

Transition Towards 2030

Building Blocks for a Low-Carbon Society

Main conclusions

NB!

Updated recommendations at the end of this document

Transition Towards 2030

Building Blocks for a Low-Carbon Society *

NB!

Updated recommendations are found at the end of this document. After the completion of this report the Danish Energy Agency raised its estimate of reductions required by 2030, and in accordance herewith the recommendations of the Danish Council on Climate Change towards 2030 have been updated. The updated recommendations are outlined in the insert *The Danish Energy Agency Has Raised Its Estimate of Reductions Required in the Non-ETS Sector Towards 2030* found at the end of this document.

Peter Birch Sørensen
Jørgen Elmeskov
Pia Frederiksen
Jette Bredahl Jacobsen
Niels Buus Kristensen
Poul Erik Morthorst
Katherine Richardson

* An excerpt of the full report consisting of foreword and main conclusions

Preface

The Danish Council on Climate Change was set up under the Climate Change Act adopted by the Danish Parliament in 2014, and its objective is to establish a main strategic framework for Danish climate policy with a view to turning Denmark into a low-carbon society by 2050. Since 2015 the Danish Council on Climate Change has provided the Danish government with recommendations in the form of annual reports supplemented with individual analyses of selected climate policy issues. In the fall of 2016 Denmark saw a change in government, and the government platform of the new government, which is composed of Venstre (the Liberal Party of Denmark), the Conservative People's Party and Liberal Alliance, reads:

'Greenhouse gas emissions must continue to decrease. Denmark is ready to undertake an ambitious 2030 target for non-ETS sector reductions. Before the end of 2017 the government will draw up a cost-effective strategy for meeting Denmark's 2030 reduction target. Among others, the government will draw on recommendations from the Danish Council on Climate Change.'

With this report on *Transition Towards 2030 – Building Blocks for a Low-Carbon Society* the Danish Council on Climate Change presents its proposal for a strategy that can help Denmark reach its 2030 target, taking into consideration its long-term goal of becoming a low-carbon society by 2050.

In this report the Danish Council on Climate Change has chosen to focus on the *elements of transition* that should form part of Denmark's green transition towards 2030, as an important step on the road to becoming a low-carbon society by 2050. Elements of transition here refer to transitions within production or consumption, which can function as building blocks in the effort to create a society that emits markedly less greenhouse gas.

Elements of transition may include the introduction of electric heat pumps within heat supply, more electric cars within transport, energy renovation of buildings and climate-friendly processing of manure within agriculture. Elements of transition are typically implemented using a series of instruments such as taxes, subsidies or prohibitions. Politicians may disagree on the choice of instruments, but with this report the Danish Council on Climate Change hopes to be able to contribute to creating consensus on which elements of transition should form part of the country's future transition to a green economy.

With this annual report of 2017 we therefore propose a selection of elements of transition facilitating cost-effective attainment of the 2030 target, while taking into consideration Denmark's long-term 2050 target. At the same time, we point to a series of instruments for realising these elements of transition.

Similar to the report recently published by the government-appointed Energy Commission, this report by the Danish Council on Climate Change contains recommendations for future Danish energy policy. The report by the Energy Commission, previous annual reports by the Danish Council on Climate Change and the 2010 report by the former Danish Commission on Climate Change

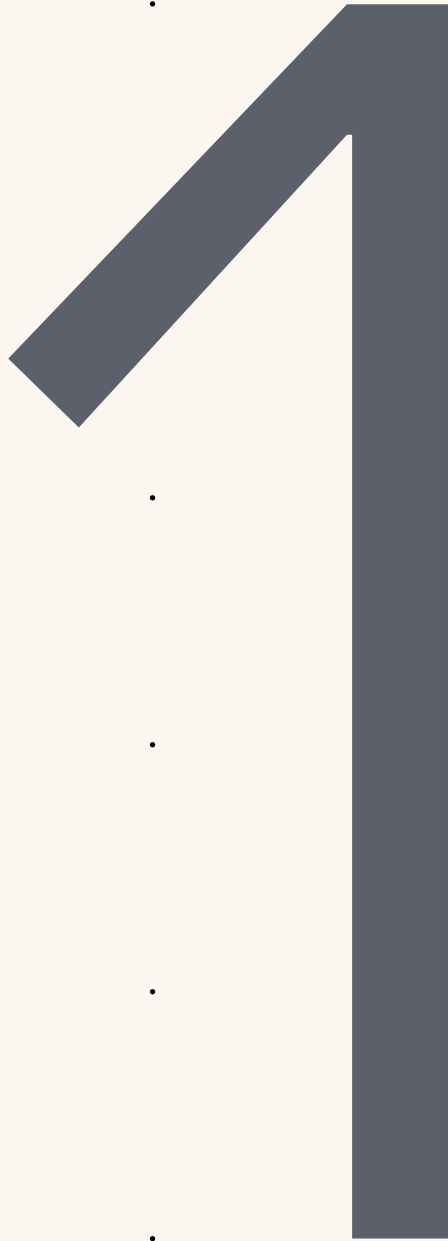
Policy all emphasise a series of elements that are vital to Denmark's transition to a green economy, including the need for increased electrification of the energy consumption, increased integration of the various parts of the energy system, development of energy storage options, continued energy efficiency improvements as well as continued efforts within research, development and demonstration of alternative energy technologies. In addition, the Energy Commission along with the Danish Council on Climate Change and the Danish Commission on Climate Change Policy emphasise the long-term Danish target of becoming a low-carbon society by 2050 as a crucial point of orientation of energy and climate change policy in the short term. Recent years' reports have thus contributed to the development of a broad, shared understanding of the main elements of Denmark's transition to a green economy. This report by the Danish Council on Climate Change continues this effort focussing especially on greenhouse gas emissions within the non-ETS sector.

In the years to come the Danish Parliament must reach a new energy agreement, and in connection with its climate policy report of 2017 the government will present a climate change plan compiling the government's energy initiatives. With this report the Danish Council on Climate Change hopes to be able to inspire the government and the remaining parties in the Danish Parliament to discuss the potential of the individual elements of transition and how they can contribute to meeting the 2030 targets, while taking into consideration the final 2050 target of becoming a low-carbon society by 2050.

Copenhagen, June 2017

The Danish Council on Climate Change is composed of:

- Peter Birch Sørensen (Chairman), Professor of Economics at the University of Copenhagen
- Jørgen Elmeskov, Director General at Statistics Denmark
- Pia Frederiksen, Section Leader and Senior Researcher at the Department of Environmental Science, Aarhus University
- Jette Bredahl Jacobsen, Professor of Environmental and Resource Economics and Deputy Head of Department for Research at the Department of Food and Resource Economics, University of Copenhagen
- Niels Buus Kristensen, Transport Researcher and Head of Research at the Norwegian Centre for Transport Research in Oslo
- Poul Erik Morthorst, Professor of Energy Economics and Head of Department at DTU Management Engineering



• • • • •

• • •

Main Conclusions and Recommendations

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

The Danish Council on Climate Change regularly offers recommendations for Danish climate policy, including paths of transition and instruments for realising the targets set by the Climate Change Act. Although the main target of the Climate Change Act is to turn Denmark into a low-carbon society by 2050, present-day Danish climate policy is typically more short-term. Therefore, in this report on the *Transition Towards 2030 – Building Blocks for a Low-Carbon Society* the Danish Council on Climate Change seeks to identify the best way to orchestrate this transition over the next decade. In order to realise the ambition of becoming a low-carbon society by 2050, it is vital that the transition towards 2030 proceeds in the right direction and at an appropriate pace.

The transition towards 2030 within the non-ETS sector is governed by the target Denmark has accepted as a member of the EU. In its government platform the current Danish government, formed in the fall of 2016, requests the Danish Council on Climate Change's views on how best to approach the non-ETS sector transition, and therefore this report focusses on 'cars, agriculture and homes' in particular, which is the popular name in Denmark for this part of the economy.

To gain an overview of such a broad task, the Danish Council on Climate Change uses the concept *element of transition* in this report. An element of transition is a transition within production or consumption contributing to lowering greenhouse gas emissions, e.g. by switching to more climate-friendly and energy-efficient technologies. This may include the introduction of electric cars, biogasification of manure or energy renovation of homes. In this report the Danish Council on Climate Change has explored the potential of 20 different elements of transition with a view to putting together a package of elements enabling Denmark to meet its 2030 target based on a set of clear criteria. The report shows that Denmark will be able to meet its 2030 target without great financial costs, perhaps even with some minor socioeconomic gains.

The analysis of the individual elements of transition considers both their price and potential compared to the reduction of greenhouse gas emissions, but not which taxes, subsidies, requirements or other policy measures are necessary to realise these elements of transition. We thus distinguish between elements of transition and instruments and are therefore able to keep deliberations at a more general level and to avoid discussing who will pay for what. Naturally, instruments are vital to the implementation of climate policy initiatives, and a future analysis of main instruments could follow and build on this report.

The transition towards 2030 also involves the ETS sector, and the goal set by the government stipulates that by 2030 50 per cent of all of our energy must come from renewables. The latest projection by the Danish Energy Agency has shown that the initiatives adopted so far will not enable Denmark to meet this target. A new energy policy is therefore required, and this report describes the scope of this challenge considering both the 2030 target and the 2050 target of an energy supply fully based on renewables.

The Danish Council on Climate Change also considers the international context. The EU to a large extent sets the framework for Danish climate and energy policy, and this report accounts for the latest developments within European climate regulation. The report also focusses on the global climate agenda and the Paris Agreement. Although the Paris Agreement represents an important step in the right direction, it is not sufficient for keeping the global warming below two degrees. Incorporated into the agreement is therefore the expectation that the individual countries' level of ambition with regard to emission reductions will rise, and we are therefore likely to see the EU raise its climate ambitions in the next few years, which Denmark should be prepared for in its efforts to meet the set targets.

The following will summarise the main conclusions and recommendations of the report.



MPH

9:16
40



P 700000 miles
53 miles

Transition of the Non-ETS Sector Towards 2030

The main question of the report is how Denmark best can reduce greenhouse gas emissions within the non-ETS sector towards 2030. Chapter 4 outlines the main principles behind the analysis, while chapter 5 presents the potential initiatives for meeting the 2030 target examined by the Danish Council on Climate Change. The initiatives are prioritised in chapter 6.

Focus on Elements of Transition over Instruments

As an EU member state Denmark must reduce its greenhouse gas emissions in the non-ETS sector towards 2030. This sector includes transport, agriculture and parts of the heat supply and industry. The target frames the Danish transition within these parts of the economy.

The Danish Council on Climate Change's analysis of Denmark's ability to meet the 2030 target builds on the concept of element of transition, which refers to climate-friendly changes to production or consumption. These may include new technology, efficiency improvements, reorganisation of production and similar. Elements of transition differ from instruments, which are the political steps introduced to realise elements of transition. Focussing on elements of transition makes it possible to concretise the discussion of Denmark's attainment of the 2030 target, setting a direction for the green transition of different parts of society.

The analysis identifies the potential of each element of transition for reducing greenhouse gas emissions in the period 2021-2030 obtained by introducing relevant instruments. The potential is determined on the basis of the Danish Energy Agency's General Projection 2017, which projects the development in energy consumption and greenhouse gas emissions if no new policy is introduced. By proposing a package of elements of transition the Danish Council on Climate Change is able to outline a strategy for meeting the non-ETS sector reduction targets. Based on this strategy the subsequent task is to select a series of political instruments for realising the chosen elements of transition.

Price and 2050 Perspective Are the Main Criteria for the Selection of Elements of Transition

The Danish Council on Climate Change identifies two main criteria for the selection of elements of transition for meeting the 2030 target. These are price and whether the element points in the direction of Denmark's 2050 climate target. The prioritisation of elements should be based on these two criteria.

The price comprises the socioeconomic costs. These include direct costs of investments and operations, but also associated social costs resulting from e.g. local pollution and traffic noise. However, we can only indicate the approximate size of the social costs, as they in practice depend on the chosen instrument.

Denmark aims to become a low-carbon society based on renewables by 2050. This will require an extensive transition conducted gradually throughout the period. Accelerating the transition over a shorter period of time would cause the costs to rise. Therefore, the transition towards 2030 should ease the transition

to the low-carbon society we wish to be in 2050. Transition costs must be kept at a minimum throughout the entire period and not be considered individually for subsidiary goals towards 2030. Therefore, up until 2030 it is important to prioritise elements of transition, which also form part of the long-term vision. This includes especially large changes that require new technology and long-term investments. The Danish Energy Commission, which published its recommendations in April 2017, also advocates that plans for the short-term transition must put Denmark on the right track towards 2050.

The Danish Council on Climate Change Has Analysed 20 Different Elements of Transition

In this report the Danish Council on Climate Change explores a number of elements of transition within various sectors. Within transport it considers electric cars, biofuel and public transport, among other things. Within agriculture its focus is e.g. on the processing of manure, permanent pasture and reduced cattle farming. Possible elements of transition within heat supply are heat pumps, solar heating and energy renovation, while the analysis also includes elements that may contribute to reducing emissions following from the industry's energy consumption. The potential of these elements of transition and assessment hereof based on the two main criteria of the analysis are shown in figure 1.1 which is described in chapter 6.

The Danish Council on Climate Change Has Selected a Package of Elements of Transition That Meet the 2030 Target

The Danish Energy Agency finds that Denmark must reduce its total emissions by 9.4 million tonnes of CO₂ over the years 2021-2030, if it also uses the opportunity to include carbon absorption in land and forests (LULUCF). A reduction of 9.4 million tonnes of CO₂ corresponds to approx. three per cent of the total expected emission in the period, if no new policy is introduced. However, there is great uncertainty about the scope of the actual reduction required.

Initially and based on figure 1.1, the Danish Council on Climate Change has compiled a package of seven elements of transition meeting the 2030 reduction target. The package consists of energy renovation of the building stack, individual heat pumps, large heat pumps within district heating, solar heating, energy efficiency improvements within production, natural gas within heavy transport and acidification of cattle and pig manure. The package focusses on energy, but also initiates the necessary transition within agriculture and transport. The overall social gains of the package are modest at approx. DKK 1 billion for the entire period. Naturally, the exact figure is uncertain, but it shows that Denmark is likely to be able to meet its 2030 targets with few or no costs.

Denmark may also choose to use allowances from the EU ETS to meet its non-ETS sector target. While this will make the process of meeting the target slightly cheaper, it will only have a minor effect on the climate in the short and medium long term and it will not bring Denmark closer to realising the required long-term transition towards 2050. Instead, it will make the task after 2030 more extensive. Therefore, the Danish Council on Climate Change recommends that Denmark abstains from using the opportunity to use allowances.



Figure 1.1 Potentials, costs and 2050 perspective of the elements of transition

Note: The size of the individual circles indicates the given element's potential for greenhouse gas mitigation in the period 2021-2030 in tonnes of CO₂ equivalents. The position of the circles in the individual spaces is not significant.

Source: Own calculations and assessments.

Denmark Should Implement More Elements of Transition than Required by the EU Target

In general, the analysis by the Danish Council on Climate Change shows that Denmark will be able to meet the non-ETS sector target without immense struggle. There is therefore reason to consider a greater reduction than indicated by the estimated reduction requirement. In that light, the Danish Council on Climate Change recommends that:

- Denmark should aim for a greater reduction of greenhouse gas emissions in the non-ETS sector than indicated by the Danish Energy Agency's estimated reduction requirement. A greater reduction will reduce the need for accelerating Denmark's transition to a green economy after 2030, just as it would demonstrate due diligence in the likely situation that the EU raises its climate target towards 2050 in order to honour the Paris Agreement, and if the actual reduction requirement proves greater than estimated by the Danish Energy Agency.

If Denmark wishes to strive for a greater reduction than the one indicated by the overall estimate, the analysis by the Danish Council on Climate Change shows that the best starting point would be elements of transition such as electric cars, wood pellet boilers and energy willow. Of these the Danish Council on Climate Change sees the greatest potential in electric cars considering the long-term transition.

Table 1.1 summarises the eight elements of transition which Denmark, according to the analysis by the Danish Council on Climate Change, should focus on up until 2030. In several areas the Danish Council on Climate Change agrees with the Energy Commission; this includes the need for electrifying the heat supply and transport and for cost-effective energy savings.

Element of transition	Potential	Socioeconomic costs	Eases the transition towards 2050
Energy renovation of buildings	1,4 million tonnes of CO ₂ e	Very cheap	To a large extent
Individual heat pumps	3,3 million tonnes of CO ₂ e	Very cheap	To some extent
Energy efficiency improvements in production	2,6 million tonnes of CO ₂ e	Very cheap	To some extent
Gas in heavy transport	0,2 million tonnes of CO ₂ e	Very cheap	To some extent
Large heat pumps	0,9 million tonnes of CO ₂ e	Cheap	To a large extent
Solar heating	0,8 million tonnes of CO ₂ e	Cheap	To a large extent
Acidification of manure	1,0 million tonnes of CO ₂ e	Cheap	To some extent
Electric cars	2,2 million tonnes of CO ₂ e	Medium	To a large extent
Overlap	-0,3 million tonnes of CO ₂ e		
Total	12,0 million tonnes of CO₂e		

Table 1.1 The Danish Council on Climate Change's selection of elements of transition

Note: Individual elements of transition overlap slightly; this has been deducted to prevent it from figuring twice.

The Danish Council on Climate Change's Recommendations for the non-ETS Sector Focus on Domestic Reductions

Based on its analysis of elements of transition the Danish Council on Climate Change recommends:

- Within the non-ETS sector Denmark should focus on introducing more heat pumps supplemented with solar heating towards 2030. At the same time, it should focus on cost-effective energy savings in the building stock and within production.
- Within transport Denmark should initiate the transition to electrified passenger transport on the roads in the form of electric cars, while gas should be introduced as alternative fuel for lorries.
- Within agriculture the transition should initially focus on the processing of manure. Here several technologies are relevant, though acidification at present appears to be the socioeconomically most attractive initiative.
- Denmark should to the greatest extent possible strive to meet the non-ETS sector target by introducing domestic reductions and only buy CO₂ emission rights in other countries if its reduction by the end of the period is insufficient and only insofar as the purchase of CO₂ emission rights is counterbalanced by documented reductions in the country selling these rights.
- Denmark should abstain from using ETS sector allowances to meet its non-ETS sector target, unless a market reform of the system is implemented before the end of 2019, which is when the decision to use allowances must be made, the aim being to significantly reduce the large surplus of allowances.

Denmark's Climate Target

As in previous reports the Danish Council on Climate Change will take stock of the Danish climate and energy targets in chapter 2. The chapter also focusses on the latest EU directives and recommendations within this area.

Denmark Meets Most of the 2020 Targets, but Lacks New Policy Towards 2030

Denmark is well on its way to meeting most of the energy and climate targets towards 2020. The latest general projection by the Danish Energy Agency expects Denmark to meet the EU demands for both increased use of renewable energy and lower emissions in the non-ETS sector. Similarly, Denmark appears to be able to meet the 40 per cent reduction target for all Danish emissions, compared to 1990 levels, previously backed by a majority in the Danish Parliament. However, the projection shows that a new set of initiatives is required if Denmark is to meet the EU target for the use of renewables in the transport sector by 2020.

For 2030, it is a different story. Many of the present climate initiatives will expire a few years from now, and then, the projection shows, the green transition will come to a halt unless new climate and energy initiatives are implemented.

Political action is therefore necessary if Denmark is to meet the 2030 EU target of a reduction in non-ETS sector emissions and the government's own target of 50 per cent renewables in the energy supply.

The Government Has Set 2030 Targets for Renewable Energy

The target of 50 per cent renewables by 2030 will come to govern the transition within Danish energy supply and transport in the next few years. Negotiations for a new energy agreement lasting until 2030 will soon begin, and in that connection the Danish Council on Climate Change recommends:

- The new energy agreement should establish a stable framework for the transition to renewable energy over the next decade, ensuring that Denmark as a minimum is able to meet the government's target of 50 per cent renewables by 2030. This should not least be seen in light of the fact that e.g. wind turbines and solar cells have become much cheaper in recent years. Therefore, the government should regularly evaluate the target of 50 per cent renewables to decide whether to accelerate the transition to renewables. A higher target than 50 per cent would facilitate a more gradual transition to a low-carbon society based on renewable energy in 2050.

These years many central Danish CHP plants are switching from coal to biomass, partly as a result of the exemption from tax on biomass. This will result in a significant increase in the use of imported biomass in the form of wood pellets and wood chips. While this helps to meet the target for renewable energy, it is also important that the biomass is produced in sustainable ways, ensuring that its application in fact contributes to reducing greenhouse gas emissions at global level. However, the general projection points to the risk that increased electricity consumption will result in increased coal-based electricity production. Coal is one of the energy forms that emits the most CO₂ into the atmosphere per

unit of energy, and increased coal consumption thus counters the government's renewable energy target. A reasonable Danish ambition would therefore be not to use coal in the production of electricity and heat as of 2030. There is a lot to suggest, though, that the market by itself will close down the remaining coal-fired generating units by 2030. However, if this market trend changes, it may become necessary to intervene.

The EU Sets the Framework for Danish Climate and Energy Policy

The joint decisions made in the EU largely govern Danish climate policy, both with regard to targets and concrete regulation of industry and sectors. Towards 2030 the EU has set the framework for non-ETS sector climate policy by imposing a reduction obligation for the period 2021-2030 on each member state. To meet this obligation, the member states may utilise so-called flexibility mechanisms as an alternative to domestic climate measures. This involves using allowances from the EU ETS, purchasing emission rights from other countries and including contributions from LULUCF measures.

The EU's system for marketable allowances has not managed to successfully propel the transition within the ETS sector. The system presently suffers from a great surplus of allowances resulting in very low prices on allowances and therefore has difficulties stimulating the technological development meant to drive the transition to renewable energy. In recent years the EU has tried introducing various changes to the ETS and is presently, in 2017, negotiating a reform of the system meant to result in higher prices on allowances. If successful, this will reduce the need for subsidies for renewable energy.

In December 2016 the European Commission introduced its so-called Winter Package. The Winter Package contains a series of concrete initiatives meant to contribute to the implementation of the EU Energy Union. Main suggestions in the package include raising the EU target for energy efficiency by 2030, introducing more stringent sustainability demands on biomass, assigning subsidies to renewables under competition and allowing parts of the subsidies to go to facilities located in other member states.

In the next few years Denmark will participate in EU negotiations on the future European climate and energy policy, and in that connection the Danish Council on Climate Change offers the following recommendations:

- In connection with the ongoing EU climate and energy policy negotiations, Denmark should strive for:
 - As ambitious a reform of the EU ETS as possible, ensuring that the present surplus of allowances is reduced significantly.
 - Rules ensuring that wood used in the production of bioenergy is included in the production country's CO₂ account.
 - Ensuring that the sustainability demands on biomass also benefit existing production facilities, as Danish facilities may not otherwise be included.

- Ensuring that the European Commission places ambitious demands on car manufacturers with regard to reducing CO₂ emissions from cars, vans and heavy vehicles as well as increasing the share of zero-emission cars of the total number of cars sold each year, which contributes to propelling the technological development, as evident e.g. from the certificate system in California.

Need for Higher Level of Ambition Globally

In chapter 3 the Danish Council on Climate Change shifts its focus from the Danish and European agendas to the global climate situation, which ultimately should be dictating the development of the Danish and European climate targets.

The Paris Agreement Moves the World in the Right Direction, but Is Not Enough

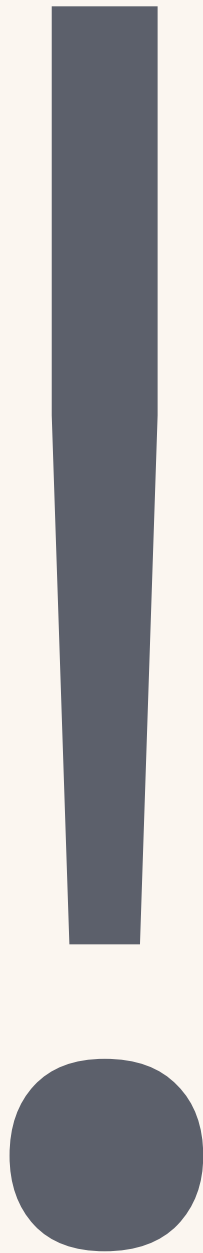
In December 2015 the world's heads of state agreed on the most extensive global climate agreement to date. The aim of the Paris Agreement is to keep global temperature rises 'well' below two degrees, compared to pre-industrial levels, with a view to limiting the rise to 1.5 degrees. According to the Danish government platform, Denmark must contribute to meeting this ambitious target at national and international levels.

The Paris Agreement constitutes an important step in the right direction. However, the contributions to the global effort to reduce CO₂ emissions so far reported by the individual countries to the UN under the agreement are far from sufficient if the world's countries are to come within reach of fulfilling the set target. The countries must raise their climate ambitions significantly if they are to meet the target. If the next few decades do not see the passing and implementation of larger mitigation efforts, the need for reducing greenhouse gas emissions will increase dramatically from the middle of this century onwards.

Global Greenhouse Gas Budget Creates Expectations of Increased Climate Ambitions in the EU

The world's population can only emit a limited amount of greenhouse gasses to the atmosphere if we are to avoid too large a concentration of greenhouse gas in the atmosphere. It will require a significant reduction in greenhouse gas emissions in the short term and increasing carbon absorption in land and forests for the Earth's carbon cycle to remain in balance in the future.

The EU is already well on its way to meeting, and surpassing, its 2020 reduction target, and for this reason there seems to be a basis for increasing the European climate target towards 2030 in order to contribute to the greater global climate effort. By 2030 the greenhouse gas emission per capita in the EU is expected to be lower than in e.g. the United States and China, though the European level continues to be above the average level for which the world, according to the UN Environment Programme, should be aiming if we are to have a chance of living up to the two-degree target. Consequently, we can expect the EU to raise its climate targets in the near future. Naturally, this will affect Danish climate policy, which therefore should take this likely increase in EU targets into account.



The Danish Energy Agency Has
Raised Its Estimate of Reduc-
tions Required in the non-ETS
Sector Towards 2030

Insert in the Danish Council on Climate Change's report *Transition Towards 2030 – Building Blocks for a Low-Carbon Society* from June 2017

In its latest report the Danish Council on Climate Change explored the opportunities for meeting the 2030 EU climate target for the non-ETS sector based on the Danish Energy Agency's estimate of reductions required. After the completion of the report the agency adjusted the estimate upwards from 9.4 million tonnes of CO₂ to 13.4 million tonnes of CO₂. As this adjustment significantly changes the premises of the report, the Danish Council on Climate Change has produced this insert containing the council's further recommendations for meeting the target in light of the new situation.

The Danish Energy Agency Has Revised Its Estimate of the Reduction Required

The Danish Energy Agency's *General Projection 2017* constitutes the official source for assessing Denmark's chances of meeting its climate targets. Therefore, the report by the Danish Council on Climate Change is based on the estimated reduction requirement presented in the general projection for meeting the 2030 target in the non-ETS sector. After publishing the general projection, the Danish Energy Agency adjusted the estimate and released a formal correction on 29 May 2017.

As described in chapter 2 of the report by the Danish Council on Climate Change, the non-ETS sector target puts a ceiling on Denmark's emissions in the years 2021-2030. This ceiling will be lowered linearly towards 2030, the start level being the average level of emissions in the period 2016-2018. The Danish Energy Agency has previously taken the view that the start level should be set in 2021, but it is evident from the European Commission's proposed reduction targets of the individual member states that this level should instead be set in 2020, thus lowering the 2021 ceiling slightly.

As shown in figure 1, the correction means that the emission ceiling is lowered in the years from 2021 up to and including 2029, while the target for 2030 remains unchanged. The overall estimate of reductions required is raised by four million tonnes of CO₂ from 9.4 to 13.4 million tonnes when including the opportunity to deduct LULUCF initiatives, as described in chapter 6 of the report by the Danish Council on Climate Change. The shaded area in figure 1 represents the four million tonnes.

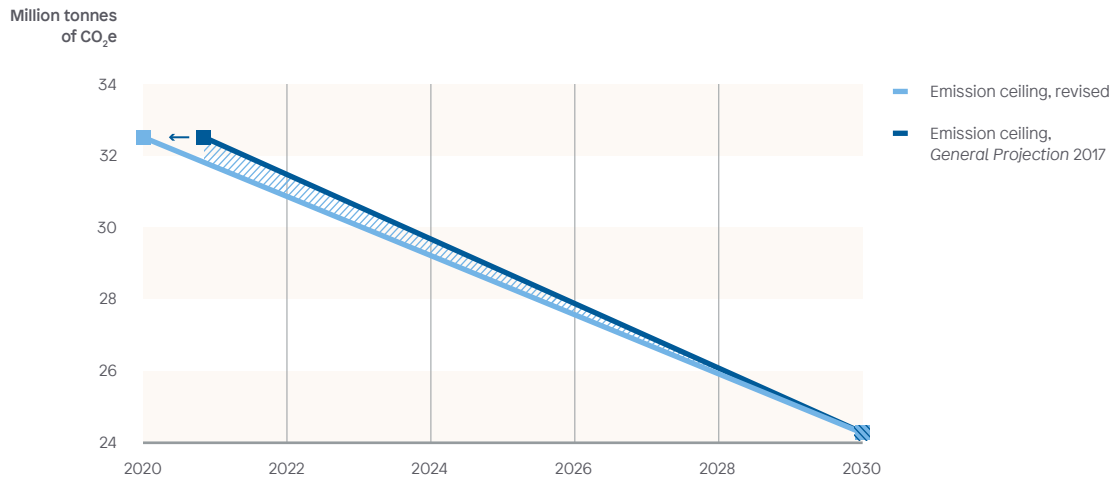


Figure 1 Emission ceilings in the original and revised versions of the *General Projection 2017*

Note: The shaded area illustrates the additional reduction required of four million tonnes of CO₂e. individual spaces is not significant.

Still Reason to Reduce Emissions More than Dictated by the Central Estimate of the Reduction Requirement

In its report the Danish Council on Climate Change encourages Denmark to aim for a greater reduction of greenhouse gas emissions in the non-ETS sector than dictated by the Danish Energy Agency's overall estimate. This recommendation still stands, even though the agency has raised the estimate.

A greater reduction would reduce the need for accelerating Denmark's transition to a low carbon society after 2030. This is illustrated in the report's figure 6.2, which has been updated in figure 2 with the new required reduction of 13.4 million tonnes of CO₂e, which graphically moves the end point of the blue line downwards. It is evident from the figure that even with the new estimated reduction requirement, the transition pace must increase significantly after 2030, if we only just fulfil the 2030 reduction target. It would also demonstrate due diligence in the likely situation that the EU raises its climate target towards 2050 in order to honour the Paris Agreement, and if the actual required reduction proves greater than estimated by the Danish Energy Agency – even after the adjustment.

More Elements of Transition Are Required to Fulfil the New Reduction Requirement

In the report the Danish Council on Climate Change points to eight elements of transition, which together reduce emissions in the non-ETS sector by 12.0 million tonnes of CO₂e from 2021 to 2030. This means that Denmark is 1.4 million tonnes short of meeting the adjusted reduction target.

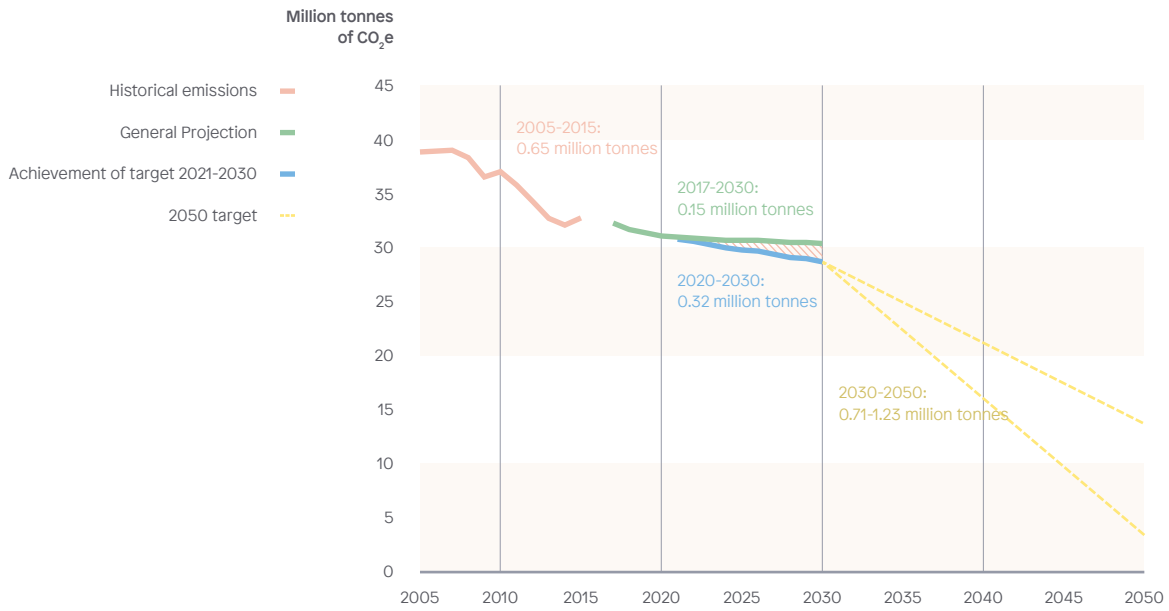


Figure 2 Emissions in the non-ETS sector: historically, projection and target

Note: The figures represent the average annual reduction for the curve of the same colour. Compared to figure 6.2 in the report, the blue line ends at a slightly lower point, for which reason the yellow lines begin at a slightly lower point.

The Danish Council on Climate Change points to two additional elements of transition, which may be relevant if Denmark wishes to aim for a greater reduction of greenhouse gas emissions before 2030. These are wood pellet boilers in individual heating replacing oil-fired boilers and cultivation of energy willow replacing more fertiliser- and energy-demanding crops. These two elements of transition are both categorised as very cheap, and they therefore represent a cost-effective way for Denmark to meet its climate obligations. On the other hand, both elements only to a limited extent ease the transition towards 2050, for which reason the Danish Council on Climate Change initially chose not to include these elements.

Overall, implementing the eight elements of transition originally included in the Danish Council on Climate Change's annual report 2017 and the two new elements will reduce emissions by 14.3 million tonnes of CO₂e. A rough estimate shows that realising all of the 10 elements will result in a socioeconomic gain of around DKK 600 million. Naturally, there is some uncertainty about the exact figure, but it demonstrates that the conclusion of the report that Denmark will be able to meet the non-ETS sector target without significant socioeconomic costs still holds.

Biogas Is More Relevant in Light of the Greater Reduction Requirement

As mentioned above, even with the adjusted reduction requirement there is reason to aim for a greater reduction than dictated by the 2030 target. One of these reasons is that the actual reduction required may still prove greater than

currently estimated, and for reasons of caution we should therefore introduce more elements of transition. The adjustment by the Danish Energy Agency clearly demonstrates the relevance of this argument. Therefore, even after the adjustment Denmark should aim for a reduction significantly above the estimated reduction required by 2030.

After adding wood pellets and energy willow the package of elements of transition is expected to meet and surpass the target by a modest 0.9 million tonnes of CO₂e over the 10-year period. The Danish Council on Climate Change recommends that Denmark aims for an even greater reduction and, based on figure 6.3 in the report, points to biogas in the natural gas grid as the most attractive of the remaining elements of transition. This element of transition both reduces emissions from the processing of manure within agriculture and from energy consumption when biogas replaces natural gas.

Biogas is expected to become an integrated part of a renewables-based 2050 energy system, and the Danish Council on Climate Change recognises the potential advantages of continuing to develop biogas-related technologies with a view to gradually reducing the costs. Upgraded biogas remains expensive, though, at a shadow price of more than DKK 1,000. This may speak in favour of only realising part of the potential towards 2030, as identified by the Danish Council on Climate Change. In any case, the Danish Council on Climate Change considers it undesirable to stop the expansion of biogas completely when the present support scheme expires by the end of 2023.

The Danish Council on Climate Change Now Points to a Total of 11 Elements of Transition

After adding the elements of transition described in this insert, the Danish Council on Climate Change now points to a total of 11 elements of transition to be prioritised in Danish climate policy towards 2030. Table 1 thus replaces tables 1.1 and 6.1 in the report.

Table 1 first lists the 10 elements of transition that together meet and slightly surpass the target. In addition, biogas is listed separately as the Danish Council on Climate Change's suggestion for an element of transition facilitating a significantly higher reduction than dictated by the 2030 target. Biogas is without a doubt the most expensive element on the list, and Denmark may consider realising only part of the potential indicated in table 1. The potential of the remaining elements of transition recommended is to some extent flexible, and it should regularly be considered whether certain potentials may be increased at a reasonable cost. For several of the elements of transition the general expectation is that the greater the potential utilised, the higher the cost per tonne of CO₂e.

Element of transition	Potential	Socioeconomic costs	Eases the transition towards 2050
Energy renovation of buildings	1.4 million tonnes of CO ₂ e	Very cheap	To a large extent
Individual heat pumps	3.3 million tonnes of CO ₂ e	Very cheap	To some extent
Energy efficiency improvements in production	2.6 million tonnes of CO ₂ e	Very cheap	To some extent
Gas in heavy transport	0.2 million tonnes of CO ₂ e	Very cheap	To some extent
Large heat pumps	0.9 million tonnes of CO ₂ e	Cheap	To a large extent
Solar heating	0.8 million tonnes of CO ₂ e	Cheap	To a large extent
Acidification of manure	1.0 million tonnes of CO ₂ e	Cheap	To some extent
Electric cars	2.2 million tonnes of CO ₂ e	Medium	To a large extent
<i>Energy willow*</i>	0.6 million tonnes of CO ₂ e	Very cheap	To a limited extent
<i>Wood pellet boiler*</i>	1.8 million tonnes of CO ₂ e	Very cheap	To a limited extent
Overlap	-0.3 million tonnes of CO ₂ e		
Total	14.3 million tonnes of CO₂e		
<i>Biogas in the natural gas grid*</i>	2.1 million tonnes of CO ₂ e	Expensive	To a large extent
Total	16.4 million tonnes of CO₂e		

Table 1.1 Danish Council on Climate Change's chosen elements of transition

Note: An * indicates elements of transition recommended in the light of the upwards adjusted required reduction.

Adjusting the Reduction Requirement Results in Further Recommendations

The recommendations of the Danish Council for Climate Change presented in *Transition Towards 2030 – Building Blocks for a Low-Carbon Society* still hold, but considering the adjusted reduction requirement the following recommendations have been added:

- Homes with oil-fired boilers, where heat pumps are not attractive in the short term for technical or financial reasons, should switch to wood pellet boilers.
- The transition to less greenhouse gas-intensive products within agriculture should begin before 2030. Initially, energy willow may replace more fertiliser- and energy-demanding crops. At the same time, energy willow may replace fossil fuels in Denmark or, if exported, internationally.
- The expansion of biogas production facilities should be prevented from stalling, as predicted in *General Projection 2017*, when the present support scheme expires by the end of 2023.

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •

• • • • •