DYNAMIX

Decoupling growth from resource use and environmental impacts

# DYNAMIX policy mix evaluation

A fossil fuel-free energy system by 2050 in Denmark

European Commission

SEVENTH FRAMEWORK PROGRAMME

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## DYNAMIX PROJECT PARTNERS

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# 1 Resource/Issue

*Name of resource targeted (or focus of the case study, if the policy mix is broader than the specific resource(s) we have decided to analyse).*

In November 2011, the Danish government published *Our Future Energy*, a package of energy policy initiatives aiming to achieve the goal of a fossil fuel-free national energy system by 2050 *(*Danish Government 2011).[1] The package built upon a strategy set out by the previous government, *Energy Strategy 2050 (*Danish Ministry of Climate and Energy 2011)[2], setting out a similar goal. The ambition level of effecting an energy system transition in *Our Future Energy* is higher, while the approach in the recommended actions is similar to *Energy Strategy 2050*. Thus, this case study tackles fossil fuels and carbon emissions.

In March 2012, an agreement between the new government and the vast majority of the parliamentary parties was achieved to identify a set of concrete medium-term initiatives instrumental to reach the targets set in *Our Future Energy (*Danish Energy Agency 2012)[3]. The time horizon for this agreement, which substitutes the previous agreement (covering 2008-2011) is 2020, thus it strongly affects likelihood of meeting the main goals for 2050.

# 2 Geographical area of policy mix coverage

*Country name, and region or city if appropriate (if policy mix is applied regionally or locally)*

The area assessed is Denmark.

# 3 Policy context

## 3.1 Needs assessment: The environmental problem /resource challenge

*What is the environmental problem/concern (consider both quantity and quality), e.g. soil erosion, excessive use of non-renewable or renewable resources and the crossing of environmental thresholds/tipping points for impact, resource scarcity concerns?*

*Are there any economic or social problems related to the issue and environmental problems – e.g. is there important price volatility, (risk of) unavailability of resources for the economy or society?*

*Who is the target group affected that have been, are or will be beneficiaries of the policy response?*

There are two main issues behind this policy: climate change and independency from fossil fuels. In relation to the Danish case, the specific effects of climate change for Denmark's energy system are further characterized as follows in the 2011 *Energy Strategy 2050* (p. 21):

- **Climate change** has been observed**:** the average temperature and precipitation in Denmark have increased respectively by 1.5°C and 15 % since 1873. The Danish wind climate has also changed, with high occurrence of powerful storms and hurricanes. In the future even greater climatic changes are expected, with potential consequences for the energy system.
- **Energy needs** will shift: up to 2050 it is expected that winters will become warmer, with correspondingly shorter heating seasons and slightly less need for heating during the winter. In contrast, the need for cooling will be greater in the summer (primarily in offices, shops etc.) with longer heat waves. The building standards for new housing will limit this need, whereas for existing housing demand for cooling installations may increase.
- **Energy production** mix will change: due to the longer growing season up to 2050 (higher temperatures and precipitation in the summer), more biomass production in both agriculture and forestry is expected. As winters become wetter and milder, energy production from hydropower in Norway and Sweden will be positively affected. In addition, wind energy potential is expected to increase.
- **Extremes events** will become more frequent: up to 2050, more powerful hurricanes may disrupt the electricity grid and infrastructure, causing the temporary shutdown of wind turbines. However, the effect of these events on security and stability of the electricity system is expected to be marginal. On the other hand, more powerful hurricanes, combined with higher precipitation, leads to a higher risk of windfalls, affecting international markets for chippings and wood pellets.
- Overall, the expected milder winters will have a modest and positive impact on the Danish energy system, and on the possibilities for the transition to fossil fuel independence, while uncertainty remains regarding the future demand for cooling.

The strategy for fossil fuel independence proposes a number of new energy policy initiatives, which are deemed as robust in relation to future climate change. Furthermore, there is the ongoing monitoring and evaluation of climate and energy policy, and this will also have to take account of observed climate change."

More and possibly more serious impacts on the Danish economy and environment are to be expected. In general, for the Nordic countries a warming higher than global average is projected. In Denmark this effect will be milder, but higher temperature extremes, increased flood and storm surges risks are expected (EEA 2012).[4]

As to independency from fossil fuels, the real issue is potential excess vulnerability of the energy system from external energy sources.[i] Denmark is currently a net exporter of both oil and gas, and taxation and royalties from fossil fuel extraction are currently the major sources of public revenues (IEA 2011).[5] This situation is bound to last for not many years to come, and this epochal transition from net exporter to net importer can be quite unsettling for the Danish economy and society. Hence, the need to manage the smooth transition towards a

[i] While in general both motives underpin the strategy on equal footing, the main rationale for fossil fuel independence is energy security and the transition to being a net importing country. This is by no means a minor concern and a respectable policy rationale in its own right. Luckily fossil fuel independence and carbon mitigation as policy targets share two powerful set of tools, namely those related to energy efficiency and those related to the promotion of renewables. However the overlapping is only partial and the two targets may in principle call for unrelated, and even conflicting, policy instruments.

situation in which fossil fuels, gradually and as painlessly as possible, lose their relevance is essential.

Climate change is going to have major impacts on society even if it is managed to be contained within the 2°C target. The main societal impacts will come in the form of health impacts (heat-related crises during heat waves, respiratory and circulatory diseases, etc.), consequences of extreme events such as flooding and storm surges that can disrupt infrastructures and generate casualties, and impacts on the activities of various economic sectors (primarily tourism, agriculture and energy generation). At high latitudes, the latter might initially not be negative (e.g. milder climate condition favouring tourism and recreational activities). Severe impacts in other regions of the world may lead to climate change induced migration, which may lead to political and social tensions even in areas where impacts are moderate.

There are multiple target groups affected that have been or will be beneficiaries of the policy response:

- Danish residential consumers;
- Danish commercial and industrial consumers;
- Energy producers and distributors;
- Danish research institutions;
- EU member countries; and
- International community.

The last two are included in the strategy because the Danish Government is clearly aware of the fact that Denmark is a too-small country to have a significant impact on global emissions, but by setting an example and engaging into international consensus building towards a coordinated action against climate change (within and outside the European Union), it can bring about more substantial progress than by acting alone.

## 3.2 Policy context and policy needs

*What policy challenge(s) did the problem pose and what policy challenges does it still pose?*

*What is the policy context related to the policy mix being evaluated? What policies have been put in place to address the issues, what policies are currently in place and which ones are already foreseen for future introduction (e.g. to address past, existing and future objectives)?*

*What sort of policy response did (and does) the problem call for?*

*Our Future Energy* is a long-term vision of the energy future of Denmark. The chances of success depend on a number of factors, some of which are not yet realised and thus uncertain and some are beyond the reach of the Danish government. For the first set of factors, the Strategy notes that “it is impossible to predict economic growth, technological development or fuel and $CO_2$ prices 40 years ahead, and in so doing detail the optimal energy system for 2050” (p. 22). Thus in this regard the major challenge is the need for *flexibility* in order to accommodate possible alternative configurations of external factors. This need is clearly foreseen in the Strategy, which allows periodic assessment of policy progress and the needs for readjusting and fine-tuning it to the changing conditions.

The second major policy challenge is Denmark’s limited influence on the international arena. This issue is well recognised in the Strategy, which sets out a number of initiatives to

maximise the impact of the diplomatic side of Danish energy and climate policy in three main international arenas: Scandinavia, the EU and the United Nations (UNFCCC and OECD).

There has been a track of policy initiatives that has preceded the Strategy. Of particular relevance are those related to energy efficiency (since they limit the consumption of fossil fuels); renewables (because they directly constraint the share of the energy mix that can be covered by fossil fuels); sectoral policies such as those for transportation, electricity generation; and buildings (because such sectors are those responsible for the greatest fossil fuel demand). A detailed if not exhaustive list of the relevant policies in place before the strategy was launched can be found in section 6.

The current consensus prescribes both mitigation and adaptation policy actions. Mitigation policy actions entail reducing the amount of greenhouse gases (GHG) released into the atmosphere, in order to stabilise their concentration to a level compatible with reasonably favourable chances of an average global temperature increase of not higher than 2°C by 2100 with respect to pre-industrial levels. Since the anthropogenic contribution to GHGs release into the atmosphere mainly comes from fossil fuel burning, agricultural practices and deforestation, such stabilisation policies entail a massive shift away from fossil fuels towards carbon-free energy sources, and sound land use and forestry management. Given the global scale of the issue, it is crucial that such policies are implemented by as many countries as possible, particularly by those which are and are posed to be the major emitters (USA, China, India, Russia, and the EU). From the Danish point of view the major policy issue here is the country's small weight in the global emission balance. Therefore, the diplomatic side of its policy initiative is particularly crucial for Denmark to provide a significant contribution to climate change mitigation.

Adaptation, on the other hand, has a strictly local dimension, in the sense that climate change impacts are specific to the various regions of the world, and require local responses. This is outside the scope of this case study, but information can be found in the Danish strategy for adaptation to a changing climate (Danish Government 2008).[6]

As to energy security, there are both country-specific and more general policy needs. The country-specific policy needs are those related to the management of Danish surviving oil and gas reserves in the years to come, and oil stockholding obligations. As mentioned before, Denmark is facing an imminent transition from being a net exporter to being a net importer of fossil fuels, and this transition will have consequences on both issues. On the reserve management, energy policy needs to deploy the correct instrument to ensure that the optimal rate of extraction is applied, possibly augmenting it with technology improvements and R&D in state-of-the-art enhanced oil and gas recovery techniques. As to stockholding obligations (that is, the duty of storing enough oil and oil products to cover a supply shortage for a pre-determined number of days), Denmark may have to manage the additional IEA obligations from which it is currently exempt as net exporter, when the trade balance in these fuels will definitely turn to negative. However, Denmark has currently a 67.5 days of equivalent consumption obligation as an EU member, and a governmental one of 81 days, mainly held in the form of refined products. Thus, it should be able to easily accommodate the IEA's obligation by extending the latter one.

Enhancing fossil fuel independency will of course have to come mainly through reduced fossil fuel consumption, either through increased efficiency and/or through a shift towards alternative fuels. Both pathways require specific policies, related to the deployment of

currently available options or the development of technologies in an earlier phase of development.

Finally, energy security depends upon the quality of the energy trade networks to which a given country belongs. In the case of Denmark, given the self-sufficiency in oil and gas, currently the issue of higher relevance is the electricity network. Denmark is well connected with other Nordic countries and Germany, a feat that has so far provided the flexibility needed to accommodate the expansion in intermittent generation capacity, mainly from wind. So far, excess electricity generation from wind could easily be absorbed by the network, mainly feeding the German demand. Should this path be followed by other Scandinavian countries, the current redundancy of the network may not be enough to accommodate the necessary flexibility and therefore policy steps should be taken, possibly in agreement with the other Nordic countries, to adapt the infrastructures and upgrade the overall flexibility of the system. This in turn may imply the deployment of extra gas capacity for back-up purposes. The fact that a common electricity spot market (Nord Pool) already exists may be a facilitating factor towards a coordinated action in this sense.

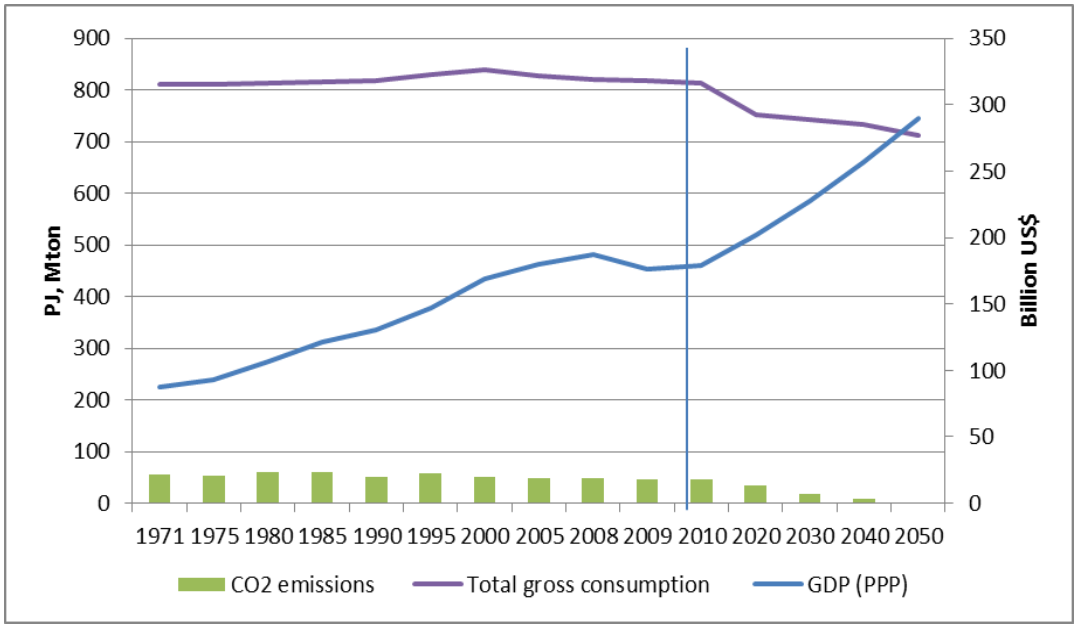
Coal is a different matter, as it does not pose major energy security issues, being abundant and not concentrated in a few producing countries. The main issue is its high content of pollutants, notably carbon. The policy needs are those related to facilitating the financing of early phase-out of obsolete plants on the one hand, and the deployment of Carbon Capture and Storage (CCS) on the other hand. Danish coal-powered plants are the most efficient in the world (IEA 2011)[7], thus the first option might be particularly costly. The second option is currently not commercially viable, and requires further R&D efforts in order to reach commercial stage. Denmark's *Our Future Energy* foresees the phase-out of coal by 2030, and its replacement with biomass.

## 3.3 Historical performance and projections into the future: Insights on decoupling

*What has been the trend vs. GDP (or other economic performance metrics, such as sectoral growth) and what type of decoupling has been achieved?*

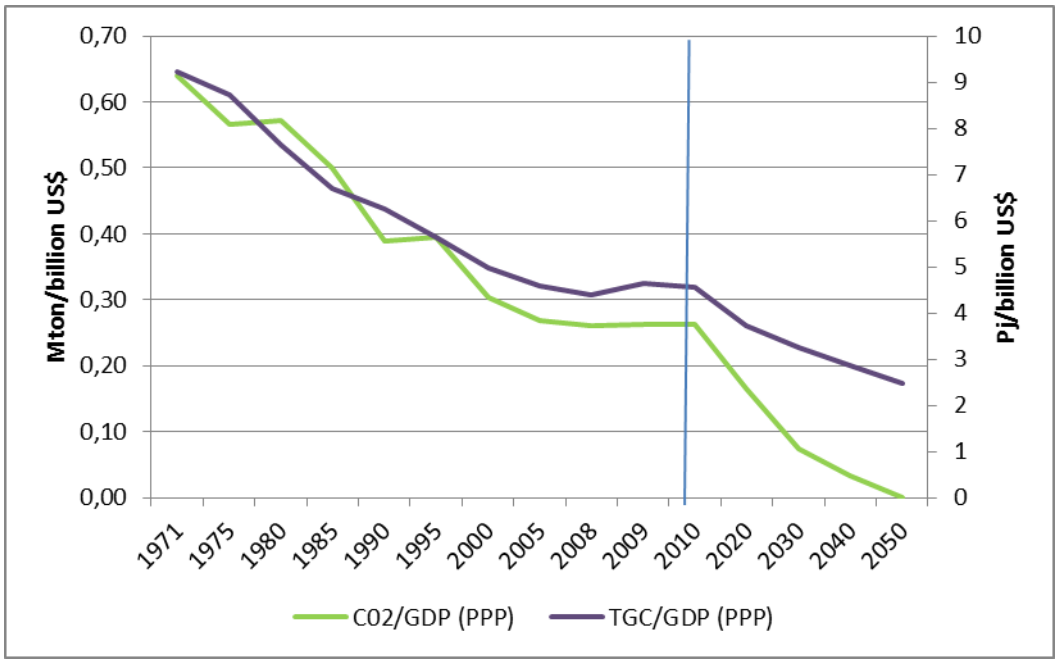
According to the IEA (2011)[8], "Denmark is one of the most efficient users of energy compared with the other OECD countries. Since 1990, energy consumption has remained more or less constant; the Danish economy has grown by 35 %, while $CO_2$ emissions have reduced by 7.2 %. This decoupling of economic growth and energy consumption and emissions is something the Danes can be rightfully proud of" (p. 29). It also means that Denmark has achieved relative decoupling of energy consumption from GDP and absolute decoupling of CO2 emissions from GDP. Indeed, available figures show convincing progress both in terms of efficiency and of $CO_2$ emissions, in absolute (Figure 1) and in relative terms (to GDP) (Figure 2).

**Figure 1: Past trends and future projections of Danish GDP, $CO_2$ emissions and total gross energy consumption, 1971-2050**




Source: IEA. 2012. *$CO_2$ Emissions From Fuel Combustion*. Paris, France: International Energy Agency; Statistics Denmark. 2013. "Homepage". Website Section. http://www.dst.dk/en; and the authors' computation on data by the Danish Energy Agency. GDP Growth based on OECD Economic Outlook average rate for the period 2010-2014, taking into account the 2020 targets set in the 2012 Energy Agreement.

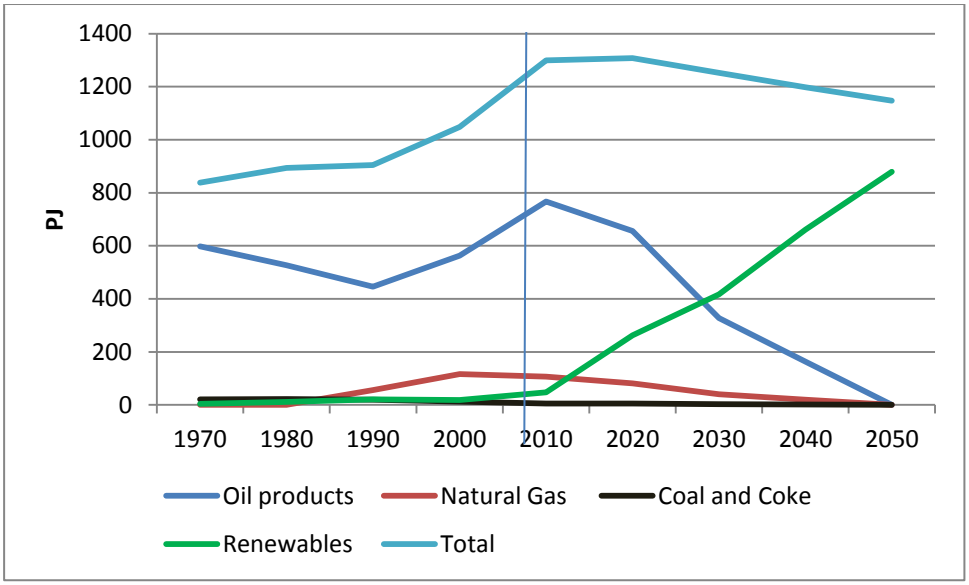
**Figure 2: Danish carbon intensity and share of total gross energy consumption on GDP (PPP), past trends and future projections, 1971-2050**




Source: IEA. 2012. *$CO_2$ Emissions From Fuel Combustion*. Paris, France: International Energy Agency; Statistics Denmark. 2013. "Homepage". Website Section. http://www.dst.dk/en; and the authors' computation on data by the Danish Energy Agency. GDP Growth based on OECD Economic Outlook average rate for the period 2010-2014, taking into account the 2020 targets set in the 2012 Energy Agreement.

In terms, of fossil fuel use, the decline is more recent: after decades of increase, it peaked in the first years of this century and declined sharply thereafter (see Figure 3).

**Figure 3: Danish gross energy consumption of fossil fuels and renewables, past trends and future projections, 1971-2050**




Source: Authors' computation on data by the Danish Energy Agency.

Figures 1-3 also illustrate the consequences of intermediate (2020) and final targets on consumption of fuels and energy related $CO_2$ emissions set in the Energy Agreement 2012. In particular, energy demand should decline by 7.6 % by 2020 compared to 2010 levels, and fossil fuels use should drop to zero by 2050 and be replaced by renewables. These latter should account for 35 % of the fuel mix by 2020.

# 4 Drivers affecting change: resource use/ environmental issues

*What are the drivers affecting resource use (driving demand for the resource and leading to resource overuse) or other environmental impacts?*

Energy demand is mainly driven by per capita income, population and the productive structure of the economy. Carbon emissions from fossil fuel burning are related to the carbon content of the fossil fuels used to create energy. A synthetic way to see this is the Kaya Identity, used in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (4AR IPCC) reports (Rogner et al. 2007).[9]

$$EMI = POP * GDP/POP * EN/GDP * EMI/EN$$

This equation states that, in a given country, carbon emissions (*EMI*) are the product of the carbon content of the energy consumed (*EMI/EN*) times the energy content of productive

activities, or energy intensity (*EN/GDP*), times total gross domestic product (*GDP*), which in turn can be written as the product of GDP per capita and total population (*POP*GDP/POP*). Thus, the richer and the more abundant the population, the more energy intensive the production structure and finally the higher the carbon content of the energy used, the higher the emissions in any given countries.

For Denmark, the key drivers are GDP per capita and the carbon content of the fuels used to generate energy. Denmark's GDP per capita is the 7th highest in the world according to the International Monetary Fund (IMF) (IMF 2013).[10] IMF rankings are not aimed at assessing energy efficiency, but for the purposes of this evaluation exercise, this means that Danes can afford a lot of energy. On the other hand coal, oil and gas have played the major role in satisfying Denmark's energy demand, and need to be substantially reduced in order to bring the country's carbon emissions under control, or to reduce them according to stringent policy targets. This has to do with the last factors in the equation above (namely, carbon content of energy and energy intensity), and depends both on demand and supply factors. On the demand side, the energy content of each Danish Krona (DDK) earned and spent in the country depends on how efficient the Danes are in their energy uses, on their energy saving behaviours, on their prevalent mode of transport, and on the relevance of energy as an input to Danish economic activities. On the supply side, it depends on the structure of the energy transformation sector (that is mainly electricity generation and refineries). On the demand side, Figure 1 to Figure 3 above show commendable progress in energy efficiency in Denmark in the last decades. On the supply side, there is still a prevalence of fossil fuels, but the country seems set to overturn the current situation.

# 5 Situation/trend prior to introduction of policy mix

*Information on the baseline situation before the policy mix was introduced.*

The 2005 National Energy Efficiency Plan's objective "was to reduce total energy consumption (excluding transport) and increase efforts to save energy which can be documented, corresponding to an average of 1.15 % per year, […] Successful implementation should result in total energy consumption (excluding transport) of 430 PJ (petajoule) in 2013" (International Energy Agency 2011, p.54).[11]

In 2007, an amendment to the plan was introduced, suggesting an increase of the annual energy saving target to 1.4 %, and the inclusion of transmission and distribution losses in the calculation of the annual energy saving target: "this increases the annual energy saving target from 7.5 PJ to 9.6 PJ, or an average increase of 2.1 PJ over the period 2008-2013" (International Energy Agency 2011, p.54).[12]

In 2008, an Energy Agreement (Danish Energy Agency 2008)[13] was signed between the Government and the almost the entirety of the parliamentary Parties concerning the promotion of energy efficiency, renewable energy sources and increased research effort in energy technologies. The agreement covered the period 2008-2011.

In 2009, with the Promotion of Renewable Energy Act (Danish Energy Agency 2009)[14], the above mentioned agreement was to a significant extent transposed into the national law. Also in 2009, a Green Growth Agreement signed between the government and the Danish

People's Party prompted, among other things, the expansion of agriculture's role as an energy provider (through biomass and biogas).

EU Directives also have had a direct influence on renewable energy policy through the Renewable Energy Directive 2009/28/EC[ii] that sets a 20 % overall target for renewables and 10 % share of renewables in the transport sector. It also required Member States to submit an Action Plan by 30 June 2010. The Danish Action Plan is more ambitious than the overall EU target and strives for a 30 % share of renewables in total primary energy supply (TPES) by 2020, and a 21.9 % share already in 2010.

Fossil fuels are subject to a variety of taxes in Denmark. According to IEA (IEA 2011)[15] the upstream taxes on the production of oil and gas "make a substantial contribution" to government revenues (currently estimated between 21 and 27 billion DKK per year). Note that the Danish government also receives royalties from extraction concessions and dividends from its share in the energy company DONG. For the downstream energy sector, the "tax system is differentiated between space heating and energy used in production processes" (p.114). Taxes are based on $CO_2$ emissions (150DKK per tonne in 2008), but there are other taxes on energy consumption and use (except for electricity generation).

Taxes on fossil fuels for transportation are geared to promote fuel efficiency. In particular according to IEA (2011)[16], "Petrol-driven (diesel) passenger cars and vans receive a tax reduction of DKK 4 000 for each kilometre (km) in excess of 16 km (18 km) the vehicles run per litre of petrol (diesel). Similarly, a tax increase of DKK 1 000 per km less than 16 km (18 km) the vehicles run per litre of petrol (diesel) is imposed. This is expected to lead to a yearly emissions reduction of 50,000 tonnes $CO_2$. This incentive replaced a reduction in the registration tax for highly energy-efficient private cars, which was introduced in January 2000" (IEA 2011, p.114).

Light duty vehicles (LDVs) and vans are also subjected to property taxes, which are among the highest in the world: "For new cars, the registration tax is generally calculated as 105 % of the part of the dutiable value under DKK 76 400 and 180 % on the part of the dutiable value exceeding DKK 76 400" (International Energy Agency 2011, p.27).[17]

# 6 Description of policy mix(es)

*This section presents the main policy mix that will be the focus of this ex-post assessment.*

**Lifecycle focus (point of application(s) of the policy mix):** Production and Consumption

**Sector(s) covered:** Electricity, gas, steam and air conditioning supply, extraction of crude petroleum and natural gas, transporting and storage, public administration and defence, manufacturing and agriculture (crop and animal production, for biogas and biomass production), residential energy use, service sectors.

**Scale of application of policy mix:** National

[ii] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

**Implementing body:** The Danish Ministry of Climate, Energy and Building: Responsible for national and international efforts to mitigate climate change and for energy. It relies on the support of the following bodies for the implementation of the Strategy:

- The Danish Energy Agency (DEA) is responsible for all tasks related to the production, transmission and use of energy, and its impact on climate change. Its principal function is to ensure the legal and political framework for reliable, affordable and clean supply of energy in Denmark.
- Energinet.dk**,** the transmission system operator, is an independent public enterprise owned by the Danish State. It is responsible for maintaining security of supply and ensuring the smooth operation of the market for electricity and gas.
- The Danish Energy Saving Trust covers electricity savings and more efficient use of all forms of energy in every sector other than transport.
- The Danish Energy Regulatory Authority (DERA) oversees the electricity, natural gas and district heating markets.
- A Commission on Climate Change Policy, established in 2007, presented its 40 recommendations to the government in 2010, before ending its activities. The Strategy is based on these recommendations (International Energy Agency 2011).[18]

**Objective of policy mix:**

The *Energy Strategy 2050* has two objectives: independency from fossil fuels and drastic curbing of $CO_2$ emissions from the energy sector by 2050. Its implementation envisages the active participation in post-Kyoto Protocol negotiations in the United Nations Framework Convention on Climate Change (UNFCCC) framework, as well as the fulfilment or the overtaking, of the EU's 20-20-20 strategy[iii] objectives as intermediate targets. Table 1, taken from IEA 2011 (International Energy Agency 2011)[19], lists the objectives of *Energy Strategy 2050* in higher detail, and the related policy actions included in that strategy (which are largely reflected in *Our Future Energy*).

**Table 1: Objectives of the Danish Energy Strategy 2050 and changes after the 2012 Agreement**

| Government goals | Energy Strategy 2050 actions | Energy Agreement 2012 Amendments |
|---|---|---|
| Fossil fuel independence by 2050 | Initiatives for increased use of renewable energy and energy efficiency improvements will reduce fossil fuel use in the energy sector by 33 % by 2020 compared with 2009. | No change |
| The share of renewable energy must be increased to 30 % of final energy consumption by 2020 as part of an overall EU target of 20 % renewable energy by 2020. | Government initiatives for increased use of biomass, wind and biogas will ensure a renewable energy share of 33 % by 2020, and thus exceed compliance with the EU target. | More than 35 % renewable energy in final energy consumption 50 % of electricity consumption to be supplied by wind power. |

[iii] Directive 2009/28/CE of the European Parliament and the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. OJ L140.6.2009, p. 16-62

| | | |
|---|---|---|
| The share of renewable energy in the transport sector must be 10 % by 2020. | Government initiative for 10 % biofuels by 2020 in addition to the government's initiatives to promote electric cars will ensure compliance with the EU target by 2020. | No change |
| In 2020, primary energy consumption must be 4 % less than in 2006. | Government initiatives for energy efficiency improvements in private homes, businesses, the State and municipalities will ensure a reduction of 6 % by 2020 compared with 2009, and thus exceed compliance with the national target. | 7.6 % reduction in gross energy consumption in relation to 2010. |
| Emissions in the non-ETS sectors must be reduced gradually in 2013-2020 and by 20 % by 2020 relative to 2005 as part of an overall EU target to reduce emissions by 20 % by 2020 relative to 1990. | Government initiatives to reduce fossil fuels will also reduce non-ETS emissions by 4-5 mt $CO_2$ in the period 2013-2020.The government will follow up on efforts regularly to ensure compliance with the 2020 climate commitment, and launch new initiatives as required. | 34 % reduction in greenhouse gas emissions in relation to 1990. |

Source: IEA. 2011. *Energy Policies of IEA countries*: *Denmark.* Paris, France: International Energy Agency, based on Danish Ministry of Climate and Energy. 2011. *Energy Strategy 2050– from coal, oil and gas to green energy.* Copenhagen, Denmark: Danish Ministry of Climate and Energy and on Danish Energy Agency. 2012. *Energy Policy in Denmark.* Copenhagen, Denmark: Danish Energy Agency.

*Our Energy Future* has slightly modified objectives:

- By 2050, energy and transport sectors should rely 100 % on renewable energy.
- By 2035, electricity and heat production should rely 100 % on renewable energy.
- By 2020, Danish greenhouse gas emissions should be reduced by 40 % compared to 1990.
- By 2020, 50 % of electricity consumption should be produced by wind power.[20]

## 6a. Supplementary context questions including elements pertinent to paradigm discussions in DYNAMIX

*Timeline for the different phases of the policy cycle (i.e. rationale and objective-setting; appraisal; implementation and monitoring).*

*Description of the government in power during each of the three following policy phases: rationale and objective-setting; appraisal; and implementation and monitoring.*

*Does the mix contain policies that are unusual or not typical of the country/ies or regional/local administration that implemented it?*

*Names of resource efficiency concepts, terms, models, ranking/classification systems, accounting methods etc. used or relied upon in each of the three phases of the policy cycle: rationale and objective-setting; appraisal; and implementation and monitoring, and how they*

*were used (e.g.: 'waste hierarchy' – used in objective-setting to link policy objectives to more desirable uses for waste).*

**Rationale and objective setting:** 2007- 2008. The second and third Cabinets of Prime Minister Anders Fogh Rasmussen: 18 February 2005 - 23 November 2007 – 5 April 2009. Political Bias: centre –right (Venstre+ Conservative Party Coalition).[iv]

**Appraisal, implementation and monitoring**: 2009 – ongoing. The cabinet of Prime Minister Lars Løkke Rasmussen 5 April 2009 – 3 October 2011. Political bias: Centre–right (Venstre+ Conservative Party Coalition).[v] Followed by the cabinet of Prime Minister Helle Thorning-Schmidt. Political bias: Left: Social Democrats, Social Liberal Party and the Socialist People's Party, 3 October 2011- incumbent.[vi]

Presidency of the Council of the EU during this period: See table below:

**Table 2: Presidency of the Council of the EU during the phases of the policy cycle**

| Policy cycle phase | Year | Semester | Presidency |
|---|---|---|---|
| **Rationale and objective setting** | 2007 | Jan–Jun | Germany |
| | | Jul–Dec | Portugal |
| | 2008 | Jan–Jun | Slovenia |
| | | Jul–Dec | France |
| | 2009 | Jan–Jun | Czech Republic |
| | | Jul–Dec | Sweden |
| | 2010 | Jan–Jun | Spain |
| **Appraisal, implementation and monitoring** | | Jul–Dec | Belgium |
| | 2011 | Jan–Jun | Hungary |
| | | Jul–Dec | Poland |
| | 2012 | Jan–Jun | Denmark |
| | | Jul–Dec | Cyprus |
| | 2013 | Jan–Jun | Ireland |
| | | Jul–Dec | Lithuania |

[iv] More info here: http://en.wikipedia.org/wiki/Cabinet_of_Anders_Fogh_Rasmussen_III

[v] More info here: http://en.wikipedia.org/wiki/Cabinet_of_Lars_L%C3%B8kke_Rasmussen

[vi] More info here: http://en.wikipedia.org/wiki/Cabinet_of_Helle_Thorning-Schmidt

Source: Council of the European Union. n.d. "Presidency Websites". Website Section. http://www.consilium.europa.eu/council/presidency-websites?lang=en

The mix does not contain policies that are unusual or not typical of the country/ies or regional/local administration that implemented it. On the contrary, the participative approach leading to the Strategy by means of Agreements between the government and other political parties is deemed to be "typically Danish" (International Energy Agency 2011)[21], although such agreements or approaches are not necessarily typical in other countries.

This policy has not been designed with resource efficiency in mind. There are however clear efficiency concepts in the strategy that can be partially mapped into a resource efficiency framework. In particular, the three concepts most used to define the targets are 'independency from fossil fuels', 'energy efficiency' and 'zero $CO_2$ emissions from fossil fuels', which can be broadly related to resource efficiency and zero-carbon, respectively.

## 6b. Instruments and orientation of policy mix

*Instruments in the mix and whether one type of tool (i.e. regulatory, economic, information) is dominant.*

*For each instrument, what is its aim? What requirements does it place on relevant players (for example, phasing out a certain substance, meeting minimum recycling targets, etc.)? What reporting requirements exist?*

It has not been possible to analyse *Our Future Energy* to the depth that *Energy Strategy 2050* was analysed. Hence, we present the analysis of *Energy Strategy 2050.* The Strategy is a comprehensive, multi-faceted plan that covers many sectors and relies on many tools. Also, it does not cancel the policy measures currently in place (it only foresees their revision at a later stage). Given the widespread use of energy taxes, one could argue that market-based instruments remain, at least in the short run, the dominant ones. For future policy actions, probably the dominant features are modularity and flexibility. The Strategy is organised into three tracks: short-, medium- and long-term actions. Given the uncertainty of long-term perspectives, the tools shift gradually from concrete market-based instruments, standard setting and regulatory tools to more preliminary activities, such as earmarking funding for future actions, planning and research actions in track three. Thus, there is no really dominant instrument along the whole strategy, but it is a dynamic policy framework that can adapt to an ever changing and uncertain world. Table 3 describes briefly the three strategies.

**Table 3: The three tracks of the Danish Energy Strategy 2050**

| Track | Initiatives |
|---|---|
| **Track one (short term)** | More renewable energy with onshore and offshore wind power. |
| | Increased use of biomass and biogas. |
| | More efficient energy consumption. |
| **Track two (medium term)** | A green transport sector. |
| | An intelligent energy system. |
| | Regulation in a new era of energy policy. |
| | A global and regional transition to fossil fuel independence. |

| | |
|---|---|
| **Track three (long term)** | Green growth through research, development, demonstration and preparation for market. |

Source: Danish Ministry of Climate and Energy. 2011. Energy Strategy 2050– from coal, oil and gas to green energy. Copenhagen, Denmark: Danish Ministry of Climate and Energy; IEA. 2011. Energy Policies of IEA countries: Denmark. Paris, France: International Energy Agency and Authors' assessment.

Table 4 lists the various policy actions in *Energy Strategy 2050*, characterising them in terms of the track they belong to, their aim, the type of policy tools proposed for each action, and their ranking (primary, enhancing or supporting instrument).

**Table 4: Policy actions in the three tracks of the Danish Energy Strategy 2050, as amended by the 2012 Energy Agreement**

| Policy area | Action | Action type | Relevance |
|---|---|---|---|
| **Track one: the transition phase** | | | |
| More renewable energy from onshore and offshore wind power | Call for tenders for 1,200 MW offshore wind turbines up to 2020, including 600 MW offshore wind turbines at Kriegers Flak. | Procurement | Primary |
| | Call for tenders on the smaller offshore wind turbine installations totalling 400 MW. | Procurement | Primary |
| | Support continued municipal planning for new onshore wind turbines, in order to establish 1,800 MW new wind power onshore (500 MW more than anticipated in the 2010 baseline). | Planning | Enhancing |
| | Analyse the opportunities for reducing the distance requirements for wind turbines. | Research | Support |
| | Gradual phase-out of premium for onshore wind turbines with introduction of a new cap of DKK 0.6/kWh for the electricity market price and premium, after which the premium will be gradually phased out for electricity market prices over DKK 35/kWh, for new onshore wind turbines connected to the grid on and after 1 January 2014 | Regulation | Enhancing |
| | In co-operation with industry, continue the wind turbine secretariat, including the mobile wind-turbine task force. | Participative approach | Support |
| Increased use of biomass and biogas | Promote the conversion to biomass at large-scale plants by amending provisions of the Heat Supply Act. | Regulation | Enhancing |
| | Set aside funds of DKK 25 million in 2012 to safeguard the required expansion of the biogas infrastructure | Funding | Enhancing |
| | Various subsidies for biogas starting in 2012: DKK 27/GJ for production; subsidy for biogas in the natural gas grid on equal terms with CHP production, entailing a total subsidy of DKK 75/GJ; subsidy for biogas in industry and transport of net DKK 12/GJ; subsidy of DKK 22.5/GJ for biogas from livestock manure; Increase the aid from a start-up construction fund from 20 % to 30 %. | Market-based | Primary |

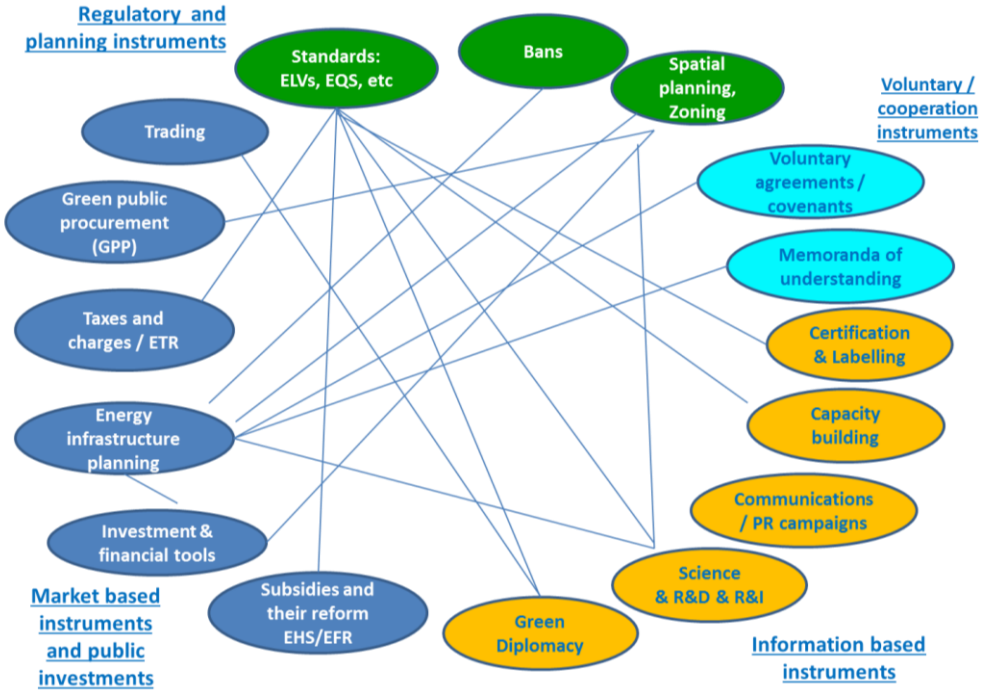
| | | | |
|---|---|---|---|
| | Allow small-scale power plants a free choice of fuel. | Regulation | Not defined |
| | Introduce a 10 % biofuels obligation in the transport sector by 2020. | Standards | Primary |
| | Change in regulation in order to allow, on a voluntary basis, changing from fixed electricity premium to a premium for 100 % biogas-based plants. | Regulation | Support |
| | Ensure the right framework conditions for biogas production. | Regulation | Enhancing |
| More efficient energy consumption | Target the energy-saving obligations of energy companies towards renovation of buildings, conversion of oil and natural gas heating. | Regulation | Primary |
| | Increase the energy-saving obligations of energy companies by 50 % from 2013 and by 75 % in 2017-2020. | Standards | Not defined |
| | Future-proof minimum efficiency standards for building components. | Standards | Primary |
| | Convert heating by oil, and eventually also natural gas heating, to district heating, heat pumps and other renewable forms of energy through:<br>- a ban on installing oil furnaces in existing buildings from 2015, and a ban on installing oil and natural gas furnaces in new buildings from 2013,<br>- market-promotion of initiatives for energy-efficient heat pumps and solar heating, including labelling schemes, certification schemes, package solutions and ESCO models,<br>- rules on compensation for gas companies converting from individual natural gas to district heating,<br>- a model and timetable for the phase-out of natural gas furnaces, taking account of the need for gas for production purposes in industry and potentials for utilizing biogas. | Standards, market support, labelling, regulation and planning | Primary |
| | Launch market promotion of energy-efficient heat pumps and solar heating to replace oil boilers. | Market support | Support |
| | Incorporate a “low-energy rating 2020” in the building regulations. | Standards | Primary |
| | The 2012 Finance Act agreement will establish a green subsidy scheme for energy renovation of housing. DKK 500 million has been earmarked for 2013 and DKK 500 million for 2014. | Subsidies | Enhancing |
| | Enhance energy-saving efforts by the public sector by 2012. | Procurement | Enhancing |
| **Track two: preparation and planning of the next phase** | | | |
| A green transport sector | Carry out a technology assessment in 2011, and subsequently every three years, in order to ensure the right framework conditions for new energy technologies. | Research | Primary |
| | Establish a fund of DKK 25 million to support the establishment of recharging stations for electric cars. | Funding | Enhancing |

| | | | |
|---|---|---|---|
| | Push in the EU for tightened standards for energy efficiency and $CO_2$ emissions of vehicles and promote the spread of electric cars in the EU. | Green diplomacy | Enhancing |
| | Push in the EU for the establishment of a car recharging infrastructure throughout the EU. | Green diplomacy | Enhancing |
| An intelligent energy system | Establish a new international electricity transmission capacity in connection with the future offshore wind park at Kriegers Flak. | Procurement | Primary |
| | Analyse the need to expand international transmission lines. | Research | Support |
| | Work for an agreement with the distribution companies to install intelligent electricity meters when electricity consumers install heat pumps or recharging stations for electric cars. | Participative approach | Enhancing |
| | Continued incentives for demonstration projects for dynamic tariffs in specific electricity distribution grids | Funding | Support |
| | State co-financing of recharging stations for hybrid cars | Funding | Support |
| | Prepare a strategy for the promotion of smart grids in Denmark. | Planning | Primary |
| Regulation in a new era of energy policy | Analyse regulation of future gas infrastructure. | Research | Support |
| | Launch an in-depth review of the electricity supply regulation. | Research | Primary |
| | Set aside DKK 20 million for the promotion of strategic energy planning partnerships constituted by municipalities, local enterprises and energy companies. | Funding | Enhancing |
| | Carry out an analysis of the use of biomass for energy-related purposes in Denmark. | Research | Support |
| | Carry out an examination of the subsidy and tax system in order to assess the need for adjustments of the existing system. | Research | Support |
| | Improve tendering procedures for offshore wind parks in order to reduce the costs of expansion and prepare the basis for decisions to expand offshore wind turbines in the period after 2020. | Regulation | Support |
| A global and regional transition to fossil fuel independence | Work in international forums for ambitious, global actions for the climate, the promotion of a green growth agenda as well as for the phase-out of subsidies for fossil fuels. | Green diplomacy | Enhancing |
| | Promote a long-term vision for an EU independent of fossil fuels. | Green diplomacy | Enhancing |
| | Endeavour to raise the common EU GHG emissions 2020 target from 20 % to 30 % compared with the 1990 level. | Green diplomacy | Enhancing |
| | Green business scheme of about DKK 250 million in 2013 and after this about DKK 500 million. per year from 2014-2020 to promote use of renewable energy in enterprises. | Funding | Enhancing |

| | | | |
|---|---|---|---|
| | Prioritise a doubling of the funds for research, development and demonstration in the energy area by 2020 compared with the level today | Funding | Primary |
| **Track three: the technology development phase** | | | |
| Green growth through research, development, demonstration and preparation for market | Undertake a strategic review of public research, development and demonstration initiatives in the climate and energy sector. | Research | Primary |
| | Allocate DKK 10 million for demonstration of large heat pumps in the district heating sector. | Funding | Primary |
| | Allocate DKK 20 million for geothermal energy exploration projects. | Funding | Primary |
| | Energy RDD to be supported with grants above 1 billion DKK covered by the 2012 Finance Act. | Funding | Primary |
| | Extend the existing public service obligation scheme to support small electricity-producing renewable energy technologies. A total of DKK 100 million will be already allocated over four years starting in 2012 | Regulation | Enhancing |
| | Allocate DKK 10 million to support demonstration projects on solar heating for household solutions. | Funding | Primary |
| | Support the establishment of large testing grounds for green solutions in Denmark. | Planning | Support |
| | Enter into partnerships with private enterprises, research institutions and others, where this can contribute to developing, testing and preparing for market of Danish clean technology solutions. | Participative approach | Support |
| | Carry out technology assessments in a wide range of areas. | Research | Support |
| | Ensure sufficient recruitment of university graduates and researchers into the green sector. | Research | Enhancing |

Source: Danish Ministry of Climate and Energy. 2011. *Energy Strategy 2050– from coal, oil and gas to green energy*. Copenhagen, Denmark: Danish Ministry of Climate and Energy; IEA. 2011. *Energy Policies of IEA countries: Denmark*. Paris, France: International Energy Agency and Authors' assessment.

**Figure 4: Policy instruments and their relationships for the Danish Energy Strategy 2050**



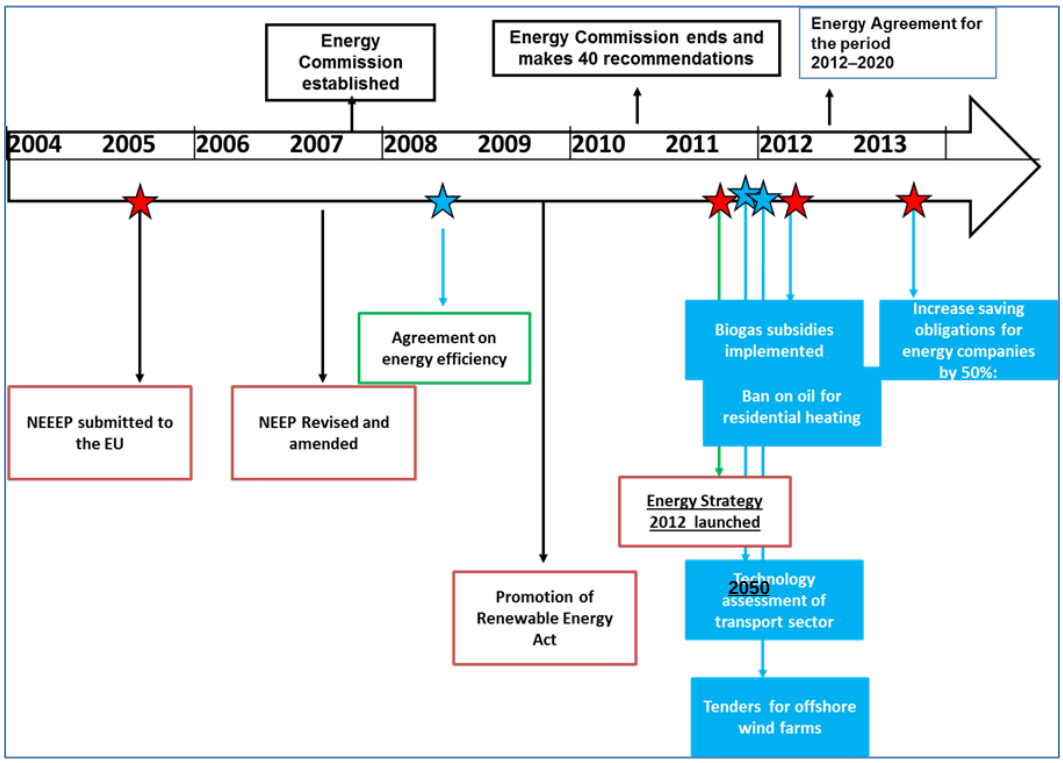

Source: Authors' compilation

## 6c. Evolution of policy mix

*Evolution of the policy mix throughout its existence –details of the introduction of the first policy tool(s), then all subsequent relevant tools, and related revisions/reforms (e.g. progressive increases in rates applied through economic tools, broader extension of regulation requirements, etc.).*

Figure 5 provides an overview of the evolution of the strategies and policies in this evaluation.

**Figure 5: Evolution of the Danish fossil fuels policy mix**




Source: Authors' compilation

# 7 Evaluation of policy mix: effectiveness (environmental sustainability)

*Does/did the policy mix result in a positive environmental outcome?*

*Were its stated objective(s) met? Were the instruments used sufficient to meet the objectives?*

*Did other, unforeseen/unintended positive outcomes or impacts (environmental, social, economic) result? Did other such negative outcomes or impacts result?*

*Were these objectives set at a level to meet environmental needs (e.g. avoid crossing environmental thresholds/tipping points or achieve more sustainable levels of resource use/extraction (e.g. maximum sustainable yield (MSY) in fisheries)?*

*Which sectors/actors were identified as having key impacts/influences on the problem/issue? (e.g. specific industrial/ business sectors, consumers, economy as a whole?) Did any of the instruments specifically target these key sectors/actors? Was there significant take-up/implementation of (voluntary) instruments by these sectors?*

*Was the policy mix applied to a sector previously not targeted by policies on the issue under question, or in a new area/issue – thereby aiming to stimulate change?*

*What were the anticipated and actual outcomes, impacts and effects of the policy mix on the behaviour of sectors and actors targeted? (e.g. reductions in emissions from industry, increased recycling rates, increase/decrease in certain product purchases, etc.).*

*Relationships between the instruments, identifying positive/negative influences on the overall policy mix or on key instruments in the mix, as well as any positive or negative impacts from changes to the mix (introduction or termination of instrument(s), increase or decrease in tax/levy/charge, etc.). Level of 'connectivity' (strong, weak) between each instrument and the primary one(s).*

*Are there any indicators, monitoring systems, review processes or other monitoring mechanisms in place to track progress?*

It is too early to tell whether the policy mix resulted in a positive environmental outcome. The strategy has been launched two years ago, and it is not clear yet if it has led to an improvement to the already outstanding performances of Denmark in this field. As mentioned earlier, the Strategy has been commended by IEA for its ambitious yet realistic stance towards a carbon- and -fossil fuels-free future. On the other hand there is still hardly any evidence that the Strategy is actually on track. The wind energy production in Denmark seem to have hit its all-time record recently with 4GW injected into the grid in March 2013 (Renewable Energy World.Com 2013)[22], almost entirely covering its electricity demand, a sign that wind energy generation is surely on the rise in this country.

Intermediate objectives are set for 2020, final ones for 2050. Only time will tell if the stated objectives will be met. An important sign that the strategy is on track is the fact that in March 2012 another Energy Agreement has been signed between the Government and all but one parties in the Parliament, covering 95 % of the political spectrum. This agreement covers the period 2012-2020 and sets ambitious intermediate targets such as (Danish Energy Agency 2012):[23]

- "More than 35 % renewable energy in final energy consumption;
- Approximately 50 % of electricity consumption to be supplied by wind power;
- 7.6 % reduction in gross energy consumption in relation to 2010;
- 34 % reduction in greenhouse gas emissions in relation to 1990."

It is not yet clear if the instruments used were sufficient to meet the objectives. However, the highly positive assessment by the IEA (IEA 2011)[24] points nevertheless to areas of possible improvement, in particular "Monitoring and maintaining momentum will present a huge challenge for the government once the Strategy is transposed into law. Consideration should be given to the establishment of a mechanism to review, evaluate and monitor implementation of all phases of the Strategy and ensure the cost-effective delivery of outcomes. This evaluation process should also include publication of regular performance reports" (IEA 2011, p.8).

Unforeseen/unintended positive outcomes or impacts (environmental, social, economic) have not yet been observed.

All sectors are targeted: there are specific measures for residential consumers (efficiency in buildings), electricity generation and transmission, renewable energy production (wind and biomass/biogas in particular), transport sector, the industry (industrial engines efficiency).

The policy mix was not applied to a sector previously not targeted by policies on the issue under question, or in a new area/issue.

Expected outcome of the Strategy is the topic of Section 4 of the Strategy document (Danish Government 2011, pp. 47-58) to which the interested reader is referred to for further details. In short, in the words of the Strategy document:

- Use of fossil fuels in the energy sector will be cut by 33 % by 2020 relative to the 2009 level.
- The share of renewable energy will account for more than 60 % of overall electricity consumption in 2020, against 29 % in 2009. Wind power will cover more than 40 % of electricity consumption in 2020.
- Electrification of an ever greater share of energy consumption for transport, heating and industrial processes; in particular less oil products used from transport.
- The use of fossil fuels for energy, transport, and for extraction and refining purposes, will be reduced by 18 % by 2020, relative to 2009. Complete phase–out by 2050.
- The share of renewable energy will reach 33 % in 2020, up from around 20 % in 2009. Energy and transport system based on renewable energy by 2050.
- Gross energy consumption will be reduced by 6 % by 2020, relative to 2006.
- Higher security of supply.
- More flexible electricity transmission and distribution system.
- Reduce non-ETS emissions by 20 % by 2020 in relation to 2005 (4-5 million tonnes $CO_2$ equivalents in the period 2013-2020).
- Denmark's total greenhouse gas emissions will be reduced by approximately 75 % in 2050, if the fossil fuels phase out is successful.
- Enhanced green growth opportunities in terms of growth of renewable energy sectors, smart grids, energy saving technologies, in terms of more jobs and increased international competitiveness through innovation.

Some of these expected outcomes are now more optimistic, following the 2012 Energy Agreement.

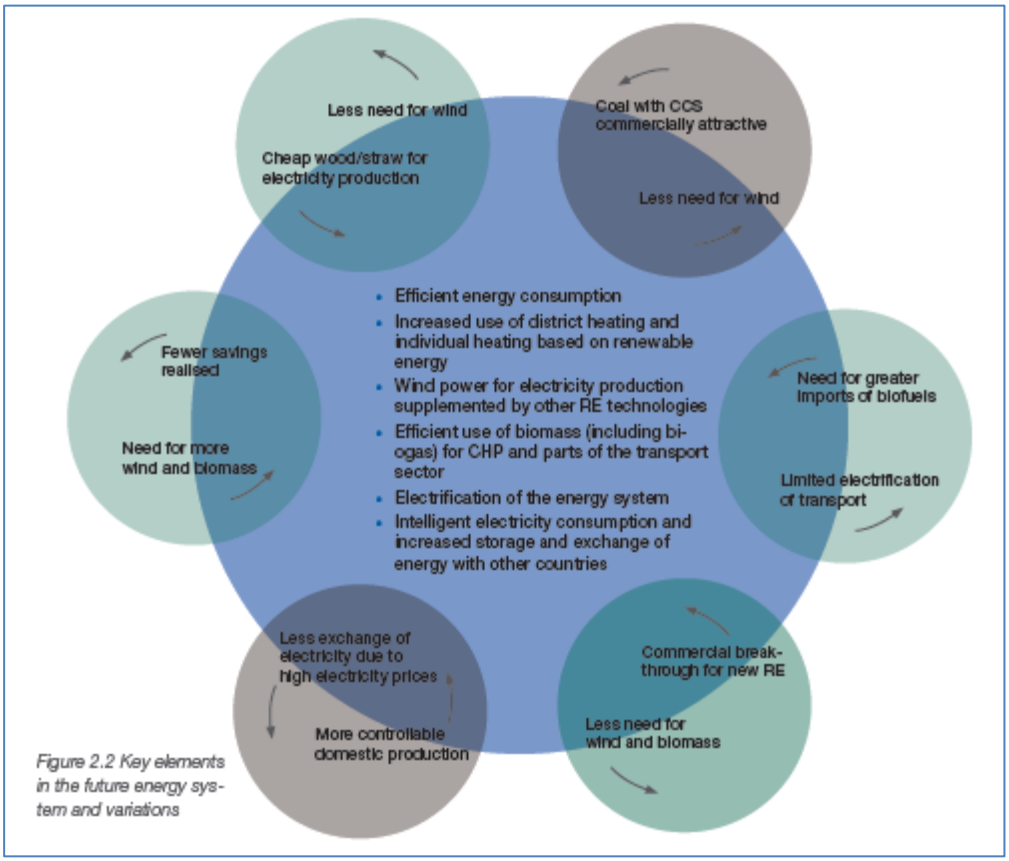
The Strategy is too complex to allow an accurate evaluation of all possible relationships among instruments. Some of them are clearly a precondition for others, some are mutually enhancing, some work in autonomy. In particular, all those actions aimed at improving the knowledge base about the situation of a specific sector or area of intervention are a precondition for a sound deployment of policies targeted to that sector. The same holds for those actions aimed at simplifying the regulatory framework or to maximise the public support of a given policy. The last column of

Table 4 should help identifying those policy actions that help the primary ones in any given area of intervention. There are of course synergies across areas: for instance 'a more intelligent energy system' is functional to provide the needed flexibility to accommodate an increasing share of renewables into the system.

As mentioned above, the lack of indicators, monitoring systems, review processes or other monitoring mechanisms in place is one of the few critiques to the Strategy put forward (International Energy Agency 2011).[25] There is a need to define more clearly the enforcement

monitoring procedures and the mechanism to track progress. A mechanism of some sort was clearly in the mind of the designers of this Strategy, as a lot of attention is devoted to flexibility of the policy and its ability to adapt to changing and uncertain conditions. Figure 6 exemplifies the elements whose evolution needs to be monitored to allow adjustments in the strategy as it will develop in the coming decades.

**Figure 6: Flexibility designed into the Danish Energy Strategy 2050**




Source: Danish Ministry of Climate and Energy. 2011. *Energy Strategy 2050– from coal, oil and gas to green energy.* Copenhagen, Denmark: Danish Ministry of Climate and Energy, p.23

The 2012 Energy Agreement partially overcomes these drawbacks by putting in place “a regular evaluation of the impact of the instruments and an overall evaluation every four years”.

# 8 Evaluation of policy mix: efficiency (economic sustainability)

*Is/was the policy mix considered cost-effective?*

*What has been the level of impact on resource use of the policy mix (the effect)?*

*What have been the costs of implementing the policy mix for target audience (e.g. business, households, etc.)?*

*What are the costs (financial, human) of implementing the policy mix for the implementing authority – i.e. the administrative/transaction costs?*

*Were sufficient resources made available to ensure an effective implementation of the policy-mix?*

*Was anything foreseen in the policy-mix to address competitiveness concerns (e.g. use of exemptions) or minimise transaction costs (e.g. thresholds below which monitoring wasn't required)?*

*Did the policy mix involve providing financial support (e.g. subsidies, low interest loans, tax breaks etc.) to key actors (e.g. sector, households, etc.)?*

*Did the measures generate revenues (e.g. in the case of taxes) and if so, was revenue recycled/re-injected into the economy, and to what levels and activities? Did revenue recycling have positive amplifying effects?*

*In synthesis - was the policy mix cost-effective?*

*What elements of the mix were (un)helpful in improving cost-effectiveness?*

*How was relative/absolute decoupling achieved?*

*Were resource limits or other thresholds taken into account and how were they addressed?*

Cost-effectiveness is one of the main pillars declared to underpin the Strategy. Thus although it is too early to call, one would expect that cost effectiveness is taken in all policy actions foreseen in the Strategy.

The effect of the policy mix must still materialise but, if objectives are attained, it will be exceptional, as fossil fuel resources will not be used any longer in Denmark after 2050. Also, intermediate objectives will entail substantial changes in resource use, with renewables in 2020 accounting for 33 % of all energy consumption and 60 % of electricity generation.

The strategy only provides cost estimates to 2020 summarised in Table 5 along with the financing instruments foreseen by the strategy. Overall, by 2020 the strategy would imply costs of about 4 billion DKK, mainly covered through energy bills of businesses and households. Note that the 'new security of supply tax' is merely a public revenue tool to keep the transition neutral on public accounts. Therefore it has not been included among the policy tools, because its main aim is not that of steering energy consumption towards greener choices. The Strategy document also computes the financial impact in 2020 on a typical household and on medium and large enterprises under different assumptions about the application of the strategy and energy efficiency features of the building.

The implementation of the Strategy would imply a 5.5 % increase in the energy bill for a medium firm (250 employees) and a 1.3 % increase for a large firm (400 employees). Overall, new initiatives will imply additional costs for private businesses, growing gradually to DKK 1.2 billion in 2020.

The variation in energy bills for a typical household with respect to 2010 ranges from an increase of 20 % where no energy efficiency interventions are made to a decrease of 10 where energy efficiency renovations are made and a heat pump is installed. The figures are much better if the comparison is drawn against the situation in 2020 in absence of the Strategy. In these cases the variations range from a 10 % increase to a 23 % decrease for the most efficient building configuration.

**Table 5: Foreseeable costs in the Danish Energy Strategy 2050 and related financing tools**

| Initiatives | Estimated cost in 2020 (DKK billion) | Source of Financing |
|---|---|---|
| Increased energy efficiency in buildings and businesses | 0.6 | Energy Tariffs |
| New initiatives for renewable energy expansion | 1.4 | Public service obligation charges in electricity and gas bills |
| State revenue losses due to reduced consumption of fossil fuels | 1.6 | new security of supply tax |
| Other new initiatives | 0.2 ( 2011-2014) | reallocation of existing funds |

Source: Danish Ministry of Climate and Energy. 2011. *Energy Strategy 2050– from coal, oil and gas to green energy*. Copenhagen, Denmark: Danish Ministry of Climate and Energy

As mentioned earlier, the Danish government is striving to ensure that sufficient resources are made available to ensure effective implementation of the policy mix. Section 5 of the Strategy document is titled “A fully financed transition”.

The IEA review seems overall to appreciate the efforts made in this direction by the Danish Government and only points to some residual room for improvement in two instances: “with respect to policies promoting the financing of energy efficiency; there is a need to promote the benefits of energy efficiency investments to financial institutions and to assist them with developing energy efficiency investments for small and medium-sized enterprises” (International Energy Agency 2011, p.65).[26] The second untapped financing potential is in Energy Technology R&D (ETRD), again according to the IEA: “Denmark fails to exploit indirect funding through tax credits for companies that invest in ETRD. This would spur innovation in the small and medium-sized enterprise sector, and, given the large energy players in Denmark, would send a strong signal to foster competition” (IEA 2011, p.139).[27]

Competitiveness concerns (e.g. use of exemptions) and minimization of transaction costs are explicitly foreseen by the Strategy. As noted by the IEA: “The Strategy also recognises the need to protect the competitiveness of Danish energy intensive industry and the need to avoid industry moving elsewhere. In response, the government proposes a tax relief for energy use for industrial processes compared to what was envisaged in the “Spring Package” of 2009. This means that the business community as a whole escapes additional costs imposed as a consequence of tax increases. The government expects that some businesses will bear increased costs but that some of these costs can be offset by increased subsides for the purchase of more energy-efficient equipment” (IEA 2011, p.26).[28]

In the policy mix financial support is provided as subsidies are explicitly mentioned among the policy tools used in the strategy, particularly for biogas production and wind electricity generation.

The whole Strategy is assumed to be budget neutral, thus revenue generating effects, if any, should be minimal.

It is too early to say if the policy mix was cost-effective, but the outlook for cost–effectiveness of this strategy is very good. The choice of the tools in the policy mix seems to be the result of a careful and expert analyses and decisions, and no conflicting or detrimental elements are apparent at this stage.

Relative/absolute decoupling is yet to be fully realised. Some mild absolute decoupling seems to have happened already (constant/decreasing consumption, declining emissions and moderate GDP growth). This is a result of the policies already in place, in particular the support to wind energy, efforts in energy efficiency in buildings and transport, the latter in particular entailing strong taxation based on vehicles' fuel economy.

# 9 Evaluation of policy mix: welfare (social sustainability)

*What social impacts have you found associated with the policy mix? E.g. jobs created, reduced health impacts, distributional impacts etc.*

*Were social aspects included in an ex-ante impact assessment of the policy mix if one was undertaken? What were these?*

*Has monitoring of social impacts been included in implementation, to identify actual effects compared to anticipated ones?*

*Was the policy mix designed to not be socially regressive? What measures were undertaken to ensure this?*

*Were equity concerns addressed and, in case of re-structuring of the economy/sector, measures in the area of reskilling of the workforce foreseen?*

*What other public acceptability elements were addressed or considered?*

The Strategy explicitly mentions the impact in terms of job created in emerging green industries and the loss of jobs in the fossil fuels value chain, in which Denmark is currently a producing and exporting country. The Strategy states that an equilibrium that minimises the negative social impacts must be found in the transition towards a fossil fuel-free economy in 2050. Another area where social impacts are mentioned is the international arena, in which a diplomatic action that promotes sustainability in developing countries should take into account, according to the Strategy, both social and environmental considerations.

Social aspects were not explicitly included in an ex-ante impact assessment of the policy mix, except for the (limited) loss of competiveness of Danish firms up to 2020 and the possible negative implications for Danish jobs.

Monitoring, as mentioned before, is the only area in which provisions are still less-developed in the Strategy. As this initiative is in its initial phase, it is possible however that this issue will be solved in the years to come.

Denmark's income distribution is among the world's top ones in terms of equality (Atkinson and Søgaard 2013).[29] This is hardly likely to be affected by the Strategy, which is designed to be budget neutral. The increase in costs for households are proportional to energy demand, thus richer households, which can afford to consume relatively more energy are likely to be hit

more severely than poorer households. This can in principle be counterbalanced by the cost of energy efficiency renovations, which can be afforded more easily by richer households.

Equity concerns were briefly addressed. Regarding social impacts, the policy mix facilitates job creation by improving competitiveness in green sectors, but leads indirectly to a loss of jobs in the transition away from fossil fuels and has specific negative consequences for the specialized labour in the fossil fuel industries. The policy mix also makes the public better informed on renewable energy, energy efficiency and climate change mitigation, improves overall health conditions in Denmark by reducing local pollution related to fossil fuel use and might marginally increase the already high propensity of the Danes towards using alternative means of transportation to private cars. Moreover, the green diplomacy side of the initiatives aim at curbing $CO_2$ emissions, enhancing sustainability worldwide, and to increase the impact of EU policies promoting energy efficiency and renewable energy. In an international perspective, the policy mix also aims at increasing the EU commitment in post-Kyoto GHG mitigation initiatives.

# 10 Overall assessment

*What is your overall view on the success(es) or failure(s) of this policy mix?*

*How did the policy mix enable decoupling?*

*How could it have been improved to achieve its original objective(s) and to achieve absolute decoupling?*

The Danish Energy strategy has been launched two years ago, but it looks like one of the most advanced, and comprehensive initiatives in the energy policy arena. It has been highly commended by the IEA, and it starts from an already highly favourable background of successful policy initiatives aimed at enhancing efficiency and renewables, which have already resulted in a noticeable decoupling of economic growth and energy use. It is thus posed to be highly successful in the decades to come, at least as far the internal objectives are concerned. On the international arena, Denmark is not a superpower, and the effectiveness of its effort will hinge on the credibility of its continued efforts through the years (and election periods) and on the diplomatic ability of its representatives at international consultations.

Residual scope for improvement remains in the area of monitoring and enforcement, for which the information is scarce.

# 11 Relevance to the EU and transferability

*Can the policy mix be applied at the EU level? Is it transferable to other Member States/countries?*

*What lessons are there that may be of general interest regarding policy mixes and what issues are there as regards transferability of the insights?*

To a certain extent, transfers to the EU policy are possible but there are a number of factors that make it likely that this experiment will remain quite unique. The level of ambition is quite exceptional, and it depends on how high climate change mitigation and independency of fossil fuel ranks in the political agenda of EU Member States, and on how much it is likely to be sustained in the decades to come. Denmark starts from a privileged position under several aspects: it has a rich resource base in terms of wind resources; has a strong and lively economy; has no budget balance issues; has a strong social cohesion and of people's confidence in the public sector. It has a record of successful energy policies that have already put its economy on an absolute decoupling path. It is connected with an already flexible international electricity transmission network that can accommodate peaks in renewable electricity generation. Moreover, it has a strong commitment to R&D and innovation in energy technology that has already placed it at the frontier of the renewable energy sector, particularly in the case of offshore wind generation. These preconditions are hard to come by simultaneously in any other EU country, with the possible exception of other Scandinavian countries. On the other hand, some ideas, if backed by enough and sustained political will can be transferred to other countries: the support for renewables, for instance, the shift of the transport sector away from fossil fuels, the measures to enhance energy efficiency in buildings are but a few examples of measures that can be transferred piecemeal to other national contexts.

The main lessons that in our view should be learnt from the Danish approach, are the pragmatism and flexibility in-built in the three-track approach: focus first on what can be done immediately, while paving the way for the transition by kicking-off long-terms processes, while keeping the flexibility to cope with uncertainty. If this will be achieved, it would indeed be an example for the world.

# 12 Stakeholder contribution

*What insights did stakeholders provide?*

No stakeholders were consulted.

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