

Denmark's Long-term Strategy

**in accordance with Article 15 and Annex IV in
REGULATION (EU) 2018/1999 OF THE EUROPEAN
PARLIAMENT AND OF THE COUNCIL**

of 11 December 2018

**on the Governance of the Energy Union and Climate Action, amending
Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European
Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC,
2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European
Parliament and of the Council, Council Directives 2009/119/EC and (EU)
2015/652 and repealing Regulation (EU) No 525/2013 of the European
Parliament and of the Council
(the Governance regulation)**

December 2019

Contents

1	OVERVIEW AND PROCESS FOR DEVELOPING THE STRATEGIES	3
1.1	CLIMATE POLICY OBJECTIVES, TARGETS AND STRATEGIES	3
1.2	LEGAL AND POLICY CONTEXT	5
1.3	PUBLIC INFORMATION	6
2	CONTENT.....	7
2.1	TOTAL GHG EMISSION REDUCTIONS AND ENHANCEMENTS OF REMOVALS BY SINKS	7
2.1.1	<i>Projected emission reductions and enhancement of removals 2018-2040/2050</i>	<i>7</i>
2.1.2	<i>National targets for 2030 and 2050.....</i>	<i>15</i>
2.1.3	<i>Adaptation policies and measures</i>	<i>20</i>
2.2	RENEWABLE ENERGY	23
2.2.1	<i>To the extent feasible, the estimated likely share of renewable energy in final energy consumption by 2050</i>	<i>23</i>
2.3	ENERGY EFFICIENCY	30
2.3.1	<i>To the extent feasible, the estimated likely energy consumption by 2050</i>	<i>30</i>
3	FINANCING AND INDICATORS	34
3.1	ESTIMATES OF INVESTMENT NEEDED.....	34
3.2	POLICIES AND MEASURES FOR RELATED RESEARCH, DEVELOPMENT AND INNOVATION	34
3.3	INDICATORS FOR THE EXPECTED PROGRESS ON TRANSITION TO A LOW GREENHOUSE GAS EMISSION ECONOMY	36
3.3.1	<i>Greenhouse gas intensity of gross domestic product</i>	<i>36</i>
3.3.2	<i>CO₂ intensity of gross domestic product</i>	<i>37</i>
4	IMPACT ASSESSMENT OF THE SOCIO-ECONOMIC ASPECTS	38

1 OVERVIEW AND PROCESS FOR DEVELOPING THE STRATEGIES

1.1 CLIMATE POLICY OBJECTIVES, TARGETS AND STRATEGIES

(i) Political, economic, environmental, and social context

On 27 June 2019 a new Danish Government was formed. The Social Democrats reached agreement with the Red-Green Alliance, the Social Liberal Party and the Socialist People's Party to form a one-party minority Government led by the Social Democrats. The parties agreed to the document titled *A fair direction for Denmark*.

The parties agreed that the Government will promote a sustainable policy under which Denmark resumes leadership of the green transition, significantly increases its ambitions concerning the climate, environment and nature, and ensures that Denmark is in compliance with the Paris Agreement.

The Government has the ambition of being among the world governments that do most – both domestically and abroad – to combat climate change and the deterioration of our environment and nature. In order to reach those targets, a very significant effort will be required throughout the tenure of the Government, which must take place in a socially balanced way.

On December 6, 2019 the Government reached an agreement on a new Climate Act with 8 out of the 10 parties in the Danish Parliament. The act will include a legally binding target to reduce greenhouse gases by 70% by 2030 (relative to 1990 level), to reach net zero emissions by 2050 at the latest, and to set milestone targets based on a five-year cycle.

It is stated in *A fair direction for Denmark* that a reduction target by 70% by 2030 is a very ambitious goal, and it will be particularly difficult to realise the last part of the goal, i.e. from 65% to 70%. This will require currently unknown methods and, therefore, also a close collaboration with the Danish Council on Climate Change and other experts.

The climate act will be followed by climate action plans, which will contribute to ensuring that national reduction targets are met. The Climate Action Plan in 2020 will include sector strategies and indicators as a minimum for central sectors as agriculture, transport, energy, construction and industry. Moreover, Denmark has already taken the first steps towards establishing a professional and efficient energy sector as the basis for the transition to a sustainable green society.

In June 2018 all Parties of the Danish Parliament at the time reached a political Energy Agreement to further build Denmark's international positions of strength with a focus on renewable energy, energy efficiency improvements, research and development and energy regulation. The measures and policies decided in the agreement are now in the process of being implemented.

(ii) Strategy relating to the five dimensions of the Energy Union

Decarbonisation - GHG emissions and removals

On December 6, 2019 the Government reached an agreement on a new Climate Act with 8 out of the 10 parties in the Danish Parliament. The act will include a legally binding target to reduce greenhouse gases by 70% by 2030 (relative to 1990 level), to reach net zero emissions by 2050 at the latest, and to set milestone targets based on a five-year cycle. Moreover, the Danish Government will develop Climate Action Plans that will outline concrete policies to reduce emissions in relevant sectors.

Decarbonisation - Renewable energy

The Government has set a very ambitious national target of reducing greenhouse gas emissions by 70 % in 2030 compared to 1990 levels. To reach this target new initiatives will be adopted which will accelerate the transition to renewables in the energy and transport sector.

Moreover, Denmark has set an ambitious course towards at least 55 % renewables energy in gross final consumption in 2030. That will give an important contribution towards the 2030 EU-target for renewable energy. In June 2018 the Danish Parliament agreed on a policy framework for the energy policy from 2020 to 2024 that will specify the first significant steps towards that achievement. As a result, the renewable capacity and renewable shares are expected to rise steadily in all sectors throughout the period.

Energy efficiency

The energy efficiency effort in Denmark has been a highly prioritised policy area since the oil crisis of the 1970s. Denmark has therefore developed a great expertise in energy efficiency, which has made it possible to keep energy consumption largely unchanged in spite of significant economic growth over the last four decades.

Due to continuing economic growth and the construction of several datacentres, the Danish energy consumption is expected to increase slightly in the period 2021-2030 by app. 1 Mtoe in primary energy consumption and 0,5 Mtoe in final energy consumption. However, Denmark is planning a number of initiatives and measures for the period 2021-2030 in order to reduce its energy consumption and fulfil its energy saving obligation. The most prominent new energy saving measure for the period, is a subsidy scheme from 2021-2024 targeting private enterprises and buildings, which is projected to save app. 1,2 Mtoe. This is supported by other measures related to energy efficiency and renovation in public and private buildings, which is projected to generate app. 0,66 Mtoe in savings.

Energy security

Denmark currently has a high level of energy security. The Danish gas production will decrease during the next three years as the Tyra facility will be shut down, but the overall energy mix in Denmark is expected to keep a relatively stable trend in its transition towards a green energy system.

The continued high level of energy security is ensured through decreased dependency on import from third countries through i) Denmark's increase in its renewable energy share largely, ii) Denmark's domestic oil and gas production, and iii) Denmark's cooperation with neighbouring countries to keep the interconnectivity level high. It is also ensured through increased flexibility in the energy system,

through systematized monitoring of adequacy of the supply in different sectors, through emergency plans and the historical development of a resilient energy system.

Internal energy market

Denmark currently has a high level of interconnectivity and Denmark will uphold and increase interconnectivity through projects coordinated with neighbouring countries. This includes a list of PCI projects and reinvestments in existing interconnectors.

Moreover, Denmark is currently focusing on the functioning and integration of electricity markets, with a focus on developing cross-border markets for balancing products. Regarding cross-border capacity, improvements are expected due to the DG COMP decision on the DK1-DE interconnector as well as measures from Svenska Kraftnät for the Swedish interconnectors. Denmark is also focusing on the increase of flexibility in the energy system and the development of better functioning markets in order to facilitate new actors and technologies.

Research, innovation and competitiveness

The new Danish Government wants to reduce greenhouse gas emissions by 70 % by 2030 compared to the 1990 level as well as reaching net-zero emissions by 2050. Denmark must be known as a nation of green entrepreneurialism. Therefore, new technologies and solutions must be developed and deployed.

Denmark has committed to spend 580 mill. DKK in 2020 and 1 billion DKK in 2024 on research, development and demonstration (R&D) of new technologies related to energy and climate. A large share will go to the EUDP programme, which funds projects in line with SET Plan objectives. Moreover, the new Danish government has proposed to increase spending to green research, development and demonstration by 1 billion DKK in 2020. It is expected that a large part of this funding will go to climate-related research and innovation, including research and innovation in clean energy. Furthermore, Denmark wants to intensify export promotion activities in the energy sector – both in scale and volume – to a total of 174 million DKK from 2019 to the end of 2024.

1.2 LEGAL AND POLICY CONTEXT

In accordance with Article 15(3) of the Governance regulation Denmark's long-term strategy will contribute to:

- (a) fulfilling the Union's and the Member States' commitments under the UNFCCC and the Paris Agreement to reduce anthropogenic greenhouse gas emissions and enhance removals by sinks and to promote increased carbon sequestration;
- (b) fulfilling the objective of the Paris Agreement of holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1,5 °C above pre-industrial levels;
- (c) achieving long-term greenhouse gas emission reductions and enhancements of removals by sinks in all sectors. This is in accordance with the Union's objective, in the context of necessary reductions according to the Intergovernmental Panel on Climate Change (IPCC) to reduce the Union's

greenhouse gas emissions in a cost-effective manner and enhance removals by sinks in pursuit of the temperature goals in the Paris Agreement. This is to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases within the Union as early as possible and, as appropriate, achieve negative emissions thereafter;

- (d) a highly energy efficient and highly renewables-based energy system within the Union.

In accordance with Article 15(4) of the Governance regulation Denmark's long-term strategy covers information on:

- total greenhouse gas emission reductions and enhancements of removals by sinks;
- expected progress on transition to a low greenhouse gas emission economy including greenhouse gas intensity, CO₂ intensity of gross domestic product, and strategies for related research, development and innovation;
- information on other national objectives, planning and policies and measures regarding renewable energy and energy efficiency.

In accordance with Article 15(6) of the Governance regulation the information included in this long-term strategy document is consistent with the information contained in Denmark's integrated national energy and climate plan submitted to the European Commission in parallel to this document.

Detailed information about projection models, assumptions etc. used for the latest frozen policy scenario (the WEM scenario) published in August 2019 is available in the projection report¹ and in summary in Denmark's Integrated National Energy and Climate Plan (NECP).

As the new Danish climate act will form a new framework for Denmark's climate policy and the climate action plan will include additional policies and measures, this long-term strategy document is to be seen as an evolving document, which is expected to be updated more often than the 5-10 years intervals required by the Governance Regulation.

An update is expected to be elaborated and sub-mitted in 2020 – in both the EU context and the UN context in accordance with the Paris Agreement.

1.3 PUBLIC INFORMATION

In accordance with Article 15(6) of the Governance regulation this long-term strategy document will be made available to the public. Relevant data such as greenhouse gas inventories as well as data from the latest energy and and greenhouse gas emission projections are also available to the public.

In the development of the new comprehensive climate action plan, the government will involve relevant parties broadly, for example through cooperation with the Danish business community in the form of the Government's 13 "climate partnerships".

¹ <https://ens.dk/en/our-services/projections-and-models/denmarks-energy-and-climate-outlook>

2 CONTENT

2.1 TOTAL GHG EMISSION REDUCTIONS AND ENHANCEMENTS OF REMOVALS BY SINKS

2.1.1 Projected emission reductions and enhancement of removals 2018-2040/2050

2.1.1.1 Projected emission reductions and enhancement of removals 2018-2040/2050 in the frozen policy scenario (with existing or adopted measures: the WEM scenario)

This section presents the assumptions and results from Denmark's Energy and Climate Outlook 2019 (DECO 2019²), which is a projection towards 2040 with existing policies and measures (the WEM scenario).

Technology cost projections assumptions and results are from Denmark's technology catalogues³

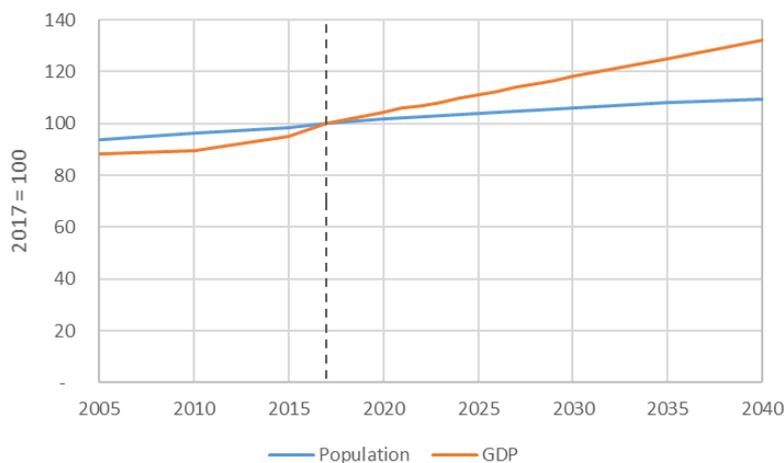
The current situation refers to 2017, which is the latest statistical year. Projections refer to 2018-2040.

A. Projected evolution of main exogenous factors influencing energy system and GHG emission developments

(i) Macroeconomic forecasts (GDP and population growth)

As shown in figure 1, from 2017-2030 the population is projected to grow 6%, while GDP increases 18%. The trend is projected to continue beyond 2030, leading to a 9% population growth and a 32% GDP growth in 2040, compared to 2017.

Figure 1. Population and GDP 2005-2040 [2017=100].



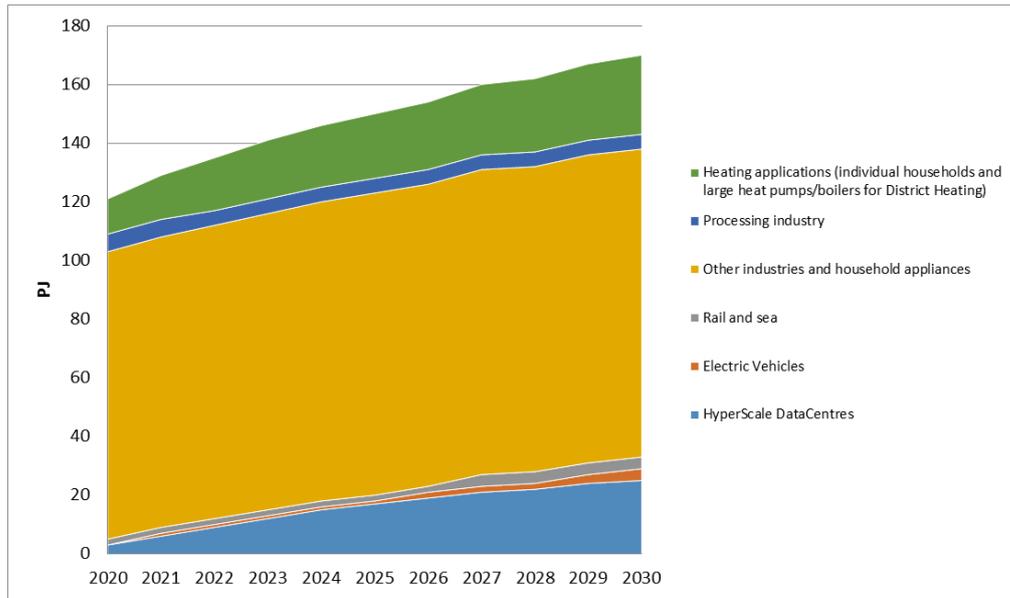
² <https://ens.dk/en/our-services/projections-and-models/denmarks-energy-and-climate-outlook>

³ <https://ens.dk/en/our-services/projections-and-models/technology-data>

(ii) Sectoral changes expected to impact the energy system and GHG emissions

Figure 2 shows the electricity consumption for various sectors from 2020-2030, highlighting significant impacts, mainly due to the increase of electricity demand for hyper-scale data centers (HSDC's) and heating applications. GHG emissions will be less affected due to the increased deployment of renewable energy capacity in the same period.

Figure 2. Electricity consumption (PJ) by sector (net loss excluded) 2020-2030.



(iii) Global energy trends, international fossil fuel prices, EU ETS carbon price

Figure 3 shows the projections of fossil fuel prices used as assumptions in the NECP.

Figure 3. Fossil fuel prices 2005-2040 [2016-EUR/GJ].

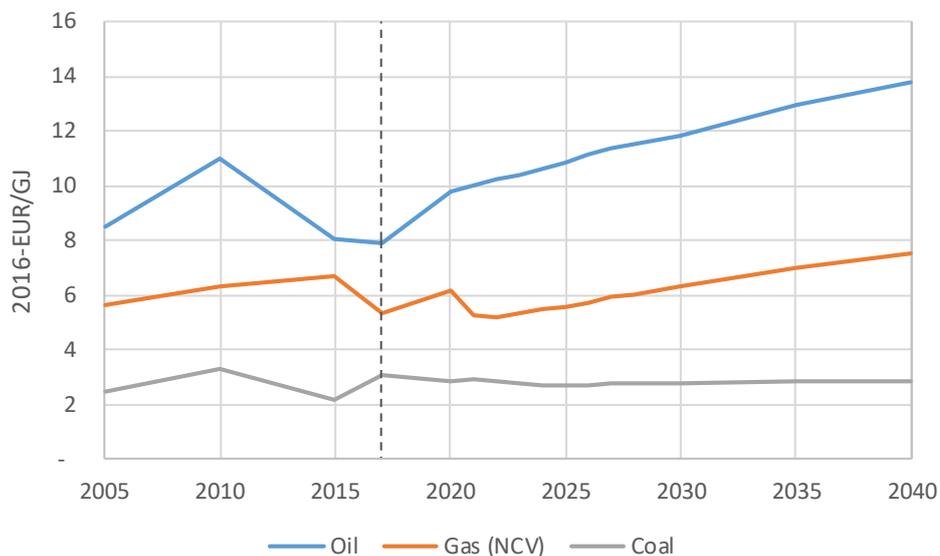
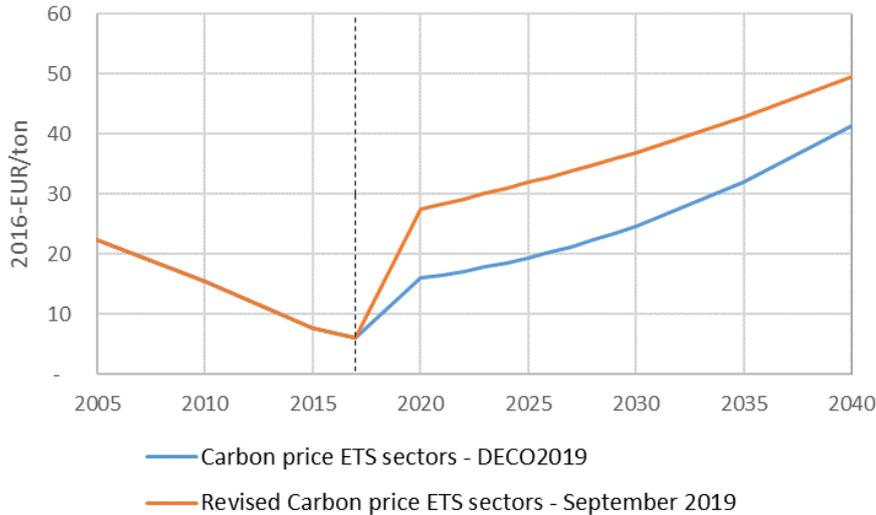


Figure 4 Figure 4 shows the carbon price for the ETS sectors used for DECO2019 as well as a revised carbon price projection.

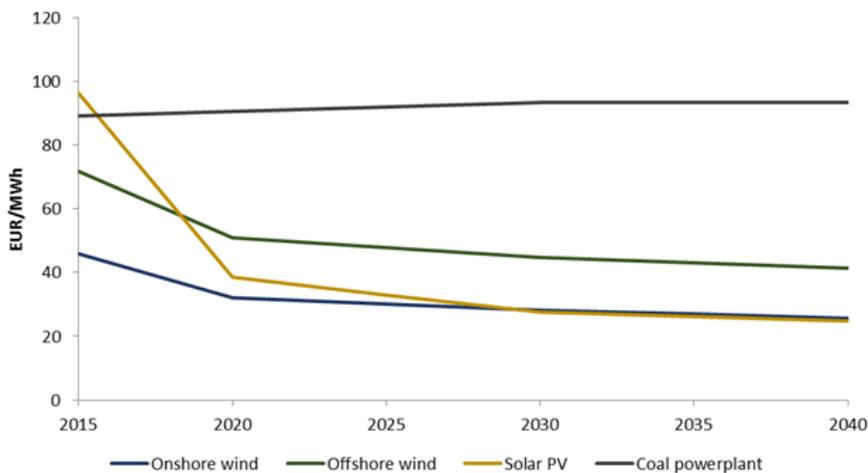
Figure 4. Carbon ETS price used for projections in DECO 2019. Carbon ETS price was revised in September 2019 [2016-EUR/ton].



(iv) Technology cost developments

Figure 5 shows the levelized cost of electricity (LCoE) for wind and solar power compared to a coal-fired power plant. The projection shows that LCoE for wind and solar power is lower than for a coal-fired power plant throughout the projection period.

Figure 5. Levelized cost of electricity generation with years of final investment decision 2015-2040 [EUR/MWh] for utility scale wind and solar and a coal-fired power plant.



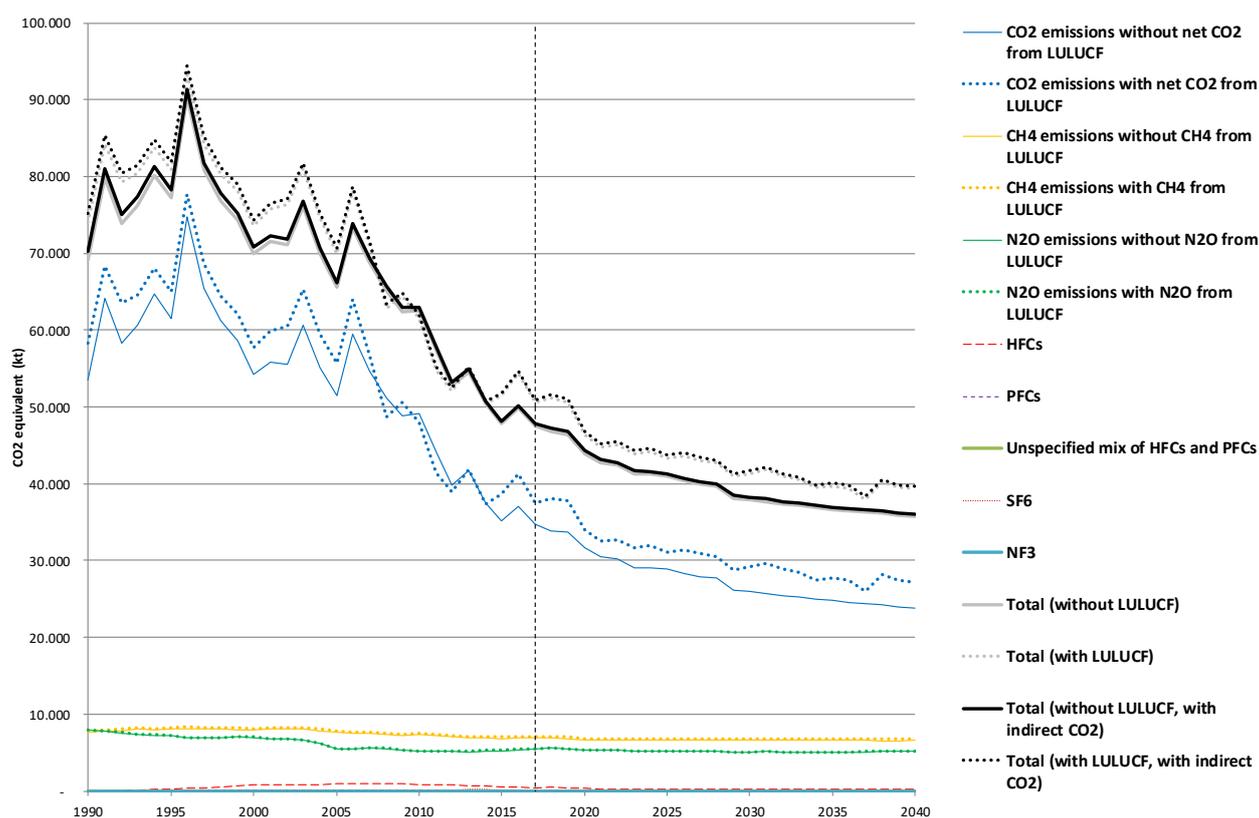
B. Trends in past and projected greenhouse gas emissions and removals in the WEM scenario

The trends in current Danish GHG emissions and removals 1990-2017 are shown as total and by gas in figure 6. A key result is that total GHG emissions without LULUCF have decreased 32% since 1990.

Other highlights are:

- total GHG emissions with LULUCF have decreased 32%
- CO₂ emissions without LULUCF have decreased 35%
- CO₂ emissions with LULUCF have decreased 36%
- CH₄ emissions without LULUCF have decreased 9%
- CH₄ emissions with LULUCF have decreased 9%
- N₂O emissions without LULUCF have decreased 32%
- N₂O emissions with LULUCF have decreased 31%

Figure 6. GHG emissions by gas 1990-2040 [kt of CO₂-eq.]



In figure 6, the developments of total GHG emissions and by gas until 2040 in the WEM scenario are also shown.

A key result of the WEM scenario projection is that total GHG emissions without LULUCF are expected to decrease 46% from 1990 to 2030 and 49% from 1990 to 2040.

Other results of the projections are:

- total GHG emissions with LULUCF decrease 45% from 1990 to 2030 and 47% from 1990 to 2040
- CO₂ emissions without LULUCF decrease 51% from 1990 to 2030 and 56% from 1990 to 2040
- CO₂ emissions with LULUCF decrease 50% from 1990 to 2030 and 53% from 1990 to 2040
- CH₄ emissions without LULUCF decrease 13% from 1990 to 2030 and 14% from 1990 to 2040
- CH₄ emissions with LULUCF decrease 12% from 1990 to 2030 and 13% from 1990 to 2040
- N₂O emissions without LULUCF decrease 36% from 1990 to 2030 and 35% from 1990 to 2040
- N₂O emissions with LULUCF decrease 36% from 1990 to 2030 and 35% from 1990 to 2040

Figure 7 shows the GHG emissions reductions achieved from 1990-2017, distributed between emissions covered by the EU ETS system and non-ETS emissions. As the EU ETS did not exist until 2005 the split of total emissions into ETS and non-ETS 1990-2004 is based on proxy estimates and not on reported ETS emissions.

From 2005, where the reporting of ETS emissions began, until 2017:

- EU ETS CO₂ emissions have decreased 43%
- non-ETS GHG emissions without LULUCF have decreased 17%

Figure 7. GHG emissions in the ETS and the non-ETS (ESD, ESR) sectors 1990-2040 [kt CO₂-eq.]

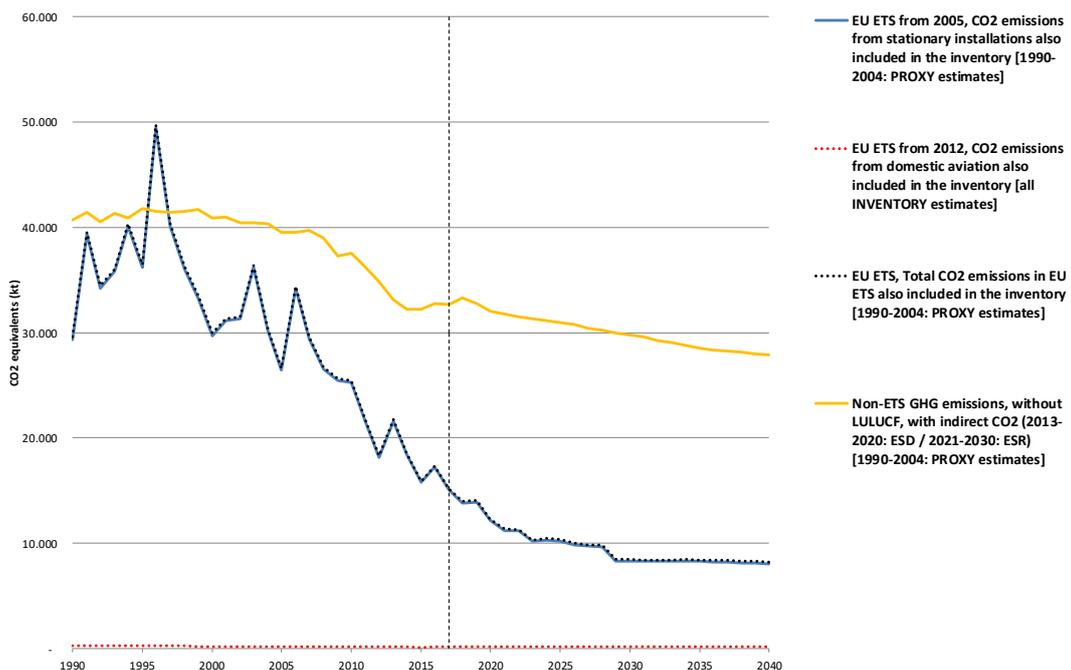


Figure 7 shows GHG emissions in EU ETS and non-ETS until 2040 in the WEM projection scenario. As the EU ETS did not exist until 2005 the split of total emissions into ETS and non-ETS 1990-2004 is based on proxy estimates and not on reported ETS emissions. From 2005, where the reporting of ETS emissions began, the projection shows that:

- EU ETS CO₂ emissions decrease 68% from 2005 to 2030 and 69% from 2005 to 2040
- non-ETS GHG emissions without LULUCF decrease 25% from 2005 to 2030 and 30% from 2005 to 2040.

The non-ETS projection should be seen in context with Denmark's obligation to limit non-ETS greenhouse gas emissions in 2030 by at least 39 % relative to emissions in 2005. Additional policies and measures to meet the objective are to be decided after the submission of the LTS, including a climate action plan. Emissions have been particularly reduced in the energy sector, which is shown in figure 8.

Highlights of GHG emissions reductions by IPCC energy sector are:

- energy sector emissions decreased 36%
- energy industry emissions decreased 57%
- manufacturing industry emissions and construction decreased 26%
- transport emissions increased 23%
- other sector's emissions (from energy use in commercial/institutional, residential and agriculture/forestry/fishing) decreased 53%

Figure 8. GHG emissions by IPCC energy sector 1990-2040 [kt CO₂-eq.]

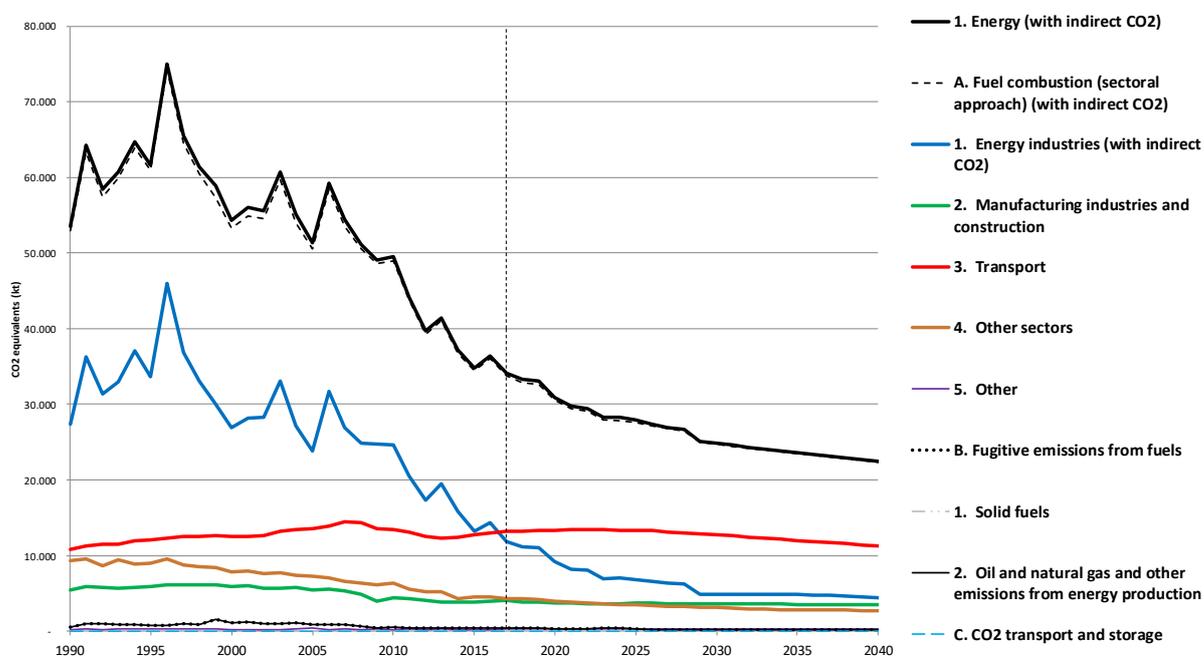


Figure 8 shows from 1990-2040 the total GHG emissions by IPCC energy sector. The projection shows that:

- energy sector emissions decreases 53% from 1990 to 2030 and 58% from 1990 to 2040
- emissions from energy industries decrease 82% from 1990 to 2030 and 84% from 1990 to 2040
- emissions from manufacturing industries and construction decrease 33% from 1990 to 2030 and 35% from 1990 to 2040
- transport emissions increase 19% from 1990 to 2030 and 5% from 1990 to 2040
- other sectors (commercial/institutional, residential and agriculture/forestry/ fishing) emissions decrease 66% from 1990 to 2030 and 70% from 1990 to 2040

Figure 9 shows the total GHG emissions by IPCC main sector from 1990-2017 where:

- energy sector emissions decreased 36%
- industrial processes and product use emissions decreased 14%
- agriculture emissions decreased 16%
- land use, land-use change and forestry (LULUCF) net-emissions decreased 40%
- waste emissions decreased 36%

Figure 9. GHG emissions by IPCC main sector 1990-2040 [kt CO₂-eq.]

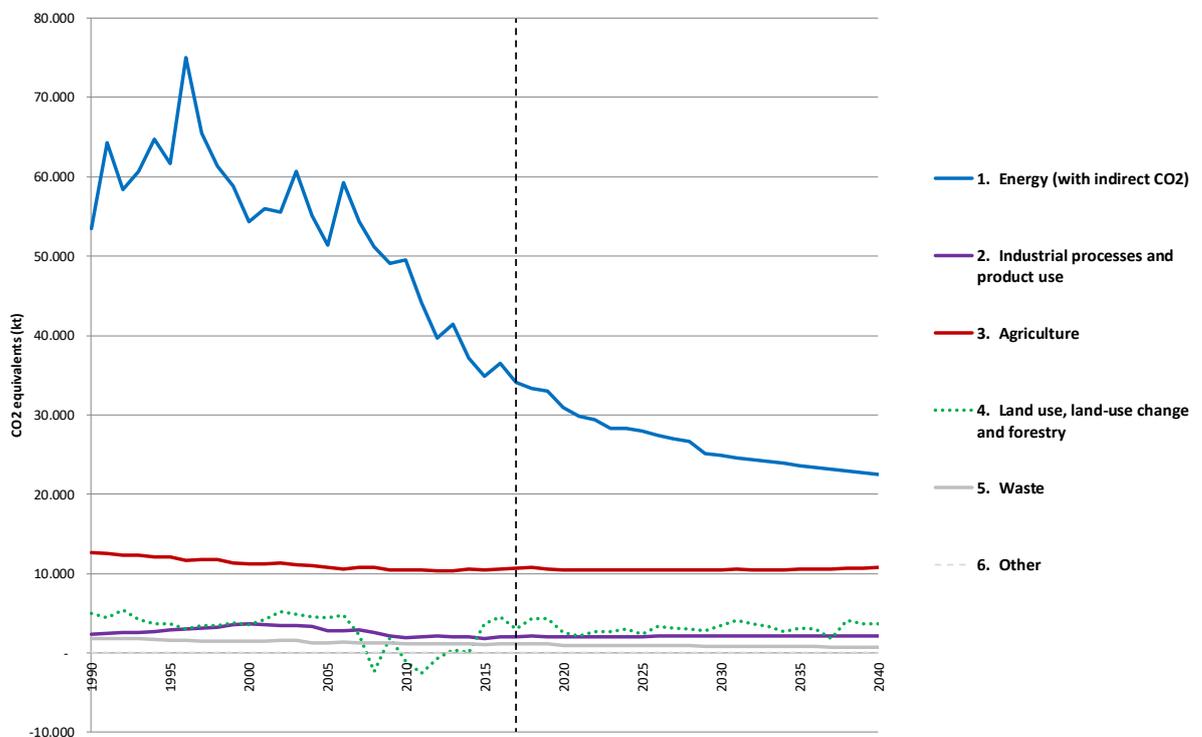


Figure 9 also shows from 1990-2040 the total GHG emissions by IPCC main sector. The projection shows that:

- energy sector emissions decreases 53% from 1990 to 2030 and 58% from 1990 to 2040
- industrial processes and product use emissions decrease 12% from 1990 to 2030 and 9% from 1990 to 2040
- agricultural emissions decrease 17% from 1990 to 2030 and 15% from 1990 to 2040
- land use, land-use change and forestry (LULUCF) net-emissions decreases 31% from 1990 to 2030 and 25% from 1990 to 2040
- emissions from waste decreases 52% from 1990 to 2030 and 63% from 1990 to 2040

Figure 10 shows that:

- LULUCF net emissions decreased 40% from 1990-2017
- KP1 net credits accumulated to 8,865 kt CO₂-eq.

Figure 10. GHG emissions and accounting quantities in the LULUCF sector 1990-2040 [kt CO₂-eq.].

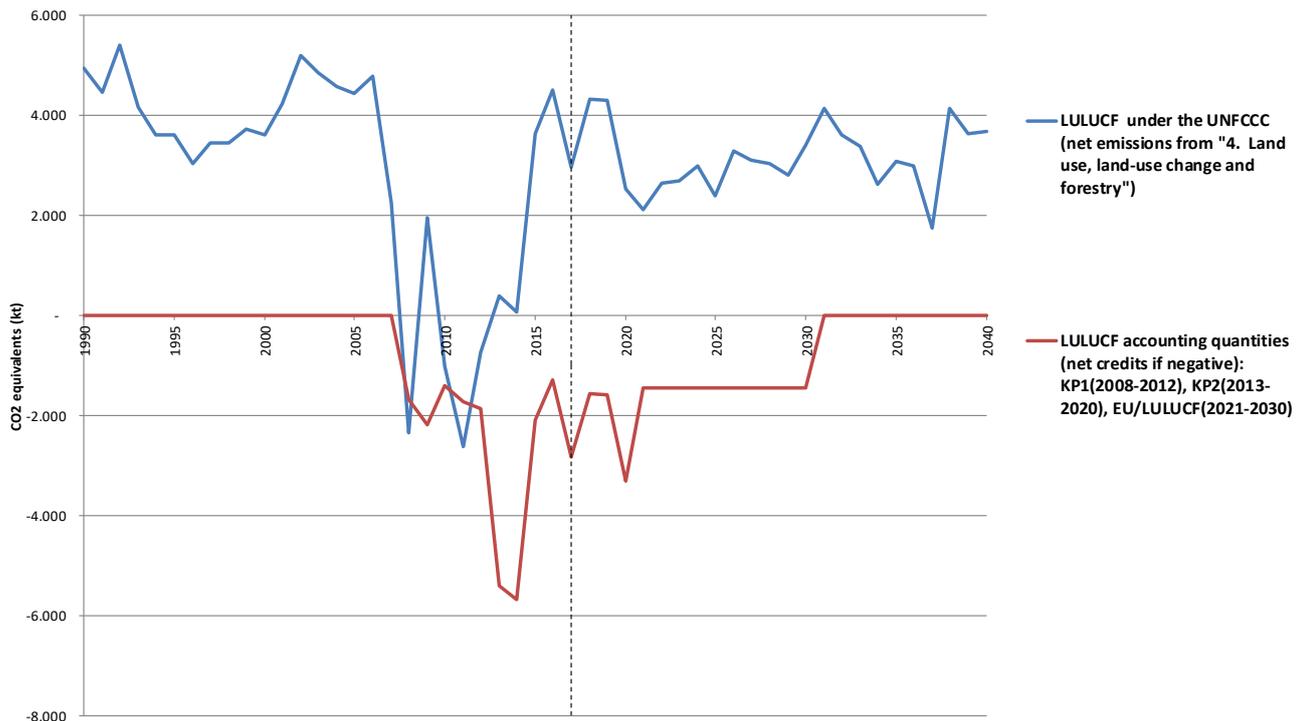


Figure 10 also shows the LULUCF emissions and net credits from 1990-2040. The projection shows that:

- LULUCF emissions decrease 31% from 1990 to 2030 and 25% from 1990 to 2040,
- KP2 net emissions accumulates to 23,806 kt CO₂-eq., and
- EU/LULUCF (2021-2030) net emissions accumulate to at least 14,600 kt CO₂-eq. (1.46 kt CO₂-eq. per year in average).

2.1.2 National targets for 2030 and 2050

The Danish government's targets to contribute to meeting the objectives and targets of the Energy Union and the long-term Union greenhouse gas emissions commitments consistent with the Paris Agreement

The Government's objective for 2030 is to reduce greenhouse gases by 70%, relative to 1990 levels and the long-term objective for Denmark is to obtain net-zero emissions no later than 2050.

On December 6, 2019 the Government reached an agreement on a new Climate Act with 8 out of the 10 parties in the Danish Parliament. The agreement includes the following key elements⁴:

- the Climate Act is legally binding,
- a target to reduce greenhouse gas emissions by 70 percent by 2030 compared to the 1990 level,
- commitment to reach net zero emissions by 2050 at the latest,
- a mechanism for setting milestone targets every five year with a ten-year perspective,
- during the Government's forthcoming Climate Action Plan in 2020, an indicative milestone target will be set for 2025,
- the milestone targets will be implemented into Danish law,
- emissions are calculated in accordance with the UN greenhouse gas inventory rules,
- the Government will develop annual Climate Programmes that will outline concrete policies to reduce emissions,
- a strengthening of the Danish Council on Climate Change (Klimarådet) with tasks such as:
 - o presentation of professional assessments of whether the initiatives in the Government's Climate Programme is sufficient to reduce emissions
 - o recommendations on climate initiatives,
 - o doubling of the council's annual budget⁵,
 - o more experts are added to the council,
 - o the council's political independence is strengthened as is can now elect its own chairperson and members,
- a new climate dialogue forum in relation to the Council on Climate Change with representatives from business organisations, think tanks, green organisations, worker's organisations and ministries,
- separate report on Denmark's impact on international emissions, including those pertaining to international shipping and aviation. Furthermore, reductions from electricity produced from renewable sources and the effects of Denmark's bilateral energy cooperation can be included in the separate report. Finally, the separate report will shed light on the impacts of consumption,
- formulation of a yearly global climate strategy to ensure that Denmark keeps on its ambitious work at the global scene.

⁴ For more information on the agreement on the Climate Act see: <https://kefm.dk/media/12965/aftale-om-klimalov-af-6-december-2019.pdf>

⁵ As part of the agreement on the Finance Act 2020, 10m in 2020 and 15m annually in the period 2021-2023 was allocated to the strengthening of the Council on Climate Change.

- a citizens' initiative in relation to the Government's forthcoming Climate Action Plan in 2020.

The Climate Act is expected to be adopted by the Parliament in spring 2020.

Moreover, on 2 December 2019 the Government reached agreement with the Red-Green Alliance, the Social Liberal Party, the Socialist People's Party and the Alternative on the Finance Act 2020. With the Finance Act the parties agreed to implement a range of initiatives which will strengthen the effort for a better environment, create more nature and which is expected to reduce greenhouse gas emissions by approximately 0.5 million ton CO₂- equivalents in the year 2030 on national level ⁶.

The Government has furthermore taken steps to ensure that climate, environment and nature will be considered across all relevant policy areas. A permanent government committee on green transition has been established to ensure that effects on climate, environment and nature is taken into account in government proposals and bills.

Moreover, Denmark has established a position among the world's elite in renewable energy through decades of committed efforts. With the Energy Agreement from June 2018 the parties have allocated funding that sets a course towards an RE (renewable energy) share of approximately 55% by 2030. The agreement will also give Denmark an RE share in electricity above 100% of consumption, while ensuring that at least 90% of district heating consumption is based on energy sources other than coal, oil or gas by 2030.

The Government (the Social Democrats) with the Red-Green Alliance, the Social Liberal Party and the Socialist People's Part have in the political understanding between the parties "A fair direction for Denmark" set the following climate and energy relevant objectives:

- **"Introduce binding targets.** During the first parliamentary year, the Government will present a proposal for a climate act with binding sub-targets and binding long-term targets, including:
 - A goal to reduce greenhouse gases by 70% by 2030, relative to 1990 levels. This is a very ambitious goal, and it will be particularly difficult to realise the last part of the goal, i.e. from 65% to 70%. This will require currently unknown methods and, therefore, also a close collaboration with the Danish Council on Climate Change and other experts.
 - That the Danish Council on Climate Change assists the Government in making decisions on reduction targets and methods which ensure that Denmark complies with the Paris Accord temperature targets.
 - That an annual follow-up target assessment is performed, and that this follow-up is linked to the national budget process. ⁷
- **Transport sector transition.** As part of a green mobility plan, a wide range of initiatives are required to ensure a significant increase in the number of electric vehicles on the roads and the required transport sector transition:

⁶ See the agreement on the Finance Act here: <https://www.fm.dk/nyheder/pressemeddelelser/2019/12/finanslovsaftale-prioriteter-velfaerd-og-et-mere-groent-danmark>

⁷ Cf. above as a follow-up on the political understanding an agreement on the climate act was reached on 6 December 2019.

- A stop to sales of all new diesel and petrol cars as of 2030 and enhanced low emissions zones.
 - It will be investigated whether the Commission for Green Transition of passenger cars can advance its work so that the final report is available before the end of 2020. As soon as possible thereafter, a political agreement must be reached to provide a sense of security to the industry and car owners and to ensure that the green transition can be undisturbed.
 - The Government will negotiate an infrastructure agreement, which will consider climate and environmental issues to a much higher degree. This requires investments in public transportation and cycling, among other things.
 - Implementing initiatives to ensure more sustainable aviation.”
- **Secure climate contributions from agriculture.** Agricultural support shall be used as an active tool to provide farmers the incentive to transition to a more sustainable production and thereby supporting the green transition of the industry. The Government has decided to implement a pilot scheme for multifunctional land distribution which will contribute with experience and knowledge for a major land reform. It is important that it is designed in a way that contributes to solving multiple challenges at the same time and engages stakeholders.
 - **“Adopt a climate action plan.** The climate act will be followed by a climate action plan, which will contribute to ensuring that national reduction targets are met. In addition to describing which initiatives, cf. above, will be required for the transport industry and agriculture, the action plan will also include the following elements:
 - 1) Energy efficiency measures, including energy saving requirements for public sector buildings;
 - 2) a national strategy for sustainable construction;
 - 3) a unified strategy for electrification of the transport sector, industry and society in general;
 - 4) increased funding for green research and demonstration programmes;
 - 5) investigating the potential for Denmark to prepare a common strategy with the North Sea nations for a significant expansion and exploitation of the offshore wind potential;
 - 6) investigating the potential for Denmark to construct the first energy island by 2030, with a minimum of 10 GW connected;
 - 7) support afforestation;
 - 8) climate adaptation, including stronger coordination of coast protection efforts.
 - **Assume the responsibility for more ambitious targets in the EU and enhance green diplomacy.** EU started off as a coal and steel union. The Danish Government will propose the objective that a future EU will be a climate union. This means, among other things, that Denmark will be working towards increasing the EU climate targets in 2030, that the EU will be climate neutral by 2050 and that the future EU budget will focus more on climate. Denmark will also, together with other ambitious nations, push for an expansion of sustainable energy in the EU so that the EU becomes self-

reliant in terms of energy. The Government will also strengthen green diplomacy, thereby increasing Denmark's international commitment. The Government will implement a new development policy strategy with climate assistance as a central element.

- **Create greater biodiversity and more woodlands.** There is a need for more untouched woodlands and more cohesive nature areas where nature is allowed to spread out on more natural terms than is currently the case. A biodiversity package will improve conditions for biodiversity in Denmark. The plan will include clear targets for the proportion of the area of Denmark to be laid out as nature zones (including untouched woodlands and national nature parks) as well as specific initiatives to ensure that targets are reached.
- **Strengthen green calculation models.** Climate and green transition considerations shall be integrated in the Ministry of Finance's calculation models, and the effort to develop greener calculation models will be secured and enhanced. A dialogue will be entered into with Statistics Denmark about strengthening the effort to produce green national accounts and GDP.
- **Increase organic foods targets and strengthen initiatives against food waste.** The Government will increase the ambitions for more organic foods in Denmark, starting with an aim to double organic farming acreage, the export of organic foods and the consumption of organic foods by Danes by 2030, and to implement initiatives to reduce food waste.
- **Include stakeholders.** With the purpose of qualifying and anchoring Denmark's green efforts, the Government will include stakeholders in the work on an on-going basis, including independent experts, popular movements and interest organisations. This will be the case, e.g., for areas such as promoting a strategy for circular economy, transitioning to a more energy-efficient society, smarter waste sorting and transitioning public sector procurements so that they support the green transition to a higher degree.”

Denmark's binding national target for greenhouse gas emissions in the EU^{8,9}

In October 2014 the European Council agreed on the 2030 climate and energy framework on objectives regarding greenhouse gas emissions, energy efficiency, renewable energy and interconnections. On greenhouse gas emissions the EU endorses a binding EU target of reducing greenhouse gas emissions by at least 40 % by 2030, compared to 1990.

The agreement on the 2030 framework, specifically the EU domestic greenhouse gas reduction target of at least 40 %, formed the basis of the EU's contribution to the Paris Agreement. The EU's so-called Intended Nationally Determined Contribution (INDC) was formally approved at an Environment Council meeting in March 2015.

⁸ Effort sharing regulation, 2018/842 <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R0842&from=EN>

⁹ LULUCF, 2018/841 <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R0841&from=EN>

The 40 % reduction target is sub-divided into two separate targets for the EU Emission Trade System (ETS) and non-EU ETS sectors elaborated below.

In May 2018 the European Council adopted a regulation on the EU effort sharing of greenhouse gas emission reductions in the non-ETS sectors in the period 2021-2030 – the so-called Effort Sharing Regulation (ESR). Under this regulation Denmark is committed to a 39 % reduction of greenhouse gas in non-ETS emissions in the period 2021-2030 by 2030 relative to 2005.

Under the Effort Sharing Regulation flexibilities mechanisms ensuring cost-effective reductions include borrowing, banking and transfer of annual emission allowances between years and between member states (cf. Article 5), cancellation of EU ETS Allowances instead – in practice meaning that reductions are made under EU ETS instead of under ESR (cf. Article 6) and use of credits from LULUCF (cf. Article 7). Further details on the commitments under the ESR regulation are included below.

In May 2018 the European Council also adopted a regulation of emissions by sources and removals by sinks in the land sector – the LULUCF regulation, where LULUCF is “Land-Use, Land-Use Change and Forestry”. Credits obtained under this regulation can be used to reach the target for the non-ETS sector in accordance with the ESR up to a certain limit. The limit for Denmark is 14.6 million CO₂-equivalent credits from LULUCF during the period 2021-2030. Further details on the commitments under the LULUCF regulation are included below.

The EU is committed to reducing its ETS emissions by 43 % in 2030 from 2005 to achieve the total greenhouse gas emissions reduction of 40 % below 1990 levels by 2030. The EU has also set itself the target of increasing the share of renewables in energy use to 32 % by 2030.

In June 2018 all parties of the Parliament agreed on a Danish Energy Agreement with funding that will set the path towards a 55 % renewables share in 2030 in Denmark. The Energy Agreement of June 2018 furthermore specifies that given the allocated funding renewables are to cover all final electricity consumption or more by 2030. The agreement also includes a phase out of coal in electricity production by 2030.

Consistency with Denmark’s long-term low emission strategy is ensured as Denmark’s targets under the ESR regulation and the LULUCF Regulation are to be seen as steps in 2021-2030 towards the objective to work towards net zero emissions in accordance with the Paris agreement and for a net-zero-emission target in the EU and Denmark by 2050 at the latest.

Effort Sharing Regulation (ESR)

In regards to “Decarbonisation”, and with respect to greenhouse gas emissions and removals as well as contributing to the achievement of the economy wide EU greenhouse gas emissions target of 2030, Denmark’s binding national target for greenhouse gas emissions and annual binding national limits pursuant to Regulation ESR are as follows:

2030: Limit Denmark's non-ETS greenhouse gas emissions in 2030 at least by 39 percent relative to Denmark's emissions in 2005 determined pursuant to paragraph 3 of Regulation ESR¹⁰.

2021-2029: Ensure that Denmark's non-ETS greenhouse gas emissions in each year between 2021 and 2029 do not exceed a specific linear trajectory.

LULUCF Regulation

As regards the dimension "Decarbonisation", and with respect to greenhouse gas emissions and removals and with a view to contributing to the achievement of the economy wide EU greenhouse gas emissions reduction target in 2030, Denmark's commitments pursuant to LULUCF Regulation are as follows:

2021-2030: Account for emissions and removals from land use, land use change and forestry ('LULUCF')¹¹ during the periods from 2021 to 2025 and from 2026 to 2030 occurring in the following land accounting categories on the EU territory of Denmark: afforested land, deforested land, managed cropland, managed grassland and managed forest land and as of 2026 also managed wetlands.¹²

2021-2025 and 2026-2030: Denmark will ensure that emissions do not exceed removals under the accounting rules, calculated as the sum of total emissions and removals on Denmark's EU territory in the land accounting categories mentioned above combined and as accounted in accordance with the LULUCF Regulation.

2.1.3 Adaptation policies and measures

As described in the previous section the climate action plan will include climate adaptation, including stronger coordination of coast protection efforts.

Moreover, updated information on adaptation in Denmark was reported to the Commission/EEA in March 2019 in accordance with the Monitoring Mechanism.

The following information on Denmark's adaptation objectives/goals, strategies and initiatives were included:

"In Denmark, the National Adaptation Strategy (NAS) was adopted in March 2008. Following a new government in 2011, a National Adaptation Plan (NAP) was adopted in 2012. The Action Plan for a Climate-Proof Denmark was launched in December 2012 and is the first NAP in Denmark. The NAP is based on the notion that a responsible climate policy must do more than just work to address climate change in the long term, it must also ensure necessary action is taken now to adapt

¹⁰ Taking into account the flexibilities provided for in Articles 5, 6 and 7 of Regulation 2018/842 [ESR] cf. the regulation's Article 9 on compliance check (see footnote 5).

¹¹ MMR: Regulation(EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC (<https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:165:0013:0040:EN:PDF>)

¹² 'Afforested land': land use reported as cropland, grassland, wetlands, settlements, and other land converted to forest land. 'Deforested land': land use reported as forest land converted to cropland, grassland, wetlands, settlements, and other land. 'Managed cropland': land use reported as: cropland remaining cropland, grassland, wetland, settlement, other land converted to cropland, and cropland converted to wetland, settlement and other land. 'Managed grassland': land use reported as: grassland remaining grassland, cropland, wetland, settlement and other land, converted to grassland, and grassland converted to wetland, settlement and other land. 'Managed forest land': land use reported as forest land remaining forest land. 'Managed wetland': land use reported as: wetland remaining wetland, settlement, other land converted to wetland, and wetland converted to settlement and other land.

our society to a climate that is already changing, and that all parts of society contribute to climate adaptation.

Dealing with the climate challenge requires collaboration between authorities, organisations, private enterprises and individuals, regardless of whether the project is maintenance of existing roads, coastal protection, construction, or investments in new infrastructure. The Government itself has a responsibility as the owner of infrastructure, buildings and land. However, the principal role for the Government is to establish an appropriate framework for local climate adaptation by, for example, adapting laws and regulations, but also by ensuring coordination and providing information. The Government requested all municipalities to develop their own adaptation action plans within two years. A solid framework for the efforts must support the specific parties involved, so that they can address the challenge in a socio-economically appropriate manner at the right time.

In the NAP, the Government commits to creating the basis for continued technological and knowledge development, so that Denmark will have a strong position on the global market for climate adaptation. The NAP presents 64 new initiatives within five general areas of initiative: an improved framework for climate adaptation; more consultation and a new knowledge base; strengthened collaboration and coordination; green transition; and international climate adaptation. A few national sectors, such as transport, roads and coastal protection, have dedicated adaptation plans. In 2017, the Danish government decided to carry out a number of initiatives to support municipalities and property owners in establishing cost-effective and holistically planned flood and erosion protection. A cross-ministerial committee was set up and 15 new initiatives were decided (Denmark's 7th NC, p. 297¹³).

In 2017 a new national mobile team with a focus of flooding and erosion was established by the Ministry of Environment and Food (MEF) to help share knowledge, best practices and enhance cooperation, primarily with municipalities. In 2018 an amendment to the Planning Act was adopted so that all municipalities know how to identify areas at risk of flooding and erosion and ensure remediation measures in their municipal plans. The amendment was in January 2019 followed by national guidelines and examples on how and what data to use in local-government spatial planning. The Danish Coastal Authority, under the Ministry of Environment and Food of Denmark, is responsible for the implementation of the Floods Directive in Denmark. Under this mandate, the Danish Coastal Authority has reviewed and updated the preliminary flood risk assessment together with an adjustment of identified areas of potential significant flood risks. The adjustment of identified areas of potential significant flood risk has resulted in the confirmation of the 10 areas appointed back in 2011 and the appointment of 4 new flood prone areas in 2018. Municipalities in the flood risk areas will be instructed to evaluate and prepare flood risk management plans.

Adaptation strategies have not been adopted at the subnational level but all municipalities have adopted local adaptation action plans in line with the national adaptation plan (NAP). Although not a formal responsibility or obligation, four of five regions have incorporated adaptation into their regional climate strategies: South Denmark, North Jutland, Region Zealand and the Capital Region. Central Denmark

¹³ Denmark's 7th National Communication (<https://unfccc.int/documents/28946>)

Region leads the EU funded project ‘Coast to Coast Climate Challenge’, which has a goal of formulating and implementing a coordinated adaptation strategy for the region between 2017 and 2022.”

Climate Atlas

The Danish Meteorological Institute (DMI) has developed a nationwide Climate Atlas based on own data and data from IPCC. Data are free and available on DMI's website.

The Climate Atlas provides an indication of areas with particular risk of storm surge and cloudburst, and thus the risk of flooding in Denmark in the future. This tool gives the climate data so municipalities can take the necessary precautions and guard citizens, infrastructure and buildings against the expected extreme weather in the future.

In Denmark, the municipalities are responsible for climate adaptation - for example, to build dikes or secure exposed areas from cloudbursts. The Climate Atlas is therefore developed in a collaboration with the municipalities and other relevant collaborators working on climate adaptation.

Data in the Climate Atlas describe the future Danish climate in the beginning, middle and end of the century. Initially there is data about future temperature, rainfall, extreme rainfall, sea level and storm surge both at national and municipal levels - down to a 1 km grid map. Further data are added towards 2021 for other relevant climate indicators such as wind, evaporation and growth season.

2.2 RENEWABLE ENERGY

2.2.1 To the extent feasible, the estimated likely share of renewable energy in final energy consumption by 2050

An estimate of the likely share of renewable energy in final energy consumption by 2050 is not available as the latest frozen policy (WEM) scenario projection has 2040 as the end year.

Information on the development in the share of renewable energy in final energy consumption until 2017 and on the development in the likely share of renewable energy in final energy consumption by 2040 according to the latest frozen policy (WEM) scenario projection is included below.

(i) Current share of renewable energy in gross final energy consumption and in different sectors (heating and cooling, electricity and transport) as well as per technology in each of these sectors

Figure 11 shows that from 2005-2017 the overall Renewable Energy Share increased from 16% to 34% and the Renewable Energy Share of Electricity increased from 27% to 64%.

Figure 11. Overall Renewable Energy Share (RES), Renewable Energy Share in Heating/Cooling (RES-H/C), Renewable Energy Share in Electricity (RES-E), Renewable Energy Share in Transport (RES-T), 2005-2040 [%]

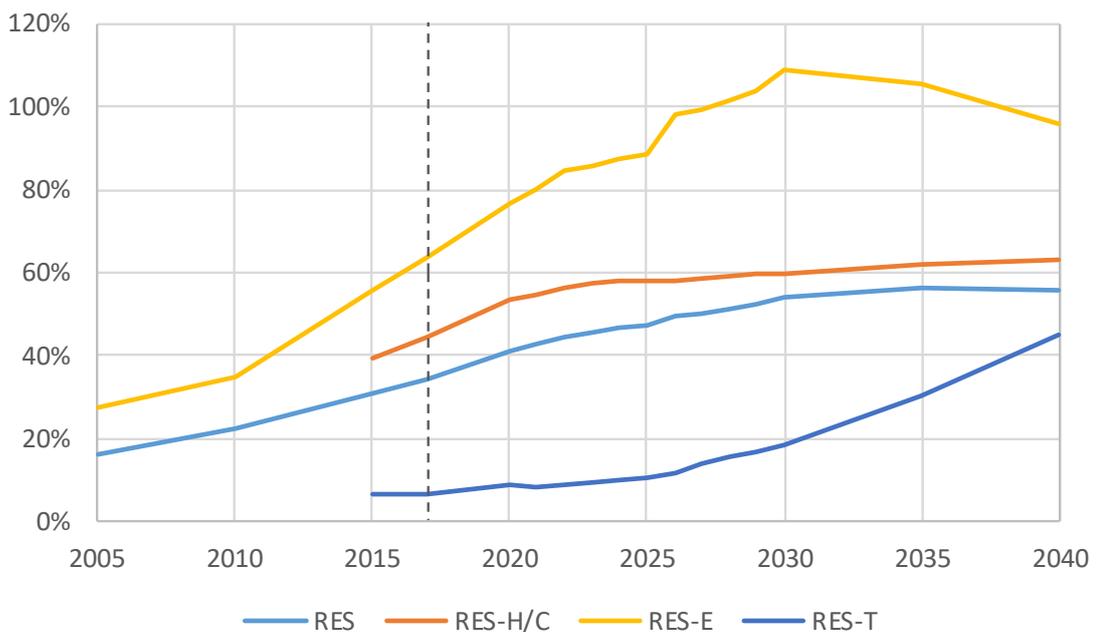
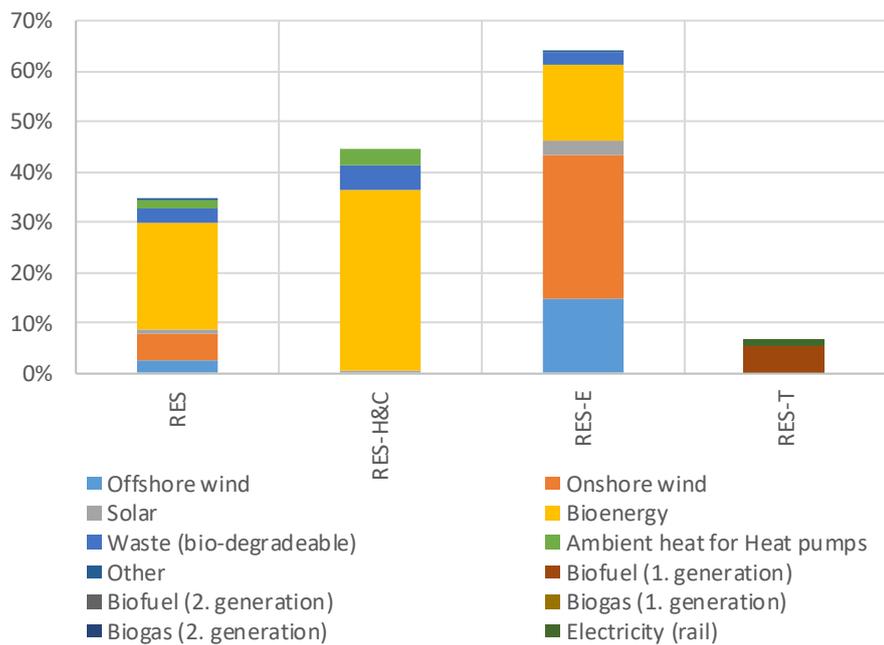


Figure 12 shows the sources of renewable energy in the respective sectors in 2017. It is worth noting that:

- bioenergy accounted for almost two thirds of overall Renewable Energy in 2017 (21 percentage points of 34 % overall RE share in energy), mainly due to its large role in heating/cooling. In electricity, bioenergy has a smaller share. onshore and offshore wind power together accounted for two thirds, i.e. 43 percentage points out of the 64% RE in electricity. The remaining part is almost entirely bioenergy.
- biofuels accounted for the 5% of the RES-T

Figure 12. RES, RES-H/C, RES-E, RES-T year 2017 [%]



(ii) Indicative projections of development with existing policies for the year 2030 (with an outlook to the year 2040)

This section refers to the projection part of the figures presented in the previous section.

Figure 11 on shares of Renewable Energy in various sectors shows the expected development from 2017-2040. A key result of the projections is that overall Renewable Energy Share increases from 34% in 2017 to 54% in 2030. This brings the renewable energy share very close to the 55% ambition of the Energy Agreement from June 2018.

Another remarkable result of the projection is that the share of Renewable Energy in electricity is expected to increase from 64% in 2017 to 109% in 2030, which implies that Danish consumption of electricity from 2028, on average over a year, is projected to be covered entirely by renewable energy. This projection should also be seen in context with the Energy Agreement, in which initiatives agreed upon are expected to lead to a renewable energy share in electricity above 100% of consumption in 2030.

The projection also shows, however, that without new initiatives, consumption of electricity will exceed RE production by the end of the 2030's. This is largely due to two factors: 1) the assumption that electricity consumption will continue to grow, mainly from data centres (HSDC's), and 2) the projections are done on the basis of existing policies and measures, and there are currently no decisions on the establishment of new production capacity beyond 2030.

In terms of heating/cooling, the RE share is expected to increase from 44% in 2017 to 60% in 2030, whereas in transport the RE share is expected to grow from 7% in 2017 to 19% in 2030.

Figure 13 shows the share of various technologies in the overall RE mix from 2017-2040. The projection shows that while biomass continues to play a major role due to its share in heating, the increase of renewable energy in the overall mix is almost entirely due to other RE sources, notably offshore wind, ambient heat for heat pumps and solar PV:

- The share of offshore wind power increases from 3 pct.-point in 2017 to 12 pct.-point in 2030 to 10 pct.-point in 2040
- The share of onshore wind power increases from 5 pct.-point in 2017 to 8 pct.-point in 2030 to 10 pct.-point in 2040
- The share of bioenergy decreases from 21 pct.-point in 2017 to 23 pct.-point in 2030 and then falls to 21 pct.-point in 2040
- The share of solar energy increases from 1 pct.-point in 2017 to 4 pct.-point in 2030 to 6 pct.-point in 2040
- The share of waste (bio-degradable) is 3 pct.-point in 2017 and in 2030, and it decreases from 3 pct.-point in 2030 to 2 pct.-point in 2040
- The share of ambient heat for heat pumps increases from 1 pct.-point in 2017 to 5 pct.-point in 2030 to 7 pct.-point in 2040

Figure 13. RES by technology 2017-2040 [%]

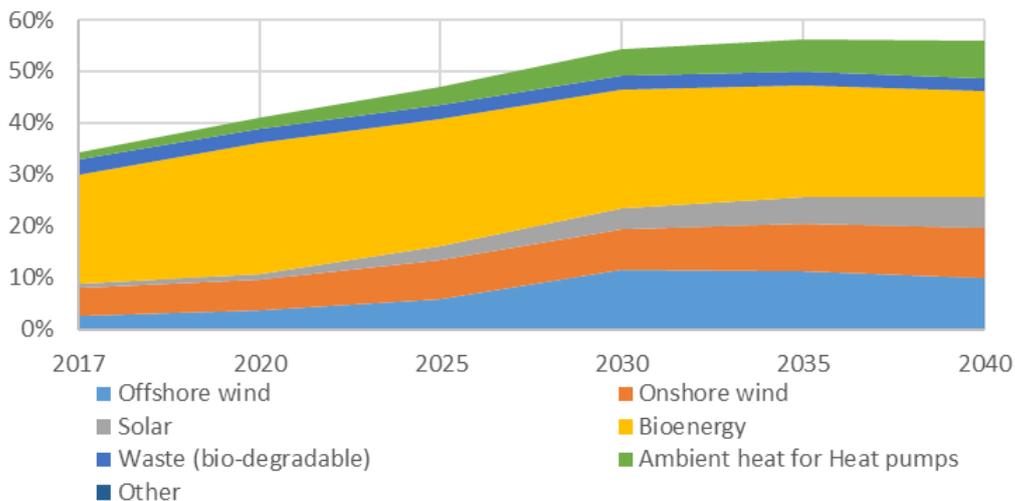


Figure 14 shows RES-H/C by technology from 2017-2040. A key result of the projection is that the share of bioenergy increases from 36 pct.-point in 2017 to 42 pct.-point in 2030, but then falls to 39 pct.-point in 2040, largely due to heat pumps penetrating the market. In the projection, the share of ambient heat for heat pumps increases from 3 pct.-point in 2017 to 12 pct.-point in 2030 to 17 pct.-point in 2040

Other results are:

- The share of solar energy increases from 1 pct.-point in 2017 to 2 pct.-point in 2030 to 3 pct.-point in 2040
- The share of waste (bio-degradable) is constant with 5 pct.-point in 2017 to 2030 and to 2040

Figure 14. RES-H/C by technology 2017-2040 [%].

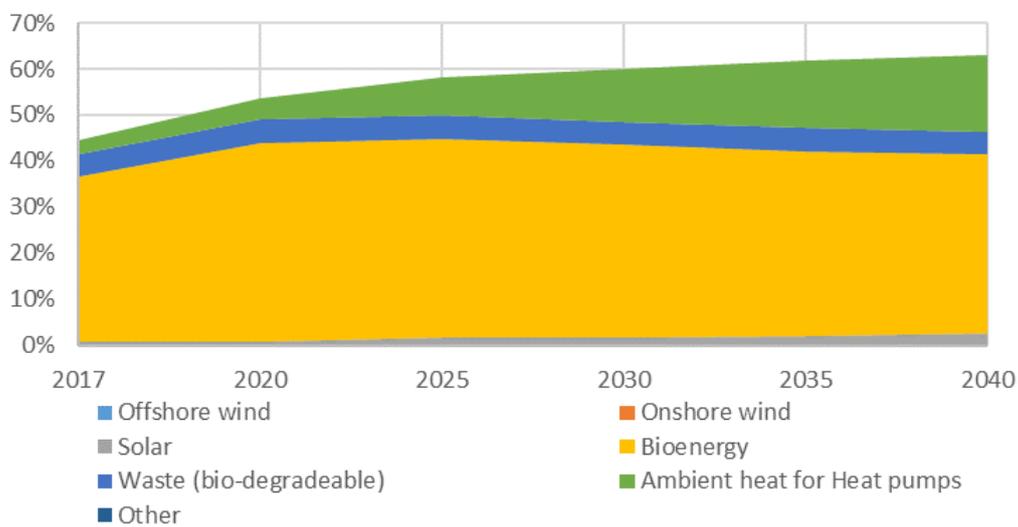


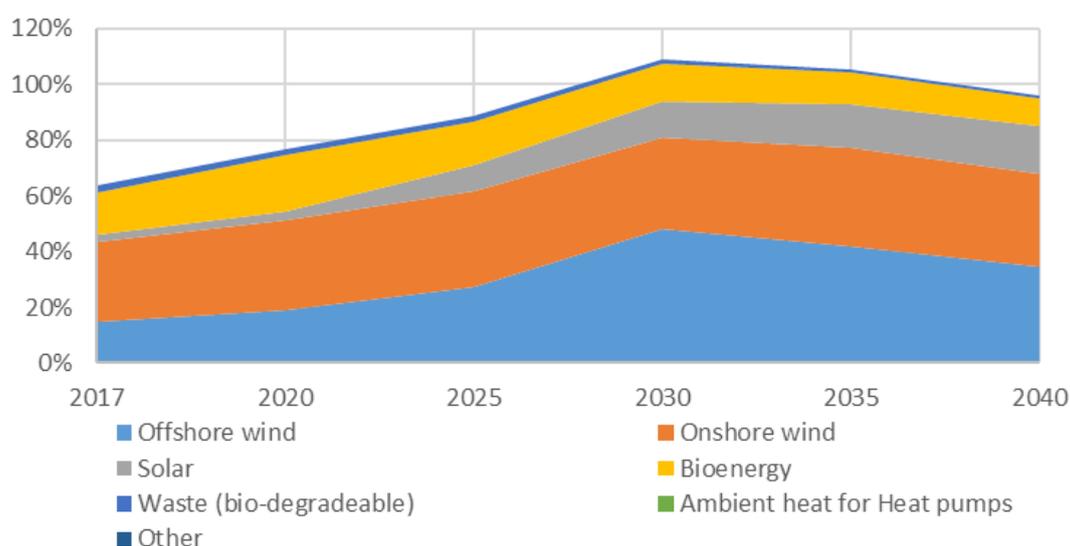
Figure 15 shows RES-E by technology from 2017-2040. Overall, it is worth noting that the increase in the RE share of electricity towards 2030 is particularly due to an increase in wind and solar. For example, the share of offshore wind power increases from 15 % in 2017 to 48 % in 2030, and the share of solar energy increases from 3 % in 2017 to 13 % in 2030.

Other results of the projection are:

- The share of onshore wind power increases from 29 pct.-point in 2017 to 33 pct.-point in 2030 to 34 pct.-point in 2040
- The share of bioenergy decreases from 15 pct.-point in 2017 to 13 pct.-point in 2030 to 9 pct.-point in 2040
- to 17 pct.-point in 2040
- The share of waste (bio-degradable) is constant with 2 pct.-point in 2017 to 2030 and decreases to 1 pct.-point in 2040

As also mentioned above, the reason why overall RE share of electricity drops below 100 % again by the end of the 2030's, is largely due to growing electricity consumption from mainly data centres (HSDC's), and that no decisions are yet taken on the establishment of new production capacity beyond 2030.

Figure 15. RES-E by technology 2017-2040 [%]

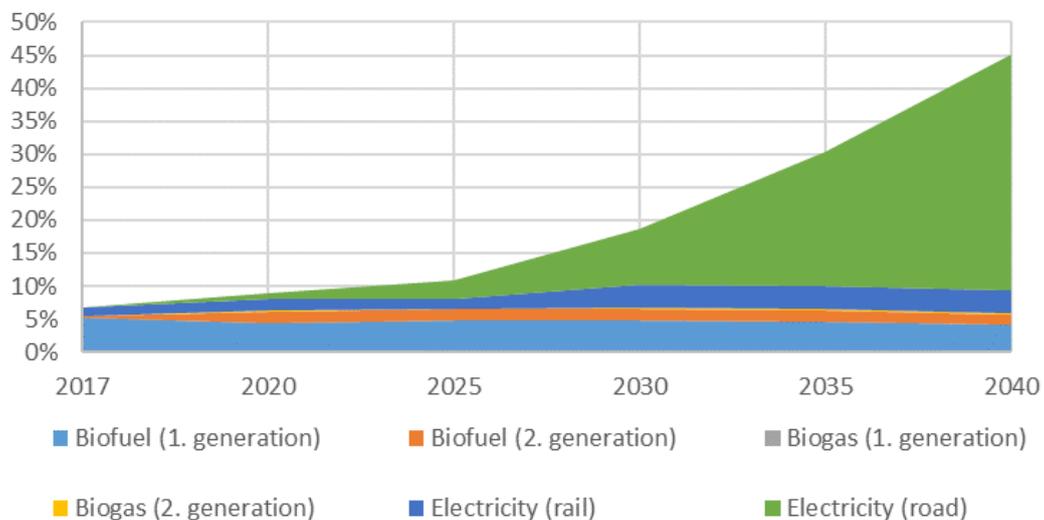


In terms of RE in transport, the development is very much dependent on how fast Electric Vehicles will penetrate the market. With the current knowledge, and the existing policies and measures, it is expected that this development takes off in the mid-2020'es. With that assumption, Figure 16 shows the share of Renewable Energy in transport by technology from 2017-2040.

The projection shows that:

- The share of biofuel first generation is constant with 5 pct.-point in 2017 to 2030 and decreases to 4 pct.-point in 2040
- The share of biofuel second generation increases from 0 pct.-point in 2017 to 2 pct.-point in 2030 and in 2040
- The share of electricity rail increases from 1 pct.-point in 2017 to 3 pct.-point in 2030 to 4 pct.-point in 2040
- The share of electricity road increases from 0 pct.-point in 2017 to 8 pct.-point in 2030 to 36 pct.-point in 2040

Figure 16. RES-T by technology 2017-2040 [%]



2.3 ENERGY EFFICIENCY

2.3.1 To the extent feasible, the estimated likely energy consumption by 2050

An estimate of the likely energy consumption by 2050 is not available as the latest frozen policy (WEM) scenario projection has 2040 as the end year.

Information on the development in energy consumption until 2017 and on the development in the likely energy consumption by 2040 according to the latest frozen policy (WEM) scenario projection is included below.

(i) Current primary and final energy consumption in the economy and per sector (including industry, residential, service and transport)

The trends in primary and final energy consumption in the economy from 2005-2040 are shown in Fejl! Henvisningskilde ikke fundet. Figure 17 below.

The figure shows that in 2017:

- Primary energy consumption was 18.131 ktoe
- Final energy consumption was 14.863 ktoe
- Ratio between primary energy consumption and final energy consumption was 0,81

Figure 17. Primary and final energy consumption 2005-2040 [ktoe]

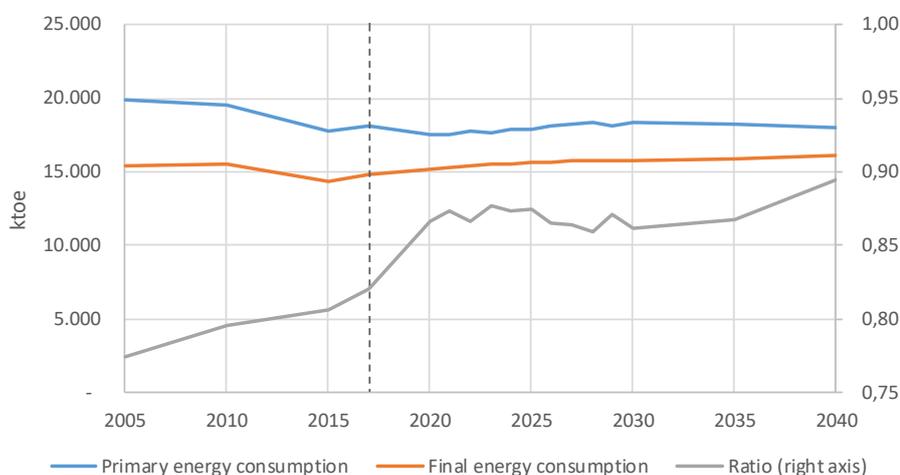


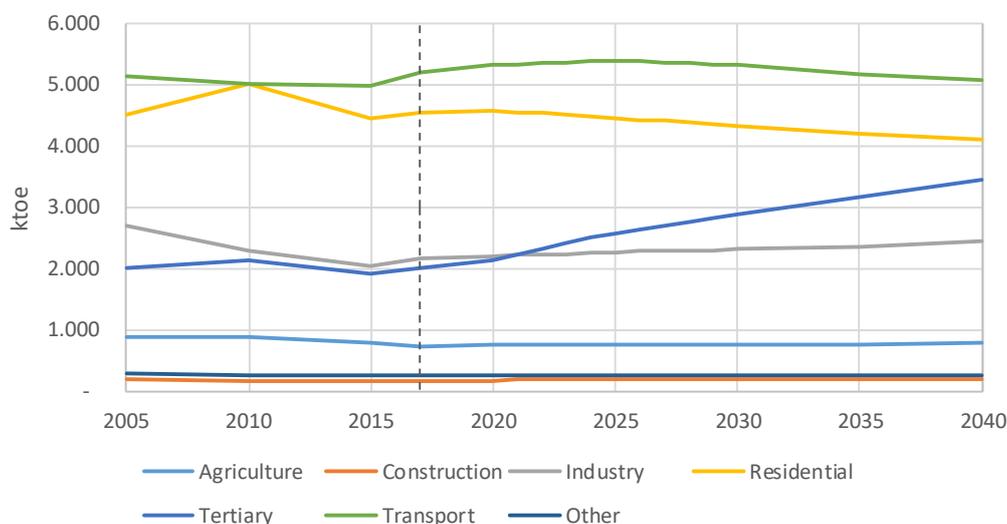
Figure 18 shows the trends in final energy consumption by sector from 2017-2040.

The figure shows that the transport (35 %) and the residential (31 %) sector accounted for the largest shares of the final energy consumption in 2017.

The share of final energy consumption in the other sectors in 2017 was:

- industry 15%
- tertiary 13%
- agriculture 5%
- construction 1%

Figure 1. Final energy consumption by sector 2017-2040 [ktoe]. Tertiary sector includes HSDC.



(ii) Current potential for the application of high-efficiency cogeneration and efficient district heating and cooling

A comprehensive assessment of the potential for the application of high efficiency cogeneration and efficient district heating and cooling in Denmark was delivered to the Commission in December 2015 in accordance with article 14, 1 in Directive 2012/27/EU.

The technical potential of district heating is expected to increase by 1194 ktoe in 2035. The business economic potential is expected to reach 3583 ktoe in 2020, which is an increase by ~1433 ktoe compared to 2013 (Energi, 2015).

The socio economic potential is expected to increase from ~1911 ktoe in 2013 to 3105 ktoe in 2020. From 2020 to 2030 the analysis shows that socio economic potential district heating potential decreases to around 2388 ktoe.

The potential for combined heat and power in Denmark is expected to decrease from covering 73 % of the district heating demand in 2012 to covering 63 % in 2025 as a result of the integration of RES-electricity sources in the electricity grid.

The combined heat and power have relatively high marginal costs compared to e.g. wind and PV, and are therefore estimated to be less feasible in the future energy system in Denmark. When there is reduced market incentive to produce electricity from the combined heat and power it is more economic feasible to only invest in heat producing units. The decrease in combined heat and power is not substituted by thermal power production, but by intermittent renewable energy share and renewable energy district heating technologies. There are no national strategies to change this development as the energy security level is high in the Danish electricity grid (99.99 %) and because there are several renewable energy share alternatives to produce heat for district heating grids.

The district cooling potential is not expected to change dramatically in the period 2006-2030 and it is expected to reach 2,866 MW. The socio economic potential is 2,211 MW and therefore it is almost corresponding to the technical potential.

(iii) Projections considering existing energy efficiency policies, measures and programmes as described in for primary and final energy consumption for each sector at least until 2040 (including for the year 2030)¹⁴

Section 2.3.1(i) showed the current primary and final energy consumption. This section describes the projections from 2017-2040, shown in the figures presented in the section 2.3.1(i).

Figure 17 shows the development in primary energy consumption, final energy consumption and ratio from 2017-2040. The projection shows that:

- Primary energy consumption increases 1% from 2017 to 2030 and decreases 1% from 2017 to 2040
- Final energy consumption increases 6% from 2017 to 2030 and 8% from 2017 to 2040
- ratio increases 5% from 2017 to 2030 and 9% from 2017 to 2040

Figure 18 shows final energy consumption by sector from 2017-2040. A key result of the projection is that only the residential energy consumption is expected to fall, while for the other sectors energy consumption is expected to stay at roughly the same level. The largest increase in energy consumption is expected in the tertiary sector, particularly due to expected new electricity consumption by large data centres, HSDC's, (COWI A/S for the Danish Energy Agency, 2018). However, there is still considerable uncertainty associated with projecting electricity consumption by large data centres.

The concrete results of the projections are:

- agriculture increases 2% from 2017 to 2030 and 5% from 2017 to 2040
- construction increases 6% from 2017 to 2030 and 8% from 2017 to 2040
- industry increases 6% from 2017 to 2030 and 12% from 2017 to 2040
- residential decreases 5% from 2017 to 2030 and 10% from 2017 to 2040
- tertiary increases 44% from 2017 to 2030 and 73% from 2017 to 2040
- transport increases 2% from 2017 to 2030 and to decreases 2% from 2017 to 2040

Moreover, Figure 18 shows the share by sector of final energy consumption (FEC) in 2030 and 2040. The projection shows that:

- agriculture accounts for 5% of FEC 2030 and FEC 2040
- construction accounts for 1% of FEC 2030 and FEC 2040
- industry accounts for 15% of FEC 2030 and FEC 2040
- residential accounts for 27% of FEC 2030 and 26% of FEC 2040
- tertiary accounts for 18% of FEC 2030 and 22% of FEC 2040
- transport accounts for 34% of FEC 2030 and 32% of FEC 2040

¹⁴ This reference business as usual projection shall be the basis for the 2030 final and primary energy consumption target, which is described in Chapter 2.3 of Denmark's NECP and conversion factors.

(iv) Cost-optimal levels of minimum energy performance requirements resulting from national calculations, in accordance with Article 5 of Directive 2010/31/EU

Denmark has submitted the latest cost-optimal report to the Commission on March 23, 2018. The cost-optimal report shows the following overall conclusions:

In general, the overall level for requirements for new buildings is a little tighter than what is required by the Energy Performance of Buildings Directive (EPBD). The weighted average for new buildings shows that the Danish requirements are 21 % tighter than the cost-optimal level. However, there are variations between different types of buildings.

For building elements that are subject to a renovation, the requirements are also near the cost-optimal point. The calculations show variations for different types of constructions depending on the starting point of the insulation levels of the existing constructions.

For buildings undergoing major renovation, the building regulations include renovation classes that can be used. The levels in these classes have been evaluated in the cost-optimal report, and the report showed that the level was not sufficiently tight. The weighted average showed that the requirement in average was 30 percent from the cost-optimal point. After the cost-optimal report was published, the levels of the renovation classes have been lowered. The renovation classes, therefore, are now within the cost-optimal range.

Overall, the report shows that Denmark fulfills the requirements of cost-optimal levels in building regulations.

3 FINANCING AND INDICATORS

3.1 ESTIMATES OF INVESTMENT NEEDED

Assessments of investment needed to obtain net-zero emissions no later than 2050 have not been carried out.

The results of such assessments will, to the extent feasible, be included in this chapter in future updates of the document.

3.2 POLICIES AND MEASURES FOR RELATED RESEARCH, DEVELOPMENT AND INNOVATION

National 2030 objectives and funding

The new Danish government wants to reduce greenhouse gas emissions by 70% by 2030 compared to the 1990 level. To achieve this, new technologies will have to be developed and deployed before 2030.

In June 2018 the Danish Parliament made a Energy Agreement supported by all parties in the Parliament. As part of the agreement, Denmark has committed to spend 580 mill. DKK in 2020 on research, development and demonstration of new energy technologies. This matches Denmark's commitment to double its public funding to research and development under Mission Innovation. With the research reserve agreement 2020, the Government and all the political parties has agreed to increase spending to green research, development and demonstration by 1 billion DKK in 2020 in addition to the spending target in 2020 that follows from the Energy Agreement.

In 2020, 514 mill. DKK will be allocated to the Energy Technology Development and Demonstration Program (EUDP). EUDP supports development and demonstration of new energy technologies, as well as research supporting preparation for development and demonstration. The objective of EUDP is to create growth and jobs, increase the security of energy supply, and contribute to make Denmark independent of fossil fuels by 2050. 83 mill. DKK will be allocated to the energy area in Innovation Fund Denmark in 2020 (cf. the Budget proposal 2020). Furthermore, 629 mill. DKK will be allocated to green research in Innovation Fund Denmark in 2020. These funds cover different themes related to green research, including energy research. Innovation Fund Denmark primarily supports strategic research and development projects.

In addition to this the Government funds Research and Innovation in the food sector and in relation to Environmental Technologies through the Green Development and Demonstration Programme (GUDP) and the Environmental Technology Development and Demonstration Programme (MUDP). It is estimated that both programmes allocates 10 mill. DKK to energy and climate related projects.

Furthermore, the agreement states that by 2024 Denmark has a spending target of 1 billion DKK on research, development and demonstration of new technologies related to energy and climate.

The Danish parliament has already allocated 90 mill. DKK to research and development in limiting greenhouse gas emissions from the agricultural sector, which is relatively large in Denmark. The 90 mill. DKK will cover the period 2019-

2021. The funds will help reach the Danish reduction target in 2030 in the non-ETS sector as well as the goal of reducing greenhouse gasses by 70% by 2030, relative to 1990 levels.

Denmark does not have any funding targets for private research and innovation relating to the energy union.

National 2050 objectives

Denmark has a long term target of net-zero emission by 2050 at the latest and independence from fossil fuels. Furthermore, Denmark has a target of 55% of energy consumption coming from renewables by 2030 and more than 100% of its electricity consumption coming from renewables by 2030.

As part of the new government's goal to reduce greenhouse gas emissions by 70% by 2030, relative to 1990 levels, it is essential that funding is in place for research, development and demonstration as well as deployment of new climate friendly technologies. New solutions will have to be developed in the energy sector, in transportation and aviation as well as in the agricultural sector. Power-to-X is one of the technologies that potentially can contribute to fully decarbonizing the energy sector, transportation and aviation as well as agricultural and industrial sectors. For this reason, research on power-to-X development and upscaling will be supported and developed.

As part of a future green mobility plan the Government wants to stop sales of all new diesel and petrol cars as of 2030 and enhance low emissions zones. This requires deployment of new green vehicles in Denmark.

As part of the Energy Agreement from 2018 three new off-shore wind farms will be deployed by 2030. Thereby Denmark will make itself increasingly independent from fossil fuels. The large ratio of green energy production will require further research, development and demonstration of technologies to fully integrate and exploit the green energy. In order to accommodate future needs, the Danish Government has established a fund supporting development and demonstration projects on energy storage. The fund's size is 128 million DKK and it was in December 2019 granted to two Power-to-X-projects. The projects will establish big scale production and storage of green hydrogen. Both projects have an ambition to demonstrate production and consumption of green hydrogen on near market based conditions.

National objectives with regard to competitiveness

The global green transition market continues to grow. In order to reach the temperature increase target limit, the international community must invest 90,000 billion DKK in green transition over the next 11 years. This represents a unique opportunity for the Danish business community, which must be exploited. The Government wants Denmark to be known as a nation of green entrepreneurialism.

It is a continuous Danish priority to deliver new green solutions to the fast-growing global market.

3.3 INDICATORS FOR THE EXPECTED PROGRESS ON TRANSITION TO A LOW GREENHOUSE GAS EMISSION ECONOMY

The indicators mentioned in Article 15(4) of the Governance regulation have been included in this chapter in addition to the chapters required in the regulation's outline of the report.

The indicators calculated as the expected progress on transition to a low greenhouse gas emission economy by 2050 follow from the government's:

- near-term strategy for 2030: to reduce Denmark's total greenhouse gas emission by 70 %, relative to 1990 levels; and
- long-term strategy for Denmark: to obtain net-zero emissions no later than 2050.

If the development in greenhouse gas emissions is assumed to meet these targets, and if the average growths in energy consumption and GDP 2030-2040 in the latest frozen policy scenario (the WEM scenario) respectively are assumed to continue in 2041-2050, the indicators for greenhouse gas intensity and CO₂ intensity of gross domestic product can be calculated for 2030 and 2050.

The results for these two indicators are shown in figures 19 and 20 respectively - for 2030 and 2050, together with the same indicator's past development 1990-2017, the development in the latest frozen policy (WEM) scenario 2018-2040, and the assumption that greenhouse gas emissions in the period 2041-2050 will stay at the level in 2040 if no new policies and measures are adopted.

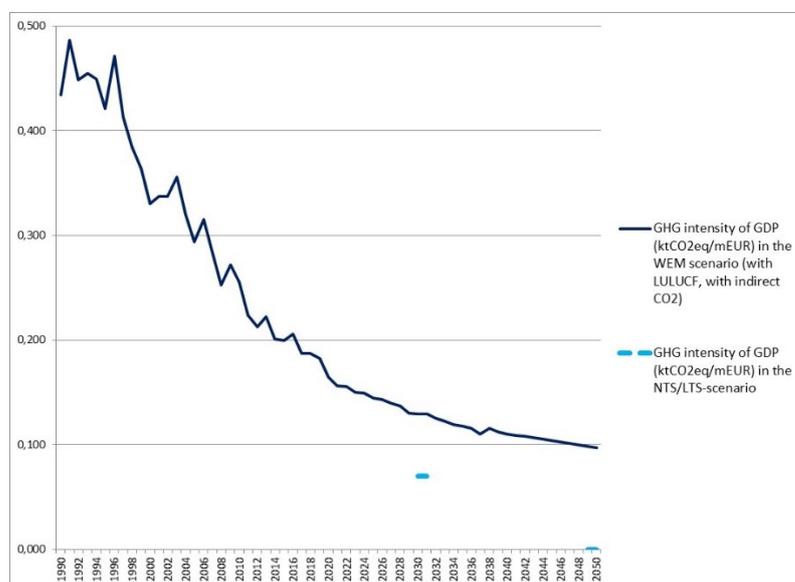
As the long-term strategy target of net-zero emissions no later than 2050 is expected to be met in 2050, the expected progress in greenhouse gas- and CO₂-intensities of GDP by 2050 is 0 tonnes CO₂-eq. per Million Euro GDP and 0 tonnes CO₂ per Million Euro GDP respectively.

The emission estimates used for the indicators are "net greenhouse gas emissions". This would also cover a situation where Denmark still has emissions by sources in 2050, but these emissions are counter-acted by removals by sinks in the LULUCF sector to achieve net-zero emissions. The role of LULUCF in relation to the 2030 and 2050 targets has not yet been decided.

3.3.1 Greenhouse gas intensity of gross domestic product

The development in greenhouse gas intensity of gross domestic product in kt CO₂-eq per Million Euro is shown in figure 19 for the WEM scenario and as expected for 2030 and 2050 in the 2030- and 2050-target achievement scenarios.

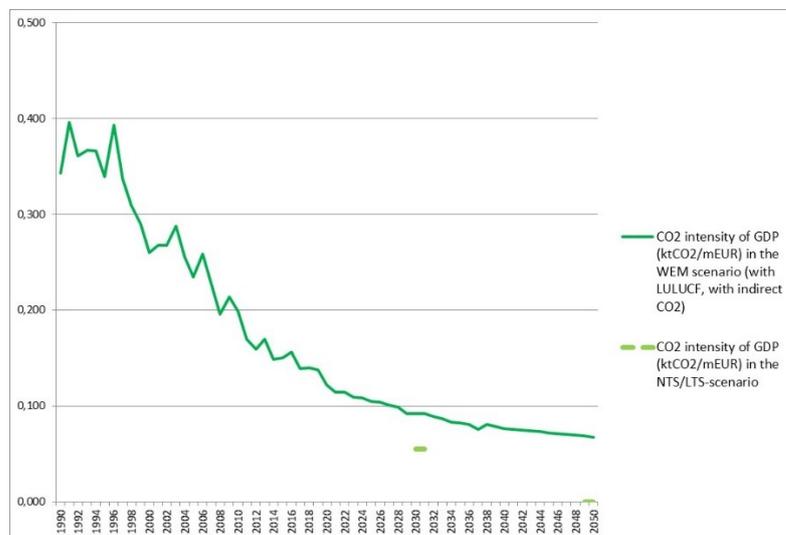
Figure 19. Greenhouse gas intensity of gross domestic product in kt CO₂-eq per Million Euro in the WEM scenario and the near-term strategy scenario (NTS for 2030) and log-term strategy scenario (LTS for 2050).



3.3.2 CO₂ intensity of gross domestic product

The development in CO₂ intensity of gross domestic product in kt CO₂ per Million Euro is shown in figure 20 for the WEM scenario and as expected for 2030 and 2050 in the 3030- and 2050-target achievement scenarios.

Figure 20. CO₂ intensity of gross domestic product in kt CO₂ per Million Euro in the WEM scenario and the near-term strategy scenario (NTS for 2030) and log-term strategy scenario (LTS for 2050).



4 IMPACT ASSESSMENT OF THE SOCIO-ECONOMIC ASPECTS

Impact assessments of the socio-economic aspects of the long-term strategy to obtain net-zero emissions no later than 2050 have not been carried out.

The results of such assessments, including information on the expected socio-economic effect of the decarbonisation measures including inter alia aspects related to macro-economic and social development, health risks and benefits and environmental protection will, to the extent feasible, be included in this chapter in future updates of the document.