countries such as Denmark, Germany, Finland and France framed also as part of a strategy to improve energy security. In this context the deployment of renewable energy and improvement of energy efficiency contribute to lower the dependency on imported fossil fuels. The latter posing a significant risk in terms of energy security.

In states where energy security is not a point of direct concern, energy markets are usually well functioning and receive in general broad political confidence (e.g. Germany, the Netherlands). This makes energy security concerns a less stringent political issue and makes it easier to consider energy policies in a context of climate mitigation, technological development, industrial opportunities and regional opportunities as well.

Climate mitigation is considered most important in the United Kingdom, because of its Climate Law and the considerable impact of the legal carbon budgets on UK energy policy.

Table 2. Schematic overview of the relative importance of drivers behind national energy and climate policies, ranked according to their supposed importance

	1	2	3	4
Security of supply	most Member States		DE EE NL UK	
Opportunities for industry and regional development	DE NL	CZ DK EL FR PL UK	SE	
Climate mitigation	UK	BE EE FI NL SE	DK FR	DE
Anti nuclear		DE IT		

Note: The ranking in this table is based on a subjective judgement by the authors, based on IEA country reviews, press articles, blogs, *etcetera*.
Member State codes: BE: Belgium; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; EL: Greece; FI: Finland; FR: France; IT: Italy; NL: Netherlands; PL: Poland; SE: Sweden; UK: United Kingdom

Denmark is often mentioned as an example of a state with stable energy policies, supported by a set of evolving underlying drivers. During the oil crisis of the 1970s, energy policy was established in Denmark, like in many other western European countries, because of immediate energy security concerns. Its goal was to make Denmark less dependent on oil by diversifying

its energy mix in combination with the long-term precondition of eliminating fossil fuel use by 2050. Renewable energy sources and energy efficiency fitted well within this strategy, additional to the oil and natural gas exploration on the North Sea that started in the 1980s. Also the government support to Danish industry and research in, for example, energy efficiency, bioenergy and wind energy, helped to make the country less energy-dependent. Industry policy aimed at innovation and international expansion of clean technology industries increased Denmark's economic opportunities and competitiveness. Climate mitigation, in fact, piggybacked on all these developments.

There is a strong anti-nuclear sentiment among German citizens [32]. There are concerns about the safety and financial risks associated with the technology, and the difficulties Germany has in finding a safe and definitive solution for its nuclear waste are widespread. After a long period of controversy, the nuclear phase-out is now broadly accepted and a precondition for Germany's energy transition. Another country that clearly has excluded the role of nuclear energy in its energy supply is Italy. In a referendum in 2011, the Italian people spoke out against a new programme that was to ensure 25% of nuclear energy in the 2030 energy mix.

Despite the strong anti-nuclear sentiments among the Germans, an overarching driver of Germany's energy policy seems to be the concerns over the competitiveness of its industrial base [33]. The country wants to remain a significant industrial world player, and this is deeply embedded in all its industrial sectors, as well as in research and politics, on both federal and state level. This industrial policy driver is a very complicated one and includes concerns about energy prices for the energy-intensive industries, the technological challenges that trigger innovation and new business models, and the constant challenge to remain competitive on an international level. Germany's industrial policy builds on a strong engineering tradition. The strong driver of 'made in Germany' has so many links to all aspects of the energy system that it is therefore considered as the main driver behind German policies that shape the 'Energiewende'.

Although not as strongly as in Germany, the formal and informal industrial policies are recognised as the driving forces behind energy policies in many Member States (e.g., Denmark, the Netherlands, France, the United Kingdom and the Czech Republic). Within this context, energy transition is considered the trigger for innovation and an opportunity for industry and business. Regional government authorities often pursue this agenda, because of particular economic benefits for their region, such as offshore industries in Scotland (United Kingdom), western Jutland (Denmark) and northern Germany. On the other hand, sometimes, there is also a strong interrelation between regional policy and concerns about employment in fossil-fuel industries, such as lignite and hard coal mining in Germany, Poland and the Czech Republic, making political agreement on the energy transition a complex matter [25].

Concern about climate change is an issue that is reflected in the energy policies of most EU Member States. However, it does not feature as a primary policy driver, except for in the United Kingdom.

5 Policy stability and certainty

An important aspect of the energy transition is policy stability. Stable and predictable policies are required to secure planning and investment certainty. Clear long-term orientation helps to shape a reliable investment and innovation climate. In none of the countries, designing stable and predictable policies appears to be easy. In extreme cases, countries have retroactively changed their policies; well-known examples being the retroactive changes to renewable energy support schemes in Bulgaria, the Czech Republic, Greece, Italy, Romania and Spain [34-37]. Such retroactive changes have proven harmful to development confidence and increased capital costs for renewable energy projects [38].

Several approaches can be discerned that may contribute to more stable policies, but in no case are they a guarantee.

First, a few countries (United Kingdom, France, Finland) have established long-term targets in law. The UK Climate Act most often is mentioned as an example. In addition to the 2050 climate target, this Act also establishes a procedure, based on carbon budgets and scientific advise by the Climate Change Committee. Finland's recent Climate Act includes a greenhouse gas reduction target for 2050, it sets a planning framework but doesn't include policies and measures. The French Energy Transition and Green Growth Act includes long-term targets, among which a 50% reduction in final energy consumption, by 2050.

Second, only a few countries have achieving broad political agreement on energy policies. A good example is the agreement for 2020 energy and climate policies by the majority of political parties in the Danish Parliament. Finland and Sweden followed a similar approach. Another example is the energy concept agreed upon by the German coalition, containing a system of cross-sectoral targets for 2020 and up to 2050.

And finally, there are the non-political agreements, such as the Dutch Energy Agreement. This is an agreement on energy and climate policies, in particular, for the period up to 2023, between more than 40 organisations – including central, regional and local governments, employers' associations and trade unions, environmental and other civil-society organisations and financial institutions. The Dutch Energy Agreement fits within a long tradition of coalition building (polder tradition) between socio-economic actors, and was a response by civil society to government policies that were perceived to be unstable.

Above all, for political and non-political agreements, there is a danger that the agreed on objectives and targets are the result of compromise. This is not necessarily a problem, as long as they are not mutually inconsistent. Scientific advice may help to clear trade-offs, so that consistent choices can be made, ideally oriented towards a cost-effective decarbonisation trajectory.

6 Decentralised energy production

Decentralised energy production with renewable energy technologies, such as solar, onshore wind and small-scale biomass, is an obvious part of the changing energy systems in many Member States. Germany and Denmark have a long tradition in privately owned renewable energy generators, by citizens and farmers, and in publicly owned utilities and SMEs. Investments in renewable power generation had always been attractive because of a regulatory system, including feed-in tariffs, guaranteeing a stable income over a long time. As a result, renewable power generation attracted a wide range of new players and led to increasing diversity in terms of the ownership of these power systems. This all contributed to enlarging the base for the energy transition in these countries. For example in Germany, in 2012, only 12% of the renewable energy capacity was owned by the utility companies [31].

National government aim to improve economic efficiency in their country's energy transition. As such, feed-in tariffs and auctions are increasingly considered important elements of renewable energy support schemes, in several Member States. Non-utility actors in the energy transition have expressed their concern about these developments, because they fear that, due to a lack of capital, expertise and level of organisation, it will be more difficult for them to participate. Utility companies have more money available and more profound knowledge of energy markets, giving them the advantage in bidding processes. Furthermore, governments like to see utility companies taking an active role in the energy transition because of their ability to finance, develop and maintain the more complicated and capital-intensive projects, such as offshore wind energy and, in the nearby future, the storage of energy. Experiences, particularly in Denmark and Germany show that governments are faced with the challenge of broadening participation and improving economic efficiency in the transition, without frustrating civil society participation and losing support [31].

7 Decarbonisation policies towards 2050

7.1 Pre-2020

Global trends and the EU energy and climate package of 2008 have shaped energy and climate policies in the EU-28, over the period up to 2020. The EU policies have set legally binding targets for greenhouse gas emission levels and for the use of renewable energy sources, as well as indicative targets for energy efficiency. Most Member States are on schedule to achieve their EU 2020 targets. Even in Member States with more ambitious national objectives, the setting of legally binding targets at EU level has driven target-based policy approaches. The EU, as a whole, has reduced its greenhouse gas emissions and has promoted a substantial increase in renewable energy. According to the European Commission, there is no evidence that the current framework has negatively impacted the competitiveness of the EU economy [3].

So far, some lessons have been learned from the energy transition in the EU-28 [3, 34, 39].

1. The various drivers of energy policy – energy security, sustainability, competitiveness – largely enforce each other and, even in cases of no final dovetailing of approaches, considerable common policy approaches are possible. Energy efficiency is an example, security of supply is a joint concern, although to varying degrees – and all Member States invest in innovation and modernisation of the economy. Up to now, no definite successes have been scored in aligning the different energy policy dimensions.

2. Although climate policies increasingly have influence on energy policies, it is rarely a key driver. There is little evidence yet that energy policies do support consciously and coherently long-term decarbonisation strategies. In a few countries, such as the United Kingdom, Finland, France, and Sweden, this is starting, but it is too early to judge the success of these strategies.

3. Energy transition is a process that will take decades and requires strong political support. Countries such as Germany and Denmark, made an early start in reforming their energy system, mainly by way of a deliberate, renewable energy policy with broad political commitment. In the United Kingdom, there is a clear long-term objective, with a decarbonisation target for 2050 enshrined in law. The transformation required to achieve decarbonisation is complex and, throughout the process, economic, technological and social circumstances can change, significantly. The challenge is to put flexible adaptive policies in place, enabling the ability to learn and adjust, without compromising the decarbonisation targets and developers loosing confidence. The carbon budget approach, as agreed on in the UK and as recently was also adopted in French policies, is an inspiring example of an adaptive policy framework. However, certainly in times of economic crisis,

there is a great deal of political pressure that may weaken the framework, undermine the objectives, and create business and investment insecurities [3].

4. The deployment of renewable energy within the power system plays a prominent role in energy transition across the EU-28. The costs of particularly wind and solar energy have decreased beyond expectations. Many actors across the EU-28 are very interested in renewable energy technologies, based on multiple motives. These technologies are low-carbon, thus with a role to play in decarbonising the energy system, they help to diversify the energy mix and contribute to reducing energy imports, they drive innovation and create industrial opportunities and new business models. These multiple motives played a role in establishing dedicated renewable energy policies in many countries. The most stable policies are found in Denmark and Germany, supported by an ambitious renewable energy industry sector that was organised early on. The costs involved were high, but it also offered first-mover advantages.

5. All countries struggle with the cost burden of renewable energy support schemes and sharing these costs among the various consumer groups (households, SMEs, industry). Concerns over the increase in energy retail costs have led governments to 'water down' some renewable energy policies, including retroactive changes in renewable energy support policies [39]. In these policies across the EU-28 a shift is visible from deployment of single technologies towards the system and market integration of these technologies into the entire energy system, including the challenge to accommodate large shares of intermittent renewable energy and to attract investments, in order to guarantee system adequacy [23, 40]. This can be seen most clearly in the first-movers Germany and Denmark, and it obviously fits in a development of growing amounts of renewable energy, reduction in related technology costs, and growing frictions between renewable and conventional energy generators within the current market structure [23].

6. Half of the 28 EU Member States have nuclear power in their energy mix. This technology is low-carbon and by many countries considered as a reliable provider of baseload electricity against relatively low operational costs. Other countries have deliberately decided on a nuclear-free power system (Denmark, Italy) or have decided to partly or fully phase-out nuclear energy (France, Belgium, Germany) because of safety risks and financial burden for society. Although, it has been shown that, once nuclear power plants are up and running, it is economically and politically attractive to extend their life times (Belgium). As long as safety is fully guaranteed, it is difficult to understand why countries would not opt for this technology. The challenge for them will be to get cost and planning issues under control and to obtain investor confidence [26].

7. The ETS crisis led to a situation, especially in Germany, where deployment of renewable energy was not complemented by comparable greenhouse gas emission reductions. Because of the extremely low CO_2 prices, there was no incentive to reduce the emissions from carbon-intensive power generators, and increasing energy exports to neighbouring countries led to stagnation of emission reduction in the German power sector [41]. Even taking the attempts to improve the effectiveness of the ETS into account, fundamental doubts exist about whether the ETS could drive transition in the power and industrial

sectors along a decarbonisation path towards -80%, let alone to an even more challenging -95% [3].

8. The ETS has delivered a very weak carbon-price signal. The United Kingdom strengthened it again, by adding a carbon price floor and implementing additional measures, such as an emission performance standard (EPS) for new power plants. Other countries, such as Germany and the Netherlands, are currently discussing additional measures to phase out coal capacity. Flanking carbon policies for the power sector at national level are politically challenging because of their inference with the ETS.

9. Although energy efficiency is the policy option that aligns different drivers of energy policy in the most fundamental way, efforts to promote energy efficiency have been weak. There is mixed evidence of the effectiveness of some of these policies to reduce energy consumption [42].

10. Citizen movements have contributed to the success of energy policy, in different ways. For example, in Denmark and Germany, it has been the fundamental basis for the transition policy; while in the Netherlands, to some extent, the Energy Agreement between 40 different groups within society has been a substitute for far-reaching government policy and has been an incentive for government to 'reinvent itself'.

7.2 Post-2020

Climate and energy policies post-2020 must put the EU Member States on a pathway towards decarbonising their economies and societies. Climate change makes decarbonisation indispensable, with energy security, competiveness and innovation being other key considerations in decarbonisation strategies. The EU's ambition to reduce greenhouse gas emissions by at least 80% by 2050, compared to 1990 levels, in fact means that each investment in the energy system should be judged on its consistency with a path towards having a low-carbon system by 2050. Otherwise, risks for stranded assets and the destruction of capital will be high [43].

The EU energy and climate package for 2020 is an important framework for the energy transition in most countries. Post-2020, the policy framework will change towards a system with stronger bottom-up elements, giving Member States greater flexibility. Details have yet to be decided, but the outlines of how the EU will deliver on climate and energy goals for 2030 are getting clearer.

For 2030, the EU is aiming for a domestic greenhouse gas emission reduction target of 40%, compared to 1990 levels, as well as a share of at least 27% renewable energy consumption, and at least 27% energy savings compared with the business-as-usual scenario. Whether these goals have to be adjusted in the light of the Paris climate agreement is currently under discussion. In the first 'State of the Energy Union', the European Commission proposed a governance system outlining the process for delivering the EU climate and energy targets for 2030 [44]. The Council of the European Union endorsed the EC's governance proposal [45].

The centre piece of governance in 2030 will be a National Energy and Climate Plan (NECP) for 2021 to 2030, to be developed by each Member State. The collective efforts in the plans should deliver the EU 2030 targets and should be in accordance with the Indicative National Determined Contribution (INDC) of the European Union, submitted under the UNFCCC as agreed at the COP21 conference in Paris. NECPs build on a tradition with national plans for renewable energy (NREAP) and energy efficiency (NEEAP), but aim for a much more holistic or integrated approach covering all aspects of the Energy Union (integration of energy markets, decarbonisation, improving energy efficiency, guaranteeing security of supply, and RD&D).

For the scope of the NECPs, the Commission [44] has identified a number of general principles. NECPs do not start from scratch, but build on existing policies and experiences. However, they also should include a perspective up to 2050. This long-term perspective, the lack of which is identified as a weakness in most Member States policies, should help to improve predictability and certainty for investments and ensure greater cooperation and coherence between the climate and energy policies of Member States.

In addition to the aim of achieving a clearer understanding of long-term perspectives and cross-sectoral aspects in the Member States energy and climate plans, the EU governance framework for 2030 intends also to foster regional cooperation and integration. For the latter, the Commission proposes that relevant cross-border issues are surveyed and opportunities and challenges for further regional cooperation and integration are identified in the NECPs. This regional approach can help to identify synergies and efficiency gains in the energy transition of Member States. This approach is not a new one, and NECPs can build on the experiences already gained in the many existing regional initiatives on renewable energy cooperation, interconnection, grid stability and market coupling [46, 47].

Regarding the urgent task to decarbonise the energy system under conditions of security of supply, affordability and competitiveness, and considering the heterogeneous state of the energy transition across the EU-28, it will be a huge task to build an effective policy framework for 2030 and beyond.

The risk of the new approach in EU coordination of energy and climate policies is that of a further fragmentation and the rise of dominant national focuses, leading to growing inefficiencies and posing a rather complicated coordination challenge. The new approach offers the opportunity creating a set of coordinated national plans, with room for national specificities, broadly supported by national actors, and utilising efficiency through collaboration. It is too early to judge whether EU 2030 coordination will evolve into a more fragmented or a more coordinated model.

Looking at the energy transition across the EU-28, we were able to identify a number of priority issues that should be considered in the preparation of the NECPs. These are issues to which different Member States might have different views. More understanding about the considerations related to these issues could help to improve understanding for each other's position in the search of successful European coordination on a cost-effective transition pathway towards a low-carbon society by 2050 and beyond. Differences will remain, but better understanding and joint efforts would benefit all Member States.

1. Do the Member States agree that the power sector will play a central role in the decarbonisation of our energy systems, taking into account security of supply and affordability? Do they agree that a joint approach of this sector together with neighbouring countries – consisting of, for example, scenarios, system adequacy evaluation, system flexibility, and using potential comparative advantages – is a pivotal step in the transition process?

2. What does this mean for policy instruments? ETS is the European flagship instrument in reducing CO_2 emissions in industry and the energy sector. Attempts to improve ETS are underway and will continue. However, individual countries with greater ambitions are searching for national approaches, as these are considered to be more effective. Without a more joint approach, this effectiveness probably indeed could be attained at a national level, but due to the 'waterbed effect' this will not result in lower European CO_2 emission levels. Is it worthwhile to search for ways in which the overall effect of these national approaches could be improved?

3. Member States have chosen different approaches in their transition strategies. Sometimes, these have a stronger 'bottom up' or 'top-down' character. All approaches have relative benefits as well as weaker aspects. To some extent, this does not matter, transition policies are searches. However, certain aspects of successful policies can be observed, such as: a strong wish to engage citizens, a strive for long-term consistency in approaches and awareness of the positions of 'losers' and 'winners'. Is it possible to define these common denominators? How could joint learning be improved?

4. Differences exist in the way different energy technologies are judged. However, renewable energy as part of an economic modernisation strategy seems to be an appealing prospect. Controlling the costs of renewable energy deployment is a challenge for all EU Member States. In the light of the EU 2030 target for renewable energy and in the knowledge that this is only a milestone on the way towards 2050, the share of renewable energy will continue to grow. This development will involve costs but also benefits. How could Members States share more effectively their experiences in balancing costs and benefits of renewable energy deployment?

5. National governments have an important role to play in the transition processes. Experience, traditions and visions vary from country to country. However, the challenges in meeting the ambitions for 2050 are the same. Although the way Member States try to achieve their policy goals will differ, a common aspect is they all wish to enable the transition process. Governments facilitate other parties so that these can play their roles in a sustainable way. Certain common aspects of this quest could be formulated, such as defining clear milestones towards the goals for 2050, checking regularly whether the process is moving sufficiently forward and evaluating how different parties are able to participate. What is the best way for Member States to help each other with these governance issues?

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