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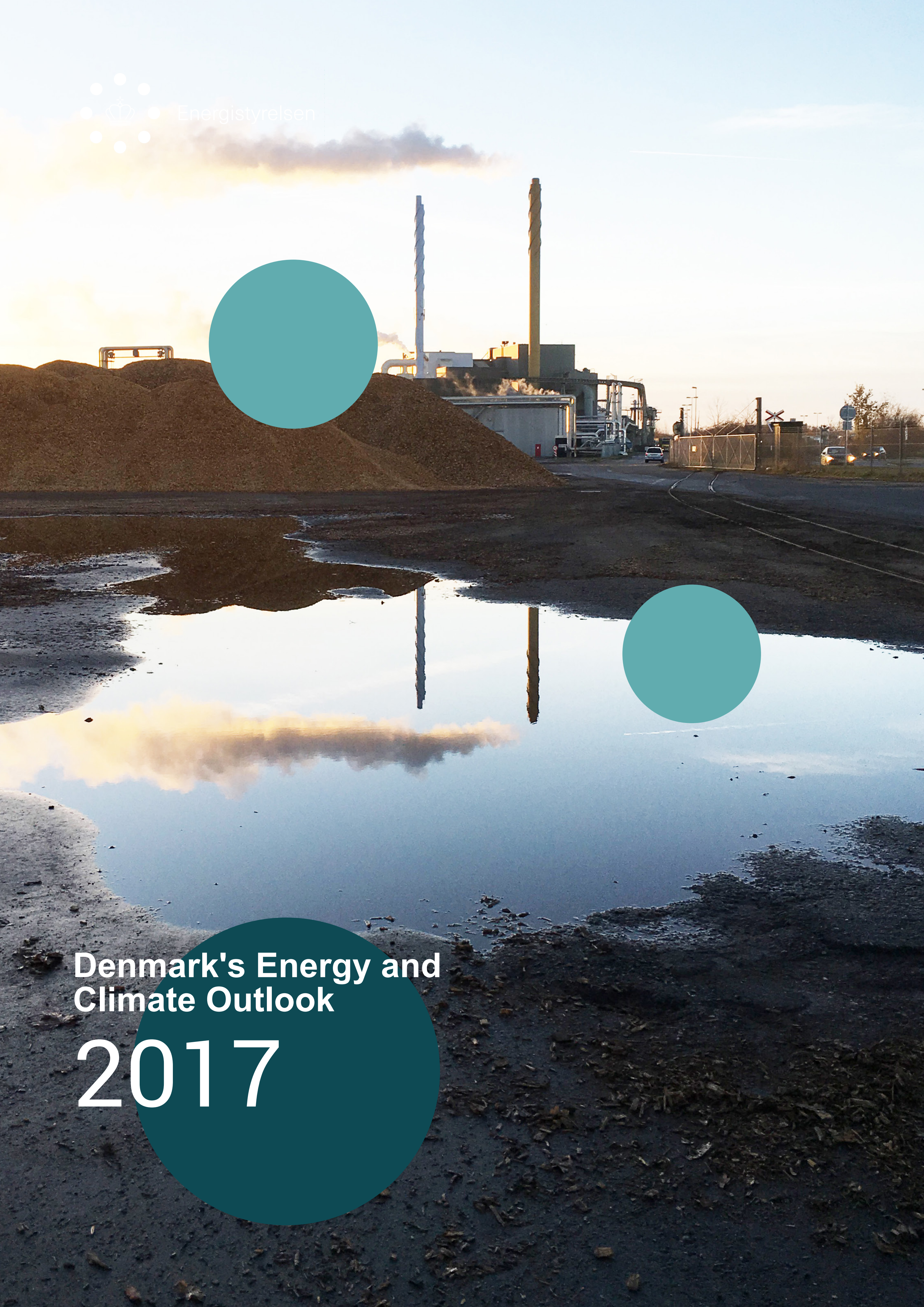

Denmark's Energy and Climate Outlook 2017

Denmark's Energy and Climate Outlook 2017
Published March 2017 by the Danish Energy Agency, Amaliegade 44, 1256 Copenhagen K, Denmark.
Tel: +45 33 92 67 00, E-mail: ens@ens.dk, Website http://www.ens.dk
Design and production: Danish Energy Agency (cover page photo by Nina Holmboe)
ISBN: 978-87-93180-28-4
Queries concerning methods and calculations should be addressed to the Danish Energy Agency.

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Background report

The background report is available (in Danish) on the Danish Energy Agency website (Fremskrivninger).

1 Introduction

1.1 What is Denmark's Energy and Climate Outlook 2017?

Denmark's Energy and Climate Outlook 2017 provides an assessment of how Danish energy consumption, energy production and greenhouse gas emissions will develop up to 2030 *with existing adopted energy and climate policy initiatives*; i.e. a climate and energy outlook that assumes no new policy will be introduced (frozen-policy approach).

The current energy policy agreement expires in around 2020, and this means that many elements of the existing energy policy framework will change at around the same time. Therefore, for the period 2020 to 2030, Denmark's Energy and Climate Outlook 2017 is based on a scenario with an undecided energy policy framework for a large number of areas.

Actual developments will be influenced by the introduction of new political initiatives, and the projections should therefore not be considered a prediction of future developments. Given that a new energy policy agreement is likely to be established for the period after 2020, the projections are likely to deviate from actual developments up to 2030.

Rather than trying to predict developments, Denmark's Energy and Climate Outlook 2017 describes a scenario based exclusively on the current political framework and which can therefore illustrate the possible challenges with regard to meeting future energy and climate goals.

This Outlook can therefore serve as a backdrop for considering possible future energy and climate policy initiatives. For this reason, it is particularly important that the projections do not attempt to anticipate future energy policy initiatives but only reflect the policy already in place, and which is the basis on which future energy policy must be built.

The projections in this Outlook rely on a number of general economic assumptions about production in the corporate sector, private consumption, fuel prices etc., and a number of technology-specific assumptions regarding prices and efficiency related to different types of energy installation. Furthermore, the projections include assessments of how energy-market players will act on the market with the assumptions applied (including the assumption of unchanged policy), as well as qualitative estimates, for instance concerning planning aspects.

Projections of this nature will always be subject to many uncertainties, and another set of assumptions than those applied would therefore provide different outcomes than those presented here.

1.2 Who is the target group?

This publication consists of a main report and a background report.

The **main report** provides a general picture of energy consumption and greenhouse gas emissions in the projection period and explains the most important causes for developments. The main report focuses on the most important trends and topics in the projections and is targeted at readers interested in the overall picture. The report describes different types of energy consumption, e.g. gross energy consumption and final energy consumption. Furthermore, it describes developments in the relationship between fossil fuels and renewables and with regard to greenhouse gas emissions.

The **background report** examines more deeply the assumptions and outcomes from each main area of the outlook: households, the corporate sector, transport, production of electricity and district heating (including developments in electricity prices), developments in fuel prices, as well as greenhouse gas emissions. This part of the publication is targeted at readers with a specific interest in the individual areas, and readers who want to know more about how the projections have been made.

An outlook regarding public service obligation tariffs and a set of socio-economic assumptions for use in calculations have been prepared separately from this Outlook report. The projections regarding public service obligation tariffs and the socio-economic assumptions for use in calculations are not included in this Outlook report; however, they are based on the outcomes of this report.

1.3 More rigorous frozen-policy approach due to future energy negotiations

This Outlook runs up to 2030 and for the period after 2020 applies a more rigorous approach than previous outlook reports by including only existing, already adopted policy (frozen-policy approach). The projections therefore provide a solid foundation for political discussions about energy and climate policy after 2020.

The more rigorous frozen-policy approach, coupled with the fact that projections run all the way to 2030, provides for an even clearer picture than previous reports of the effect of not introducing new policies. The more rigorous frozen-policy approach means the following changes compared with the 2015 outlook report:

- The energy saving efforts by energy companies have only been agreed up to 2020, and they have therefore not been included after 2020[1].
- EU approval of state aid for onshore wind, biomass CHP and biogas under the state aid rules expires in 2018, 2019 and 2023, respectively, and this means that a new political position will have to be taken on whether to continue to subsidise these technologies. Therefore, aid for *new capacity* in these areas has not been included in the projections after the relevant expiry years. However, the *existing* plants will continue to receive aid according to the same rules as applied before the expiry of the aid scheme.

In addition to the change in focus, this Outlook also contains a number of other changes to assumptions relative to the previous report. These include updated energy statistics, updated fuel prices, new policy (e.g. phase-out of public service obligation tariffs and discontinuation of the RE-for-production-processes subsidy pool). The changes to conditions due to policy changes are outlined below in figure 1.

[1] The 1.5% annual energy saving obligation under in the EU Energy Efficiency Directive only applies up to 2020. The European Commission has presented a proposal to extend the commitment up to 2030. This proposal has not been included in the frozen-policy assumption.

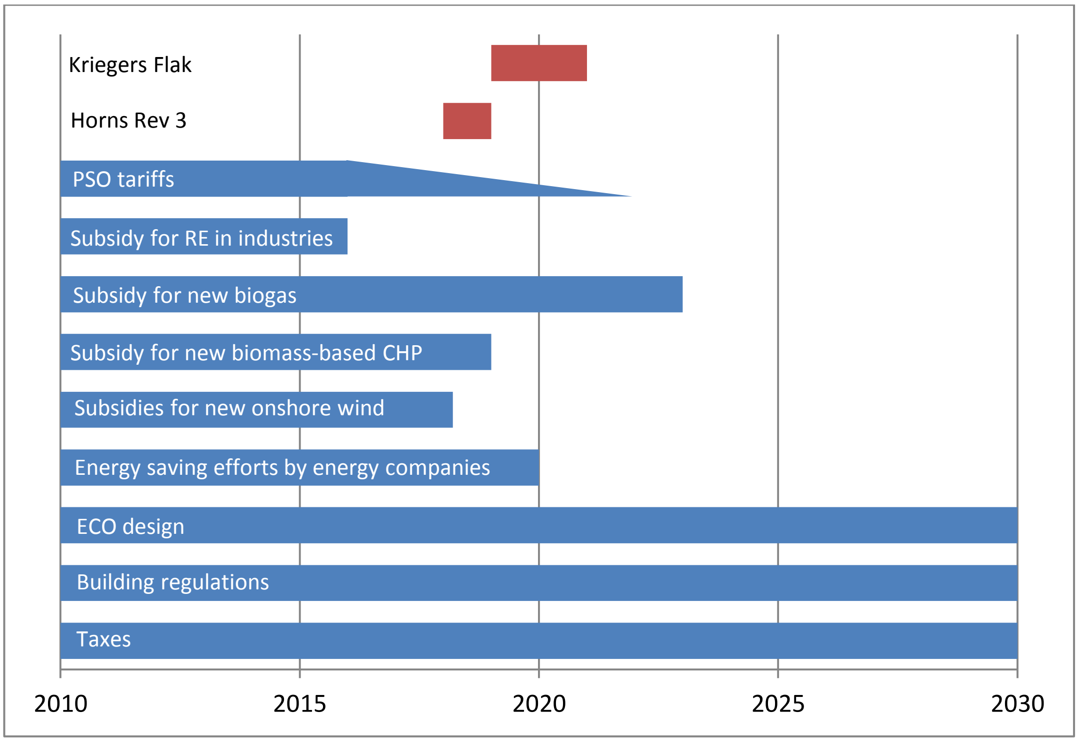

Figure 1: Due to the frozen-policy assumption, existing tariffs and taxes are retained throughout the projection period, while e.g. subsidies are retained until the time during the period projected when new political decisions are required to continue the subsidy schemes.

1.4 Why do outcomes change from one outlook to the other?

The outcomes of the projections change from outlook to outlook because of new statistics and, thus, a new basis for projections. For example, this Outlook is based on new statistics on firewood consumption which reveal considerably higher consumption than previous statistics. This means that this Outlook is based on another expected mix of household energy consumption for heating than the previous outlook report.

The outcomes of the projections also change because central assumptions for future developments change; including expected economic developments and developments in fuel prices. Since the previous outlook report, there have been changes e.g. a political agreement to phase-out public service obligation tariffs, including to and, consequently, discontinue the RE-for-production-processes subsidy pool. The more rigorous frozen-policy approach, as described in section 1.3 above, also gives rise to changes compared with the previous outlook report.

Moreover, the models used are being continuously developed and improved, and this in itself may lead to differences in outcomes. For example, the heating model that was applied in the previous outlook has been replaced by the TIMES-DK model, which models at a higher level of detail building stock, choice of heating technology and resulting energy consumption in terms of fuels.

1.5 What are the assumptions behind the projections?

The impacts of already adopted, but not necessarily implemented, initiatives have been factored in. For example, all elements of the 2012 political energy agreement (2012 Energy Agreement); all finance acts up to and including the 2017 Finance Act; the December 2015 political agreement on a food products and agriculture package; and the November 2016 agreement to phase-out the public service obligation tariffs have all been included in the projections.

The assumptions regarding economic growth have been based on the same baseline scenario as is used in the Finance Bill 2017, while the development in fossil fuels prices has been calculated on the basis of expectations in the market (forward prices) as well as on projections in the New Policy Scenario in the International Energy Agency (IEA) World Energy Outlook 2016 from November 2016.[2]

In addition to the assumptions above, and in line with previous projections, some major, isolated projects have also been included in the projections. The methodologies applied allow for the incorporation of specific projects (e.g. projects to convert power plants from coal-based to biomass-based) in the projections, where one or more of the following factors apply:

1) An application has been approved or a commitment of subsidies has been granted.

2) There is a financial basis for the project with the assumptions used in the projections.

Thus, 'a declared objective' does not in itself merit inclusion in the projections; rather there must be specific measures in place for declared targets to be included in projections. For example, the government's target of 50% renewables in 2030 has not been included, nor have the CO2 targets of Danish municipalities, such as the objectives of the City of Copenhagen and the City of Aarhus to become carbon neutral by 2025 and 2030, respectively. Similarly, the City of Aalborg's objective to convert the municipally-owned power plant *Nordjyllandsværket* to 'greener energy' has not been included either. However, specific initiatives that have been adopted or are being implemented to meet targets have been included.

1.6 A basic scenario and an alternative scenario for projections

This Outlook includes a **basic scenario** describing the expected developments assuming no new policies (frozen-policy approach). This basic scenario covers the period up to 2030 and is based on a best guess of developments against the background of the existing framework, e.g. developments in fuel prices and technological advances. However, with regard to national energy and climate policy, as well as with regard to subsidies and tariffs/taxes, the basic scenario is based on a frozen-policy assumption and therefore does not, necessarily, present a “best guess” of how things will develop. The basic scenario assumes that specific projects that have already been launched will be completed, e.g. the conversion of plants from coal to biomass.

Furthermore, this Outlook also presents an **alternative scenario,** the aim of which is to illustrate the isolated impact of DONG Energy's announcement on 2 February 2017 to stop all use of coal from 2023. DONG Energy today owns the majority of power plants in Denmark that have the possibility to increase their production of electricity based on coal. If the announcement from DONG Energy is fully implemented, this could have significant impacts on developments compared with the basic scenario, e.g. in the form of a higher share of renewable energy, increased imports of electricity, and lower level of greenhouse gas emissions from Denmark.

[2] Read more about fuel price assumptions in the background report.

Due to the frozen-policy assumption of the basic scenario[3], increasing electricity consumption will be met by coal-based electricity production. This is because such a scenario is a particularly good business case for coal-based electricity generation at Danish plants. In the alternative scenario, this option has been removed for plants owned by DONG Energy, due to DONG Energy's announcement, see above. The outlined scenario is merely one among several possible scenarios, as there are currently no specific applications to factor in.

In addition to the basic scenario and the alternative scenario, figures and key outcomes are also provided with a sensitivity range to reflect the **uncertainties** in the basic scenario. Sensitivity increases over time as the uncertainties linked to the parameters on which the projections are based increase as the projections look further into the future, just as the impacts of deviations accumulate over time.[4]

1.7 The models applied

This Outlook was prepared on the basis of models. To best reflect the energy system, we chose to work with a number of different models:

- **EMMA** models energy consumption in the corporate sector and energy consumption by household appliances.
- **TIMES-DK** models energy consumption for heating homes.
- **RAMSES** models electricity and district heating production on the basis of consumption figures from EMMA, TIMES-DK and the Transport model.
- **The Transport Model** models energy consumption by the transport sector.
- Data from the models is collected in the **Summary Model**, which ensures an output that can be used directly in reporting and in statements.

In addition to our own model setup, the projections also include external inputs. You can read more about the models applied in the background report.

[3] Among other things, the frozen-policy assumptions entail that subsidies for new biomass-based CHP and onshore wind turbines will cease and that no new offshore wind farms will be established.

[4] A relatively simple approach has been applied to illustrate the sensitivity: For each sector, a number of parameters have been set up which are important for sector outcomes. These parameters can be changed within what is deemed to be a probable range of events for each parameter, and the maximum deviations from the total variation of parameters are stated as the probable variation in outcomes for the sector.

2 The overall picture

2.1 Main points

- Due to the expiry of the current energy policy agreement in 2020, as well as the discontinuation of subsidies for renewables as a result of the expiry of EU approvals, increases in the use of renewable energy will stagnate after 2020 and consumption of fossil fuels will increase as a consequence of increased electricity demand.

- This trend will be most evident within electricity and district heating. Electricity and district heating will see a massive conversion to biomass and wind power up to 2020, but from 2020 to 2030 developments will come to a standstill.

- The renewable share of final energy consumption will reach 40% in 2020 and the EU target of 30% renewables will thus have been exceeded by a considerable margin. After 2020, the renewable share will be close to constant, leaving a challenge for future policy makers with regard to the government's goal of achieving at least 50% renewables by 2030.

- Renewable energy increased by more than 2.5 times from 2000 up to today. This trend will change from 2020 onwards in the projections, when consumption of renewable energy will stay at a fairly constant level. The three most important causes of this are: 1) That no more power plants are expected to be converted to biomass under the assumptions modelled; 2) that no more offshore wind farms have been approved; and 3) that no wind turbines will be established onshore because the subsidies for onshore wind are not included in the modelling after 2018 due to the discontinuation of the EU's approval of state aid for this.

- The transport sector will continue to almost exclusively use fossil fuels throughout the projection period. Electrification of road transport will play a very limited role over the projection period. New political initiatives are required if the transport sector's renewable energy goal of 10% by 2020 is to be met.

- After having followed a downward trend for many years, consumption of fossil fuels will increase again after 2020. While consumption of oil (primarily for transport) and natural gas will be constant, consumption of coal will increase, e.g. due to a combination of increased electricity demand at data centres, in particular, and a halt in the expansion of renewable energy for electricity production.

- Danish emissions of greenhouse gases are expected to drop up to 2020, when the modelled assumptions of no new climate and energy policy agreements mean that emissions are likely to increase again up to 2030.

- Denmark will still achieve its overall reduction target for non-ETS greenhouse gas emissions for the period 2013 to 2020; however, with an expected underachievement in 2020. Meeting the expected target for 2030 will require total reductions of around 24 million tonnes CO_2-eq. in the period 2021 to 2030.

2.2 New trend after 2020: An end to falling energy consumption and to growth in renewables

Danish gross energy consumption has been more or less constant since 1990 and has been following a slightly downward trend since 2000, while GDP has increased considerably. Looking forward toward 2030, energy consumption is likely to be slightly higher towards the end of the period than it is today. However, this trend reflects a continued slight drop up to 2020 followed by an increase in demand up to 2030. The drop in energy consumption up to 2020 is due primarily to energy efficiency improvements and new wind power capacity[5] (including the establishment of Kriegers Flak), while the expected increase in consumption after 2020 is due to a halt in the installation of new wind power capacity, fewer energy efficiency improvements and increased electricity demand from new data centres.

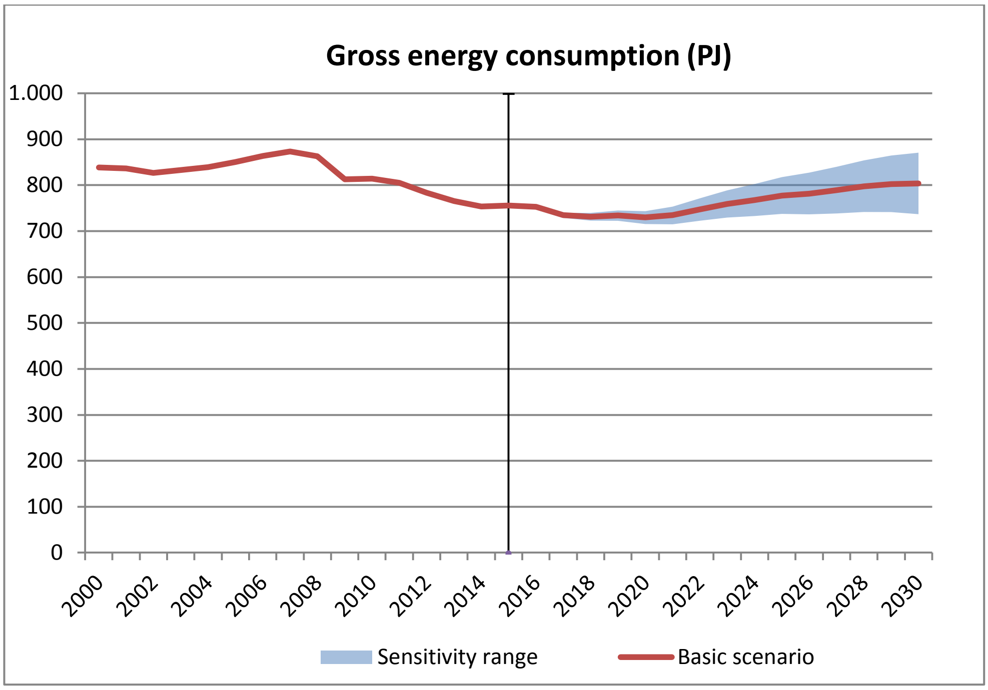

Figure 2: Following a slightly downward trend from 2000 to 2020, gross energy consumption will increase slightly from 2020 to 2030

Total consumption of renewable energy will increase significantly from 2016 to 2019, after which time it will stay at a more or less constant level up to 2030. The increase early in the projection period is due primarily to the conversion of large-scale CHP plants to biomass in combination with the deployment of new wind power capacity.

[5] Wind power can reduce gross energy consumption if the new capacity replaces thermal electricity production, since there is no loss from converting from fuel to electricity in the case of wind power.

After 2020, many of the large-scale power plants will have been converted to biomass-based production, and no more conversions are expected under the basic scenario, see the description in section 1.5 of the assumptions underlying the projections. No more offshore wind farms have been approved for establishment after Kriegers Flak has been fully commissioned in 2021, and in February 2018, the EU's approval of state aid for onshore wind expires. Consequently, subsidies for onshore wind capacity have not been included after 2018, which is one among several reasons why the increase in renewable energy consumption will stagnate after 2019 under the basic scenario. There will be a significant increase in electricity production from photovoltaic solar modules, since there will continue to be a self-generation incentive. However, electricity production from photovoltaic solar modules will continue to play a minor role for the overall picture.

As mentioned above, we have also prepared an alternative scenario. In this scenario, consumption of renewable energy after 2020 will be slightly higher compared with the basic scenario. This is due to increased consumption of biomass as it has been assumed that DONG Energy's plants will be fired exclusively by biomass under this scenario.

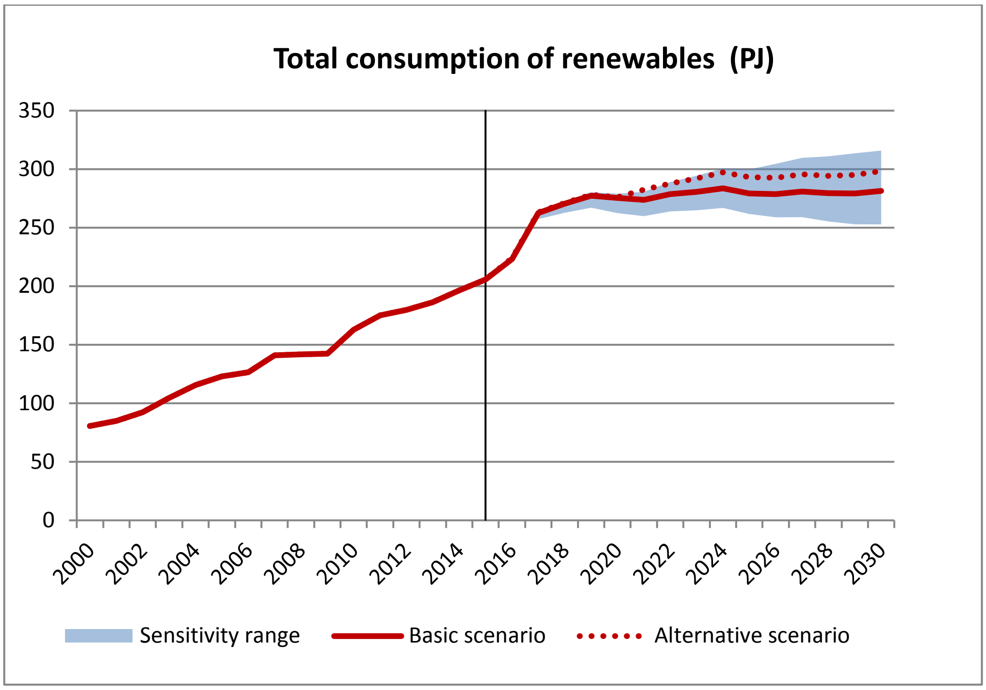

Figure 3: The conversion of several large-scale plants to biomass and the establishment of offshore wind farms will lead to an increase in renewables from today up to 2020, after which time these initiatives will end and the increase in renewables will therefore stagnate.

2.2.1 Renewable share and targets

Under the 2009 EU Climate and Energy Package, Denmark is committed to achieving at least 30% renewables in gross final energy consumption[6] by 2020, as well as various sub-targets before 2020. With a

[6] Gross final energy consumption has been calculated by adding cross-border trade, electricity and district-heating distribution losses and own consumption in connection with district heating and electricity production to final energy consumption, less consumption for non-energy purposes.

projected renewable share of 40% in 2020, this target will have been exceeded by a large margin. Annual targets up to 2020 will also be reached by a large margin. The increase in the renewable share from today and up to 2020 will be due, in particular, to the conversion of large-scale plants to biomass, as well as to the deployment of more offshore wind power capacity, including the establishment of the Horns Rev 3 and Kriegers Flak offshore wind farms; however, it will also be due to continued energy savings leading to less consumption.

In 2014, the EU committed to a 27% renewable energy share of consumption for the EU as a whole by 2030. However, this target has not been translated into national targets. Instead, from 2018, in national energy and climate plans, Member States must account for their expected contribution to achieving the common EU target for renewable energy by 2030, as well as for their ambitions to deploy renewable energy after 2021.

The current Danish government platform includes a target of at least 50% renewables by 2030. According to the basic scenario, the renewable share of gross final energy consumption will be around 35-43% in 2030. The standstill in the increase of the renewable share will be primarily due to a halt in biomass-conversion of plants and in new wind power capacity installation, in combination with increased energy consumption. The government's 2030 target will therefore not be achieved, unless new policy is introduced to ensure this.

Under the alternative scenario, the increase in the renewable share will not stagnate until after 2024. In 2030, the renewable share will be around 3 percentage points higher in the alternative scenario than in the basic scenario. The alternative scenario will have a higher share of renewable energy due to more use of biomass.

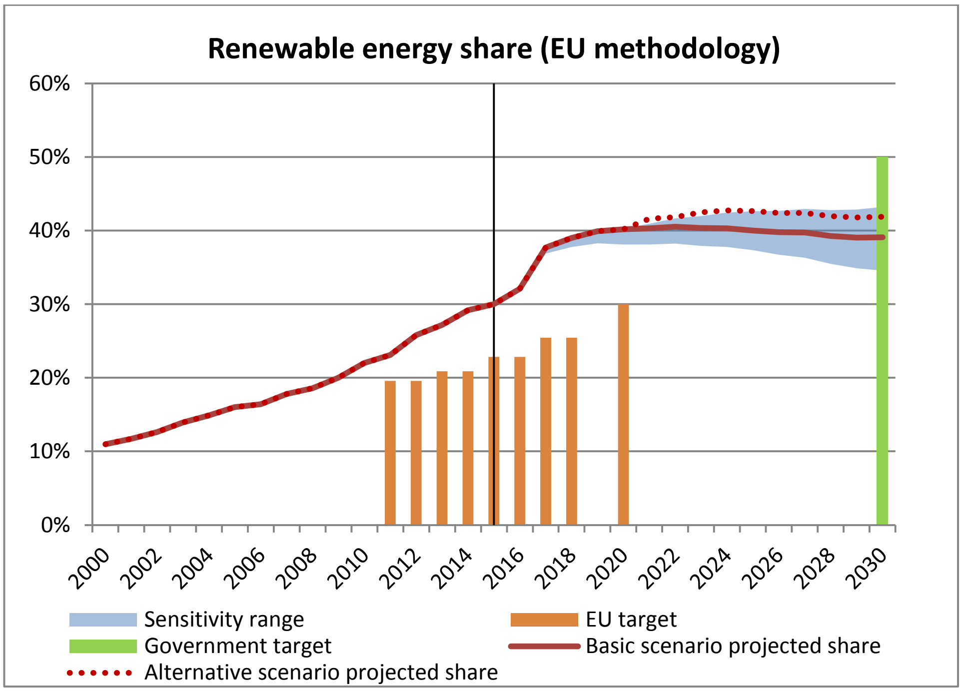

Figure 4: EU targets before and by 2020 will be exceeded by a large margin, but the government will fall short of the 2030 target by 7-15 percentage points.

2.2.2 Renewable energy targets for transport will not be achieved with current initiatives alone

The EU Climate and Energy Package also includes a separate target for renewables in the transport sector, by which Denmark is obligated to reach a renewable share in land-based transport of at least 10% by 2020. This target only applies for 2020 with no requirements for sub-targets towards 2020.

The Danish 2012 Energy Agreement included a decision to amend the Danish Biofuel Act so as to ensure a mix of 10% biofuels in transport fuels by 2020. However, implementation of this is pending an analysis of alternative routes to achieving the renewable energy target. Without this change, the share of biofuels in transport in 2020 will not be enough to ensure an overall renewable share of 10% by 2020. However, the expected 5.5% biofuel share[7] in 2020, in combination with the electrification of railways, will result in an overall renewable share of 8.7%.

2.2.3 Coal behind increased use of fossil fuels after 2020

For many years, Denmark has seen falling consumption of fossil fuels; a trend that is expected to continue up to 2020. After 2020, a decline in the efficiency improvements in energy consumption, increased demand for electricity e.g. from data centres, and a halt in the installation of new wind power capacity will mean that consumption of fossil fuels will go up. In overall terms, consumption of fossil fuels will fall from around 650 PJ in 2010 to 450 PJ in 2020 (an approx. 30% reduction); however, by 2030 consumption will have increased to 520 PJ. The increase will be due, in particular, to an increase in coal-based electricity generation, while consumption of oil and natural gas is projected to stay at a relatively constant level after 2020.

Under the alternative scenario, coal consumption will not start to rise until after 2025. This scenario assumes conversion to biomass of one additional plant and it assumes that none of DONG's plants will exploit the possibility to use coal in production of electricity and district heating (several of the plants can usually shift between coal and biomass depending on prices). Therefore, this scenario projects a lower consumption of coal than the basic scenario. In the alternative scenario, the increased electricity demand will instead be by met by electricity imports, but this scenario is sensitive to developments in fuel prices and to the energy mix in neighbouring countries.

7 The anticipated 5.5% biofuel share is lower than required pursuant to the Biofuel Act; however, since the Act allows for second generation biofuels to be multiplied by 2 (i.e. to count double), the legal requirement will have been met nonetheless.

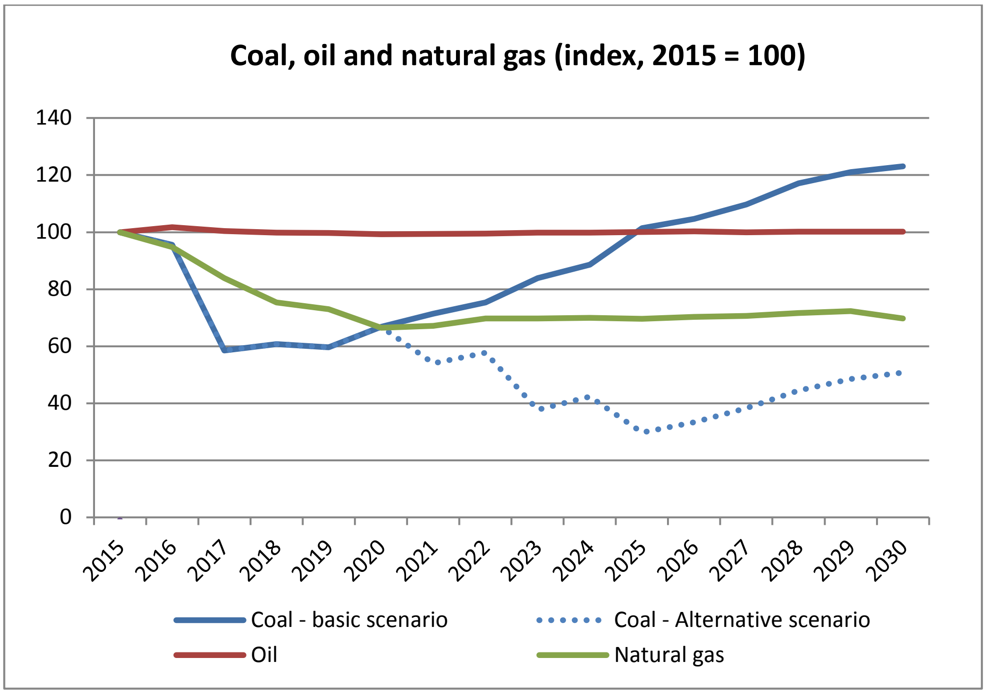

Figure 5: Consumption of oil and natural gas is projected to stay at a relatively constant level after 2020, while coal consumption will increase due to increased electricity consumption. However, in the alternative scenario the increase in electricity consumption will be met by an increase in imports.

2.3 Developments in greenhouse gas emissions up to 2020 and 2030

Total Danish greenhouse gas emissions have exhibited a downward trend since the mid-1990s. In 2015, total emissions had fallen by about 27% compared with 1990.

Basic scenario projections show a fall in total emissions up to 2020, after which emissions will begin to rise. The decrease up to 2020 will mainly occur within energy-related emissions, and it is closely linked to implementation of the energy agreements from 2008 and 2012. The fall in emissions is due to the deployment of and conversion to renewable energy, as well as decreased energy consumption as a consequence of energy efficiency improvements. After 2020, many of the existing energy policy framework elements will cease to apply, including support schemes for renewable energy capacity installation and energy saving efforts. With the assumption of no new policy (frozen-policy approach) applied in this Outlook report, these schemes will not be replaced by new ones, and this will lead to an increase in emissions. This will primarily be driven by rising energy demand, which will be met by increased energy production based on fossil energy sources, particularly coal. The increased consumption of coal will lead to increasing emissions.

Under the alternative scenario, which involves realisation of DONG Energy's announced phase-out of coal by 2023, the rise in coal consumption will be considerably more modest and emissions are therefore expected to increase at a somewhat slower pace. Conversion from coal to biomass is part of the reason for the difference between the alternative scenario and the basic scenario; another part of the reason is increased imports of electricity to cover rising electricity consumption. Greenhouse gas emissions linked to imported electricity are not included in the Danish emissions statements.

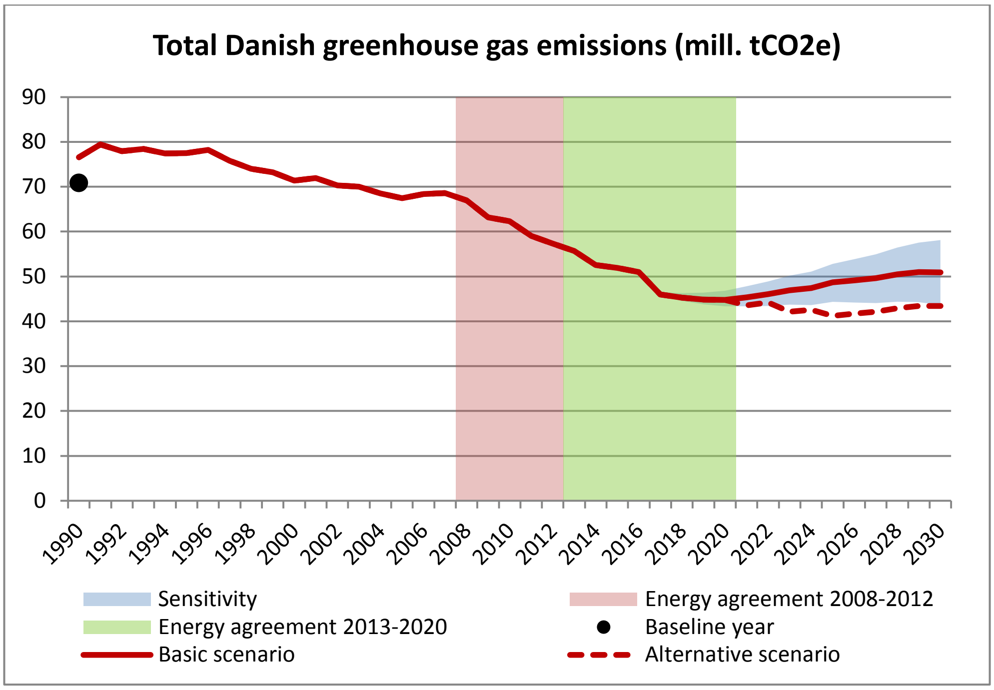

Figure 6: The decrease in Danish emissions is closely linked to the energy policy framework up to 2020. In the alternative scenario, DONG phases out the use of coal at its power plants and the rise in emissions after 2020 will therefore be more modest than in the basic scenario. Historical emissions have been adjusted for electricity trade with other countries in order to provide a clearer picture of the development. The Danish UN baseline year is based on observed emissions in 1990, which were particularly low due to considerably high levels of electricity imports.

2.3.1 The target for non-ETS greenhouse gas emissions for 2013 to 2020 will be achieved, whereas achievement of the reduction target for 2021 to 2030 will require additional efforts

Under the 2009 EU climate and energy package, Denmark is committed to reducing emissions from non-ETS sectors by 20% by 2020 relative to the 2005 level, as well as to achieving a set of sub-targets up to 2020. These sub-targets become progressively stricter up to the end-target in 2020. Overachievement in one year can be carried forward and used for target achievement in the subsequent year. The 2020 end-target is expected to be met; however, with an expected underachievement of the sub-target for the year 2020 itself.

By 2030, Denmark must reduce its non-ETS emissions by 39% relative to 2005. There are progressively stricter sub-targets for the years 2021 to 2030, and these will have to be met, just as in the 2013-2020 commitment period. The projections show that, by 2030, Danish non-ETS emissions will have been reduced by between 20% and 26% relative to the 2005 level, and this is not enough to meet the target. Thus, achieving the target will require additional reduction efforts or the use of flexible mechanisms.

Overall, it is anticipated there will be a need for reductions of between 17 to 34 million tonnes CO2-eq. (central scenario of around 24 million tonnes) over the entire period, and between 5 and 8 million tonnes in 2030, if Danish non-ETS emissions are to be in line with reduction targets.

The alternative scenario deviates from the basic scenario in terms of electricity generation. Since electricity generation only slightly affects non-ETS emissions, the alternative scenario will not be dealt with in more detail in the following.

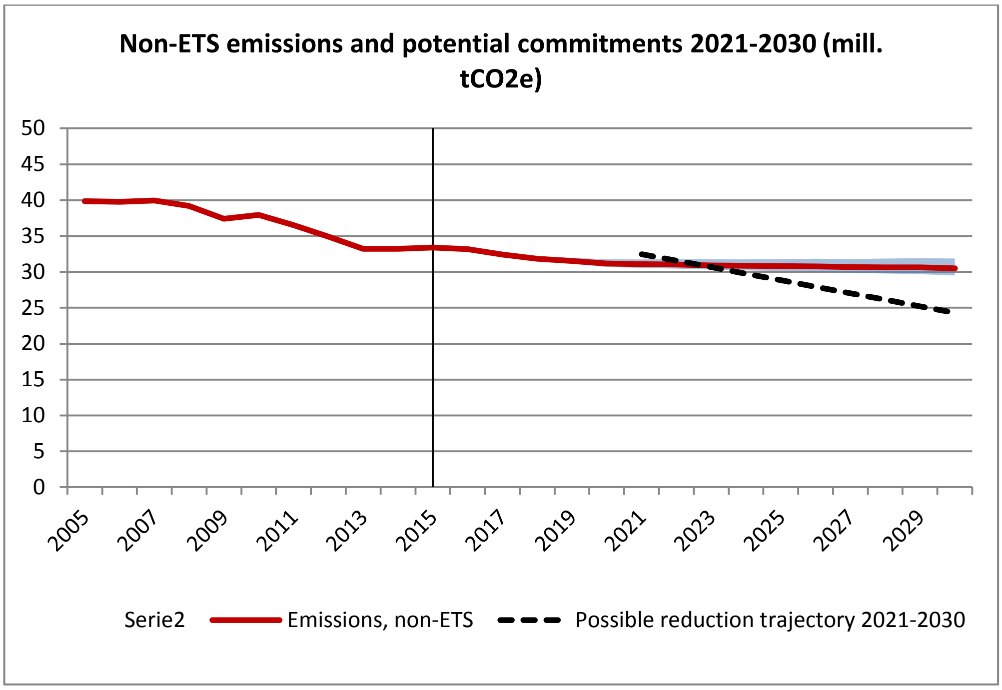

Figure 7: Emissions from non-ETS sectors are expected to stay at a fairly constant level up to 2030. The progressively stricter reduction targets mean that a climate deficit will accumulate up to 2030. This reduction trajectory represents a best estimate and, with regard to start and end points, is based on data from Denmark's Energy and Climate Outlook 2017.

3 Household energy consumption

3.1 Main points

- Total final energy consumption by households is expected to fall by almost 8% between 2015 and 2030. This is a fall of 15 PJ and a continuation of the trend from the past nine years.

- Due to improvements in the energy efficiency of existing buildings, the demolition of existing buildings and the establishment of new energy-efficient buildings, the total net space heating demand of households[8] will decrease by up to 8% from 2015 to 2030, even though the total floor area that requires space heating will increase by 10% during the same period.

- Total final energy consumption for heating by households will drop by 10% from 2015 to 2030 due to the fall in net space heating demand as well as due to improvements in the technologies generating the heat. That is, home owners will shift to other, more energy-efficient sources of heat; e.g. oil-fired and gas-fired boilers replaced by electricity-driven heat pumps.

- In 2030, heat pumps are expected to cover around 15% of the net space heating demand of households; the share was around 7% in 2015.

- Electricity consumption by household appliances will remain unchanged throughout the projection period as efficiency improvements will offset the growth in the number of household appliances.

3.2 Introduction

Energy consumption by households today amounts to about 30% of total Danish final energy consumption. A total of 83% of the final energy consumption of households is spent on heating, and the remaining 17% on household appliances.

Energy consumption for heating has remained at a fairly constant level throughout the past 15 years, but there have been significant changes in the energy sources used. The number of oil-fired boilers has been reduced significantly, so that, in 2015, oil consumption for heating by households was approximately one-third of consumption in 2000.

Despite a rising number of household appliances, the associated electricity consumption has remained more or less constant over the past 15 years because household appliances have become considerably more efficient. This continuous energy efficiency improvement has primarily been driven by EU standards for products (ecodesign requirements) and EU energy labelling requirements.

[8] Net space heating demand is a measure of the heating required to heat a building (i.e. both space heating and hot water). Final energy consumption which is used to meet the net space heating demand, is typically higher because of losses e.g. from boilers when producing the heat.

3.3 Developments in final energy consumption by households up to 2020 and 2030

Continued growth in private consumption during the projection period is expected to result in an increase in the number of appliances and total heated area; however, energy efficiency improvements are also projected to take place, even under the frozen-policy assumption, e.g. as a consequence of technological progress.

The total final energy consumption of households is expected to be around 8% lower in 2030 than today. Thus, gross energy consumption was at 190 PJ in 2015 and is expected to be around 185 PJ in 2020 and 175 PJ in 2030. This accounts for unchanged electricity consumption by appliances and a drop in energy consumption for heating.

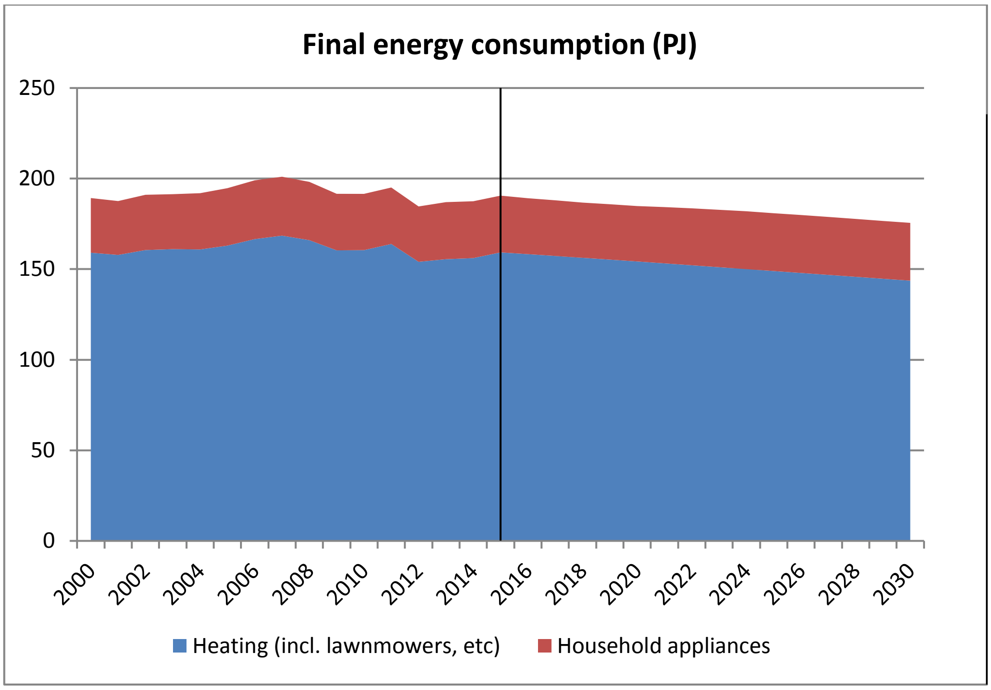

Figure 8. Total final energy consumption of households for heating etc. and of household appliances is expected to fall by around 8% from 2015 to 2030.

3.3.1 Improvements in the energy efficiency of buildings will reduce energy consumption for heating

A steady increase in the demand for housing as a consequence of an increasing population and demands for larger homes will affect the total heated area. Total living floor space is projected to increase by around 9% by 2030, and it is anticipated that around 96% of the total existing floor space in 2015 will remain in 2030. Overall, the projections show an annual growth of 0.6% in the total heated area.

Despite an increase in total heated area, the net space heating demand is expected to drop from around 136 PJ in 2015 to around 125 PJ in 2030. This drop will be due to a higher degree of energy efficiency in new buildings but, more so, due to energy efficiency improvements in existing buildings. The net energy consumption for heating residential buildings will be the result of various instruments such as tightening the building regulations and energy savings efforts by energy companies up to 2020.

The energy requirements for new buildings in the Danish building regulations were tightened by 25% with effect from 2016 (Building Regulations 2015). Moreover, the 2008 Energy Agreement includes an agreement to tighten energy requirements by an additional 25% for buildings erected after 2020. The requirements in the building regulations apply to new as well as existing buildings. New buildings must be built to comply with the tighter requirements, whereas existing buildings must observe a number of energy efficiency requirements for components when they are renovated. These requirements are assumed to be observed on a large scale; however, some comfort improvements are also assumed to take place in connection with refurbishments (rebound effect).

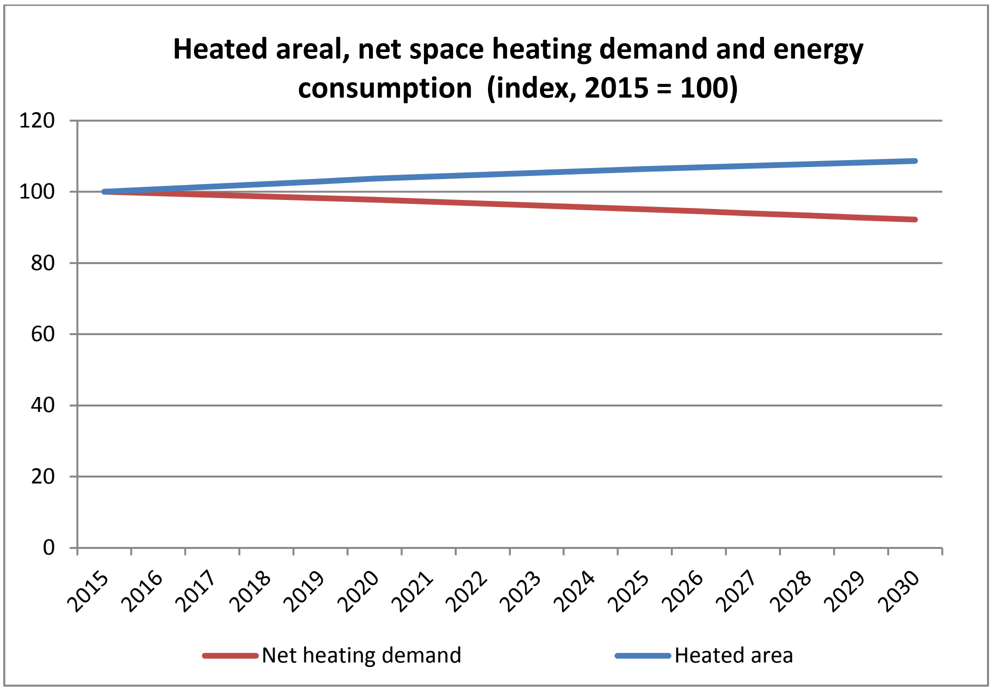

Figure 9. The total heated area is likely to increase steadily up to 2030, whereas the net space heating demand will fall over the period as a result of more efficient buildings.

3.3.2 Decline in final energy consumption for heating up to 2030

Final energy consumption for heating residential buildings will fall by around 10% over the projection period. This fall exceeds the fall in net space heating demand because the efficiency of heating technologies, i.e. the amount of energy output relative to energy input, will increase by around 2 percentage points over the period. Average efficiency will improve as a result of households changing to more energy efficient heating sources. The improved efficiency will be due partly to ongoing tightening of EU energy efficiency requirements (ecodesign requirements) and EU energy labeling requirements, which also apply to heating technologies. The efficiency improvements will also be due to expected general technological advances.

Final energy consumption includes ambient heat for heat pumps. However, surrounding heat can be considered free energy. If ambient heat is not included, the decline in consumption will be even greater, as energy consumption will go from being based on fossil fuels (oil and natural gas) to being based on electrically powered heat pumps, see Figure 10. Heat pumps consume only about one-third of the energy (electricity) used by conventional boilers (oil, natural gas and biomass). The surrounding heat exploited by heat pumps is included in the renewable energy share.

The mix of energy types used to cover the net heating demand in homes will change from 2015 to 2030. The share of the net heating demand covered by heat pumps will increase from its current level of 7% to 15% in 2030. Conversely, the share of natural gas and oil will decline over the period. The share of the net heating demand covered by district heating amounts to almost 50% and will remain unchanged over the period. The share of biomass will also remain unchanged over the period, and covers approx. 20% of the heating demand.

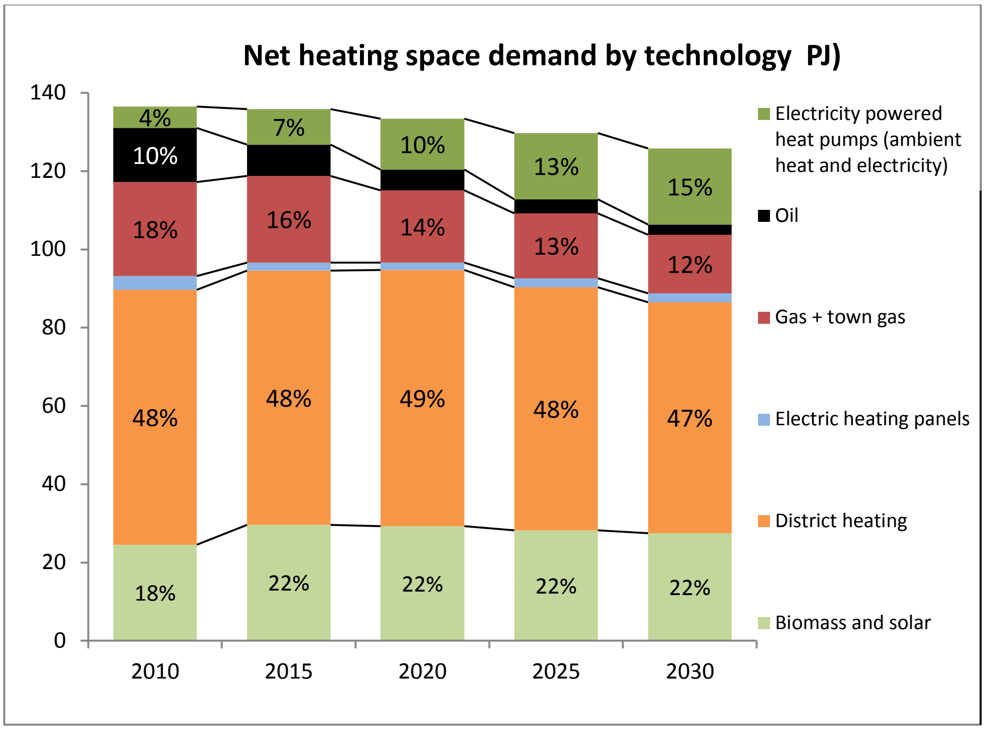

Figure 10: The projected decline in net heating demand reflects a decline in all technologies, except heat pumps, which see an increase over the period.

3.3.3 More household appliances in Danish homes; but they will be more energy efficient

Electricity consumption by household appliances will remain unchanged throughout the projection period. Due to growing private consumption, people will invest in more household appliances. However, at the same time the energy efficiency of these appliances will improve throughout the projection period as a consequence of the continuous tightening of EU minimum requirements for energy efficiency (ecodesign requirements) [9] and tighter EU energy labelling requirements[10], including that a greater number of

[9] In order to reduce the energy consumption of various products, the EU has imposed requirements (i.e. ecodesign requirements) to ensure that the least energy efficient products are removed from the market. The Ecodesign Directive is the legislative basis for introducing ecodesign requirements on products and appliances.

products will be covered by the requirements. The effects of these regulatory requirements were analysed in 2013[11]. In 2030, efficiency improvements will amount to almost 20% of total electricity consumption by household appliances, compared with a scenario without regulatory requirements.

3.4 What we did

The projection of household energy consumption was partly completed in the EMMA consumption model, and partly in the Danish Energy Agency's version of the TIMES-DK model. EMMA is a macro-economic tool which describes corporate and household energy demand on the basis of production, energy prices and developments in energy technology. EMMA is linked to the ADAM macro-economic model, which provides assumptions about economic growth. The Danish Energy Agency uses growth assumptions from the Danish Ministry of Finance. We used the TIMES-DK model to calculate energy consumption for heating by households. We used this in combination with assessments of inertia in behavioural change and the significance of energy saving efforts. The TIMES-DK model is in effect a complete energy system model; however, for these projections we only used the part of the model that concerns space heating by households.

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[10] Since 1995, EU requirements have been introduced for energy labelling of a number of products. Today, there are requirements on e.g. domestic appliances, lighting, boilers and heat pumps. The energy labelling is known as the A to G label scale.

[11] "*Effektvurdering af ecodesign og energimærkning*" (Impact Assessment of Ecodesign and Energy Labelling), prepared by IT-Energy and Viegand Maagøe for the Danish Energy Agency in 2013.

4 Energy consumption by the corporate sector

4.1 Main points

- The energy efficiency of the corporate sector will improve up to 2020. Furthermore, the final energy consumption of the corporate sector will remain unchanged during this period, while the economy will see growth.
- From 2020 to 2030, final energy consumption will increase by 20%. The increase will be greater than economic growth, partly because new data centres and the phase-out of public service obligation tariffs will result in a sharp 35% increase in electricity consumption, and partly because the energy efficiency of the corporate sector will fall because energy savings efforts by energy companies will end after 2020 (due to the frozen-policy assumption applied in projections).
- The consumption of fossil fuels by the corporate sector will increase by around 5% between 2015 and 2030. This overall increase involves a drop of around 10% up to 2020 followed by an increase of around 15% between 2020 and 2030.

4.2 Introduction

Energy consumption by the corporate sector today amounts to about 30% of total Danish final energy consumption. Historically, manufacturing industries have accounted for almost half of energy consumption by the corporate sector, but since 2000 energy consumption by this sector has fallen and today it accounts for about 40%. Furthermore, the service sector also accounts for 40%, while agriculture, fisheries and building and construction account for the remaining 20% of energy consumption.

The fall in energy consumption by manufacturing industries is due, in particular, to a decline in production, which was particularly evident during the financial crises from 2007 to 2010. During this period there was a drop in economic growth in industry of almost 5% annually, and this led to a more or less corresponding drop in energy consumption. In agriculture, energy consumption fell by around one-fifth from 2000 to 2015. Energy consumption by the service sector remained almost constant during from 2000 to 2015.

Seen over the past 15 years, energy consumption by the corporate sector has seen minor changes: the share of fossil fuels has gone down while the shares of electricity, renewable energy and district heating have gone up. The fossil fuel share was 40% in 2015 as opposed to 48% in 2000, and the natural gas share of the fossil fuel share increased over the same period. The renewable share in the corporate sector increased from 4% in 2000 to 7% in 2015.

4.3 Developments in energy consumption by the corporate sector up to 2020 and 2030

Corporate sector final energy consumption will remain at the same level as in 2015 up to 2020. During this period, there will be economic growth; however, final energy consumption is projected to remain unchanged nonetheless due to improved efficiency.

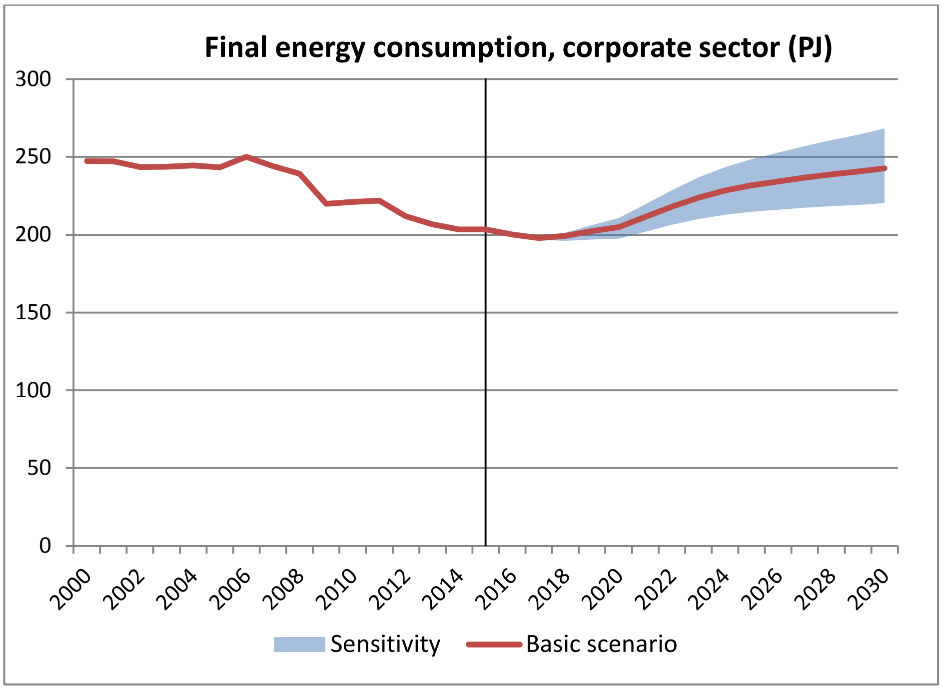

Figure 11: Total final energy consumption by the corporate sector is expected to remain at the 2015 level up to 2020, after which time it will increase by nearly 20% up 2030.

The projected increased efficiency in the corporate sector from 2015 to 2020 will largely be due to the energy savings that the energy companies are obligated to realise during the period. However, EU standards for products and tightened requirements for the energy efficiency of buildings will also play a part.

Final energy consumption will increase from around 200 PJ in 2020 to around 240 PJ in 2030, corresponding to an annual increase of 1.7%. This increase will be due to economic growth, the establishment of data centres with large electricity demand, as well as lower electricity prices as a result of discontinuation of the public service obligation tariffs. Furthermore, the assumption of no new political agreement regarding the energy saving efforts of energy companies after 2020 (frozen-policy approach) means that there will be no more energy efficiency improvements in this context. As mentioned in the footnote in section 1.3, a possible EU commitment for the period after 2020 has not been included.

The energy efficiency of the corporate sector can be estimated as the production value created per energy unit spent. Some types of industry - so-called energy-intensive industries - have a significantly greater demand for energy than others. There are generally large differences between manufacturing industries and the service sector: Manufacturing industries have an efficiency of DKK 7.2 billion output per PJ (2015); whereas the private service sector has an efficiency of DKK 22.1 billion per PJ.

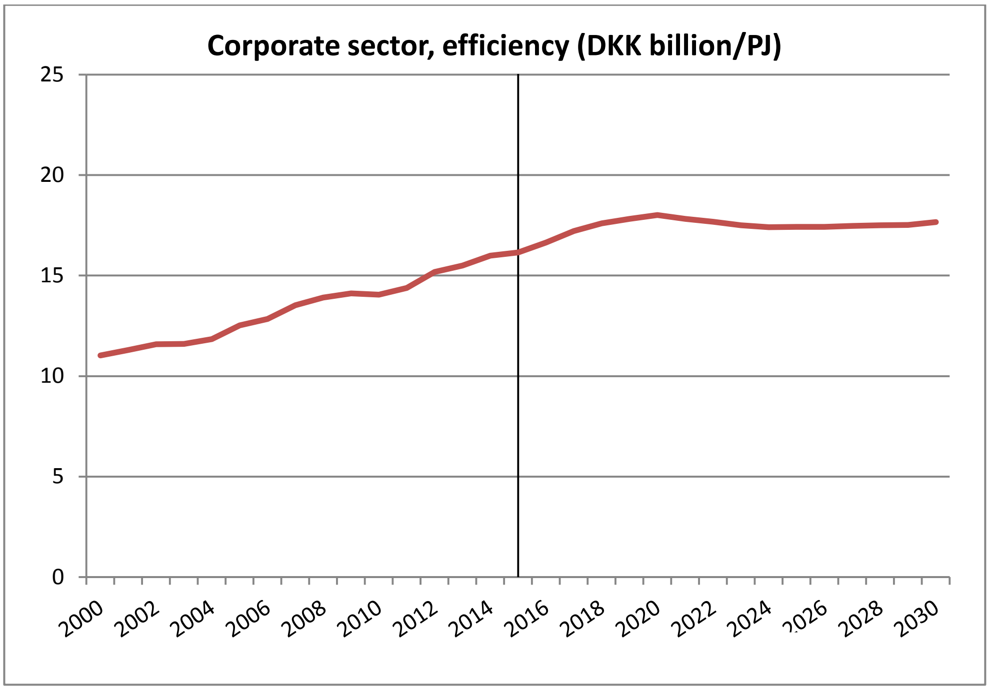

Figure 12: Improvements in energy efficiency will continue to increase up to 2020. After 2020, energy efficiency improvements will come to a standstill.

Energy consumption by the corporate sector would increase even more throughout the projection period if not for the continued effect of energy saving efforts by energy companies up to 2020, the EU minimum requirements for the energy efficiency of products (ecodesign requirements) and the tightened energy efficiency requirements on buildings (the Danish building regulations). The effect of ecodesign requirements and the building regulations will increase over the period from 2020 to 2030, while the effect of energy saving efforts by energy companies (up to 2020) will wane.

Parts of the corporate sector, primarily the manufacturing industries, are covered by the EU Emissions Trading System (ETS). With the low CO_2 price level currently anticipated for the projection period, the ETS will have a relatively minor role to play for corporate sector energy consumption.

4.3.1 Electricity consumption will rise significantly, and consumption will increase for all energy types

Electricity consumption by the corporate sector will grow by 35% in the period 2015 to 2030. This increase will be due, in particular, to the commissioning of data centres, but also to the phase-out of public service obligation tariffs. Disregarding electricity consumption by data centres, the increase in electricity consumption will be 10%. This increase would have been twice as high without the EU energy efficiency requirements on products. Product standards are the energy saving measure that will have the largest effect on electricity consumption, not least after 2020 when the energy saving obligation of energy companies is no longer included in the projections.

Furthermore, there will be an increase in consumption of all energy types by the corporate sector during the projection period. Consumption of fossil fuels will increase by around 5%, reflecting a fall of up to 10% between 2015 and 2020 and an increase of around 15% between 2020 and 2030. The increase in fossil fuel consumption after 2020 is primarily attributable to the discontinuation of the energy saving obligation of energy companies.

With the increase in energy consumption, there will be less change in fuel mix over the projection period. Electricity consumption accounts for 36% of final energy consumption by the corporate sector in 2015; a share that will increase to 40% in 2030. The share of renewable energy in the corporate sector will remain fairly constant throughout the projection period. The fossil fuel share will fall from a 40% share of final energy consumption by the corporate sector in 2015 to an around 35% share in 2030. The shift in the fuel mix will be due, in particular, to a relatively sharper increase in electricity consumption as a result of the establishment of data centres.

4.4 What we did

We projected the energy consumption of the corporate sector using the EMMA consumption model. EMMA is a macro-economic tool which describes corporate and household energy demand on the basis of production, energy prices and developments in energy technology. EMMA is linked to the ADAM macro-economic model, which provides assumptions about economic growth. The Danish Energy Agency applies growth assumptions from the Danish Ministry of Finance in the projections.

More information is available in the background report.

5 Energy consumption by the transport sector

5.1 Main points

- Up to 2030, energy consumption for transport is projected to remain more or less unchanged.
- Seen across the whole projection period, the number of road transport kilometres will increase; however, more energy efficient cars will ensure more or less constant energy consumption.
- Electrification of road transport will only play a limited role for total energy consumption by the transport sector up to 2030; however, it will win a substantial market share of the sale of new cars during the final years of the projection period.
- Fossil fuels will be dominant in transport and will account for 92% of energy consumption in 2030, as opposed to 95% today.
- Energy consumption by air transport will increase by around 12% during the period as a consequence of increased demand.

5.2 Introduction

Energy consumption by the transport sector today amounts to about one-third of total Danish final energy consumption, and is almost entirely composed of fossil fuels (95%). The sector includes road transport, rail transport, aviation, domestic shipping as well as energy consumption by the military for transport purposes. Road transport today accounts for 75% of energy consumption, followed by aviation, which accounts for 19%, of which 97% is international air transport. With regard to road transport, cars account for more than 63% of energy consumption, vans and lorries account for 18%, and 14%, respectively, while busses and motorcycles account for the remaining 5%.

Energy consumption increased steadily until the economic crisis in 2008, which coincided with a greater focus on energy efficient cars. Together, this resulted in a drop in overall energy consumption.

Within the past couple of years, however, energy consumption by road transport has again seen an increase. This is due mostly to an increase in the sale and use of small petrol-driven cars and medium diesel-driven cars, which has resulted in an increase in the overall number of cars and passenger-kilometres.

5.3 Developments up to 2020 and 2030

Total energy consumption by the transport sector will remain fairly constant throughout the projection period. There will be an increase in energy consumption by around 1% up to 2020 compared with today. Post-2020, energy consumption will increase by an additional 1% from 2020 to 2030.

The development in energy consumption by the transport sector over the projected period will be driven primarily by transport performance[12], which is expected to increase continuously; however, which will be compensated for by a gradual improvement in the energy efficiency of vehicles. The increase in transport performance will therefore be more or less balanced out by increasing energy efficiency, so that total energy consumption remains constant. The slight increase projected can be attributed to increased energy consumption in air transport, transport by lorries and transport by vans, in the order stated. Energy consumption by international air transport is expected to increase by 12% up to 2030. A fall of around 5% in energy consumption by cars throughout the projection period due to more efficient cars will halve the overall increase from these transport vehicles.

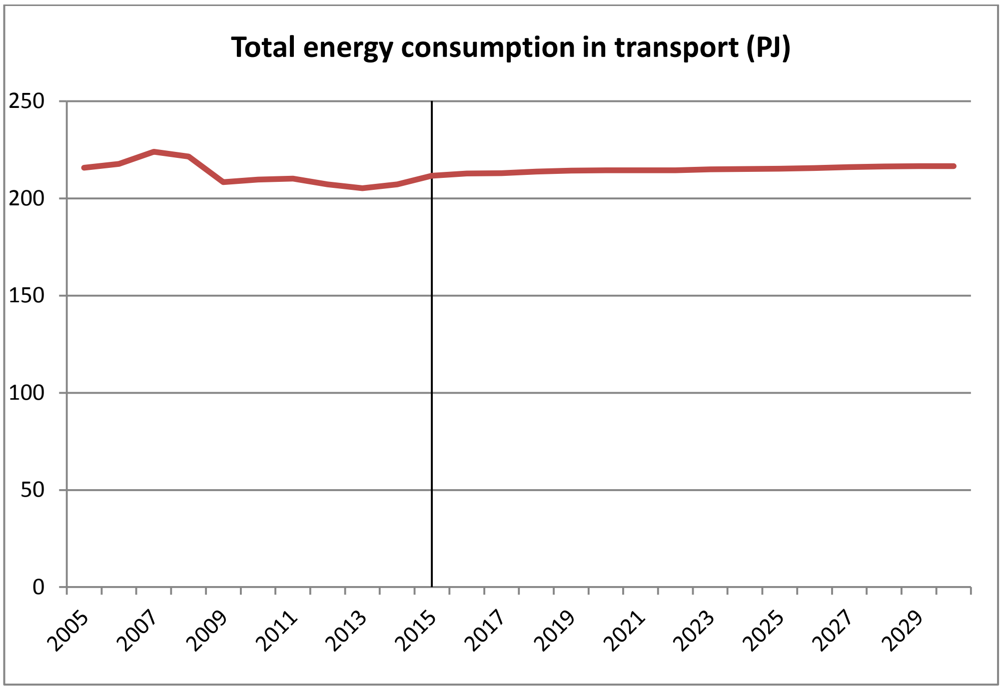

Figure 13: Total energy consumption by the transport sector will remain fairly constant in the projection period.

Due to the basic frozen-policy premise of the projections, the share of biofuels is assumed to remain at the current level throughout the period projected. Biofuel blending in 2020, coupled with other renewables in transport, will therefore not be enough to ensure that Denmark meets its commitment to the EU with regard to the use of renewable energy in transport (see the Renewable Energy Directive).

5.3.1 Electrification of road transport will play a very limited role up to 2030

Electrification of road transport will play a very limited role up throughout the projection period. Thus, electricity for road transport will make up only 0.8% of energy consumption by road transport in 2030, despite relatively rapid growth from 2025. The rapid phase-in after 2025 can be explained by the expected

[12] Transport performance is the number of kilometers driven for each type of transport vehicle (car, bus, van, train, etc.).

cheaper prices of electric cars as a result of technological advances, and this will lead to the electric car becoming an attractive option for a wider group of buyers by around 2025, making it competitive with conventional cars.

Assuming no new policy is introduced, electrification of road transport will leave a relatively limited mark on energy consumption within a 2030 horizon. This is because sales are not expected to gather momentum until 2025 and because it will take a long time to replace the total number of cars on the road due to the relatively long lifespan of cars. Despite substantial shares of electric cars in new sales in 2030, it will take several years before this trend is visible in the total number of cars on the road. This can be seen in the figure below.

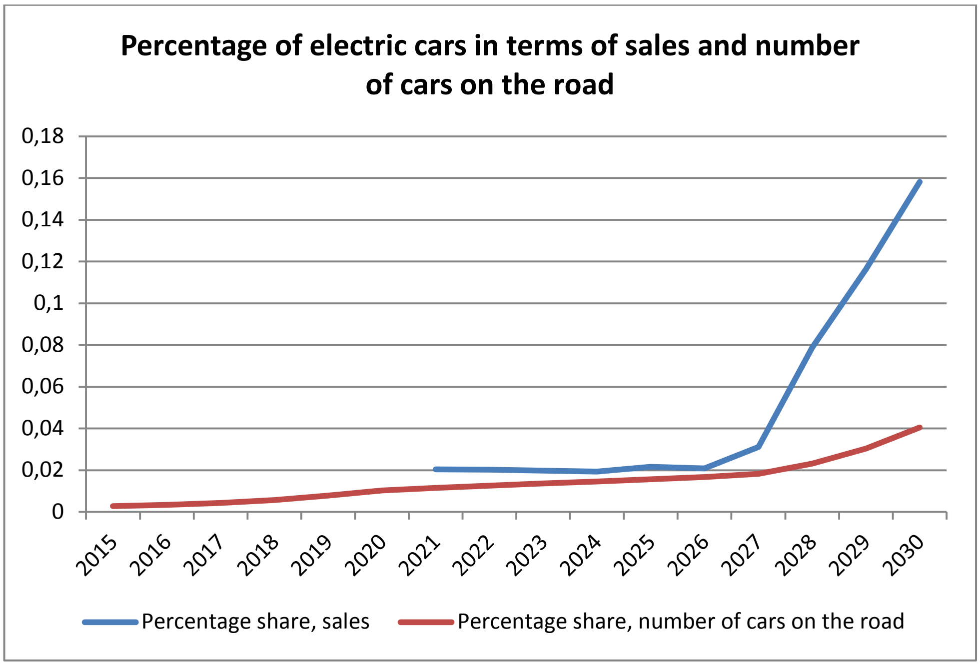

Figure 14: Percentage of electric cars in terms of sales and number on the road in the projection period. As can be seen, the transition to electric cars is sluggish due to the relatively long lifespan of cars. The model used to project sales of electric cars from 2021-2030 is still under development. Therefore, the estimates of electric car sales are very uncertain.

Electrification should therefore be considered as a development with only a gradual effect. In the long term, however, it could have a very significant effect once it breaks through. Note that assumptions regarding the fall in prices of electric cars and the subsequent growth in sales are associated with a high degree of uncertainty. See the background report on sensitivity calculations.

In addition to electricity, hydrogen and biogas can also play a role in the transition from fossils fuels to renewable energy. However, these fuels play a much more minor role than electricity in the projections and will therefore not be discussed further here.

5.3.2 Fossil fuels expected to account for over 90% of energy consumption in 2030

The challenge of ensuring increased independence from fossil fuels in the transport sector will remain mostly unchanged in terms of absolute energy consumption. The share of fossil fuels in total energy consumption by the transport sector will fall slightly during the projection period from 95% to 92%. The continued electrification of railways will be most significant in this decrease. The electrification of road transport and the assumed minor use of biofuel blends in aviation fuels up to 2030 will also contribute to the decrease.

However, it should be noted that, due to the frozen-policy approach, the projections assume that biofuel blending for road transport will not increase up to 2020 as a possible consequence of Denmark's commitments under the Renewable Energy Directive. Developments are illustrated in the figure below.

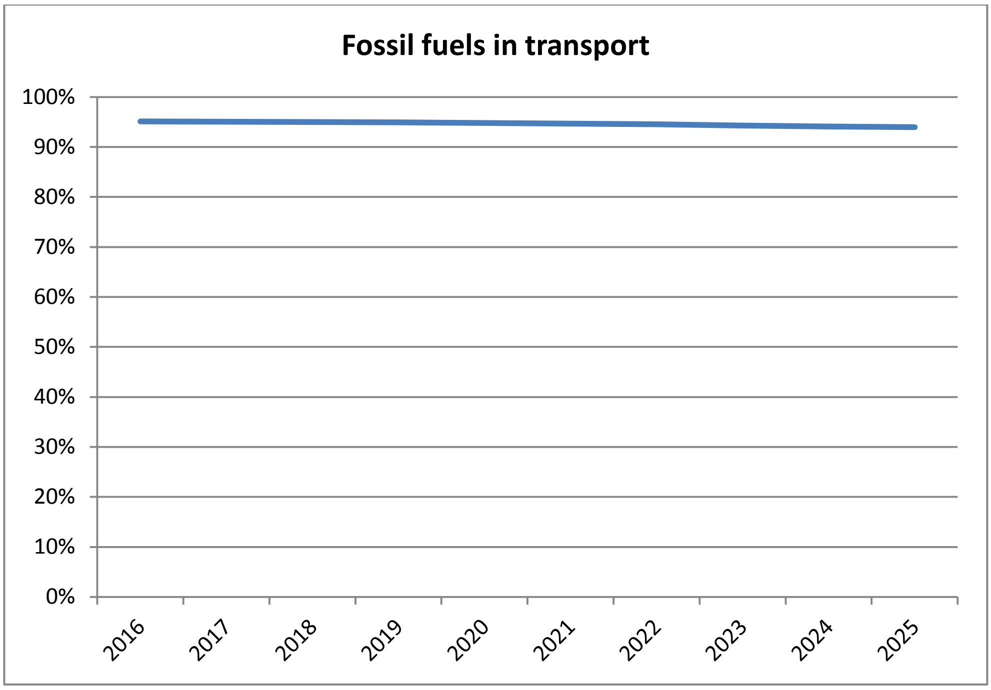

Figure 15: Share of fossil fuels in energy consumption by transport in the projection period.

5.3.3 Rising energy consumption for air transport

Energy consumption by air transport is governed by the demand for air travel and developments in energy efficiency. As mentioned above, the rise in demand is higher than growth in energy efficiency, and this will lead to increased energy consumption corresponding to a 12% rise in 2030 compared with today. A 5% rise in biofuel blending in aviation fuels up to 2030 has been assumed on the basis of the industry's own projections. Note that this blending is not on the basis of any statutory requirements, and this increases uncertainty with regard to whether blending will take place. If blending does take place, there will be a 6% annual rise in fossil energy consumption by air transport up to 2030. It is important to note that there is a high degree of uncertainty in the projections of energy consumption for air transport.

5.4 What we did

The projections of energy consumption for transport have been based on the Danish Energy Agency's transport model, with considerable input from the Danish Transport and Construction Agency in particular, on developments in transport performance for road transport (based on the *Landstrafikmodel* (national traffic model)), and on energy consumption by railways.

The transport model projects road transport based on projections for growth in transport performance, developments in energy efficiency for vehicles broken down into 33 vehicle categories and survival rates, and journeys by vehicles as a function of the age of the vehicles. This provides relatively detailed projections for energy consumption by road transport.

Energy consumption by air transport has been based on projections using the PRIMES model's projections of expected growth rates for passenger kilometres and developments in the energy efficiency of aircraft. Simpler projections have been used for the other sectors based on historical developments.

More information about the projections for the transport area is available in the background report.

6 Production of electricity and district heating

6.1 Main points

- The green transition of electricity and district heating production will continue up to 2020. Renewable energy is expected to cover about 72% of electricity consumption and 71% of district heating consumption in 2020, compared with about 56% and 51%, respectively, today.
- From 2020 to 2030 the share of renewable energy will fall to 62% for electricity and 67% for district heating. This is primarily due to rising electricity consumption coupled with the assumption of the discontinuation of the subsidy scheme for onshore wind, etc.
- The share of wind power in electricity consumption will increase from 42% in 2015 to 48% in 2020 and then drop to 39% in 2030. The fall in the share up to 2030 is due to the fact that many wind turbines that reach the end of their operational life will not be replaced by new ones. However, it is also due to increasing electricity consumption.
- Photovoltaic solar modules will cover up to 4% of electricity consumption in 2020 and up to 7% in 2030 compared with 2% today.
- There will be no significant increase in deployment of large electrically powered heat pumps.
- Consumption of solid biomass will increase from just less than 57 PJ in 2015 to 98 PJ in 2020. Consumption will fall to 89 PJ up to 2030. Consumption is sensitive to changes in the relationship between coal prices, CO_2 prices, and the price of biomass.
- Consumption of coal will fall from 103 PJ in 2015 to 61 PJ in 2018, but will then increase dramatically to 127 PJ in 2030. The increased use of coal will be especially driven by a pronounced rise in electricity consumption combined with the assumption of low deployment of new wind power.
- In the alternative scenario, in which coal will be phased out from Dong Energy's plants in 2023, coal consumption will not increase to the same degree as in the basic scenario, while biomass consumption will increase more than in the basic scenario.

6.2 Introduction

Energy consumption to produce electricity and district heating accounts for almost 41% of total Danish gross energy consumption, and therefore it is an important element in the overall green transition towards fossil-fuel independence and reducing emissions of greenhouse gases.

Electricity will increasingly be generated by wind power and biomass, instead of by coal and natural gas.

District heating production is also undergoing a transition, primarily from coal and natural gas to biomass. A fall in the share of district heating co-produced with electricity (Combined Heat & Power, CHP) has resulted in a development with heat production only, based on renewables such as biomass and solar heating, while production from large electricity-powered heat pumps has so far been absent from Denmark.

In 2015, 56% of electricity consumption and about 51% of district heating consumption was covered by renewable energy, compared to 16% and 19%, respectively, in 2000. The large expansion of wind power has meant that wind power has risen from covering 12% of electricity consumption in 2000 to 42% in 2015. Electricity production is increasingly taking place through interplay with countries neighbouring Denmark, because electricity is exchanged through interconnectors. If it is very windy in Denmark, it is possible to sell electricity abroad. On the other hand, if there has been a lot of rain, Norway will have a surplus of hydropower-based electricity which it can sell to Denmark. Exchange is important as overall it ensures efficient exploitation of electric power plants, high security of electricity supply and lower prices.

6.3 Developments up to 2020 and 2030

Continued development of the sector has already been planned for the years up to 2020, and many power plants have decided to transition, or are already in process of transitioning, from coal or natural gas to biomass. At the same time, further deployment of wind power is expected to continue, among other things due to the offshore and nearshore wind turbine projects in the 2012 Energy Agreement. Less extensive deployment is expected after 2020 as Kriegers Flak is expected to be in full operation in 2021.

Renewable energy is expected to cover about 72% of electricity consumption and 71% of district heating consumption in 2020, compared with about 56% and 51%, respectively, today. Up to 2030, the shares of renewable energy in the basic scenario will fall to 62% for electricity and 67% for district heating. Note that there is great uncertainty attached to renewable energy shares, particularly in the long term. For example, the sensitivity calculations show that a combination of increased electricity consumption, lower wind deployment and the use of biomass can reduce renewable energy in electricity consumption to 55% in 2030, whereas the opposite could increase it to 71%.

Table 1: Share of consumption of electricity and district heating covered by renewable energy. Biodegradable waste is included in renewable energy. Numbers in brackets cover the alternative scenario with implementation of DONG Energy's announced phase-out of coal.

Share (%)	2000	2005	2010	2015	2020	2025	2030
Renewable energy in electricity consumption	16	27	35	56	72 (78)	68 (70)	62 (70)
- of this, wind power	12	18	22	42	48	49	39
- of this, other renewables	4	9	13	14	24 (30)	19 (21)	23 (31)
Renewable energy in district heating consumption	19	27	34	51	71	68 (75)	67 (74)

The share of electricity generated by wind power will rise in the short term, at the expense of decreased CHP production and in particular decreased separate electricity production (condensing power production) at large-scale power plants. After 2020, wind power generation will decrease because obsolete turbines will not be replaced by new turbines. In the basic scenario, power plants with separate electricity generation will take over some electricity production in order to meet the rising demand for electricity from a greater number of data centres, etc.

Photovoltaic solar modules covered about 2% of electricity consumption in 2015 and, according to this Outlook, will cover up to 4% in 2020 and up to 7% in 2030. The further deployment of solar photovoltaic installations will primarily take place in connection with buildings that can obtain a financial benefit by producing their own electricity which will not be subject to taxes. However, with the current framework, i.e. without subsidies, further deployment of commercial installations supplying all the electricity produced to the grid, is not likely.

District heating from CHP plants will be about 71% in 2020 and 70% in 2030, compared with 62% today. A small part of district heating from boilers will be replaced by CHP, solar heating and electricity in the coming years.

6.3.1 Electricity from wind power to reach 49% in 2025, but decrease in the long term

Electricity from wind power accounted for 42% of electricity consumption in 2015. In 2020, the share of wind power is expected to be 48%. This development will be due primarily to the commissioning of offshore wind farms (Horns Rev 3, Kriegers Flak) and nearshore wind turbines (Vesterhav Syd and Vesterhav Nord) as agreed in the 2012 Energy Agreement. This deployment is reasonably certain, albeit there may be delays in commissioning dates. The extent of the deployment of onshore and offshore wind power under the Open-Door scheme is less certain. This is primarily due to the expiry of the current scheme in 2018, and due to the frozen-policy approach applied in the projections, it is assumed that all new projects will subsequently depend solely on market terms. At the moment, low electricity prices on the spot market are causing some uncertainty about the future revenue base for investors. Likewise, planning aspects, such as municipal administration of the distance requirements and certain public concerns, contribute to the uncertainty regarding future deployment of onshore wind turbines.

According to this Outlook, new onshore wind capacity will not be installed to the same extent as is expected to be dismantled as turbines reach then end of their technical lifespan. The total capacity of onshore wind will therefore stagnate and fall up to 2030. It is estimated that some new capacity will be established at the end of the period; however, not enough to maintain the total capacity. The speed and timing of this decrease in capacity depends on the actual technical and economic lifespan of the turbines, which is uncertain.

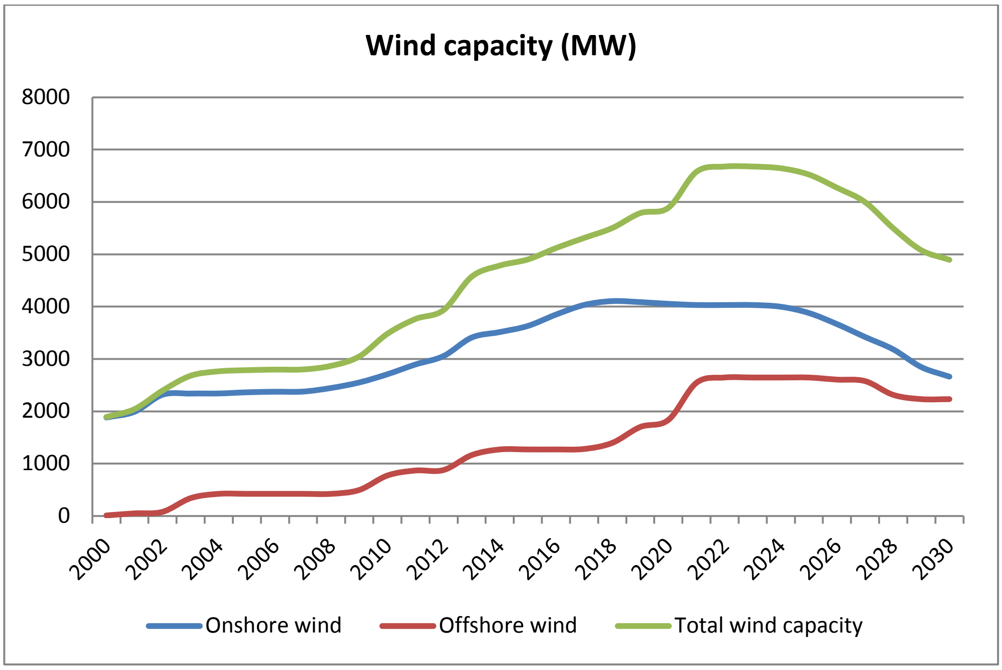

Figure 16: Onshore and offshore wind capacity will decrease up to 2030.

6.3.2 Interconnectors play an important role

A large share of wind power increases the value of cooperation with Denmark's neighbouring countries in the form of strong interconnectors. This means that intermittent production from wind power can be sold cost-efficiently, while also minimising the need for national capacity reserves and maintaining a high security of electricity supply.

Denmark is already electrically connected to Norway, Sweden and Germany, although the capacity in the connection between Jutland and Germany cannot be fully exploited due to internal bottlenecks in Germany. The connection to Norway has recently been improved with the establishment of Skagerrak 4, and up to 2020, part of Denmark will be electrically connected to the Netherlands. Similarly, a new connection to Germany will be constructed from the future offshore wind farm at Kriegers Flak. The Viking Link connection from Denmark to the United Kingdom, as proposed by Energinet.dk and which is being considered by the government, has not been factored in.

The connection between Jutland and Germany is expected to provide higher capacity up to 2020, and an additional upgrade after 2020 is also expected. This could be significant for the economic aspects of incorporating increasing amounts electricity from wind power in the short term. Furthermore, improved interconnectors will help increase the operational hours for large-scale power plants in the period after 2020.

Box 1: Cross-border electricity in Denmark's Energy and Climate Outlook 2017

Denmark's cross-border electricity exchange with neighbouring countries is considerable. It varies depending on fluctuations in weather (e.g. precipitation and wind) but other factors are also very important, such as the power plants and interconnectors available in Denmark and abroad.

In this Outlook, cross-border electricity exchange is modelled as part of the operation of the Danish electricity system in the so-called RAMSES model. The critical factor is the state of competition between Danish and foreign electricity production. A normal year is used in the calculations, which is why fluctuations in climate are not significant. Calculations on cross-border electricity for a single year are very uncertain, in part because calculations for neighbouring countries are carried out on an aggregate level. Due to this uncertainty and because historical electricity production is closely connected to consumption, the basic scenario assumes that cross-border electricity exchange is on average zero, meaning that electricity production corresponds to electricity consumption. A production of electricity that corresponds to electricity consumption is the best estimate of Danish fuel consumption in connection with electricity production.

This means, that in terms of calculation methodology, the modelled fuel consumption for electricity production is adjusted according to calculated cross-border electricity exchanges (see the background report for further information). This adjustment is made using the average thermal variable electricity production for the year in question (the average electricity production from coal, natural gas, oil, wood pellets and wood chips). The Danish Energy Agency uses the same approach for calculating energy statistics.

The above does not apply to the alternative scenario, however. In the context of this Outlook, the implementation of DONG Energy's announced phase-out of coal would mean significantly higher electricity imports, and this is an important point in itself. Due to this, and in order to be able to compare directly with the basic scenario, the alternative scenario includes cross-border electricity calculated using RAMSES; however, adjusted using the same figures as are used to adjust electricity generation in the basic scenario. This also applies to the sensitivity calculations.

In the future, the Danish Energy Agency will continue to work on improving the basis for calculation to assess cross-border electricity exchange in the projections. This includes improving data, methodology and the interpretation of the model results themselves, particularly with regard to this element in the work.

Box 2: Implementation of DONG Energy's announcement in the alternative scenario

On 2 February 2017, DONG Energy announced that they will stop using coal from 2023. This announcement is not included in the basic scenario, see section 1.6. However, because implementation of DONG Energy's announcement will have serious consequences for development, it is included in the alternative scenario in this Outlook. The outlined scenario is merely one among several possible scenarios, as there are currently no specific applications that would enable inclusion of the objective to phase out coal.

Implementation of DONG Energy's intention has two overall consequences for their power plants:

1. CPH plants which have been retrofitted from coal to biomass will continue operating solely on biomass.
2. Older coal-fired power plants will remain out of operation and can therefore not be used as extra capacity for the production of electricity to meet the expected rise in Danish electricity consumption.

The first point will lead to a phase-out of coal in the larger cities (Copenhagen, Aarhus). Furthermore, it will lead to slightly lower electricity production from the retrofitted plants than would otherwise be the case.

The second point will have significant consequences for electricity production and electricity imports. The older Danish power plant units are expected to be competitive with foreign plants. If they are not put into service, the cheapest alternative will be increased imports of electricity.

However, this development is uncertain and it depends on trends in fuel prices and the production mix in neighbouring countries.

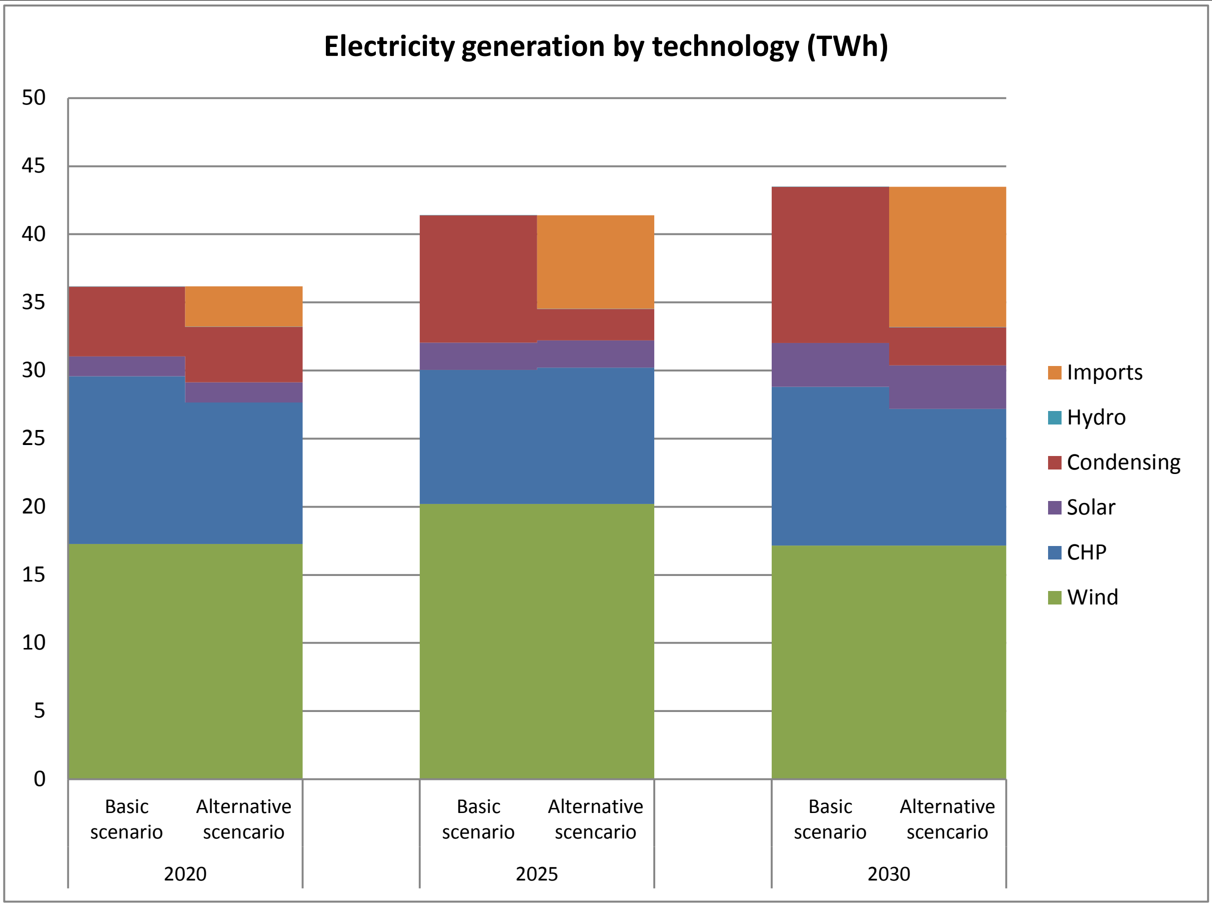

Figure 17: Total electricity production by different technologies in the basic scenario and the alternative scenario in which DONG Energy phases out coal. Note that DONG Energy phasing out coal would eliminate a certain amount of condensing power production. This electricity would then have to be imported instead.

6.3.3 Transition increases biomass consumption in the short term

The conversion to biomass will continue up to 2020, both through converting existing coal and natural-gas fired CHP plants and through the deployment of new CHP plants and heating plants. Several conversions and new builds have already been completed or are expected to be completed within the next few years. However, the amount of electricity and heat produced by the converted and new plants, and thereby the amount of biomass they burn, depends on other developments in the electricity and district heating markets.

Consumption of solid biomass will increase from 57 PJ in 2015 to 98 PJ in 2020. In the basic scenario, consumption will then drop to 89 PJ in 2030. This is because at times biomass cannot compete and gets squeezed out of the market by fossil fuels, for example. As illustrated in figure 18, the precise development is uncertain and primarily depends on trends in the price ratio between coal and biomass.

There is a significant difference between the basic scenario and alternative scenario in which DONG Energy's power plants no longer use coal after 2023. In the alternative scenario, biomass consumption will further increase by 106 PJ between 2020 and 2030 - corresponding to about 19% more biomass for electricity and district heating than in the basic scenario.

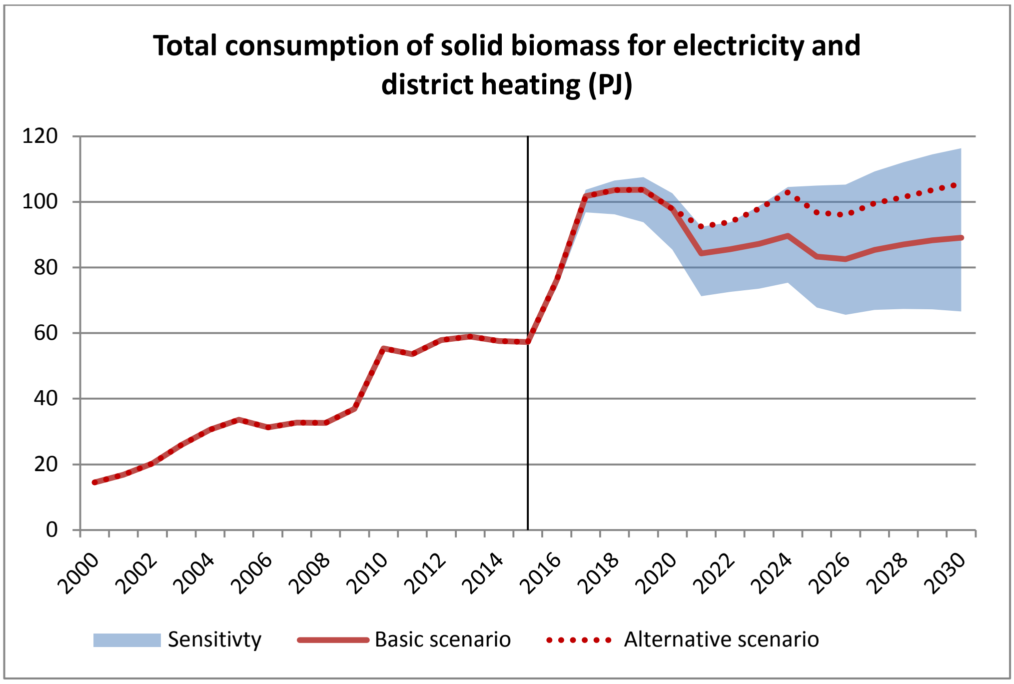

Figure 18: Consumption of solid biomass for electricity and district heating has increased up to 2017, after which it will begin to decrease from 2019.

6.3.4 Increasing electricity consumption covered by coal or imports.

In the short term, consumption of coal will drop from 103 PJ in 2015 to 61 PJ in 2018. This trend will mainly be a result of the conversion from coal-fired plants to biomass-fired plants. There is uncertainty regarding large-scale power plants after 2020. The basic scenario assumes that it will be possible to use existing coal-fired plants throughout the entire period. This is not considered an option in the alternative scenario.

In the basic scenario, increased electricity consumption for new data centres, in particular, coupled with the discontinuation of subsidies for onshore wind in 2018, will result in coal-fired plants becoming increasingly responsible for Denmark's electricity production after 2018. This development will continue up to 2030 due to the assumption of no new policy in the projections. In 2030, coal consumption will rise to 127 PJ, almost 23% higher than the current consumption. However, this development is extremely uncertain.

Increasing electricity consumption will create the financial basis for coal-fired plants, that otherwise were not intended to be in operation, to come into operation in the projections. This is an important factor behind increasing coal consumption. However, this development would be markedly different if power plants owned by Dong Energy, which are able to increase production of coal-based electricity, choose not to. In this scenario, coal consumption would increase by far less than in the basic scenario, and increasing electricity consumption would be covered by imports to a much higher degree.

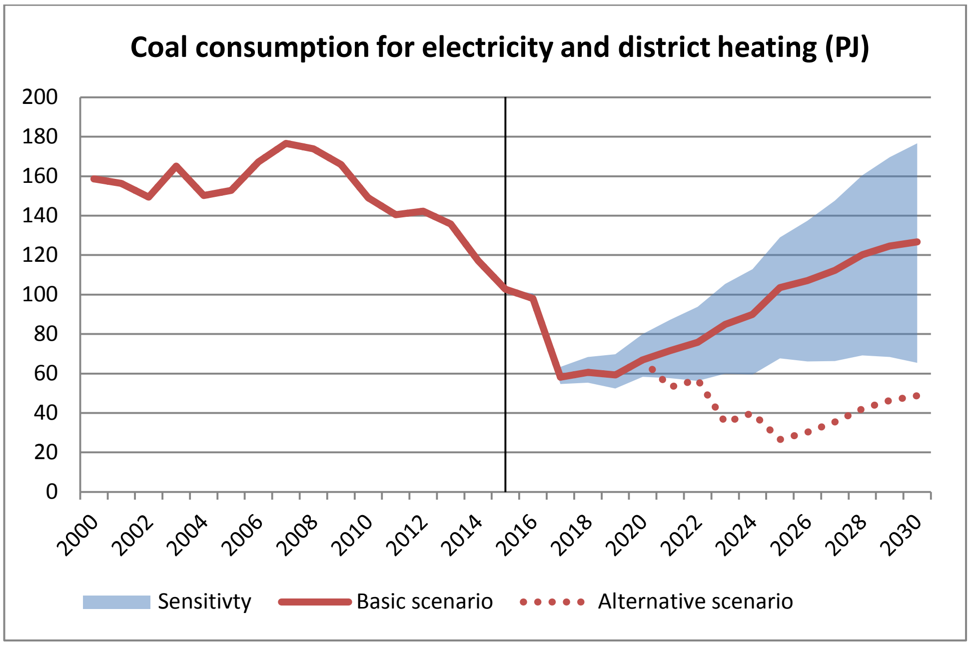

Figure 19: Coal consumption for electricity and district heating greatly depends on whether it is possible to continue using DONG's existing coal-fired plants. Note that decreasing coal consumption is replaced by electricity imports in the alternative scenario.

6.4 What we did

Electricity and district heating production have been calculated on the basis of the Danish Energy Agency's RAMSES model. RAMSES is a simulation model, which calculates the electricity and district heating production plant by plant in time intervals down to one hour. Fuel consumption, environmental impacts and financial aspects are also calculated for the individual plants, as well as electricity prices for the countries included and cross-border electricity trade between them. The model does not include calculations on new investments and capacity is therefore exogenously included in the model.

Denmark, Norway, Sweden, Finland, Germany, the Netherlands, the United Kingdom and France are part of RAMSES. Countries outside the model, to which there are electrical connections, are modelled using cross-border electricity given exogenously.

More information is available in the background report.

An important result of the calculations is the expected developments in electricity prices on the spot market. These developments are significant for the financial framework of Danish electricity producers and the expected costs in connection with renewable technology subsidies. The projections for electricity prices are described in a separate document which was published in the same week as the Outlook.

On the basis of the calculated developments, expectations for subsidy costs for renewables etc., will also be drawn up in the PSO Outlook. This will be published as a separate document in extension of this Outlook.

7 Emissions of greenhouse gases

7.1 Main points

- Danish emissions are expected to fall up to 2020. The assumed absence of new climate and energy policy agreements in this Outlook means that emissions are likely to increase again up to 2030.
- In the basic scenario, greenhouse gas emissions are expected to have fallen by 37% in 2020 (not including LULUCF uptakes) compared with 1990. In 2030, the reduction will have fallen to 28% compared with 1990.
- The largest development will continue to be within energy related emissions - and will particularly depend on developments in coal consumption.
- Denmark will still achieve its overall reduction target for non-ETS emissions for the period 2013 to 2020; however, with an expected shortfall in 2020.
- Meeting the expected EU target for non-ETS emissions in 2030 will require total reductions of around 24 million tonnes CO2-eq. in the period 2021 to 2030.
- In the alternative scenario, in which coal will be phased out from DONG Energy's power plants by 2023, greenhouse gas emissions will decrease up to 2025, after which they will increase slightly up to 2030, at which point a reduction of 39% compared with 1990 will have been achieved.

7.2 Introduction

Total Danish greenhouse gas emissions have exhibited a downward trend since the mid-1990s. In 2015, total emissions had fallen by about 27% compared with 1990. Emissions from the energy sector - which include emissions from electricity and district heating production, energy consumption by households and industries, as well as oil and gas extraction and refineries - have traditionally played a significant role in the calculations, but have also exhibited the most significant decrease as a result of Danish conversion of the energy system. Since 1990, the transport sector's share of total emissions has grown steadily due to rising transport needs in the wake of economic development.

In connection with the financial crisis in 2008, the rising curve of emissions by the transport sector was broken. In addition to the financial situation, another contributing factor was increased focus on energy efficiency in cars. Emissions from agriculture have been falling since 1990, primarily due to increased efficiency of agricultural production and stricter environmental regulation. The remaining emissions, about 5-7% of total emissions, come from industrial gases, waste and wastewater. These emissions increased from 1990 up to 2000, after which they significantly decreased up to today.

7.3 Developments up to 2020 and 2030

Basic scenario projections show a fall in total emissions up to 2020 after which emissions will begin to rise. The decrease up to 2020 will mainly occur within energy related emissions, and it is closely linked to implementation of the energy agreements from 2008 and 2012. The fall in emissions is due the deployment of and conversion to renewables, as well as decreased energy consumption as a consequence of energy efficiency improvements.

After 2020, many of the existing energy policy framework elements will cease to apply, including support schemes for renewable energy capacity installation and energy saving efforts. With the assumption of no new policy (frozen-policy approach) applied in this Outlook report, these schemes will not be replaced by new ones, and this will lead to an increase in emissions. This will primarily be driven by rising energy demand, which will be met by increased consumption of energy based on fossil fuels, particularly coal. The increased consumption of coal will lead to increasing emissions.

Under the alternative scenario, which involves realisation of DONG Energy's announced phase-out of coal by 2023, the rise in coal consumption will be considerably more modest and will not begin until the middle of the 2020s. Emissions are expected to drop in a period up to 2025, after which they will begin to rise again, but at a much slower rate than in the basic scenario. Conversion from coal to biomass is part of the reason for the difference between the alternative scenario and the basic scenario; another part of the reason is increased imports of electricity to cover rising electricity consumption. Greenhouse gas emissions released by imported electricity production are not included in the Danish emission calculations and are therefore not included in the figure below.

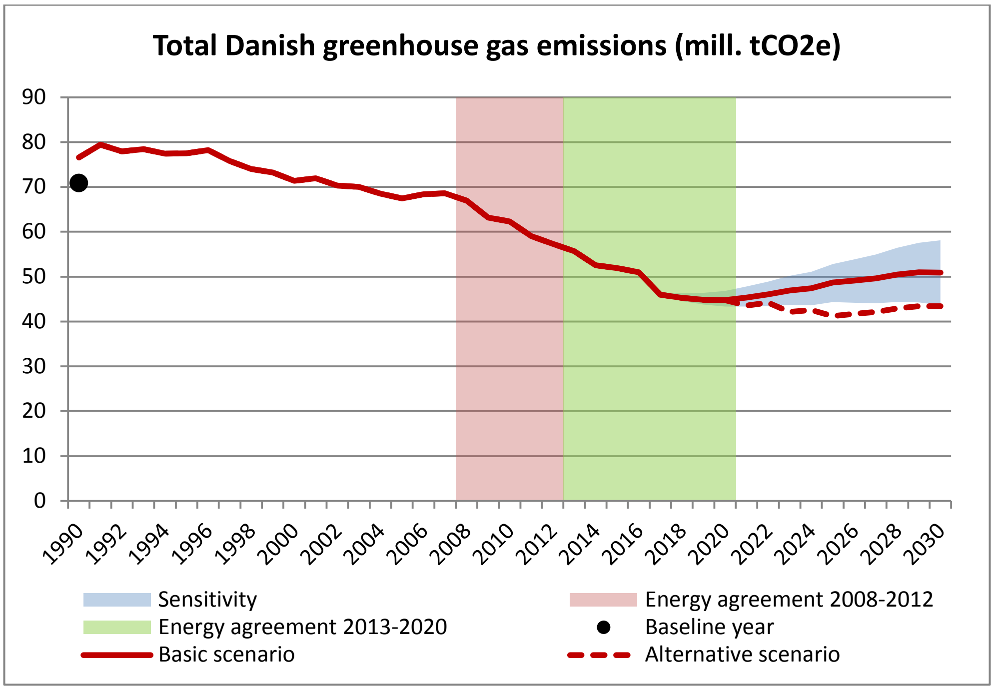

Figure 20: The decrease in Danish emissions is closely linked to the energy policy framework up to 2020. In the alternative scenario, DONG phases out the use of coal at its power plants and the rise in emissions after 2020 will therefore be more modest than in the basic scenario. Historical emissions have been adjusted for electricity trade with other countries in order to provide a clearer picture of the development. The Danish UN baseline year is based on observed emissions in 1990, which were particularly low due to considerably high levels of electricity imports.

7.3.1 Reduction of greenhouse gases in 2020 more than in 2030.

In an international context 1990 is applied as the baseline year for evaluating efforts to reduce greenhouse gas emissions. It became the baseline year because data from 1990 was the most recent when the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992. The year 1990 thereby became a kind of "year zero" for global climate efforts. The advantage of this joint frame of reference is that it becomes possible to compare the efforts and developments of individual countries.

Denmark has already achieved a considerable reduction since 1990 and this development is expected to continue in the coming years. Starting around 2020, emissions in the basic scenario are expected to increase, primarily due to the discontinuation of many of the elements of the energy policy framework which are currently keeping emissions low. Danish emissions will increase again after 2020 due to rising coal consumption. If new policy decisions are made for the energy area, for example a new energy agreement, conditions and, thus, developments will change accordingly. The alternative scenario is an illustration of this situation: it assumes that DONG phases out coal by 2023. This situation involves coal being replaced by biomass, which means that coal consumption will first drop and then increase again; however, at a slower rate. This will result in a drop in greenhouse gas emissions up to 2025, after which emissions will rise slightly again up to 2030.

Table 2: Realised and expected reductions in greenhouse gas emissions compared to 1990

1990 (baseline year)	2015		2020			2030		
Mill. tCO2e	Mill. tCO2e	Reduction relative to 1990, %	Mill. tCO2e	Reduction relative to 1990, %	Incl. sensitivity	Mill. tCO2e	Reduction relative to 1990, %	Incl. sensitivity
70.8*	51.9	27%	44.8	37%	34% to 39%	50.9	28%	18% to 38%
Assuming implementation of Dong Energy's coal phase-out						43.4	39%	-

* Note that emissions in the baseline year 1990 have been adjusted compared with earlier projections in part due to altered emission factors for historical activities.

As with all other signatories of the UNFCCC, Denmark's baseline year is based on observed emissions on Danish territory in 1990. Emissions this year were unusually low due to plentiful precipitation in Sweden and Norway providing a large supply and low prices for hydropower electricity. Denmark therefore opted to import electricity rather than produce it. Danish emissions would have been a little over 6 million tonnes CO2-eq. higher if adjusted for this electricity trade. In relation to an adjusted and higher baseline year, realised and expected reductions would be about 5 percentage points higher each year.

Box 3: Biomass and carbon neutrality

Burning biomass emits CO_2. Biomass based energy is nevertheless considered renewable in terms of carbon emissions and resource utilisation because biomass resources are renewable and can be regenerated by plant growth. However, this assumes that biomass is produced in a sustainable manner without permanent loss of carbon pools in plants and soil. A fundamental component in this context is ensuring that biomass removed for energy purposes is replaced by new biomass, i.e. replanting and sustainable management of forests designated for production.

Biomass based energy is registered as carbon neutral in national greenhouse gas inventories. This is in line with international guidelines prepared by the UN climate panel - IPCC (Intergovernmental Panel on Climate Change). This is because the carbon footprint of felling the tree is reflected elsewhere in the inventory system i.e. under land use (LULUCF). The felling of forests or other biomass will therefore be registered under land use regardless of what the biomass is used for, e.g. producing materials or generating energy. Thus, when biomass is incinerated and recovered for energy, the carbon effect has already been accounted for in the overall inventory, and to avoid double-counting, the emission factor is therefore always set at zero in the energy sector.

This subject is described in further detail in the Danish Energy Agency bioenergy analysis from 2014.

7.3.2 Shifts in the distribution between sectors

The developments in greenhouse gas emissions by sector has shifted over time because changes are primarily occurring in the energy sector. In 1990, energy related emissions in Denmark accounted for 60% of total emissions, while transport and agriculture both accounted for 16% respectively. Additional sources jointly accounted for only 5% of total emissions. This situation was vastly different in 2015. Energy related emissions had been almost halved and accounted for less than 50% of total emissions while transport emissions had increased by a quarter. The share of emissions from agriculture had also increased to 20% despite absolute emissions for the sector having decreased by 18% since 1990.

This development is expected to continue until the current energy agreement expires in 2020. Transport and agriculture will both account for an increasing share of total emissions, and simultaneously slightly increase absolute emissions. The share of emissions by the energy sector is expected to decrease to just over 40% and absolute emissions are expected to have been reduced by 60% compared to levels in 1990.

Box 4: Greenhouse gas emissions and sectors

Greenhouse gas emissions have been divided into four overall sectors:

- Energy: All energy related emissions excluding transport. The production of electricity and district heating, energy consumption by manufacturing industries and households, and energy consumption by agriculture.
- Transport: Includes road transport and railways, as well as domestic ferries and aircraft
- Agriculture: Emissions from biological processes in agriculture - animal digestion, slurry management and crop production.
- Other: Includes emissions from industrial gases, non-energy related process emissions, and emissions from waste and wastewater.

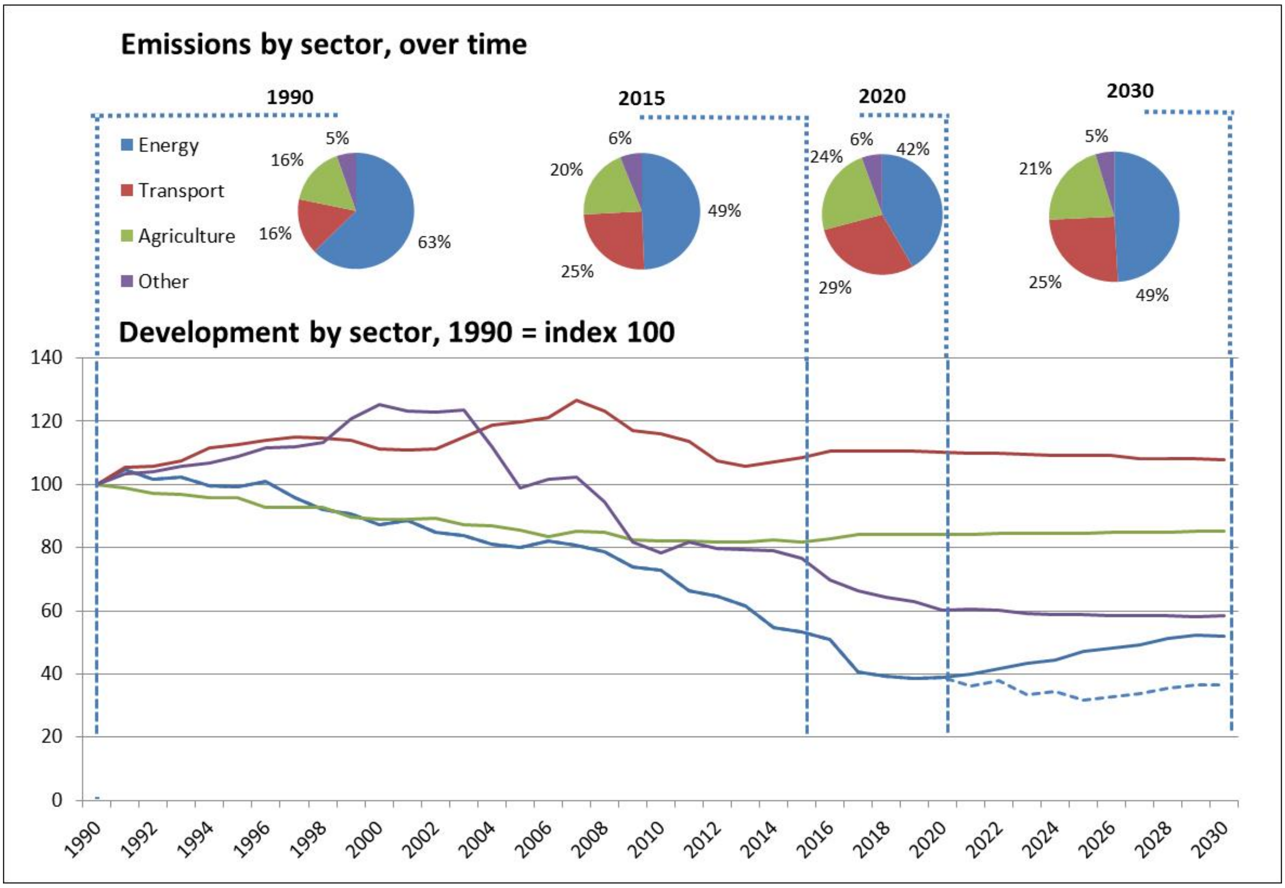

Figure 21: Development in emissions and share of total emissions, by sector. In 1990, energy accounted for the largest share of total emissions. Due to emission reduction efforts, this share will drop up to 2020. The distribution of emissions by sector is mainly determined by developments in the energy sector.

After 2020, emissions from both transport and agriculture will remain mostly unchanged up to 2030 - agriculture will increase slightly while transport will decrease slightly. In the basic scenario, energy related emissions are also expected to increase again up to 2030. This means that the energy sector's share of total emissions will increase to almost 50% again, while the share of other sectors will decrease correspondingly.

In connection with DONG Energy's end to the use of coal at its power plants by 2023 (the alternative scenario), energy related emissions are expected to decrease and then increase slightly up to 2030. In this situation, energy related emissions will account for about 40% of total emissions in 2030.

7.3.3 Reduction target for the period 2013-2020 met overall - But not in 2020

Under the 2009 EU climate and energy package, Denmark is committed to reducing emissions from non-ETS sectors by 20% by 2020 relative to the 2005 level, as well as to achieving a set of sub-targets up to 2020. These sub-targets become progressively stricter up to the end-target in 2020. Overachievement in one year can be carried forward and used for target achievement in the subsequent year.

Overachievement is expected for the period 2013-2018. In 2019 the sub-target will be more or less reached, and 2020 will see an underachievement of slightly less than 1 million tonnes C02-eq. As previous years' overachievement may be carried forward and used for target performance in years with underachievement, Denmark is expected to achieve its reduction commitments. A total, accumulated overachievement of about 9 million tonnes CO2-eq is expected for the whole commitment period. When sensitivities are taken into account, the 2020 underachievement is expected to be between 0 and 1½ million tonnes CO2-eq. A total, accumulated overachievement of between 8 and 11 million tonnes CO2-eq is expected for the whole period when including sensitivities.

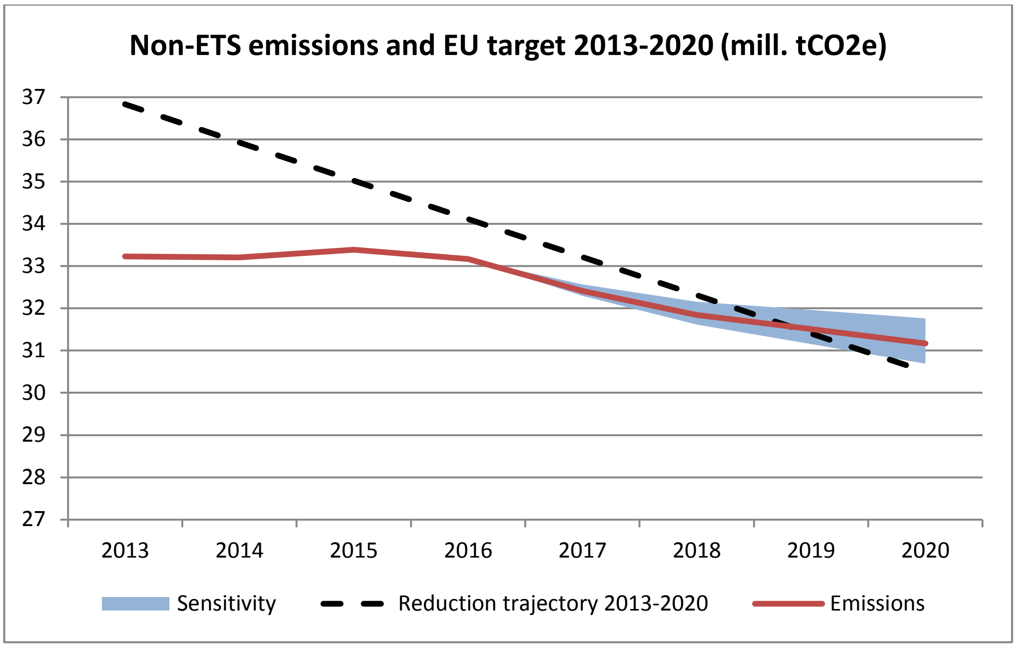

Figure 22: Overachievement is expected up until around 2019, after which time emissions are expected to exceed targets. Note that the y axis does not begin at 0.

7.3.4 Additional efforts will be required to reach the reduction target for the period 2021-2030

On 20 July 2016, the European Commission published a proposal for climate efforts for non-ETS sectors for the period 2021-2030. The proposal contains both effort sharing and the framework for achievement of targets. The proposal is now being negotiated. Negotiations are expected to take a number of years before

Member States and the European Commission can agree on the final format. Thus, all assessments on the consequences of the proposals are therefore subject to the reservation that the final format might look different.

The framework for efforts is essentially the same as for the period 2013-2020, with one target for 2030 and progressively stricter binding annual sub-targets up to 2030. By 2030, Denmark must reduce its non-ETS emissions by 39% relative to 2005. However, the start-up date for the reduction effort and the absolute target in tonnes in 2030 may vary depending on the methodology chosen by the EU. There is also uncertainty with regard to the projections themselves. In addition to this, negotiations are underway on a number of flexibility mechanisms which could be used in overall reduction efforts. All in all, this means that the assessments of reduction needs are subject to considerable uncertainty.

Even so, we can already now see the outlines of the challenge facing Denmark, if we look exclusively at the projected emissions and the expected commitment.

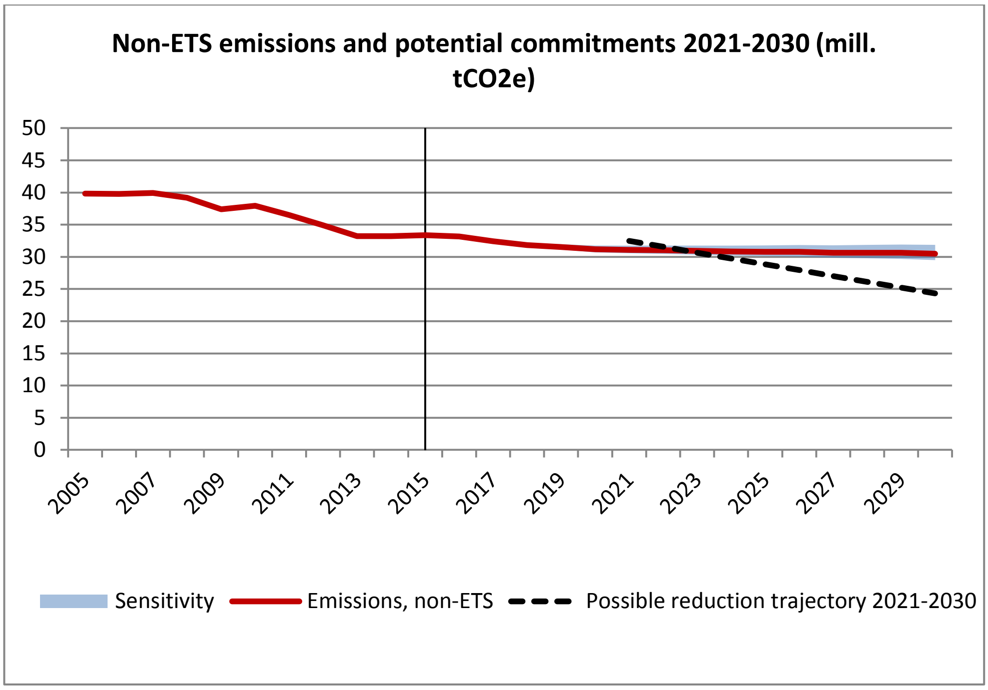

Figure 23: Emissions from non-ETS sectors are expected to stay at a fairly constant level up to 2030. Progressively stricter reduction targets mean that a climate deficit will accumulate up to 2030. This reduction trajectory represents a best estimate and, with regard to start and end points, is based on data from Denmark's Energy and Climate Outlook 2017.

By 2030, Danish non-ETS emissions are likely to have been reduced by between 20% and 26% relative to the 2005 level, which is not enough to meet the target without additional reduction efforts or the use of possible flexible mechanisms. On the basis of these assumptions, it is anticipated there will be an overall need for reductions of between 17 to 34 million tonnes CO2-eq. (middle estimate of around 24 million tonnes) over the entire period, and between 5 and 8 million tonnes in 2030, if Danish non-ETS emissions are to be in line with reduction targets.

The EU Commission's proposal includes the option of using the so-called LULUCF credits, which represent the carbon uptake by soil and plants in Denmark. It has been suggested that Denmark may be able to use up to 14.6 million tonnes of LULUCF credits. Under the proposed regulations, see Box 5 below, LULUCF credits are expected to be generated at a much higher volume in the period 2021-2030. With regard to utilising LULUCF credits, it will most likely be access to the credits, rather than the actual amount, that will be the limiting factor in connection with achieving the target, since the projections of future LULUCF credits are very uncertain. Additionally, the proposal contains a number of other flexible mechanisms such as limited access to the use of ETS allowances for non-ETS target achievement or the trading of emission rights between EU countries.

Box 5: LULUCF - carbon uptake

The uptake of CO_2 by soil, plants and trees, known as LULUCF (LandUse, LandUSeChange and Forestry) also plays a role in climate efforts. There is potential for enormous uptake or emissions in connection with land use just due to the size of the carbon pools in question.

It can be relatively difficult to determine the uptake and emissions from land use. There is therefore great uncertainty in connection with these estimates - both in connection with historical figures and the projected figures.

In addition to the complexity of natural science methodologies used to calculate LULUCF contributions, the rules for applying LULUCF in the climate accounts are also difficult. Different regulations apply to different commitment periods. Under the United Nations Kyoto protocol, LULUCF could be used in the period 2008-2012 but with certain restrictions. There has not been an equivalent framework for LULUCF for the period 2013-2020, and in connection with the EU's own efforts, it has not been possible to use LULUCF credits for target achievement during that period either.

It has been proposed that LULUCF credits may, to a certain extent, be used in European efforts in the period 2021-2030. This means that Denmark might have the option of utilizing up to 14.6 million tonnes CO_2-eq. of LULUCF credits during that period. The contribution is determined based on emissions from cultivated lands in comparison with the average emissions levels in the years 2005-2007. Credits will be generated if emissions have dropped since then and vice versa. The absolute emission level is not included. With the current projections and methodology used to calculate LULUCF, 44 million tonnes of LULUCF credits are expected to be generated from Danish soil in the period 2021-2030. Note that estimates on LULUCF contributions are subject to considerable uncertainty due to the fact that even relatively small adjustments to methodology can result in very different results.

7.4 What we did

Danish fuel consumption, including the breakdown into ETS/non-ETS, has been projected by the Danish Energy Agency. The Danish Centre for Environment and Energy (DCE) at Aarhus University has subsequently converted this fuel consumption into greenhouse gas emissions. Furthermore, the Danish Centre for Environment and Energy (DCE) has projected other non-energy-related activities such as certain parts of agriculture, waste and wastewater as well as industrial processes. The DCE has converted this activity data into greenhouse gas emissions, broken down by gases and sources.

The projections on agriculture activities stem from *"Fremskrivning af dansk landbrug frem mod 2030"* (Projections for Danish agriculture up to 2030) prepared by the Department of Food and Resource Economics (IFRO) and published in January 2017.

More information about the projections for greenhouse gas emissions is available in the background report.

Definitions regarding energy consumption and greenhouse gases

Final energy consumption: The final energy consumption expresses energy consumption delivered to end users, i.e. private and public enterprises as well as households. The purpose of this energy use is the manufacture of goods and services, space heating, lighting and other appliance consumption as well as transport. Added to this is consumption for non-energy purposes, i.e. lubrication, cleaning and bitumen (asphalt) for paving roads. Energy consumption in connection with extraction of energy, refining and production of electricity and district heating is not included in final energy consumption. Moreover, final energy consumption excludes cross-border trading with oil products defined as the quantity of petrol, gas/diesel fuel and pet-coke, which due to differences in price is purchased (net) by private individuals and transport operators etc. on one side of the border and consumed on the other side of the border.

Gross final energy consumption: Gross final energy consumption has been calculated by adding cross-border trade, electricity and district-heating distribution losses and own consumption in connection with district heating and electricity production to final energy consumption, less consumption for non-energy purposes. Gross final energy consumption is used in connection with the EU's renewable energy targets.

Observed energy consumption: Observed energy consumption is found by adding final energy consumption, distribution losses and energy consumption in connection with energy extraction and refining. Furthermore, applied energy consumption (fuel consumption, wind energy, etc.) is added to the production of electricity and district heating.

Gross energy consumption: Gross energy consumption is found by adjusting observed energy consumption for fuel consumption linked to foreign trade in electricity. Gross energy consumption describes the total input of primary energy to the energy system. The primary energy input to the Danish energy system is a mix of fuels and fuel-free energy in the form of wind power, solar energy and geothermal energy.

Gross energy consumption (adjusted): Adjusted gross energy consumption is found by adjusting observed energy consumption for fluctuations in climate with respect to a normal weather year. In practice, the final energy consumption is climate-adjusted. In connection with projections, a normal weather year is assumed, and therefore the adjusted gross energy consumption equals the gross energy consumption and the projections only mention gross energy consumption. The adjusted gross energy consumption is used in connection with national targets.

Renewable energy: Defined as solar energy, wind power, hydropower, geothermal energy, biomass (straw, wood chips, firewood, wood pellets, wood waste, bioliquids and biodegradable waste), biogas and ambient heat for heat pumps.

Greenhouse gases:

- CO_2 (carbon dioxide): Derives primarily from burning fossil fuels such as coal, oil and natural gas.
- CH_4 (methane): Derives primarily from organic processes such as the digestion system of animals and waste composting.
- N_2O (nitrous oxide): Derives primarily from nitrogen conversion.
- F gases: Derive primarily from chemical processes.

CO_2 is the dominant greenhouse gas. In order to compare the climate impact of emissions of various gases, their climate impact is converted into CO_2 equivalents or CO_2-eq. The result is a figure that shows the number of tonnes of CO_2 corresponding to one tonne of methane, nitrous oxide or F-gas.

Emissions of greenhouse gases are not measured but assessed using emission factors linked to emission activities. These emission factors are adjusted regularly as new knowledge come to light. When this happens, the projections and historical figures are also adjusted to produce a more correct presentation of historical emissions. This means that projections can vary solely on the basis of altered emission factors.

The emissions trading market: All emissions covered by the EU ETS system are regulated by a common emission trading market. ETS emissions account for CO_2 emissions from energy production, heavy industry and other large point sources. In 2012, ETS emissions accounted for about 41% of total EU emissions. The total number of emission allowances are set at EU level and this number is tightened annually. The allowances are traded on a common European market. Companies buy emission allowances on the market, which means that direct regulation of the allowance sector cannot be achieved at a national level through allowances allocation. Emissions that are not emitted by ETS companies are non-ETS emissions and these stem primarily from transport, agriculture, households and smaller industries.

Non-ETS emissions: Non-ETS emissions primarily stem from transport, agriculture, households, industries and waste, i.e. numerous large and small emissions sources. Non-ETS emissions accounted for about 59% of EU emissions in 2014. Regulation takes place through national initiatives by the individual countries which have received reduction targets relative to 2005 levels. 2005 is the baseline year as it is the earliest year for which data was available which made it possible to distinguish between ETS and non-ETS emissions. The combined European efforts is shared between Member States according to an Effort Sharing Decision, which has been agreed for the period 2013-2020. A proposal for effort sharing for the subsequent period 2021-2030 from the European Commission is currently being negotiated.