



ENERGY STRATEGY 2050

– from coal, oil and gas to green energy

THE DANISH GOVERNMENT
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Preface



The 20th century was largely driven by access to cheap and plentiful coal, oil and gas. However, in the 21st century we will have to find other means of satisfying our energy needs

A new era for energy policy

Energy Strategy 2050 is a huge step towards realising the Danish government's vision of becoming independent of coal, oil and gas.

In 2010 the Danish Commission on Climate Change Policy concluded that transition to a fossil fuel independent society is a real possibility. Energy Strategy 2050 builds on this work.

This strategy is the first of its kind; in Denmark and in the rest of the world. The strategy outlines the energy policy instruments to transform Denmark into a green sustainable society with stable energy supply. The strategy is also fully financed, taking full account of Danish competitiveness.

The strategy presents a wide spectrum of new energy policy initiatives. These initiatives will already in the short term considerably reduce fossil fuel dependence. Just in the period up to 2020, the strategy will reduce the use of fossil fuels in the energy sector by 33% compared with 2009. In addition, the strategy will increase the share of renewable energy to 33% by 2020 and it will reduce primary energy consumption by 6% by 2020 compared with 2006 due to a strong focus on energy efficiency improvements.

The government's goal of making Denmark independent of fossil fuels by 2050 is based on the realization that the world is facing a new era for energy policy. The 20th century was largely driven by access to cheap and plentiful coal, oil and gas. In the 21st century we will have to find other means of satisfying our energy needs.

Within the next 25 years, the world's total energy consumption is expected to increase by one-third. At global level, the increasing pressure on fossil energy resources has contributed to an energy race, in which the influence and growth opportunities of regions largely depend on their access to fossil fuels, with increasing prices and uncertainty as a consequence.

The Danish government does not wish to be part of this race. The government's resolve is only strengthened by the fact that much of the world's fossil energy reserves are concentrated in just a few, often politically unstable, countries. This combination can have negative con-

sequences, with increased dependence on producing countries. Therefore, the transition to green energy is also a foreign policy requirement.

In addition to addressing the challenges in a new era of energy policy, Energy Strategy 2050 is also Denmark's contribution to curbing global warming. The international community has committed to drastic reductions in greenhouse gas emissions at international climate change conferences in Copenhagen and Cancún. The world - and Denmark - can only do this by becoming less dependent on fossil fuels.

Finally, the strategy will bolster Danish growth and wealth. The transition will strengthen companies' opportunities for innovation and demonstration of new green solutions. This will improve the opportunities of Danish companies in a rapidly growing global market for energy solutions.

The transition to fossil fuel independence is a huge task that will fundamentally change Danish society. Fortunately, Denmark can draw on many years of solid experience. Denmark has a successful track record of securing economic growth without energy consumption growth. Since 1980, the Danish economy has grown by 78%, while energy consumption has remained more or less constant, and greenhouse gas emissions have been reduced.

It is important to emphasise that the Danish transition cannot be realised in isolation, independent of the world around us. Denmark is not an island – not geographically and not in the field of energy policy. We need other countries – and our European neighbours in particular – to move in the same direction. Therefore, the Danish government will continue to work for ambitious global reduction targets. The government will strive for an EU commitment of 30% carbon emission reductions by 2020. Furthermore, the Danish government is committed to working against green protectionism.

The Danish government's strategy ensures responsible transition to a new era of energy policy. A transition that safeguards affordable, stable energy supply, is gentle on the public purse, supports the growth potential of Danish companies, and protects the leeway in our foreign policy.

The Danish government, February 2011

Introduction:

From coal, oil and gas to green energy



Energy Strategy 2050 fulfils the government's pledge as set forth in its work plan "Denmark 2020", that it would present a target for when Denmark is to become independent of fossil fuels, as well as a strategy to meet this target

The goal of the Danish government is independence from coal, oil and gas by 2050. With this move to fossil fuel independence, Denmark will also satisfy two other important ambitions:

- Denmark will maintain a high security of supply and ensure stable, affordable energy supply. Security of supply will be a key challenge in a future, where the global demand for energy is growing in line with population growth and economic growth, and where the remaining oil and gas resources will be concentrated in few, and often politically unstable, countries.
- Denmark will contribute to limiting global climate change as agreed in Copenhagen 2009 and in Cancún 2010. Therefore, Denmark must contribute to meeting the EU objective to reduce greenhouse gas emissions in 2050 by 80-95% compared with 1990 levels. This requires the transition to an economy with low greenhouse gas emissions.

In addition, the government's strategy for fossil fuel independence will help secure and develop the strength of Danish companies within the fields of new green energy, climate and environmental technology. A stronger coupling between innovation, production and deployment will improve companies' opportunities to take advantage of the increasing global demand for green technologies in order to create growth and employment.

Energy Strategy 2050 fulfils the government's pledge as set forth in its work plan "Denmark 2020", that it would present a target for when Denmark is to become independent of fossil fuels, as well as a strategy to meet this target.

At the same time, Energy Strategy 2050 supports and meets a number of Denmark's ambitious targets in the climate and energy area in the government's work plan, in the national energy agreement for 2008-2011, and as a consequence of the EU climate and energy package from 2008.

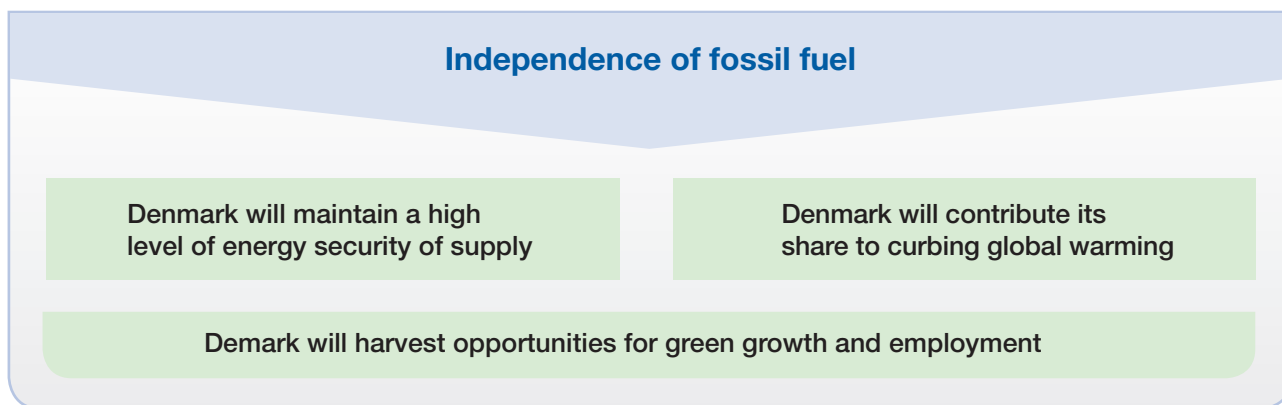


Figure 0.1. Effects of independence of fossil fuel

Introduction: From coal, oil and gas to green energy

Targets in the government's work plan

- Denmark is to be a green and sustainable society
- Denmark is to be among the three countries in the world to raise its renewable energy share most by 2020
- Denmark is to be among the three most energy-efficient countries in the OECD by 2020.

Danish targets arising from the EU climate and energy package

- The share of renewable energy will be increased to 30% of final energy consumption by 2020 as part of an overall EU target of 20% renewable energy by 2020.
- The share of renewable energy in the transport sector will be 10% by 2020

- Emissions in the non-ETS sectors will be reduced gradually in 2013-2020 and by 20% by 2020 relative to 2005 as part of an overall EU target to reduce emissions by 20% by 2020 relative to 1990.

Targets in the national energy agreement for the period 2008-2011

- In 2020, primary energy consumption will be 4% less than in 2006.

Danish objectives for EU climate and energy policy

- The government is working for an EU commitment to reduce overall emissions of greenhouse gases by 30% by 2020 relative to the 1990 level.

Box 0.1 The government's targets underpinned by Energy Strategy 2050

Fossil fuels are cheaper than renewables. This will probably hold true for some time yet. This implies economic costs in the transition to fossil fuel independence and will ultimately have to be paid by the Danish consumers of energy; in other words by companies and private households. The government therefore believes it is vital that the transition takes place as cost-effectively as possible, with concern for the long-term viability of public finances, the competitiveness of companies and ultimately for Danish jobs.

On the one hand, measures should not be forced through with an unnecessarily high expenditure right now. On the other hand, the benefits of lower greenhouse gas emissions, lower energy consumption, more stable fuel costs and less dependence on fossil fuels, also have value in the years up to 2050.

An economically responsible transition to fossil fuel independence is important to the Danish government

What is implied by independence of fossil fuel?

Obviously, any goal reaching almost 40 years into the future is associated with uncertainties. Therefore, the government's goal of fossil fuel independence includes some flexibility.

In summary, the government's goal is a greenhouse gas neutral energy sector, which utilises 100% renewables, or a combination of renewables and coal/biomass with CCS (carbon capture and storage). The goal also entails the continued exchange of energy products with other countries, so that Denmark continues to exploit all the

advantages of being part of an international energy market. For example, developing and participating in the European electricity market.

The ambition is also for a renewable energy based transport sector. However, in respect of achieving this Denmark is dependent on international technological developments and therefore has to adapt the level of ambition to the future technological and economic development.

Box 2.0 The goal of fossil fuel independence

Principles for the transition to independence

An economically responsible transition to fossil fuel independence is important to the Danish government. This means that the transition will meet the following principles:

A cost effective transition

The transition will be cost effective, with initiatives providing maximum security of supply and the highest reduction in the use of fossil fuels for every DKK of expenditure. This means that focus is not on large-scale use of technologies which require high subsidies. Instead, for these technologies focus is on research, development and demonstration, which in the long term can make them competitive, at lower levels of subsidy.

Minimal impact on public finances

The distribution of benefits and costs in connection with the transition must not burden public finances. Therefore, the transition is fully financed, with expenditures primarily covered by consumers of energy (companies as well as households).

Retaining competitiveness

The transition needs to take the competitiveness of Danish businesses into account. This requires that companies know the long-term framework, within which they must operate, and that energy costs do not increase significantly.

Full utilisation of international frameworks

The transition will make full use of the opportunities of a globalised world and of ever closer EU cooperation. The goal is not a self-sufficient Denmark. On the contrary, Denmark will continue to exploit all the advantages of being part of an international energy market.

The strategy will also ensure that the transition does not undermine nature or environmental assets. This implies for instance, that the infrastructure will take account of nature and people's opportunities to enjoy it. It also entails a sustainable use of biomass resources.

New challenges and new opportunities for energy policy



The 21st century will have to be the century in which we find new solutions to satisfy the demand for energy services, i.e. lighting, heating, transport, production etc.

The next 100 years will bring considerable change, with an increasing number of people demanding a share of the energy

Energy is a prerequisite for a modern society with economic growth and welfare. We take power and heating for granted, just as we take access to clean drinking water and clean air for granted. This has held true for most of the 20th century, and it should to apply for the 21st century.

However, for economic, strategic and environmental reasons, we will have to take a completely fresh look at the way in which we consume and produce energy. Over the last hundred years, western societies have had access to plentiful and relatively cheap fossil energy. The next 100 years will bring considerable change, with an increasing number of people demanding a share of the energy, while available fossil fuels become ever scarcer and oil resources are concentrated in the hands of just a few countries. There is also the fact that global climate problems will require us to burn far less coal, oil and gas. The 21st century will have to be the century in which we find new solutions to satisfy the demand for energy services, i.e. lighting, heating, transport, production etc.

With these challenges also come new opportunities for Denmark, since the majority of countries will be faced with the same challenges, meaning that there will be a

considerable growth in the demand for green technologies; an area in which Danish enterprises excel.

A good foundation

Over a number of years, Denmark has enjoyed high security of supply with world-class energy efficiency, and an increasing share of renewable energy. This is due to a radical conversion of the Danish energy system since the first oil crisis in 1973. Firstly, considerable energy efficiency improvements have taken place at companies and in households, and energy production has likewise been made more efficient, for example through the expansion of district heating and combined heat and power production (CHP). Secondly, the fuel mix has changed from 95% dependence on imported oil to a differentiated energy supply based on coal, oil, natural gas and renewables.

Independence of fossil fuels is to preserve this favourable situation in a future where Denmark and the rest of the world will experience increasing demand for energy services, while the production of fossil fuels, especially oil and gas, will be concentrated in ever fewer countries and regions.

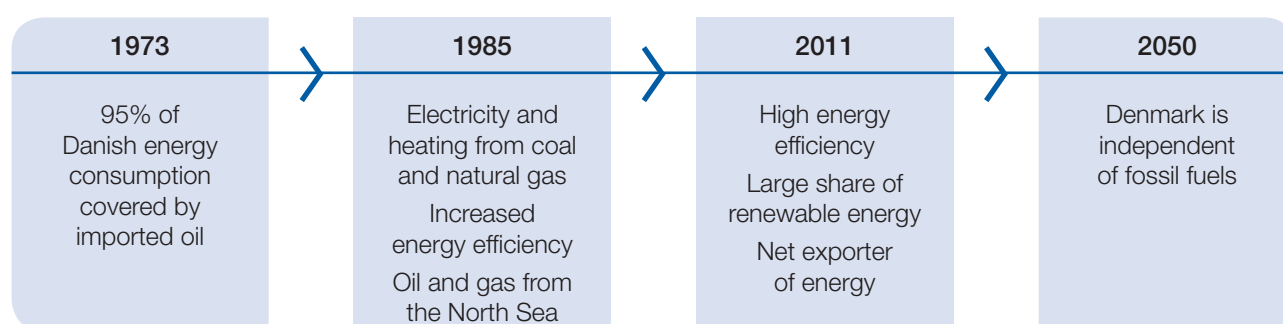


Figure 1.1 Phases in the transition of the Danish energy system

Security of supply under pressure

The world's population will increase towards 9 billion by 2050. Many people will become wealthier and as a consequence, the demand for energy for electricity, heating, transport and industry will increase. Within the next 25 years alone, it is expected that the world's total energy consumption will grow by approximately 34% according to calculations by International Energy Agency, IEA. This development is driven primarily by a growing demand in large developing countries and growth economies such as China and India.

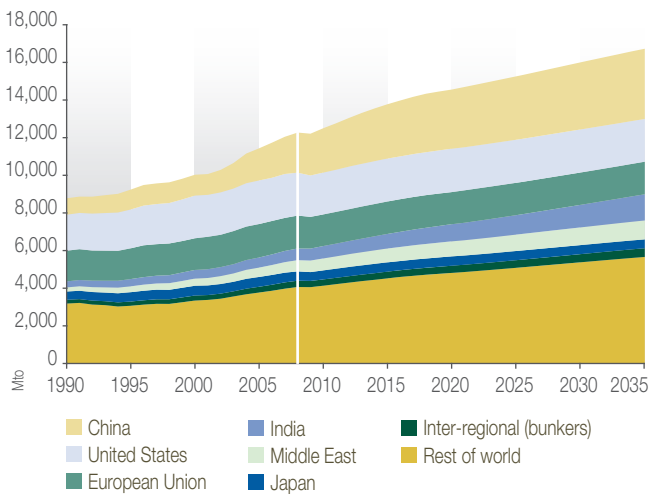


Figure 1.2. World primary energy demand by region up to 2035 (scenario based on national climate and energy policy targets).

(World Energy Outlook © OECD/IEA, 2010)

As the need for energy grows, ever fewer fossil fuels will be available. In particular, the world's oil reserves will be exhausted more quickly than new oil fields are discovered. Furthermore, for part of the remaining oil, extraction involves considerable environmental challenges. This applies, for example, to oil in the Arctic regions or to deepwater oil fields. Furthermore, it applies to oil production from natural gas and coal, tar sand and oil shale.

As regards natural gas production, the situation is less critical, at least in the short and medium term. As regards coal, global occurrences are plentiful, but other factors, primarily the consideration for the global climate, necessitate limited use.

In addition to this pressure on reserves, the world's oil, and to a certain extent natural gas resources as well, are increasingly concentrated in just a few countries. Thus, the OPEC countries will account for an ever growing share of global oil supply, as illustrated in figure 1.3.

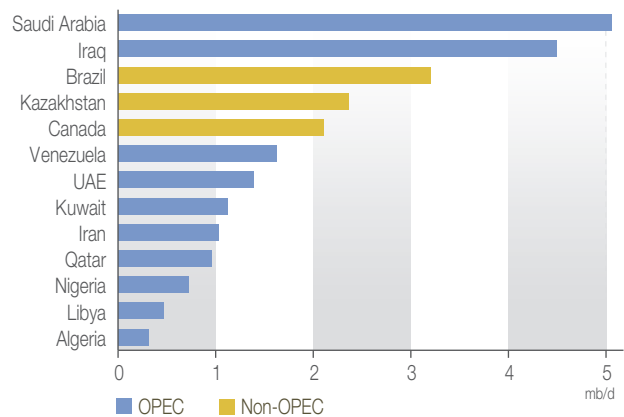


Figure 1.3. Incremental oil production by key country, 2009-2035

(World Energy Outlook © OECD/IEA, 2010)

On the basis of the IPCC's recommendations, the EU has committed to the objective of reducing emissions by 80%-95% by 2050

Security of supply can be expressed as the probability that there will be energy services available at competitive prices when consumers demand it, without this leaving Denmark in the unfortunate grip of dependency on other countries.

(Source: Energiforsyningssikkerhed – Redegørelse om forsyningssikkerheden i Danmark, 2010; Report on energy security of supply in Denmark, 2010)

Box 1.1 Definition of security of energy supply

The increased concentration of oil and gas resources in relatively few countries and transit routes increases the vulnerability to accidents, war and terror, threatening security of supply and price stability. Furthermore, this exacerbates the potential for producer countries to exert political pressure, wield market influence and thus push prices upwards. The consequence of such a development is growing dependence on the oil and gas producing countries. Another consequence is the transfer of wealth from the oil and gas importing countries to the oil and gas exporting countries. This transferral of wealth would be minimised if the consuming countries were to reduce their consumption and imports by instead investing in energy efficiency improvements and renewable energy.

On the other hand, a shift to an energy supply based on renewables is not without security of supply challenges either. For example, incorporating large amounts of fluctuating electricity produced from wind power into the energy system presents a huge technical challenge. As regards biomass and biofuels, availability of these resources may also come under pressure both domestically and abroad. All indications are, however, that Denmark can manage these security of supply challenges, although this requires continued integration, expansion and liberalisation of the European energy market.



The lasting climate challenge

Future climate change due to greater greenhouse gas effects seems inevitable. Even in a very ambitious scenario, where global emissions of greenhouse gases peak within the next few years and fall quickly hereafter, the atmosphere's content of greenhouse gases will only stabilise at present levels. This will undoubtedly contribute to a continued global temperature rise within this century. This prediction is confirmed by global temperature measurements which point at a continued rise in global mean temperatures. Furthermore, observations indicate, for example, that climate change in the Arctic is now occurring at an even faster pace than anticipated only a few years ago.

With the Copenhagen Accord concluded at COP15 in December 2009, a large number of countries agreed that the greenhouse gas concentration in the atmosphere should be stabilised at a level corresponding to a global average temperature rise below 2 degrees Celsius. This objective was confirmed at COP16 in Cancún, in December 2010. According to the Intergovernmental Panel on Climate Change (IPCC), satisfying this objective requires the developed countries to reduce their combined emissions by 25%-40% by 2020 relative to 1990 levels, and by 80%-95% by 2050 relative to 1990 levels as a step towards cutting global emissions by 50% by 2050.

On the basis of the IPCC's recommendations, the EU has committed to the objective of reducing emissions by 80%-95% by 2050 relative to 1990 levels as a part of concerted efforts by the developed countries. The EU objective cannot readily be transferred to a Danish reduction commitment by 2050, however it provides a good indication of the climate challenge which all EU member states, including Denmark now face.

A global green growth market

Denmark will become independence of fossil fuel. Over the coming years, many other countries will likewise have to decarbonise their economies. The global market for renewable energy and climate technologies, and for energy efficiency improvement solutions, will therefore grow considerably.

Figure 1.4 below illustrates the combined, expected investment in renewable energy technologies, broken down by electricity production technologies and biofuels, in key countries and regions during the period 2010-2035, assuming current climate and energy policy objectives. This development in the global market will primarily take place in large growth markets such as India and China, where energy demand will grow at an explosive rate in the coming years. China has a goal of meeting 15% of its energy consumption from non-fossil fuels by 2020. However, also within the EU, the national plans of member states to meet the EU 2020 renewables targets, witness the need for large investments in green technologies over the next ten years.

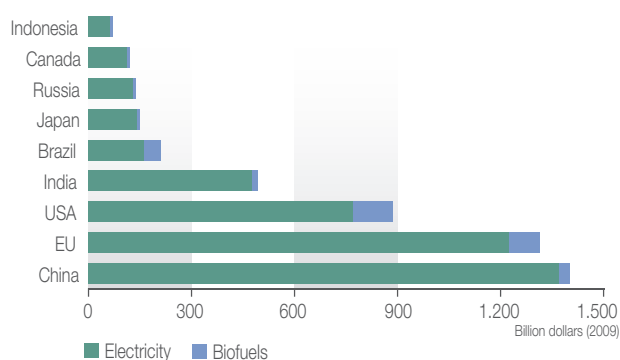


Figure 1.4. Energy technology share of total goods exports in 2009, from Denmark and EU15 average
(World Energy Outlook © OECD/IEA, 2010)

Exports of energy technologies and equipment accounted for approximately 12% of total Danish goods exports in 2009

The International Energy Agency (IEA) estimates that, in the period 2010-2030, the required overall global investment in renewable energy will amount to USD 6 billion, provided countries realise their existing climate and energy policy goals. If global emissions of greenhouse gases are to be reduced in line with IPCC recommendations, according to the IEA this will require significant extra investments in climate and energy technology solutions at the consumer and supply sides, respectively.

Exports of cleantech solutions

Exports of cleantech solutions are already playing an ever increasing and ever more important role for overall production and exports. Exports of energy technologies and equipment accounted for approximately 12% of total Danish goods exports in 2009. This is almost twice the figure in 2000, and far more than in any other European country, see figure. 1.5.

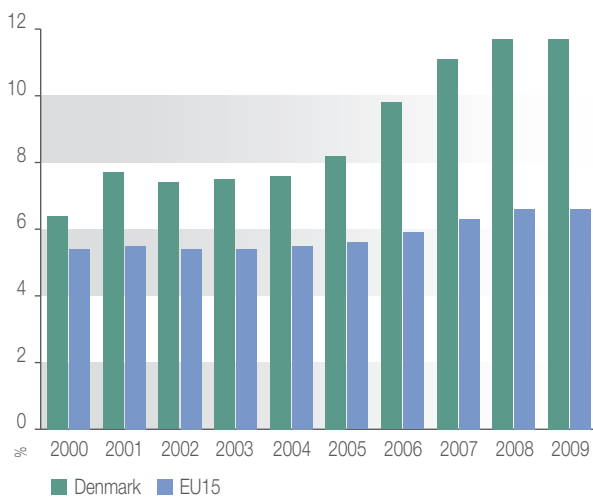


Figure 1.5. Energy technology share of total goods exports in 2009, from Denmark and EU15 average

Source: Danish Energy Agency

Danish companies therefore already possess an array of key competences in the energy area. However, global competition to deliver solutions to the rapidly growing market is intensifying considerably. Retaining and developing Danish skills and international market shares therefore places great demands on Danish companies. It is also essential to ensure Danish companies have optimal framework conditions in comparison with competitors abroad.

Amongst other things, it is important that the transition of the energy system, in combination with targeted efforts within research, development, demonstration and preparation for market uptake, allows companies to assist in developing the new solutions. This will create the best business setting for developing new export technologies in Denmark. Obviously, it is important that this platform for cleantech companies is not detrimental to the competitiveness of the rest of the Danish business community.

A flexible strategy

2



The great challenge is to ensure an appropriate transition process. Over the next 40 years more or less the entire energy system will be replaced

Measures should be organised cost effectively to achieve the highest levels of security of supply and reductions in fossil fuels

In 2050 Denmark could well be a wealthy society which uses considerably less energy than at present and which covers its energy needs with renewable energy sources. This is clear from the analyses by the Danish Commission on Climate Change Policy. The great challenge is to ensure an appropriate transition process. Over the next 40 years more or less the entire energy system will be replaced. In some areas, the consequences of investments and decisions made now will have an impact right up to 2050. Therefore, it is important that energy policy supports the goal of fossil fuel independence. Without this, the goal will be harder and more expensive to reach.

Denmark also has a number of energy and climate policy goals which set the scene for immediate measures. Therefore, it is necessary to adopt initiatives pointing towards the long-term goal of fossil fuel independence, and which contribute to meeting goals in the short and medium term. Energy efficiency and renewables are the two key focus areas to put Denmark on track to meeting the long-term goal of fossil fuel independence and to help meet the 2020 targets of increasing the share of renewables, reducing gross energy consumption, and reducing non-ETS greenhouse gas emissions.

Measures should be organised cost effectively to achieve the highest levels of security of supply and reductions in fossil fuels for each DKK invested. This means that measures should be targeted, and timing is vital. On the one hand measures should not be forced through with unnecessarily high expenditure right now. On the other hand, the benefits of less dependence on fossil fuels and lower greenhouse gas emissions also have value in the years up to 2050.

An energy and transport system without fossil fuels

Achievement of fossil fuel independence requires efficiency improvements in energy consumption to a level which can be covered by massive renewable energy expansion – although we will still exchange energy (electricity, biomass, biofuels etc.) with the world around us. The transition is outlined very generally in figure 2.1.

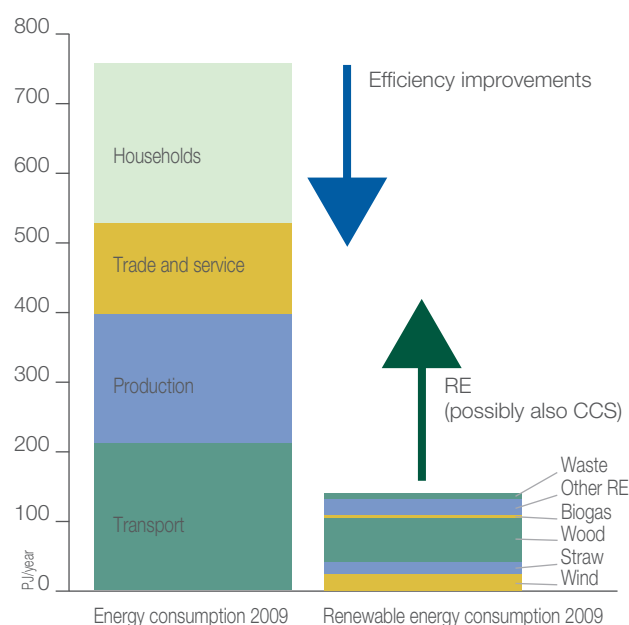


Figure 2.1. Energy consumption and renewable energy 2009. Source: Danish Energy Agency

A cost effective energy system, independent of fossil fuels, requires significant improvements in energy efficiency

A flexible strategy

Key elements

A number of technologies and focus areas already well known today will probably be pivotal in a cost effective transport and energy system without fossil fuels. The energy technologies with significance for the energy system today have been known and used for more than 40 years. Clearly these technologies will develop, but it is likely that the energy system of 2050 will be borne by technologies we already know today. Likely elements in an energy and transport system independent of fossil fuels are:

A highly efficient energy consumption

A cost effective energy system, independent of fossil fuels, requires significant improvements in energy efficiency. Demand for energy services will very likely be considerably higher than today, but energy services will be supplied using a lower amount of energy. Therefore, in 2050 Danish energy consumption could be more than 50% more efficient overall. This is partly due to the fact that far-reaching energy efficiency improvements could make more financial sense than increasing energy supply.

Electrification of heating, industry and transport

There are strong indications that in 2050 many more energy services than today will come through electricity. District heating, individual heating systems and industrial installations can be based on electricity. Transport can be electrified by converting cars, railways and, to a cer-

tain extent, busses and lorries to electricity. This will also provide massive efficiency improvements as combustion motors typically waste four-fifths of the energy, while only one-fifth is lost in electric motors. Electric cars will probably be an important transport technology, but in 2011 it is not possible to predict exactly the comparative roles and advantages of, for example, electric cars, plug-in hybrids or fuel-cell cars, in 2050.

More electricity from wind power

It is very likely that wind power will account for a very large amount of future electricity production. Wind is one of the renewable energy sources showing greatest physical potential in Denmark, and costs are expected to drop. In principle, wind power could cover current levels of electricity consumption many times over. Today, production costs are lowest for onshore turbines, but there are only limited locations to site them. Therefore, offshore wind turbines will probably be crucial, even though production costs are higher than for onshore installations.

An efficient utilisation of biomass resources

In the future, biomass will play an even more important role in the energy system than today. This will be to cover a large proportion of CHP production, and also probably to produce biofuels for heavy and very energy-demanding modes of transport such as aircraft and heavy goods vehicles. However, the potential in biomass is not unlimited. If global demand for biomass increases, so will the costs of utilising biomass.

Utilisation of biogas

The natural gas grid and its associated storage facilities could also play a key role in an energy system without fossil fuels. This may be through utilising biogas and possibly other types of gas from organic sources. RE gasses can be used at CHP plants in the same way as solid biomass and thereby they can act as a balance for the fluctuating electricity production from wind turbines.

Photovoltaic solar modules and wave power as supplements

In the longer term, photovoltaic solar modules and wave power could replace some wind power. How much wind power they will replace will depend on technological development. Photovoltaic solar modules are a well tested technology, but at present they are more expensive than electricity from wind turbines. However, there may be technical and financial advantages in spreading electricity production between different technologies. Wave power is still at the developmental stage, but it may play a role in the long term.

Spreading RE-based district heating and individual heating

District heating systems make it possible to incorporate large amounts of fluctuating renewable energy at relatively low investment requirements. Continued exploitation and expansion of this infrastructure is an important element. There are strong indications of significant cost effectiveness potentials in converting from individual natural gas supply to district heating. The challenge is to find an appropriate cut-off between district heating and individual heating in a technical and economic context.

An intelligent energy system

Energy production with significant amounts of fluctuating energy places pressure on the energy system to ensure that energy consumption can be covered hour by hour. Most important is exchange with foreign countries, and this requires gradual expansion of transmission capacity. In addition, there is the need for more flexible (intelligent) electricity consumption so that electricity is used for heat pumps, electric boilers and to recharge electric cars, for example, when there are strong winds and normal electricity consumption is low. Finally, there will be a need for electricity storage capacity which can be supplied cost effectively by the Norwegian and Swedish hydropower facilities. However, it is possible that other types of electricity storage, for example based on battery technology, could in the future supplement foreign electricity trade.

A flexible strategy

Nuclear power - still many arguments against

In 1985 the Danish Parliament (the *Folketing*) decided that nuclear power would not be part of Danish energy planning. There remain arguments against nuclear power in Denmark. It would be difficult to find locations for nuclear power plants in Denmark and there is limited Danish growth potential in the technology, because the technology has to be purchased from abroad. Finally, there are still challenges with regard to safety and disposing of radioactive waste.

Experience with regard to the economics of nuclear power varies greatly. In many cases installations are fully or partly owned by the state, with a number of direct or indirect subsidies for nuclear power. Theoretical comparisons between the economics of nuclear power and other types of production indicate that nuclear power provides relatively cheap electricity. In practice, however, there are many examples of nuclear power plants which significantly exceed budgets.

On the basis of information from the new Finnish nuclear power plant, Olkiluoto-3, which has been plagued by long delays and budget overshoots, investment per unit of electricity capacity is about 3.5-times more than coal power, approximately eight-times more than gas power and two-three-times more than wind power. The high investment costs of nuclear power must be recouped

through operating revenues, and this is possible if the plants are in operation for a long time. With considerable uncertainty, it has been estimated that for Danish conditions, nuclear power and offshore wind power cost almost the same, although it should be noted that the economics of nuclear power plants are very sensitive to interest rates.

There are system challenges linked to incorporating nuclear power in Denmark into an electricity system dominated by fluctuating wind power and electricity production bound to heating. Furthermore, there are relatively large variations in electricity consumption over a 24-hour period in Denmark (compared with countries with more energy-intensive industry and more electric heating, for example Finland and Sweden). For economic and technical reasons, nuclear power plants should preferably operate at full capacity all the time, and therefore they are not very suitable for adjustment to compensate for variations in wind production.

Although there are several arguments against basing Danish electricity production on nuclear power, at all events Denmark will continue to trade electricity with other countries and therefore also import electricity from countries where nuclear power will account for a considerable amount of electricity production in the future.

Box 2.1 Nuclear power

Observed climate change

The average temperature in Denmark has increased by 1.5°C and precipitation has increased by 15% since systematic national records began in 1873. The Danish wind climate has also changed over the period. More powerful storms and hurricanes have been observed. In the future even greater climatic changes can be expected, with potential consequences for the energy system.

The energy need

Up to 2050 it is expected that winters will become warmer, with correspondingly shorter heating seasons. Therefore, there could be slightly less need for space heating. In contrast, the need for cooling in summer (primarily in offices, shops etc.) is expected to rise in line with longer heat waves. In new housing, the new building standards will limit the need for cooling, but for existing housing there may be increased demand for cooling installations.

Energy production

Up to 2050 there are chances of a longer growing season. Together with higher temperatures and more precipitation in the summer, this could lead to more biomass production in both agriculture and forestry. As winters become wetter and milder, there will also be good opportunities for more energy production from hydropower in Norway and Sweden. In addition a modest increase in wind energy potential is also expected.

Extremes

Towards 2050 more, and more powerful hurricanes may disrupt the electricity grid and infrastructure and mean that wind turbines will be shut down for short periods. However, it has been estimated that these effects will only have marginal significance for the security and stability of the electricity system. On the other hand more, and more powerful hurricanes, in conjunction with more precipitation, could lead to a greater likelihood of massive windfalls and this may affect international markets for chippings and wood pellets.

Consequences

Overall, the conclusion is that the expected milder winters in the future will have a modest, yet positive impact on the Danish energy system and the possibilities for the transition to fossil fuel independence, although there is a large degree of uncertainty regarding the future demand for cooling.

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

Box 2.2 Potential changes in the Danish climate and the possible effects on the energy system

A flexible strategy

An unpredictable future demands flexible answers

On the one hand, it is possible to mark out the contours of an energy system in 2050 without fossil fuels and to identify a number of the key elements. However, on the other hand it is impossible to predict economic growth, technological development or fuel and CO₂ prices 40 years ahead, and in so doing detail the optimal energy system for 2050.

Development and costs of technologies and fuels will depend to a large extent on the level of ambition for climate and energy policy set by the rest of the world. At the same time these aspects are crucial for determining how best to achieve a cost effective energy system without fossil fuels. For example, investors' choice between electricity production technologies will be based on the relative costs of the various fuels, technologies, financing etc. In the long term, cost effective transition will therefore involve securing more or less uniform support across technologies in which account is also taken for the effects of the technologies in relation to, for example, relevant political objectives, environmental impacts and security of supply.

A robust and cost effective strategy

The government will organise the transition so that it is robust and cost effective. On the basis of the knowledge available today, it is expected that the goal of fossil fuel independence will be realised most cost effectively by making energy consumption more efficient; with more electrification of energy consumption in combination with greater electricity exchange and a more intelligent energy system; with more district heating and individual RE-based heating; with expansion of wind power and other renewables; and finally with effective utilisation of biomass resources for CHP and parts of the transport sector.

On the other hand, electric cars, solar energy, wave power, CCS and so on are currently relatively expensive technologies, which require continued subsidies. However, this can change over time. Therefore, the strategy should be flexible, i.e. open for all technological possibilities. For example, the government will not yet exclude some utilisation of coal with CCS, if this proves to be a more cost effective and environmentally appropriate solution in a green transition. If it turns out to be technically and economically untenable to convert the entire transport sector to non-fossil alternatives, it will also be necessary to manage the security of supply issue and climate impacts in some other way.

CCS

Coal power combined with CCS (Carbon Capture and Storage), could also be a relevant technology in the longer term, possibly in combination with biomass, whereby CO₂ is "withdrawn" from the system. There are relatively large coal resources globally and Denmark has geological formations well suited to depositing CO₂. The CCS technology is not yet commercially viable and involves high costs and energy consumption. However, there is no reason to exclude this technology from being part of the Danish energy system at a later date.

Hydrogen

Biomass could be a limited resource in the future. A replacement could be other fuels such as hydrogen in the transport sector rather than biofuels, or hydrogen for electricity and heating instead of biomass. Hydrogen cannot be found in nature and therefore it has to be manufactured, for example using electricity from wind turbines for electrolysis. There is great potential, but at present prospects are inhibited financially because of losses in manufacture, storage and conversion of the hydrogen.

Box 2.3 Examples of technologies which could play a role in a 2050 perspective

The government will organise the transition so that it is robust and cost effective

Figure 2.2 illustrates that, in addition to the key elements, there are a great many possible variations with clear significance for how the energy and transport system of the future is best designed. For example the relationship between wind, photovoltaic solar modules, wave power and other RE technologies will depend on technological developments and how they compare financially. Correspondingly, transition from fossil fuels to biomass will depend on potentials to produce as well as import biomass at reasonable prices.

There is a crucial uncertainty in developing competitive alternatives to the combustion engine. The solutions which come to dominate the transport sector will have an impact on other parts of the energy system. Finally, but also importantly, the need for foreign trade should be considered in the light of relative prices for imported electricity compared with Danish adjustable production, or possible new storage options.

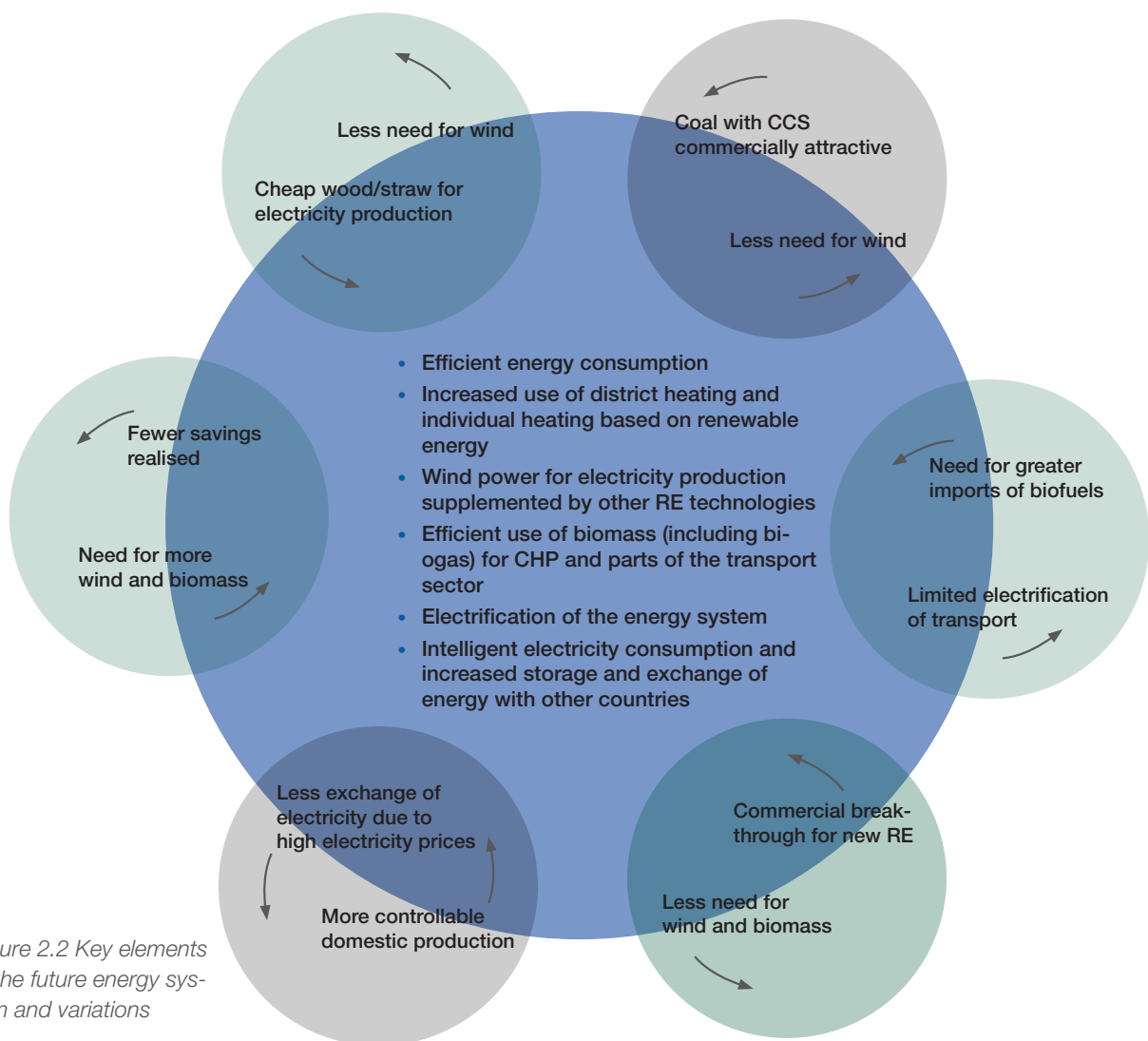


Figure 2.2 Key elements in the future energy system and variations

A flexible strategy

A strategy with robust choices and the right timing

In this strategy for fossil fuel independence, the government is focussing efforts on elements which are robust and expected to make up the core of a cost effective energy and transport system without fossil fuels. Efforts should also take account of the lifetimes of the relevant technologies and installations, the length of time from decision to practical implementation, the need to retain knowledge and skills, as well as the issue of maturity and prices of the relevant technologies.

Long operational life in the energy sector

The energy system is made up of both the producer and consumer sides of a number of technologies and installations which call for huge investment and which have a long operational life. For example, power plants typically run for 30 years or more and the buildings often stand for more than 100 years. This means that in the transition of the energy system it will have to be considered when the existing installations will wear out and require replacement or renovation, in order to avoid unnecessarily scrapping well functioning installations. It is also vital to choose future-proof solutions when replacement or renovation of, for example, buildings is carried out. In some circumstances this will only happen once before 2050.

Long time from decision to practical implementation

Many types of installation in the energy sector require a long time for decision-making, planning and establishment processes. A large offshore wind farm often takes at least five-six years from decision to commencement

of operation. New high tension installations or central power plants can easily take up to 10 years from decision to implementation. This means that many of the decisions made today will not take effect for five, 10 or even 15 years.

Great need for skills and knowledge

The rate of transition should also be considered in the context of development and retention of skills as well as building new knowledge. Danish companies already possess an array of key skills in the energy area. These include RE technology and efficient technologies, as well as knowledge and experience on integrating renewables. A crucial element in retaining these companies' development departments is that it is possible to realise results and to develop new knowledge on the basis of specific experience from applying new technology. Innovation, production and application cannot be considered independently of each other.

Large differences in technological maturity and prices

Today there are already technologies in a number of sub-sectors in the energy system which are or are expected to soon becoming financially and technologically competitive with technologies using fossil fuels. For example, wind turbines and biomass to produce electricity. In other areas technologies have yet to be fully developed to be able to completely replace fossil fuels. In this context there is a need for further research and demonstration in collaboration with foreign knowledge centres. For example, in transport there remain a number of challenges before full transition to non-fossil technologies such as electric cars, biofuels or fuel cells can take place.

Innovation, production and application cannot be considered independently of each other

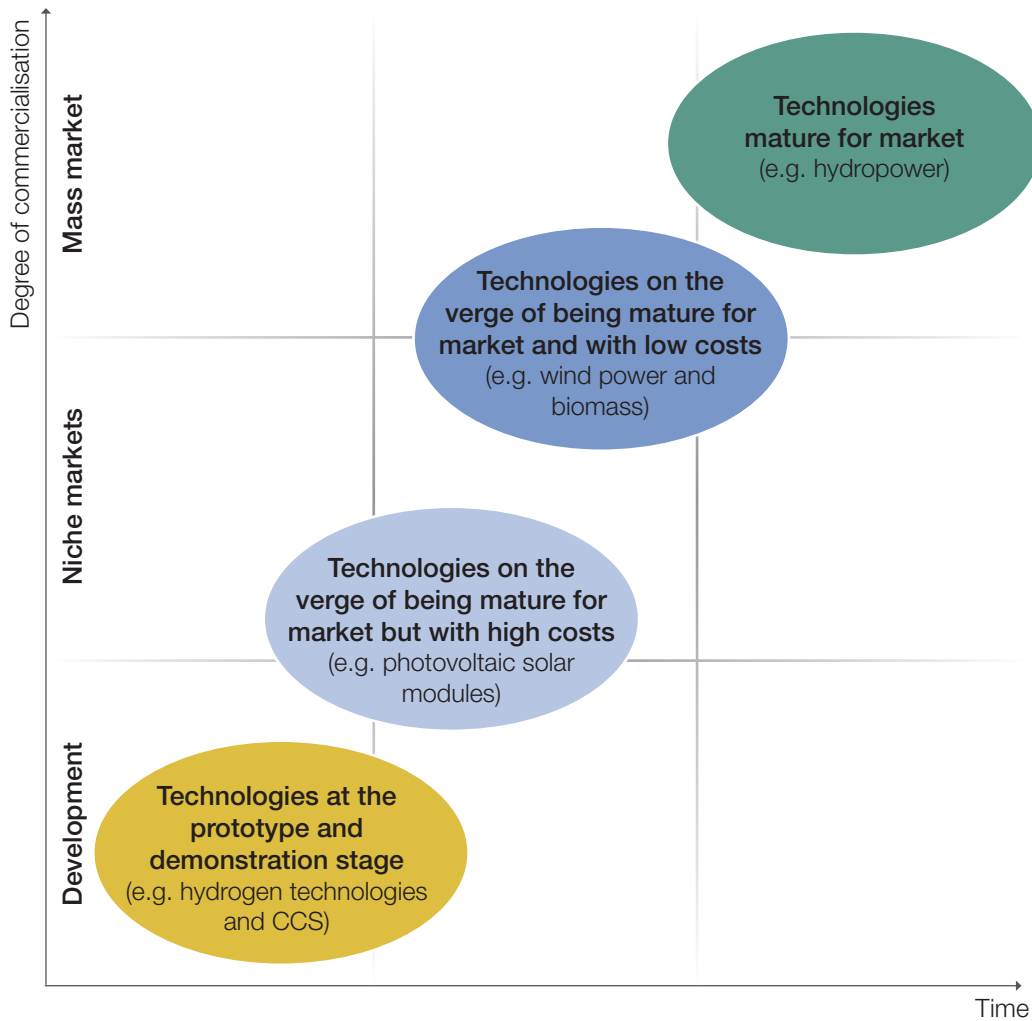


Figure 2.3 Non-fossil-based energy and transport technologies

A flexible strategy

A strategy with three tracks

Operational life, decision-making processes, technological maturity and prices vary across the energy system. The same applies for the need to retain and develop knowledge and Danish skills. Therefore the government's

strategy follows three tracks. The strategy starts up immediate initiatives in all three tracks, but the types of initiative vary.

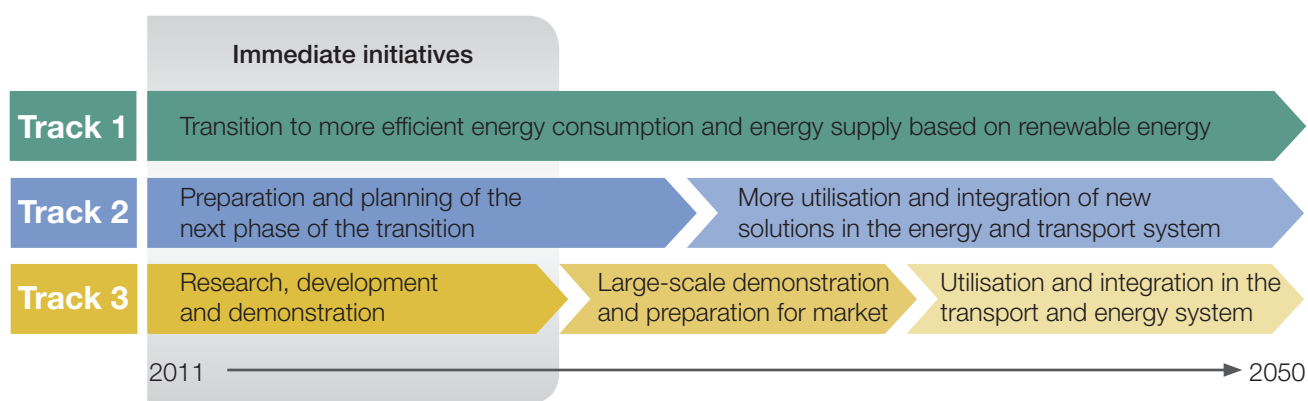


Figure 2.4 Illustration of the three tracks in the strategy

The transition track (track 1) deals with the areas in which physical conversion can already start today because the technology is cost effective with long operational life and decision-making processes. In addition, because the areas involved also contribute to realising short and medium-term objectives.

The planning and preparation track (track 2) deals with areas in which initially there is a need to ensure establishment of the framework before specific measures towards 2050 can be initiated.

The technology development track (track 3) deals with areas in which the primary need is for more knowledge, analysis, research, and development as well as demonstration and preparation for market efforts before concrete incorporation into the energy and transport system of the future can be implemented.

Chapter 3 describes the specific initiatives in the strategy which can be implemented within the three tracks immediately.

Track 1. Examples where the transition will commence immediately:

Making buildings more efficient

Extensive improvements in the energy efficiency of existing buildings should be implemented in connection with renovation and replacement in order for them to be cost effective. At the same time, efficiency improvements contribute immediately to meeting the 2020 targets.

Electrification of heating and process installations

Installations to heat buildings and for industrial processes have a long operational life; typically 25 years or more. Therefore it is advisable to start converting to electricity or heat pumps already now, as oil and gas furnaces and boilers have to be replaced. This will also contribute to meeting the 2020 targets.

Expansion of wind power

Wind power seems to be cost effective and robust against future developments in fuel and CO₂ prices, and it will be able to replace a great deal of the existing electricity capacity which will have to be replaced over the next 10-20 years.

Increased use of biomass

Biomass can play a central role in combination with wind production and possibly also in connection with coal and CCS. In the short term, conversion to more biomass at power plants could reduce use of fossil fuels and thereby contribute to meeting the target of 30% renewable energy by 2020.

Track 2. Examples where transition has to be prepared and planned:

Planning of the energy infrastructure

Integration of more fluctuating electricity production and electrification of end use involves a long-term need to develop the infrastructure. In this context, the gas infrastructure of the future should also be planned with a view to enabling biogas and other RE gasses to take over from natural gas to a certain extent. This means that planning must commence immediately.

Framework for future district heating production

District heating production will change as consumption of fossil fuels at electricity and CHP plants is phased out. As this involves long-term investments, there is a need to set the framework for future district heating production now, through amongst other things strategic energy planning.

Track 3. Examples of areas with a need for further research, development and demonstration:

Research focussing on incorporating wind power

Denmark's vast wind resources provide future opportunities to harvest large parts of energy consumption from the wind. Increased incorporation of wind requires, however, continued research and technological advances to reduce the energy costs and optimise the interplay of wind power with the electricity grid and electricity consumption, including methods to store the energy for a period.

Large-scale demonstration

A large number of technologies may require large-scale testing before subsequent preparation for market and full-scale implementation. For example, this applies for offshore wind, fuel cells for CHP production, smart grids, biorefineries, low-energy building and energy renovation.

Box: 2.4 Examples of the initiatives in the three tracks

Initiatives in the strategy

3



The package includes initiatives with immediate effect, initiatives setting out long-term frameworks, and initiatives that encourage more technological development.

With this strategy, the government presents a package of energy and climate policy initiatives. The package includes initiatives with immediate effect, initiatives setting out long-term frameworks, and initiatives that encourage technological development.

The package consists of initiatives that promote:

- Good framework conditions for future electricity and heat production
- Increased expansion of wind power
- Greater use of biomass
- A solid foundation for biogas expansion
- Highly efficient energy consumption
- Efficiency improvements in households and in buildings in general
- A cohesive and intelligent energy system
- Transition to green energy in the transport sector
- An energy system with appropriate financial incentives
- A transition which creates green growth through research, development, demonstration and preparation for market
- Ambitious endeavours for a global transition
- An EU independent of fossil fuels
- Long term reduction in the emission of greenhouse gases from agriculture
- Efficient and environmentally sound use of North Sea resources.

Energy efficiency improvements

Enhancement and targeting of saving efforts by energy companies aimed at private homes and businesses.

Future-proof efficiency standards for building components to ensure houses which are more energy efficient.

No new oil boilers in new buildings from 2012 and in existing buildings from 2017.

Market promotion of RE-based alternatives to oil and gas heating.

Promotion of new buildings with very low energy consumption.

Enhanced energy saving efforts in the public sector.

Heating and electricity production

Call for tenders for a 600MW offshore wind farm at Kriegers Flak.

Call for tenders for smaller offshore wind turbine installations totalling 400MW closer to the coast than the actual wind farms. Initiatives for more onshore wind power, aiming at an additional 500MW.

Fuel shift from coal to biomass at large-scale plants with greater freedom of agreement between producers and buyers.

Shift from natural gas to biomass at small-scale CHP plants with free choice of fuel.

Improved framework conditions for production of biogas.

Funds for strategic energy planning in municipalities with a view to better utilisation of local resources, including district heating.

Transport

A 10% biofuels obligation in the transport sector by 2020. Technology assessment in order to support the right framework conditions for new transport technologies.

Fund to promote the establishment of recharging stations for electric cars. Efforts to tighten EU standards on vehicle energy efficiency and CO₂ emissions.

Push for EU harmonisation and standardisation of technologies for electric cars.

An intelligent and international energy system

New international electricity transmission capacity in connection with the offshore wind park at Kriegers Flak.

Analysis of the need to expand international transmission grid.

Roll-out of intelligent electricity meters.

Strategy for the promotion of smart grids.

Analysis of the regulation of the future gas structure.

Central elements of the energy system in 2050

Efficient energy consumption

Increased use of district heating and individual heating based on renewable energy.

Wind power in electricity production supplemented by other RE technologies.

Efficient use of biomass (including biogas) for CHP and parts of the transport sector.

An electrified energy system.

Intelligent electricity consumption and increased storage and cross-border trade in energy.

Cross-sectional measures

Enhanced prioritisation and cohesion in research, development and demonstration in the climate and energy area.

Support for large-scale demonstration and preparation for market of new RE technologies (solar, large heat pumps, geothermal energy etc.).

Review of regulation of the Danish electricity supply sector.

Examination of the subsidy and tax systems.

Efforts to increase the EU greenhouse gas reduction target to 30% by 2020.

Figure 3.1 From 2011 to 2050. Key initiatives in the strategy

Background

The government will

Good framework conditions for future electricity and heat production

A large part of Denmark's consumption of fossil fuels, in the form of coal and gas, is used to produce electricity and district heating. Extensive conversion of the electricity and heating sector to renewable energy is an essential step towards independence of fossil fuels.

Since supply technologies and infrastructure in electricity and heat production generally have very long life spans, in many cases there will be only one opportunity to convert before 2050. It is anticipated that a great number of Danish plants will either be taken out of operation or will wear out before 2020 and have to invest if they are to maintain production of heat. All things being equal, it will be cheaper to replace worn out installations than to replace still functioning installations. Therefore, the most appropriate solution is to make the shift away from fossil fuels when an existing plant is worn out. Furthermore, it must be anticipated that electricity consumption will increase as an ever greater share of energy consumption is electrified. It is therefore important that frameworks are established today which underpin investments in technologies bringing us closer to the 2050 target.

Furthermore, in the short term, the need for new RE capacity is justified by the target of a 30% share of renewables by 2020. Meeting and upholding this target will require significant efforts in the years to come.

Being the most developed and most cost-effective sources of energy, biomass and wind will play primary roles in an energy system without fossil fuels. In the long term, other technologies may also come into play. Continued support will therefore be necessary for the development of a wide range of RE technologies.

As a general rule, the government's goal of fossil fuel independence means no use of fossil fuels in 2050. However, the government will not a priori exclude some use of coal with CCS, if this turns out to be an efficient, feasible and environmentally appropriate solution in a green transition.

- Launch an in-depth review of electricity supply legislation and regulation in order to ensure that incentives and rules support the transition to fossil fuel independence. In the long term, other areas of energy supply will also be reviewed
- Allocate DKK 20 million for strategic energy planning partnerships between municipalities, local companies and energy companies. These funds are to promote the integrated development of energy demand and energy supply which underpins the transition to fossil fuel independence. This is to take place e.g. through the expansion of district heating
- Allocate DKK 10 million for demonstration of large heat pumps in the district heating sector, and analyse the conditions for, and implications of, the phasing-in of large heat pumps
- Allocate DKK 20 million for geothermal energy exploration projects
- Extend the existing PSO scheme that supports small electricity-producing renewable energy technologies such as wave power, bio-gasification and solar photovoltaics for a further four years, so that a total of DKK 100 million is allocated for the period
- Allocate DKK 10 million to support demonstration projects on solar heating for household solutions, including use of solar heating in combination with other RE solutions such as heat pumps. Efforts will also include an information campaign and the launch of a certification/quality assurance scheme
- Work for a revision of the EU's CHP Directive towards an efficient energy system in a future EU free of fossil fuels.

Background

The government will

An increased expansion of wind power

To the extent that suitable locations can be found, onshore wind turbines are far cheaper than offshore wind turbines and most other RE technologies. Due to technological development and rising electricity prices, it is expected that wind power in the long term will be able to compete with conventional electricity production, and that subsidies for onshore wind turbines can therefore gradually be phased out.

The majority of existing onshore turbines are more than ten years old and will most likely be scrapped before 2020. The need to designate more locations suitable for new and larger turbines is therefore great. In order to cater for the technological development of new turbines, it will also be necessary to designate suitable land where the wind turbine industry can test and demonstrate new turbines.

Future wind turbines will increasingly have to be placed offshore, since there are only a limited number of suitable locations available onshore. The potential for offshore wind turbines is huge in Denmark. In order to promote technological development of offshore wind turbines, it is necessary, that newly developed turbines can be erected and operated on a continuous basis, preferably closer to the coast than previously. This will also provide opportunities for the general public, private organisations, municipalities etc. to be involved in the projects.

- Call for tenders for a 600MW offshore wind farm at Kriegers Flak. Kriegers Flak can be realised as a joint project between Denmark and Germany (and possibly also Sweden) with expected operationalisation 2018-2020
- Call for tenders for smaller offshore wind turbine installations totalling 400MW closer to the coast than current wind farms. This will enable testing and demonstration of new turbines, foundations etc., as well as sites for conventional wind mills, up to 2020. Suitable locations will be found through a screening process
- Improve tendering procedures for offshore wind farms to reduce the costs of expansion and prepare the basis for offshore wind turbine expansion decisions in the period after 2020
- As part of a general analysis of subsidy systems examine how subsidies for onshore turbines from 2014 can be designed most appropriately, so that they are adjusted to rising electricity prices and technological development
- Support continued municipal planning for new onshore wind turbines and at the same time look more closely at planning tools for onshore wind turbines. Up to 2020, in combination with other external conditions, this is expected to contribute to new turbines totalling a capacity of 1800MW. This is 500MW more than expected so far
- Analyse the opportunities for reducing the distance requirements for wind turbines placed along roads and railways with a view to better use of locations in such areas
- Commission a strategic environmental assessment with a view to both call for tenders on nine state-owned land plots for the erection of onshore wind turbines, and to assist municipalities with wind turbine planning
- Designate land for testing prototypes and 'series 0' wind turbines
- In cooperation with industry, continue the wind turbine secretariat, including the mobile wind turbine task force, which assists municipalities with wind turbine planning.

Background

The government will

A greater use of biomass

Biomass has the potential to replace large amounts of coal and natural gas cost-effectively in the relatively short term. In the long term, conversion from fossil fuels to renewable energy outside Denmark can lead to pressure on biomass resources and thus rising prices, and possible challenges to security of supply. On the other hand, it must be anticipated that the technologies used in the production of biomass and biofuels will undergo developments which can lower the price of energy produced from biomass.

At present, the majority of large-scale power plants in Denmark can use biomass for part of their production, while many natural gas fired small-scale plants have long had an ambition to convert to biomass-based heat production.

The largest Danish cities have ambitious climate plans and have expressed their wish to make heating from large-scale plants carbon-neutral within the next 20 years. The government will therefore allow for a greater degree of freedom of contract between producers and buyers of district heating in the larger cities. Furthermore, the government will remove the restrictions on the free choice of fuel for smaller plants outside the ETS sector, so that these plants can replace natural gas with biomass.

By removing these restrictions and introducing the free choice of fuel, the government can also contribute to lower heating prices in the district heating areas involved. This will especially benefit the open-field plants, some of which today charge very high prices. The free choice of fuel will also make for greater use of local biomass resources by smaller plants, for instance straw and chip-pings, to the extent that this is profitable.

- Change the provisions of the Danish Heat Supply Act, so that the settlement of prices on heating produced from biomass at large-scale CHP plants will no longer be limited by non-profit regulation. In this way, producers and buyers of CHP can agree on a price by which they share the tax benefits of the transition to biomass
- Allow plants of up to 20MW a free choice of fuel, which will enable a number of natural gas fired plants to convert to production based on biomass
- Carry out an analysis of the use of biomass for energy-related purposes in Denmark. The analysis will focus on whether the right framework conditions for efficient and environmentally sustainable use of biomass resources are in place. The analysis will prepare a long-term strategy for the use of biomass resources for energy purposes and will draw on experience from other countries

Background

The government will

A solid foundation for biogas expansion

Agriculture will play a key role as a green energy supplier in the transition to fossil fuel independence. In accordance with the national Green Growth agreement, the government wants Denmark to aim for the exploitation of up to 50% of livestock manure for green energy. There are large unexploited biogas resources, especially in the form of livestock manure in agriculture. These can replace natural gas, oil and coal for energy purposes. Greater use of livestock manure will also benefit the aquatic environment and will contribute to reducing emissions of greenhouse gases from agriculture, which in turn will contribute significantly to meeting Denmark's international climate commitments.

The government is monitoring closely the expansion of biogas and has agreed with the Danish People's Party to take stock of these developments at the end of 2012, see the Green Growth agreement. However, even now the government is presenting a package of initiatives to support realisation of a 50% use of livestock manure by 2020, whilst taking into account the effects of introducing the free choice of fuel.

The biogas package proposes raising the start-up aid and introducing a new subsidy system, which will provide subsidies for a greater variety of uses. It is the government's ambition that a greater share of the subsidies be paid directly to the biogas plants, so that the plants may receive subsidies for all biogas production irrespective of ultimate use. Biogas plants will therefore be able to choose whether to use biogas in their own processes or sell it off to the highest bidder. In the longer term this will help improve financial performance in the biogas sector and it will enhance the use of biogas for a greater variety of purposes, e.g. in the natural gas grid and in industry. In order to cover the costs of livestock manure separation, the government will moreover introduce a subsidy for biogas from livestock manure.

- Introduce a subsidy of DKK 27/GJ for biogas production from 2012. The subsidy will be paid to the biogas plant regardless of how the plant uses the biogas
- Retain current levels for preferential treatment of biogas in CHP production, and for the average plant this will correspond to approximately DKK 75/GJ, including the biogas production subsidy, in 2012
- Introduce a subsidy for biogas in the natural gas grid on equal terms with CHP production, entailing a total subsidy of DKK 75/GJ, including the biogas production subsidy, in 2012
- Introduce a subsidy for biogas in industry and transport of net DKK 12/GJ, so that the total subsidy for biogas in industry and transport is raised from 2012 by net DKK 39/GJ, including the biogas production subsidy
- Introduce an additional subsidy of DKK 22.5/GJ for biogas from livestock manure. The subsidy will be reduced in line with natural gas prices
- Increase the aid from a start-up construction fund from 20% to 30%
- Set aside funds of DKK 25 million in 2012 to safeguard the required expansion of the biogas infrastructure with a view to alleviating any negative consequences for existing biogas plants in connection with the introduction of the free choice of fuel
- Allow, on a voluntary basis, changing from fixed electricity settlement to an electricity price supplement for 100% biogas-based plants.

Background

The government will

A highly efficient energy consumption

A cost-effective realisation of the goal of Danish fossil-fuel independence requires considerable energy efficiency improvements in the various sectors. In many cases, energy efficiency is cheaper than the otherwise required renewable energy expansion, both in the short, medium and long term.

The energy efficiency improvements of companies must be enhanced. Although many companies have already carried out large energy efficiency improvements, considerable cost-effective potential still exists for reducing energy consumption in the different business sectors through energy efficiency improvements.

The EU plays a key role in the promotion of energy efficiency improvements. Greater and cheaper efficiency improvements can be obtained through concerted efforts in a number of sectors. This applies not least to appliances, because the Danish market is too small to efficiently push the development of more energy efficient products. Concerted efforts will also mean equal terms of competition for producers and consumers.

Energy consumption in the public sector is relatively limited compared with other sectors, but the public sector has a special obligation to also contribute its share, as ever stricter efficiency requirements are placed on the business community and private households.

- Target the saving obligations of energy companies towards companies in general. These efforts must cover energy efficiency improvement as well as conversion away from oil and natural gas. The obligations of energy companies will be raised by 50% from 2013 and by 75% in 2017-2020. Efforts will be financed via net tariffs
- Push for the EU to achieve at least 20% improvement in energy efficiency by 2020 by means of instruments and policies at EU level and at national level. This will take place through e.g.:
 - more requirements, and more ambitious requirements, for the energy efficiency of appliances and products; and tightening of the requirements for efficiency and labelling of appliances and products in connection with upcoming revisions of the Ecodesign and Energy Labelling Directives
 - push for the future framework directive on energy efficiency to be ambitious and action-based
 - push for a further tightening of the Energy Performance of Buildings Directive
 - push for a higher level of ambition among businesses in the EU with regard to energy efficiency
- Enhance public sector energy savings efforts from 2012:
 - before the end of 2011, a proposal will be presented to replace the existing requirements for a 10% reduction in energy consumption by the state, relative to 2006
 - in 2012, when the current agreement on energy savings with Local Government Denmark and Danish Regions elapses, the government's budget agreements with municipalities and regions will include voluntary agreements on energy consumption in buildings
- Continue the efforts by the Knowledge Centre for Energy Savings in Buildings.

Background

The government will

Efficiency improvements in households and in buildings

Buildings have long life spans; up to 100 years or more. In addition, buildings are typically only renovated at 30-40 year intervals, and perhaps only once before 2050. Therefore, it is vital to choose future-proof solutions when constructing new buildings and when renovating old ones, so as to realise the full potential for savings. Denmark currently has some of the strictest standards for the energy performance of new buildings, and the government has agreed to tighten these standards by at least 75% no later than 2020. The government has moreover stepped up preparation of a voluntary 'low energy rating 2020', expected to be announced in spring 2011. However, new buildings on a yearly basis only account for 1% of the total existing building stock. Accordingly, increased efforts will be directed towards existing buildings.

Existing technologies and solutions provide great opportunities to reduce the energy consumption of existing buildings through improved insulation, replacement of inefficient windows etc. If the improvements are implemented in connection with ongoing maintenance, heating consumption in existing buildings can be reduced by approximately 50% of consumption levels today at a reasonable cost. Realising these opportunities calls for a combination of ambitious standards which must be met in connection with renovation, replacement, etc. and assistance to carry out these projects.

Along with a reduction in energy consumption in buildings, the buildings which today are heated by oil and natural gas must undergo a fuel shift. This conversion should take place when existing heating installations wear out. In densely populated areas, district heating may be expanded, but for a large number of existing oil and gas furnaces, a heat pump, possibly in combination with solar heating, will however be the most cost-effective alternative.

- Target the saving obligations of energy companies towards renovation of buildings and conversion of oil and natural gas heating. Obligations will moreover be increased by 50% from 2013 and by 75% in 2017-2020. Efforts will be financed via net tariffs
- Future-proof the minimum efficiency standards for building components (windows, insulation etc.) which have to be met when renovating buildings, relative to future challenges and expected energy prices. Whether new components are to be included will be examined. The standards will be determined by taking into account the financial situation of home owners, a healthy indoor climate and freedom of architectural expression. Initiatives which can ensure greater compliance with the standards will be considered
- Convert heating by oil, and eventually also natural gas heating, to district heating, heat pumps and other renewable forms of energy. This will be through:
 - a ban on installing oil furnaces in existing buildings from 2017, and a ban on installing oil and natural gas furnaces in new buildings from 2012. Derogations may be allowed in cases where no suitable alternatives are available
 - market-promotion of initiatives for energy-efficient heat pumps and solar heating, including labelling schemes, certification schemes, package solutions and ESCO models
 - rules on compensation for gas companies converting from individual natural gas to district heating
 - a model and timetable for the phase-out of natural gas furnaces, taking account of the need for gas for production purposes in industry and potentials for utilising biogas
- Incorporate a 'low-energy rating 2020' in the building regulations with a view to promoting the establishment of new buildings with very low energy consumption.

Background

The government will

A cohesive and intelligent energy system

Electricity will be the dominant energy carrier in the future energy system with rapidly increasing electricity consumption. Moreover, wind power's share of electricity production will grow. Against this backdrop, flexible consumption will be important for operation of the system.

This will require enhancing cross-border transmission capacity considerably, in order to ensure efficient incorporation of wind power in particular into the Danish electricity supply system.

Furthermore, an intelligent system with ongoing temporal adjustments between production and consumption of electricity can provide for even greater flexibility. In this context, increased use of electricity boilers for district heating production, flexible electricity consumption in industry, and flexible recharging of electric cars will be key.

This will reduce the need for investments in production capacity, however there is still the need to develop cheaper solutions for intelligent electricity consumption in a number of areas, and a large-scale roll-out is therefore not appropriate at present.

Gas will come to play an important role in a future with fossil fuel independence. For example, biogas-fired CHP plants can serve to balance intermittent wind power production. Hence, an up-to-date gas infrastructure for the use of biogas and other renewable gasses will be needed, e.g. gas formed from gasification of biomass or from electricity.

- Establish new international electricity transmission capacity in the form of a transmission line to Germany and possibly also to Sweden in connection with the future offshore wind farm at Kriegers Flak. A new type of technology will be used providing new operational experience. Ultimately, this will achieve better connections between electricity markets. This project is supported financially by the EU with approximately DKK 1.1 billion
- Analyse the need to expand international transmission lines in order to achieve a socio-economically optimal expansion as well as ensure the necessary reserves/back-up in an electricity system with a large share of wind power
- Work for an agreement with the distribution companies to install intelligent electricity meters when electricity consumers install heat pumps, or recharging stations for electric cars. Furthermore, the limit for installation of intelligent meters will be lowered in 2013 from 100,000 kWh to 50,000 kWh annual consumption. The government will also ask the distribution companies to replace all electricity meters which are replaced after 2015 by an intelligent electricity meter
- Continue to encourage the electricity sector to perform demonstration projects with dynamic tariffs in specific distribution grids and prepare a strategy for the promotion of smart grids in Denmark, and in this connection determine investment needs and a financing model
- Analyse regulation of the gas infrastructure in future years in order to ensure optimal use and maintenance of the existing gas infrastructure; both in the transitional phase, while natural gas still plays a role, and in the future, when biogas and other renewable gasses have taken over
- Work for a strengthened grid infrastructure in the EU in order to ensure a well-functioning electricity market.

Background

The government will

A transition to green energy in the transport sector

The transport sector accounts for approximately one-third of the total use of fossil fuels and is today almost fully dependent on fossil fuels. The transport sector will therefore have to go through a radical transition before 2050. This transition will depend extensively on international technological developments within the field, as currently there are no alternatives to fossil fuels which are competitive in terms of technology and price. However, several promising technologies are emerging, with for example biomass and electricity. At the same time, alternative transport technologies are showing a clear tendency towards falling costs.

In the short term, increased use of biofuels is expected, and it is anticipated that improved fuel efficiency in traditional combustion engines will play a key role. In the long term, much of the transition to fossil fuel independence in the transport sector will probably have to be based on more electric power. Electric power will moreover represent a huge energy efficiency improvement, as electric motors are far more energy efficient than combustion engines.

Transition in the transport sector will firstly have to be promoted by establishing the required framework as well as an infrastructure in Denmark and in the EU, which can ensure the initial transition and a basis for building experience. When the technologies have achieved sufficient technological and price maturity, the subsequent phases of transition will have to pave the way for a broader roll-out of, as well as a large-scale transition to, these technologies. The work to establish the required framework and infrastructure is already well under way in Denmark, e.g. the government has agreed to exempt electric cars from the vehicle registration fee and car tax up to and including 2015.

- Carry out a technology assessment in 2011 and subsequently every three years in order to ensure the right framework for new technologies to support the targets for reducing greenhouse gas emissions from the transport sector in the short term up to 2020, and in the long term up to 2050
- Secure a requirement for 10% biofuels by 2020
- Push in the EU for more comprehensive sustainability requirements for first generation biofuels, and the option to prioritise second generation biofuels
- Establish a fund of DKK 25 million to provide state co-financing for the establishment of recharging stations for electric cars in order to kick start development in the area and design appropriate regulation
- Push in the EU for the promotion of electric cars, amongst other things through enhanced harmonisation and standardisation of technologies for electric cars; and push for the establishment of a car recharging infrastructure throughout the EU, which is coordinated with the regulation of intelligent infrastructure
- Push in the EU for more intensive research and development efforts within green transport technologies; and for tighter requirements for the energy efficiency and carbon emissions of cars.

Background

The government will

An energy system with appropriate financial incentives

A cost-effective transition to fossil fuel independence requires financial incentives, which as far as possible are uniform across different sectors of society. This will ensure the expansion of the renewable energy technologies that are the most competitive under current world market prices for fossil fuels, CO₂ emissions and renewable energy.

The government will therefore analyse the existing subsidy and tax system in the energy and transport sectors and examine the consequences of gradually increasing the taxes on fossil fuels. The dual purpose is to ensure government revenues, and thus the basis for continued welfare, and at the same time reduce the use of fossil fuels with cost-effective incentives. Tax-related issues with relevance for heat production, e.g. excess heat, will be examined in connection with the analysis.

In light of the uncertainties linked to technological development and fuel prices, the results of efforts will be monitored systematically and they will be subject to regular evaluation.

- Carry out regular evaluation of the effect of instruments deployed in order to ensure adequate progress towards the goal of fossil fuel independence and to ensure cost-effectiveness in overall efforts, including developing an analysis tool which can help clarify security of supply issues
- Carry out an evaluation of overall efforts every four years
- Carry out an examination of the subsidy and tax system in order to assess the need for adjustments of the existing system. This should be seen in the context of Denmark's international climate and energy commitments as well as the objectives for fossil fuel independence in the strategy, and the public budget
- Establish an economic model for use in the energy sector, in order to improve the basis for performing socio-economic analyses within climate and energy.

Background

The government will

A transition which creates green growth through research, development, demonstration and preparation for market

In a number of areas development of more efficient and cost-effective energy technologies is required. Strong efforts are therefore needed in research, development and demonstration (RD&D) in the energy area.

Enhanced energy research initiatives also support the possibilities of the Danish energy and climate sector in the growing international market for green technology by enabling large-scale demonstration and access to test environments.

With the Erhvervs-klima-strategien (climate strategy for companies), the government improved the framework conditions for Danish clean tech companies, e.g. through the establishment of Green Labs and through the market maturity efforts of the Innovation Foundation. In overall terms in 2010, the government ensured for instance more than DKK 1.5 billion for RD&D and market preparation of new green solutions to make them more profitable on market terms.

Further focus and coordination of the allocations for energy technology (RD&D) is needed. Danish research and development cannot lead the way in all green technology areas. It is important that efforts are more targeted and support the focus areas in Energy Strategy 2050.

Therefore, the government will identify and assess energy-technology RD&D initiatives, in cooperation with relevant players, in order to identify areas where strategic support for research, development and demonstration has the greatest societal value. On the basis of such an assessment, a number of specific “flagships” could be established, underpinning the robust focus areas in Energy Strategy 2050 as well as current Danish commercial strengths.

- Undertake a strategic review of the public research, development and demonstration initiatives in the climate and energy area in order to support the transition to fossil fuel independence as well as the needs of the business community. Ways to improve coordination and interaction between relevant programmes and councils will also be identified
- Prioritise a doubling of the funds in the EU's future budget for research, development and demonstration up to 2020 in the energy and climate change areas, particularly for renewable energy, smart grids and energy efficiency
- Enter into partnerships with private enterprises, research institutions and others, where this can contribute to developing, testing, and preparing for market of Danish cleantech solutions, e.g. wind solutions and bio-based products
- Actively support the establishment of larger test environments for green solutions in Denmark such as the wind turbine test centre at Østerild. The large, green support programmes such as the EUDP, Green Labs and the Innovation Foundation will be supplemented by partnerships or additional support for setting up more specific testing grounds such as “Samsø as a fossil fuel free island”
- Present an overall plan for test turbines
- Carry out a series of technology assessments in collaboration with experts from the business community and research in order to support a cost effective framework for using renewable energy. The technology assessments will focus on a wide array of technology areas
- Investigate the need and opportunities for ensuring sufficient recruitment of university graduates and researchers into the green area.

Background

The government will

Ambitious endeavours for a global transition

Security of energy supply is best achieved when all countries cooperate to minimise and make the consumption of scarce resources more efficient. Similarly, only global action can solve the climate challenge. Most countries have submitted reduction initiatives to the UNFCCC. Enhanced global reduction efforts are required to meet the climate challenge and bring about greater focus on efficient and innovative solutions which can realise reduction commitments and develop new solutions to adapt countries to climate impacts.

At the same time, such a transition to a global green economy will create a significant international economic growth potential; a potential from which Denmark can also benefit through exports of Danish green solutions. In addition, if other countries also implement stricter requirements for their industry and businesses, the risk of impairing the competitiveness of the most ambitious countries will be reduced.

Therefore, Denmark will push for a global green transition in international forums. Further to this, the government will work to establish a Global Green Growth Forum to create an annual global forum for dialogue between leading international politicians, businesses, experts and investors on the transition to a global green growth economy. The main themes will be the role of the business community in the green transition, financing green growth, and the political framework conditions for green growth within sectors such as transport, energy and water. The initiative is to contribute to the development of specific solutions and responses to the global growth challenges and also to help maintain and enhance Denmark's brand in the green area.

- Work in international forums such as the UN, the OECD, the Rio+20 Conference, the International Energy Agency, and the Clean Energy Ministerial etc. for:
 - ambitious, global efforts for the climate. Primarily by having countries' reductions efforts implemented and enhanced through negotiations within the UNFCCC as well as through expansion of the regional allowances trading systems, enhancing the global carbon market through improvements in the institutional framework for international and national project-based reductions after 2012, and by enhancing environmental integrity through requirements and standards for utilising climate credits in the EU and UN after 2012
 - promotion of a green growth agenda, for example Green Economy is a main theme for the Rio+20 conference in 2012 on sustainable utilisation of natural resources in a social and economic context
 - energy efficiency and transition to clean and renewable energy such as "smart grids", electric cars etc.
 - phase-out of subsidies etc. for fossil fuels
- Work to establish a Global Green Growth Forum
- Support green transition in developing countries, not least the very poorest, in accordance with the countries' economic and social development goals, in particular through conversion of the energy sector to more renewable energy and greater energy efficiency of the transport sector and other relevant sectors. This involves developing reduction and adaptation strategies, including methods to calculate emissions.



Background

The government will

An EU independent of fossil fuels

An efficient step for both Danish and global transition would be if the entire EU were to move towards fossil fuel independence.

In May 2010 the government sent a proposal to the European Commission to contribute to the preparation of a new European energy policy for the short, medium and long terms.

The Danish government believes, that the energy agenda should be incorporated in all relevant EU policy areas: research, development, transport, agriculture, foreign affairs and the EU budget; and that EU energy policy and energy research should be given higher priority financially.

In May 2010, the European Commission highlighted a number of advantages in increasing the greenhouse gas reduction target for 2020 from the current 20% to 30% compared with 1990, including the advantage of stronger incentives for energy savings and more use of renewable energy throughout the EU. This would be a strong signal globally, but it would also contribute specifically to less dependence on fossil fuels and a better climate. Of course it should be done in such a way as to ensure employment, competitiveness and a fair burden sharing.

- Promote a long-term vision for an EU independent of fossil fuels as a starting point for a strengthened European energy policy, including time perspectives and possible milestones within a socio-economically sustainable framework
- Endeavour to raise the common EU greenhouse gas emissions 2020 target from 20% to 30% compared with the 1990 level in a way that ensures employment, competitiveness and fair burden sharing
- Urge the EU to adopt an ambitious long-term strategy to support a low-carbon energy supply and greater fossil fuel independence in the transport sector
- In the EU, prioritise a doubling of the funds for research, development and demonstration in the energy area by 2020 compared with the today's level, including a significant increase in the EU's future budget, particularly for renewable energy, smart grids and energy efficiency
- Push for the adoption of minimum standards for energy and CO₂ taxes in the EU in connection with the revision of the EU Energy Tax Directive
- Endeavour to develop EU's energy infrastructure so that Denmark and EU member states can incorporate still larger amounts of renewable energy.

Background

The government will

Reductions in agriculture's emissions of greenhouse gases in the long term

The realisation of fossil fuel independence through initiatives in the energy and transport sectors will ensure that Denmark comes a long way towards reducing emissions of greenhouse gases and meeting climate targets in the short and longer terms. However it is important that emissions are also reduced in other sectors.

In addition to the energy and transport sectors, agriculture is the largest emitter of greenhouse gases. Emissions of nitrous oxide and methane from agriculture have been showing significant falls over a number of years, partly because of limits on nitrogen emissions in the action plans for the aquatic environment. Today, agriculture accounts for 16% of total greenhouse gas emissions and approximately one-third of greenhouse gas emissions for the non-ETS sectors.

A number of initiatives to reduce greenhouse gas emissions from the sector have already been decided and are being implemented. For example the Green Growth agreement for better conditions for using biomass and biogas for energy purposes is helping support farmers to supply green energy. The government's proposed biogas package will also contribute to reducing emissions from agriculture. In the future it is important, that Danish efforts stay in line with other countries to avoid unequal competition which will impact the competitiveness of Danish farmers.

- Analyse long term opportunities to reduce emissions from agriculture as part of cost effective climate efforts
- Promote a sustainable common EU agricultural policy, for example in relation to climate, so that agricultural policy can be used to promote climate friendly production forms, including innovative efforts and efforts targeted on shallow soil, and to ensure common green terms for competition in the agricultural sector
- Evaluate the pilot project and potential to establish a possible permanent scheme for national JI projects in 2011
- Improve conditions for expansion of biogas with the biogas package.

Background

The government will

An efficient and environmentally sound utilisation of North Sea resources

In recent years, oil and gas production in the North Sea has been crucial for the Danish economy. Since 1995 Denmark has had a surplus on its trading balance for oil and gas, and up to 2009 government revenues from oil and gas activities have corresponded to more than DKK 250 billion in today's prices.

This has given economic leeway for more welfare and to the repayment of national debt. At the same time, oil and gas activities have created economic growth and a large number of specialist jobs in oil companies, research, and not least in western Denmark, where there are more than 250 offshore-related companies in the Esbjerg area alone. This has provided experience and knowledge which could also be developed in connection with future green offshore activities.

Oil production peaked in 2004, and it is expected to drop by 37% up to 2014 in relation to 2009. Although North Sea production has been falling in recent years, it has been estimated that there are still oil and gas resources in the Danish subsurface to contribute to the economy.

The technology of today only extracts approximately a quarter of the oil lying in the known fields. More effective exploitation of oil and gas resources as well as new discoveries could therefore provide government revenues and contribute to securing sound public finances whilst helping to cover the increasing global demand for energy.

- Secure a more transparent framework for using the existing infrastructure in order to improve possibilities to expand economically marginal oil and gas occurrences
- Implement a review of the framework for oil and gas extraction for future tendering rounds and for the use of CO₂ injection to improve extraction rates
- Analyse the exploration potential in Denmark and assess when, and on what terms, new exploration licences can be offered (7th round)
- Promote a new phase of the Joint Chalk Research collaboration between Danish and Norwegian authorities and oil companies with a view to increasing oil extraction from chalk fields
- Promote exploration for new oil and gas fields in deeper layers through a project led by the Geological Survey of Denmark and Greenland (GEUS) in research collaboration with oil companies. The project will assess opportunities for new oil/gas finds and reassess existing finds in deep layers
- Negotiate with oil companies for a new action plan to replace the existing plan for more energy efficient extraction of oil and gas from the North Sea
- Examine possibilities to improve and coordinate authority administration of oil and gas activities onshore
- Analyse opportunities to secure recruitment for the oil sector through education initiatives in the field of oil and gas
- Negotiate a new environment action plan with the oil companies to secure lower environmental impact from oil and gas extraction in the North Sea and evaluate and possibly revise the strategy for inspection by the Danish Energy Agency of safety and health conditions in the North Sea.

On the way towards fossil fuel independence by 2050 – effects and benefits of the government's initiatives



In addition to the benefits for the environment and climate from the new initiatives, the strategy will also provide Danish companies with new opportunities to exploit the global green growth potential.

‘The largest contributions come from increased wind power, increased use of biomass and energy efficiency

The government’s strategy contains a wide range of initiatives to bring Denmark closer to its objective of an energy and transport system without fossil fuels by 2050; initiatives which will also help meet the energy and climate targets already set out in the short and medium term. The strategy will already have significant effects in the period 2011-2020, in the form of reduced use of fossil fuels, increased use of renewable energy, reduced energy consumption, cuts in greenhouse gas emissions and enhanced security of supply. With this strategy, the government is establishing a flexible framework for long-term efforts, but needless to say the transition will require further initiatives in the period after 2020 to realise the goal by 2050.

In addition to the benefits for the environment and climate from the new initiatives, the strategy will also provide Danish companies with new opportunities to exploit the global green growth potential by ensuring stronger cohesion between innovation, production and sale of new technologies to the advantage of Danish exports.

Phase-out of fossil fuels in the energy sector

As appears from the government’s three tracks for the transition, the phase out of fossil fuels will take place at different rates. The transition will first be in the energy sector, whereas large-scale conversion of the transport sector is expected later, once the non-fossil based alternative fuels have become financially and technically more attractive.

The government’s new initiatives to improve energy efficiency and expand renewable energy will already provide a significant reduction in the use of fossil fuels over the next ten years. With the initiatives the government is presenting, the use of fossil fuels in the energy sector will be cut by 33% by 2020 relative to the 2009 level. The greatest contribution to this reduction will come from the government’s initiatives to increase the use of biomass, biogas and biofuels, expand wind power and increase energy efficiency.

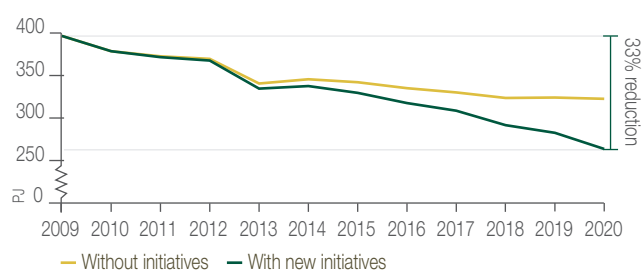


Figure 4.1 Fossil fuel use in the energy sector 2009-2020 (excluding transport, extraction and refining).

Source: Danish Energy Agency

The electricity sector in particular will see a very significant reduction in the use of fossil fuels. With the government’s new initiatives, the share of renewable energy will account for more than 60% of overall electricity consumption in 2020, against 29% in 2009. Wind power alone will cover more than 40% of electricity consumption in 2020, compared with just 19% in 2009. A high share of renewables in the electricity supply also implies electrification of an ever greater share of energy consumption for transport, heating and industrial processes.

On the way towards fossil fuel independence by 2050 – effects and benefits of the government’s initiatives

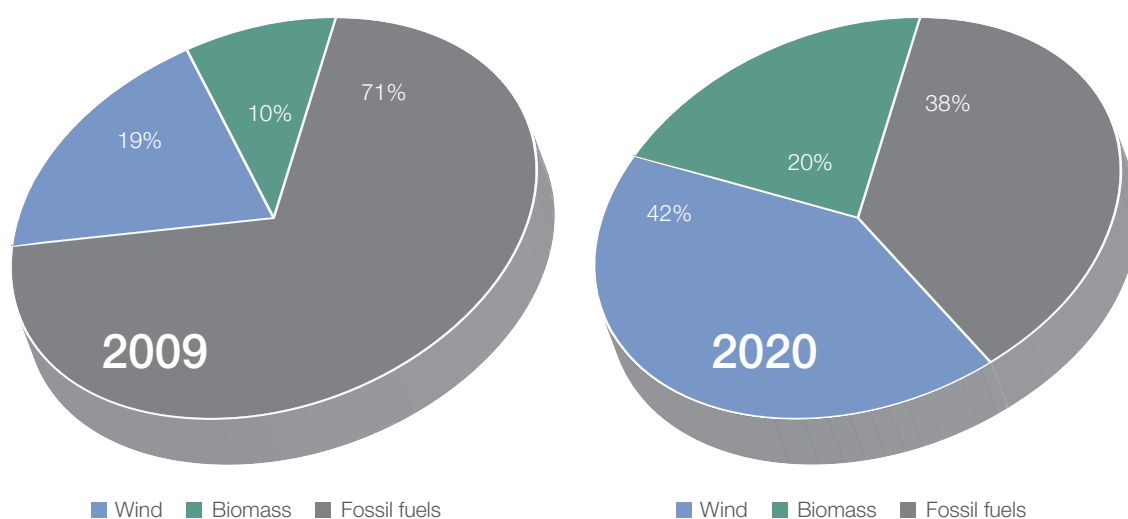


Figure 4.2 Share of renewable energy in electricity production 2009 and 2020. Source: Danish Energy Agency

Lower oil consumption in the transport sector

A substantial conversion of the transport sector to non-fossil alternatives will not happen within the next ten years. A substantial shift of this type is both technically and financially unrealistic in the short term. It is expected that the use of oil will stabilise within this decade, amongst other things because of greater use of biofuels and increased efficiency. A more efficient transport sector provides a sound basis for subsequent reductions in the transport sector’s use of oil as alternatives to transport powered by petrol and diesel become more competitive. A technology shift from oil-based transport to non-fossil alternatives is the challenge that will have to be dealt with in the next decades.

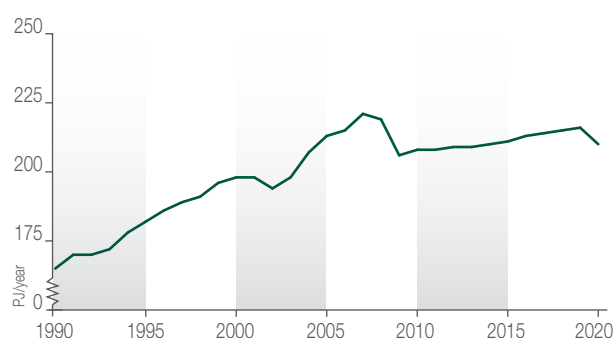


Figure 4.3. The transport sector’s use of oil 1990-2020
Source: Danish Energy Agency

The government strategy entails ambitious efforts for the period up to 2020, but also points onwards to 2050

On the way towards fossil-fuel independence

Total use of fossil fuels in Denmark, that is, the use of fossil fuels for energy, transport, and for extraction and refining purposes, will be reduced by 18% by 2020, relative to 2009, due to greater use of biomass, wind, biogas and biofuels as well as increased energy efficiency.

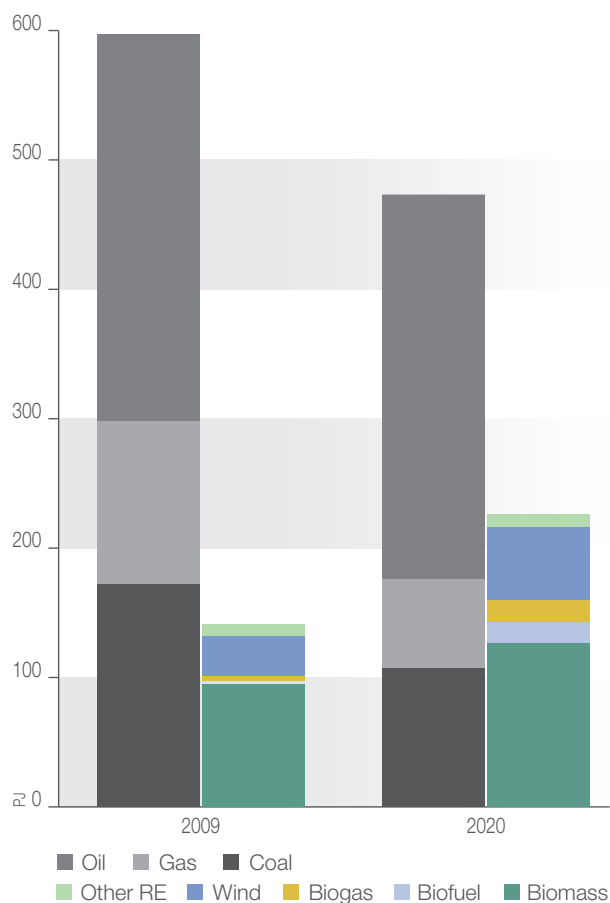


Figure 4.4 Consumption of fossil fuels and RE in 2009 and 2020 (excluding extraction and refining)

Source: Danish Energy Agency

The government's strategy entails ambitious efforts for the period up to 2020, but also points onwards to 2050. With considerable reductions in the use of fossil fuels in the energy sector, stabilisation of oil use in the transport sector, and a framework for future efforts, the government's strategy is a huge step towards the target of phasing out fossil fuels completely by 2050, see figure 4.5. However, realising the goal by 2050 will require a continuation of existing efforts and implementation of new initiatives in the period after 2020.

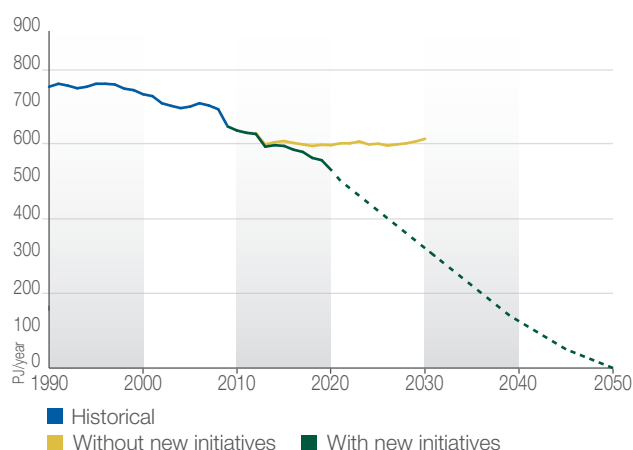


Figure 4.5. Consumption of coal, oil and natural gas 1990-2050. Source: Danish Energy Agency

Phasing in renewable energy

With the proposed initiatives, it is estimated that the share of renewable energy will reach 33% in 2020, up from around 20% in 2009. In other words, with this strategy, Denmark will exceed the EU target of a 30% RE share by 2020 by 3 percentage points.

On the way towards fossil fuel independence by 2050 – effects and benefits of the government’s initiatives

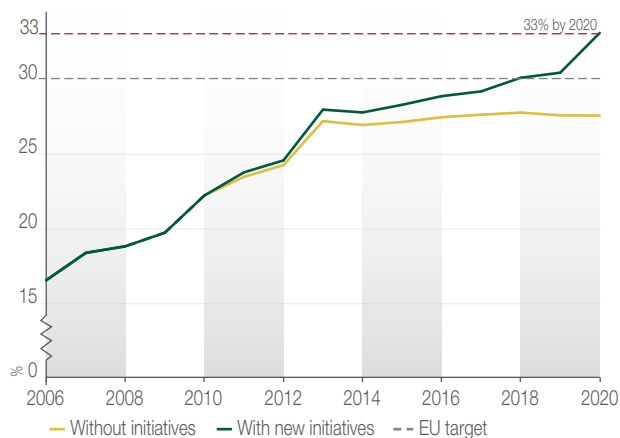


Figure 4.6. Share of renewable energy in final energy consumption 2006-2020. Source: Danish Energy Agency

The significant expansion of renewable energy will ensure, that Denmark keeps its place as a global leader in raising its RE share. Up to 2020, consumption of biomass, wind, biogas and biofuels will increase significantly as a consequence of existing and new initiatives. With a significant increase in solid biomass, biogas as well as biofuels, bioenergy will continue to make up the majority of total renewable energy consumption in 2020, see figure 4.7.

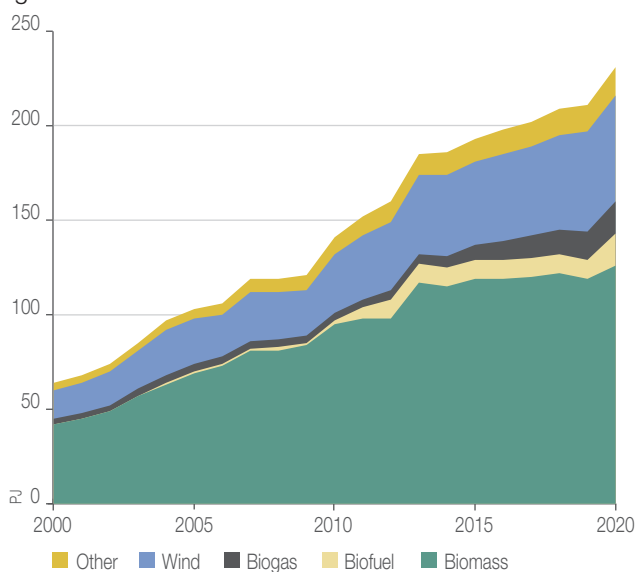


Figure 4.7 Renewable energy in primary energy consumption 2000-2020. Source: Danish Energy Agency

It has been estimated that the RE share will continue to increase after 2020, depending on price developments, new initiatives etc. With the government initiatives for expansion of wind and biomass, Denmark is well on its way to having an energy and transport system based on renewable energy by 2050. This is illustrated in figure 4.8.

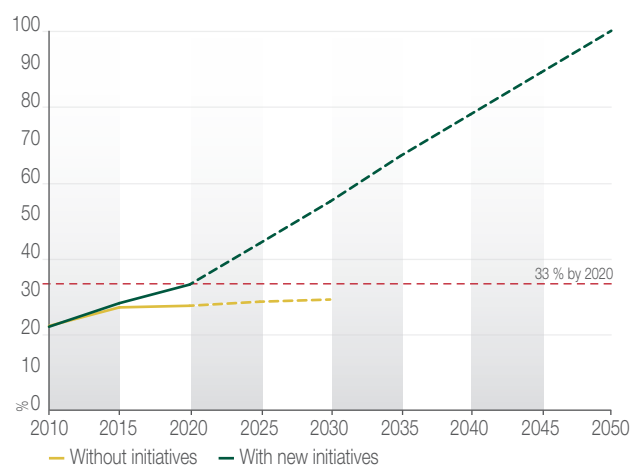


Figure 4.8. RE-share 2010 to 2050

Source: Danish Energy Agency

A lower energy consumption

With the proposed initiatives, this strategy will help reduce gross energy consumption in 2020 by significantly more than expected, as it has been estimated, that gross energy consumption will be reduced by 6% by 2020, relative to 2006. Thus, the target of reducing gross energy consumption by 4% by 2020 compared to 2006 will be more than met. This means, that Denmark is well on its way to meeting the government's goal of being one of the three most energy-efficient countries in the world by 2020.

Denmark is well on its way to meeting the government's goal of being one of the three most energy-efficient countries in the world by 2020.

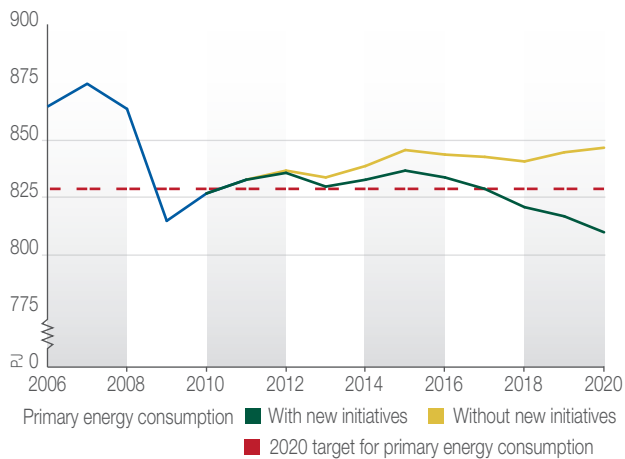


Figure 4.9. Primary energy consumption 2006-2020

Source: Danish Energy Agency

Maintaining the high security of energy supply

The government strategy will improve Denmark's energy supply security in the short term as well as in the long term. Ever-lower gross energy consumption and reductions in imports of fuels will mean that Denmark will be less dependent on politically unstable regimes and will result in a greater robustness with regard to unstable energy prices and supply crises. Thereby, a higher degree of security of supply will be achieved than in a system with greater energy consumption and more dependence on imports of fuels.

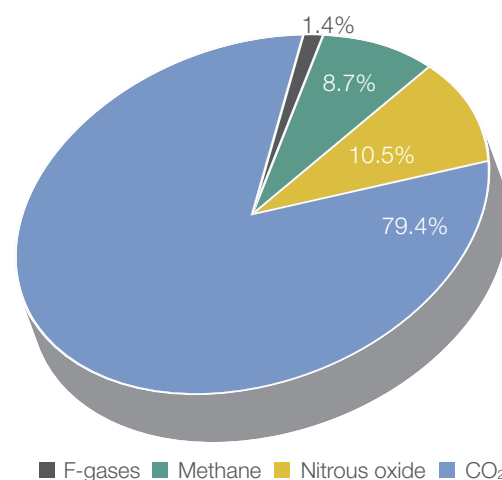
Paradoxically, an energy and transport system with greater electrification of end consumption, and therefore greater electricity consumption as a whole, is not significantly more vulnerable to physical breakdowns in the electricity system. This is because by far the greatest part of the extra electricity consumption is flexible and will therefore not be affected by any brief failures in the electricity supply. On the other hand, maintaining the security of supply in an energy and transport system based on fluctuating energy sources such as wind requires a strong electricity infrastructure, more trade with foreign

suppliers, a well functioning electricity market and back-up capacity. It also requires storage facilities for electricity and heating.

On the way to meeting climate objectives by 2020 and 2050

Greenhouse gas emissions will be reduced in line with the phase out of fossil fuels. With the government initiatives, Denmark is well on the way to meeting the Danish climate commitment for the period 2013-2020, while at the same time setting a long-term course towards an economy with a very low climate impact.

However, reducing greenhouse gas emissions poses a challenge that extends beyond the energy and transport sector. CO₂ constitutes just under 80% of Denmark's total greenhouse gas emissions. After CO₂, the greatest contributors to Danish greenhouse gas emissions are nitrous oxide and methane, which primarily stem from agriculture. However, emissions from waste and industrial processes also contribute to total greenhouse gas emissions.



Figur. 4.10. Observed emissions by type of greenhouse gas in 2008. Source: National Environmental Research Institute (NERI)

Reduction of non-ETS emissions

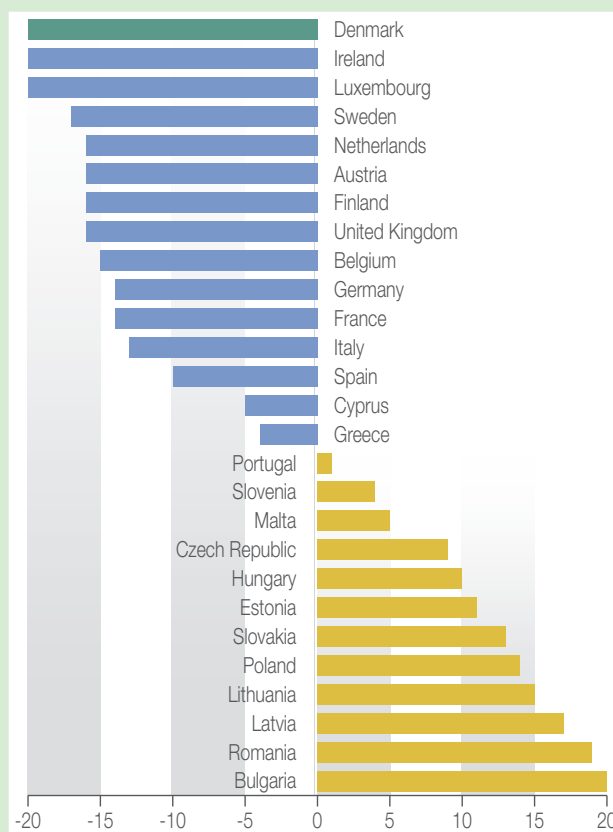
Efforts to reduce greenhouse gas emissions are required in the short term if Denmark is to meet its commitments for 2020, i.e. to reduce non-ETS emissions by 20% by 2020 in relation to 2005. In 2008, non-ETS emissions made up approximately 58% of Denmark’s total emissions and included greenhouse gas emissions

from transport, agriculture, households, waste and less significant parts of industry and the energy sector, e.g. small-scale CHP plants. ETS emissions primarily stem from electricity and heat production as well as energy-intensive companies, and are regulated by the EU Emissions Trading Scheme.

As part of the EU climate and energy package of 2008, a common EU target for the non-ETS sectors was set for a reduction of approximately 10% by 2020 in relation to 2005. The common target has been divided into national reduction commitments. Denmark has committed itself to reducing non-ETS emissions by 20% by 2020 in relation to 2005. Denmark’s reduction commitment is one of the highest in the EU. In comparison, other member states have reduction commitments that lie between -20% and +20%, see Figure 4.11.

In contrast to the commitment period 2008-2012, where the emissions average throughout the period may not exceed the commitment target, commitments for the period 2013-2020 are annual commitment targets. This means that member states must meet a fixed reduction target every year. Reduction targets follow an ever increasing linear path with a fixed increase from the start in 2013 until the final target is reached in 2020. In Denmark’s case this corresponds to 20 % reduction in relation to 2005. Thus a reduction path is created made up of annual sub-targets. Member states may exceed their commitment targets in the first years, so as to ‘save up’ for years to come.

Figure 4.11 Burden sharing of the EU reduction commitment in non-ETS sectors by 2020 relative to 2005



Box 4.1 Target for 20% reduction in non-ETS emissions by 2020

Total greenhouse gas emissions will be further reduced in line with the phase out of fossil fuels.

Efforts for greenhouse gas reductions made until now have laid the foundation for compliance with the reduction commitment. A number of the government initiatives to reduce fossil fuel use will also lead to significant reductions in the non-ETS sectors. All in all, it has been estimated, that the government's new initiatives will reduce non-ETS emissions by 4-5 million tonnes CO₂ equivalents in the period 2013-2020. The greatest effect will be achieved from enhanced efforts to improve energy efficiency. In addition, effects will also be achieved by conversion away from individual heating based on oil and gas, a greater share of biofuels, an improved framework for using biogas and free choice of fuel.

This will allow for a flexible and dynamic choice of further climate initiatives in sectors such as agriculture, waste and transport. The government will follow up on efforts regularly to ensure compliance with the 2020 climate commitment, and launch new initiatives as required.

Significant greenhouse gas reductions in the long term

The need for significant reductions with regard to total greenhouse gas emissions in the long term also requires that the right foundation is laid down early in the process. Thus short term efforts will contribute to steering Denmark in the right direction with regard to the common EU objective of an 80%-95% reduction by 2050 relative to 1990. Even though the EU target cannot be translated into a Danish reduction commitment, it gives an impression of the challenge facing Denmark with regard to long term reductions.

Total greenhouse gas emissions will be further reduced in line with the phasing out of fossil fuels. Calculations made by the Danish Commission on Climate Change Policy show that when Denmark's energy and transport systems no longer use fossil fuels, and therefore have more or less no carbon emissions, Denmark's greenhouse gas emissions will be reduced by approximately 75%. Thus Denmark will be able to contribute to meeting the EU objective, as well as the objective to limit the average temperature rise to 2°C, as agreed in Copenhagen in 2009 and in Cancún in 2010. However, cost-effective reduction of total emissions requires efforts to limit greenhouse gas emissions outside the energy sector, both CO₂ and other greenhouse gases, see figure 4.12.

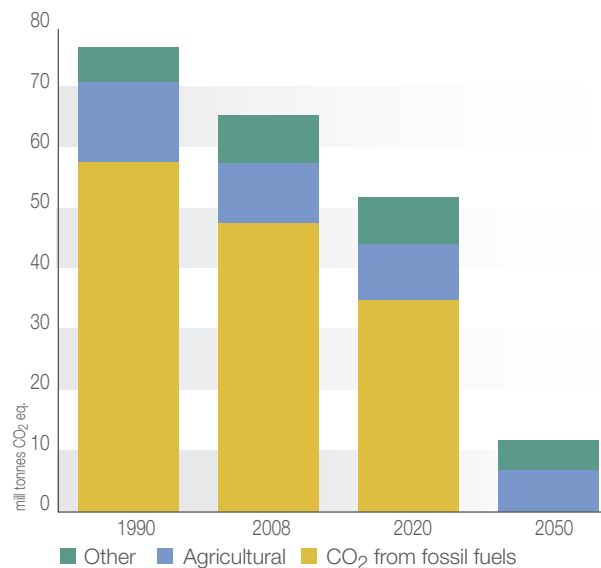


Figure 4.12. Denmark's greenhouse gas emissions in 1990, 2008, 2020 and 2050 (adj. emissions, excluding carbon storage). Source: Danish Energy Agency/Danish Commission on Climate Change Policy (2050-scenario)

A transition creating green growth

Many other countries are facing the same challenge; to move their economies away from dependence on fossil fuels. This will lead to a growing global market for renewable energy technologies and energy-efficiency improvement solutions.

The government has already launched a number of initiatives to support Denmark becoming an attractive place for research, development, demonstration and testing of energy technologies; for Danish as well as foreign companies. With the Erhvervs klimastrategien (climate strategy for companies), the government presented its vision to create a new green growth economy in Denmark. In connection with this, framework conditions for clean tech companies were strengthened by e.g. establishing Green Labs DK and the market maturity efforts of the Innovation Foundation. In overall terms, in 2010 the government allocated more than DKK 1.5 billion for research, development, demonstration and market preparation of new green solutions. In addition to this, the government has initiated establishment of a national test centre for wind turbines in Østerild in the north-western part of Jutland. This test centre will meet the requirements of the wind turbine industry and research institutions for full-scale test facilities of the highest international standard.

Initiatives with green growth potential

In addition to energy and climate effects, the wide range of initiatives in Energy Strategy 2050 will also support Denmark’s strong position as a laboratory for green technology research, development and demonstration, notably for energy technology.

- With regard to wind power, opportunities for a close interplay between test, demonstration and production of wind turbines will be enhanced, equipping Danish companies to continue taking full advantage of the global expansion of wind power.
- With regard to biomass and biofuels, increased use in combined heat and power production and transport will improve Danish companies’ opportunities for development and innovation in a promising area in which Denmark has already demonstrated core competences.
- With regard to biogas, improved framework conditions will underpin Danish skills and strengthen the role of agriculture as a green energy supplier.
- With regard to smart grids and electricity transmission, these will be expanded, and there will be greater integration of renewable energy into the electricity system; all areas in which Danish companies already have a strong position.
- Last but not least, with regard to energy saving efforts, these will place Danish companies at the forefront of developments within energy efficiency solutions; solutions which will be in high demand by other countries. In addition, jobs will be created in the building and construction sector.

Research, development, demonstration and preparation for market will also in future be pivotal and contribute to continued innovation and testing of Danish energy technology. The government initiatives aim at stronger focus and coordination of allocations for energy technology research, development and demonstration. Moreover, the Danish government will enter into partnerships with the business community to strengthen coordination of private and public efforts in the areas above, for example. The government will also increase its focus on providing Danish and foreign cleantech companies in Denmark with access to highly qualified labour and research communities with skills in green energy.

Government initiatives will strengthen cohesion between development, testing, production and sale of new technology, and thereby strengthen companies’ opportunities for innovation and demonstration of new green solutions. Thus this strategy provides Danish companies with a good launch pad for exporting to a rapidly growing global market.

Under the auspices of the EU, the Danish government is pushing to promote CO₂ reductions, energy savings and the use of renewable energy across member states. These efforts are contributing to securing sales of efficient and renewable energy technologies within the EU and to ensuring fair competition, which will benefit Danish companies.

Thus this strategy provides Danish companies with a good launch pad for exporting to a rapidly growing global market.



A fully financed transition

5



An economically responsible transition is important for the Danish government. Therefore all the new initiatives in the government's strategy are fully financed.

The transition to fossil fuel independence will not be free.

The transition to fossil fuel independence will not be free. It will cost money to convert to more energy efficient technology and renewable energy. It will require investment which in the long term will mean lower fuel costs, but which in the short term will often be more expensive than the fossil alternatives. In the longer term, transition will result in an economy less vulnerable to fluctuating energy prices, and Denmark will make its contribution to meeting the costs arising from extensive global climate change. If these benefits are taken into consideration, the extra costs of the transition to a society without fossil fuels will overall be modest, although transition will have to be gradual and over a long time period.

An economically responsible transition is important for the Danish government. Therefore all the new initiatives in the government's strategy are fully financed. Furthermore the financing has been designed with full respect for existing economic policies and in a way, which retains the overall competitiveness and employment of Danish companies, and which provides new opportunities for green growth.

In line with the phasing out of fossil fuels, government revenues from taxes on fossil fuels will naturally fall as well. This means that the government's revenue base will deteriorate with an unchanged tax system. This in turn means that there will be a need to gradually introduce taxes on other energy sources to ensure government revenues, and thus the basis for continued welfare. Together with continued taxes on fossil fuels, transition can be financed while also ensuring the right incentives to reduce the use of fossil fuels.

In any case, changes in the existing tax system will have to take full account of the competitiveness of Danish businesses and the finances of individual households. There is no benefit in conducting energy and climate policy at the cost of Danish businesses and Danish jobs. However, neither is it possible to exempt the business community entirely from the burden of transition to fossil fuel independence. The government's strategy has established a balance between competitiveness and the need for a fair distribution of the burden of transition.

A fully financed transition

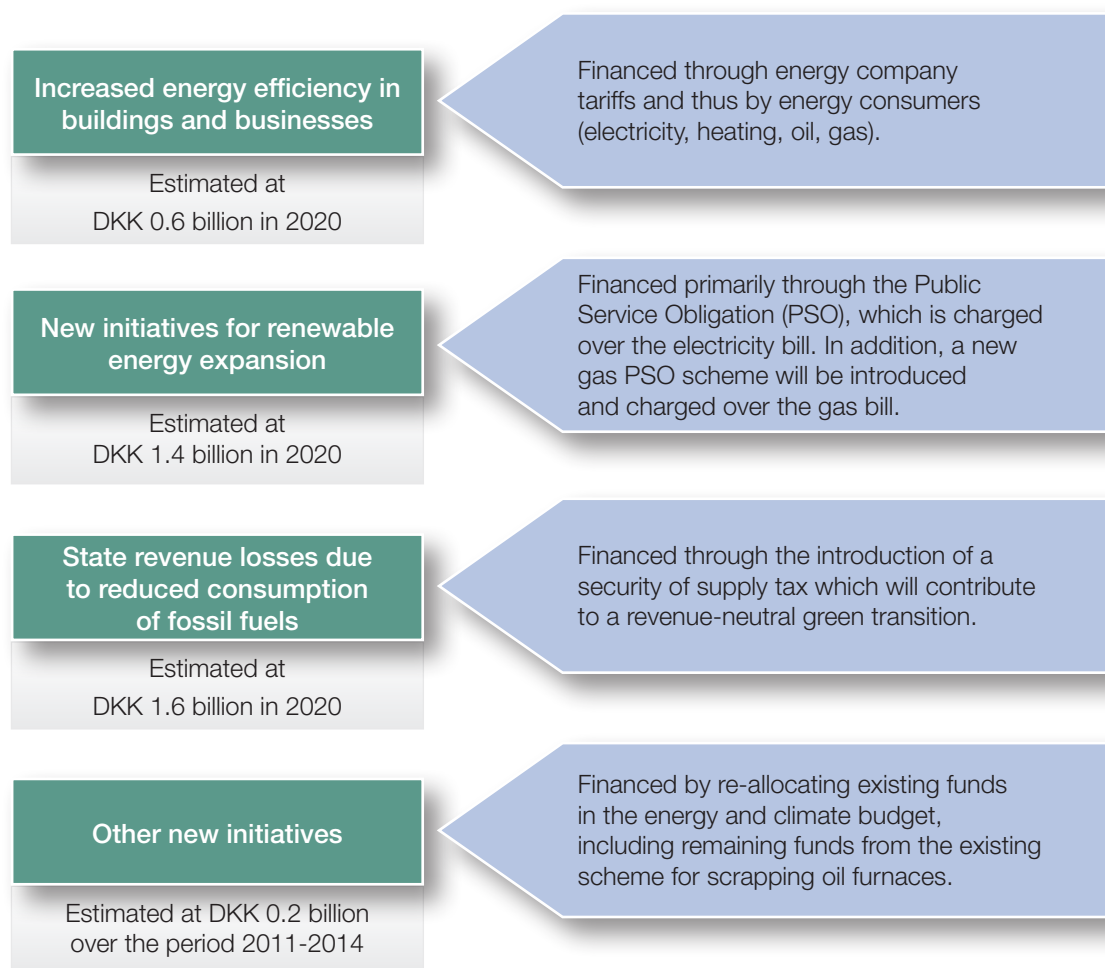


Figure 5.1 Financing the government's proposal

A fully financed package of initiatives

The government's new climate and energy policy initiatives up to 2020 are fully financed. This also applies to tax revenue losses resulting from lower energy consumption and in particular lower consumption of fossil fuels. This implies, that the transition to fossil fuel independence will primarily be financed by the energy consumers, who will also reap advantages in the form of lower fuel costs and better security of supply.

Financing energy saving initiatives through grid tariffs and energy consumers

The costs of energy companies relating to energy saving initiatives are covered through the companies' grid tariffs, and thus ultimately paid by energy consumers. The grid tariffs are subject to financial regulation set in advance. The regulation is implemented by executive order following political negotiations. If the increases in the obligations are distributed proportionately on the basis of current consumption, the higher costs will be more or less equally distributed between electricity consumers, district heating consumers and oil and gas customers.

An important tool to achieve more efficient buildings and businesses is to increase the energy saving obligations

Most of the funds charged by energy companies to energy consumers in 2020 to meet the savings obligations will be used as subsidies for companies and households to buy energy efficient equipment and energy consultancy. The costs of energy saving efforts will therefore to a large extent be recouped through falling energy consumption and thus lower energy costs for consumers.

Financing renewable energy expansion through the PSO scheme

Government initiatives to expand renewable energy up to 2020 include an offshore wind farm at Kriegers Flak, coastal wind turbines and onshore wind turbines, biomass in electricity and heat production, as well as biogas. These initiatives are financed through the PSO scheme (Public Service Obligation). The PSO contribution is a supplement to the price of electricity which, in addition to expanding renewable energy, finances subsidies for small-scale CHP plants, electricity-related

research, development and demonstration, as well as other common costs of the electricity system. The PSO contribution is paid by all electricity consumers through their electricity bills, although there is an upper limit.

As a new element, a small proportion of the PSO costs will be covered by gas consumers. This will finance the costs of replacing some of the natural gas in the grid with biogas. Gas consumers are expected to have to pay DKK 0.2 billion of the total PSO costs in 2020. In addition to this, some of the expansion of biogas will be financed through the security of supply tax.

With these government initiatives, PSO costs will gradually increase up to 2020, when additional PSO costs will amount to DKK 1.4 billion and the total PSO payments will therefore amount to almost DKK 4.5 billion (2011 prices).

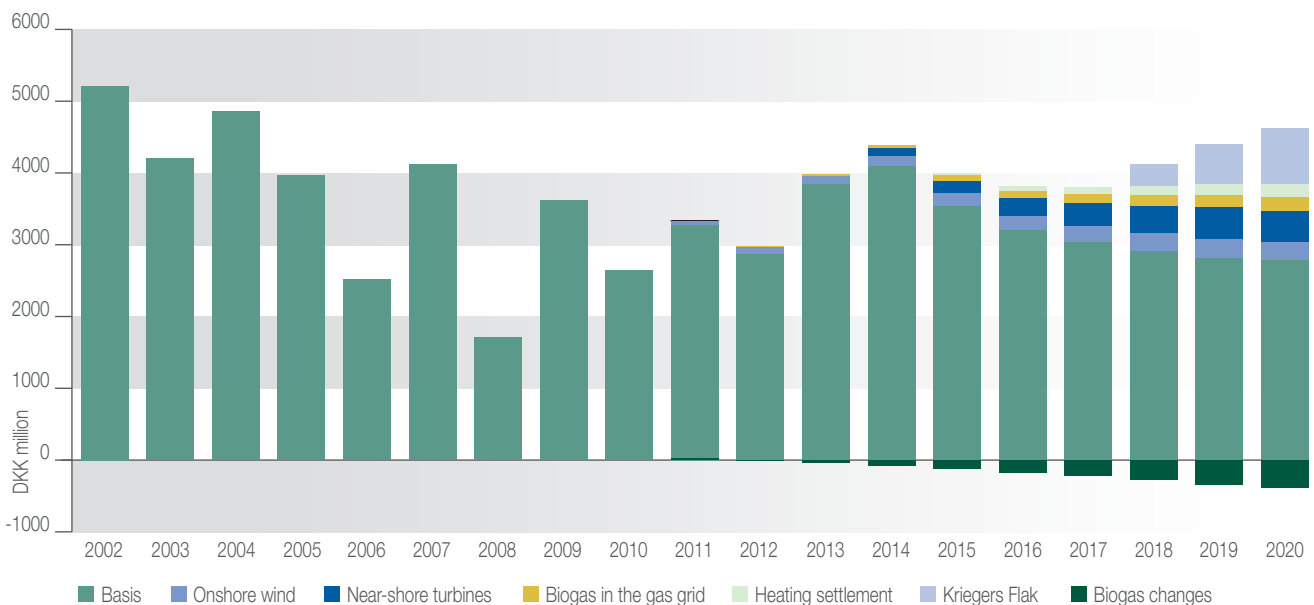


Figure 5.2 PSO costs 2002-2020 (2011 prices)
 Note: the negative contribution to PSO costs from the new biogas initiatives is because some of the subsidies for biogas will in future be granted outside the PSO system.

A fully financed transition

Since the introduction of the scheme in the late 1990s, the PSO payment has fluctuated as a result of varying market prices for electricity, which affect the need for support for renewable energy; varying rates of renewable energy expansion; and changes in RE subsidy rates. Even with significant expansion of renewable energy towards 2020, both as a result of the government's new initiatives and policies already implemented, the total PSO payment will not reach more than the level in 2002-2004 (at fixed prices). The reason it is possible to finance more renewable energy without the total PSO payment increasing to record levels is that the need for support for renewable energy per unit is falling and that previous support is falling away. In other words there will be more and more renewable energy for the same cost.

Financing lost state revenue through a security of supply tax

As the consumption of fossil fuels drops as a consequence of energy-efficiency improvements and more renewable energy, state revenues from taxes on coal, oil and gas will also drop. Revenue losses will increase gradually in line with the phase-out of fossil fuels and will amount to approximately DKK 1.6 billion in 2020. In order to finance this loss in revenues, the government will introduce a security of supply tax which, mirroring revenue losses, will gradually raise energy taxes on all fuels for space heating, i.e. coal, oil and gas as well as biomass. It is estimated that a security of supply tax of approximately DKK 17 per GJ in 2020 will secure neutral government finances and therefore this figure has been used in the following calculations. The exact tax rates and phase-in will be finally determined in connection with the specific implementation in future legislation.

In order to relieve the burden of the security of supply tax for consumers already paying high taxes on fossil fuels, the tax increase on fossil fuels already taxed will be reduced by approximately DKK 7.5 per GJ in 2020. This

adjustment will also establish a better balance between taxation of fossil fuels and taxation of biomass, which the Tax Commission proposed and which the Commission on Climate Policy Change also suggested. The security of supply tax will provide revenues of approximately DKK 2.0 billion in 2020.

Furthermore, taxes on electricity and fossil fuels used for industry will be reduced by approximately DKK 3-3.5 per GJ in 2020 compared with what was otherwise planned in the Spring Package 2.0 in order to relieve the tax burden for the business community by DKK 0.4 billion in 2020 for reasons of competitiveness. This means total revenues will amount to approximately DKK 1.6 billion in 2020, ensuring that overall the government's proposal is neutral in terms of total government revenues.

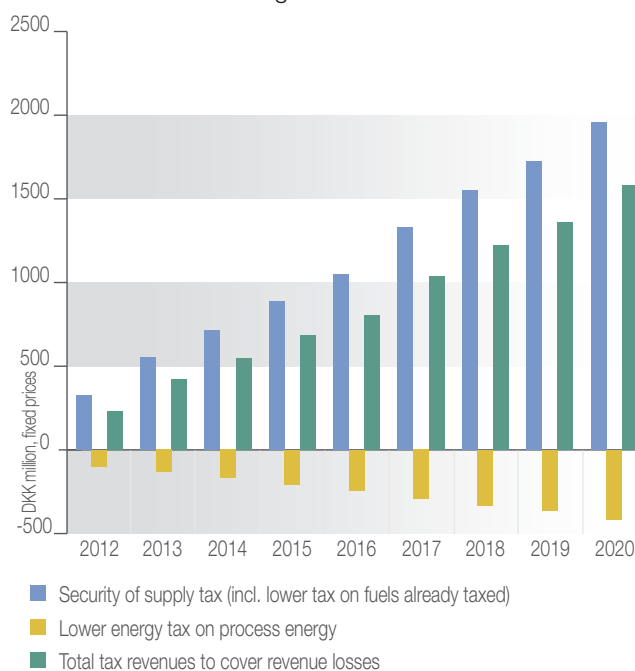


Figure 5.3 Tax revenues from the security of supply tax 2012-2020 (2011 prices)

The strategy includes a large number of smaller initiatives to support and prepare for the transition to fossil fuel independence

The goal of fossil fuel independence will increase pressure on public budgets gradually up to 2050 as a consequence of tax revenues lost by reduced use of fossil fuels. In order to support the objective of fossil fuel independence, it is necessary to amend the environmental clause of the government's tax freeze, so that the guidelines for the tax freeze are expanded as follows:

"The government's objective is that Denmark is to be independent of fossil fuels. This has the effect, that fossil fuels that are highly taxed will be replaced by other, more environmentally friendly types of energy taxed at a lower rate and in some cases tax exempt. In order to counteract this detrimental effect on tax revenues, other energy taxes may be increased, provided the overall tax burden is not increased."

Box 5.1. Relationship with the government's tax freeze

The proposed security of supply tax, combined with the tax relief for energy use for industrial processes will especially affect households, but it is also important to consider a number of benefits for heating consumers from the other initiatives in the government proposal. The proposed changes in heating settlement and the free choice of fuel means better access to lower taxed fuels such as biomass and biogas and therefore lower heating bills for a large number of consumers. Efforts for energy savings will also be intensified with corresponding benefits for consumers. From an overall perspective therefore regulation will be adapted on market terms to the benefit of consumers. This is then financed through a security of supply tax, which adjusts taxes on fuel used in heat production.

The security of supply tax in itself also provides an incentive for more efficient energy consumption for heating – for example to insulate housing better and to install heat pumps instead of gas furnaces when replacing old installations.

Financing new energy policy initiatives through reprioritisation

The strategy includes a large number of smaller initiatives to support and prepare for the transition to fossil fuel independence. There are very specific initiatives such as demonstration projects and subsidy pools for smaller renewable energy technologies. There are also broader initiatives to establish the right framework for the future transition. In total these initiatives will cost DKK 0.2 billion for the period 2011-2014.

Of course the initiatives require that financing is in place. It is proposed that the initiatives be financed by non-utilised funds from the oil furnace scrapping scheme, which was decided in connection with the Central Government Budget for 2010. It has been assessed that it is possible to reallocate these funds partly because the scheme has not seen the expected demand and partly because it has been estimated that it is still financially viable to convert to other types of heating, even without government subsidies. The full return on investment of for example installing a heat pump instead of an oil-fired furnace when replacement is due is typically of 5-10 years.

A fully financed transition

Micro economic effects of the transition

The transition towards fossil fuel independence will strengthen growth opportunities considerably for Danish energy and climate companies. However, it is crucial for the government that the transition to fossil fuel independence takes account of the competitiveness of all Danish companies.

Considered in isolation, financing the government's new initiatives will incur additional costs for private businesses, growing gradually to DKK 1.2 billion in 2020. This represents approximately DKK 600 per employee or approximately 0.1% of the gross added value in the entire private sector. In the longer term, it has been estimated that the burden will fall, in part as a result of falling costs of supporting RE production. Table 5.1 shows specifically what the initiatives will mean for energy costs for a medium-sized service company and a large energy-intensive manufacturing company.

The calculations have been made on the basis of fuel and tax assumptions for 2020; the year in which additional costs are estimated to be highest. The increase will take place gradually up to 2020. Companies therefore have good opportunities to adapt to the new conditions.

For most of the business community, exemplified here by a medium-sized service company, this will involve modest additional costs and will not affect the competitiveness of companies. However, increases in PSO

contributions and taxes could impact competitiveness for a number of energy-intensive companies.

Therefore, the government proposes that energy taxes on energy for industry be relaxed by DKK 0.4 billion, so that the whole business community escapes additional costs as a consequence of tax increases. However, companies will still contribute to renewable energy expansion and further energy efficiency efforts by paying a PSO contribution and a grid tariff. For a large, energy-intensive company, this will mean, that additional costs are reduced to approximately 1.3% of the company's energy costs in 2020. This will ensure the right balance between competitiveness and the need for a fair distribution of the transition costs.

Furthermore, the government will direct half of the increase in energy companies' energy saving obligation towards production companies, for example as subsidies to purchase energy-efficient equipment etc. Enhanced energy saving efforts could be a competitive advantage for energy-efficient companies in periods of increasing energy prices.

With regard to conversion to more biomass in electricity and heat production, it is still possible to differentiate the price of heating and in so doing take account of business customers. The government presupposes, that producers and buyers agree heating prices which are not unnecessarily detrimental to the competitiveness of businesses.

Fully implemented in 2020	Total energy expenditure without proposal	Expenditure in connection with proposal without reduction of energy taxes	Expenditure in connection with proposal with reduction of energy taxes	Change in relation to a situation without the proposal
Medium-sized VAT-registered enterprise (About 250 employees)	DKK 0.65 mill.	DKK 0.69 mill	DKK 0.69 mill.	+5,5 pct.
Large industrial enterprise in energy-intensive sector (About 400 employees)	DKK 100.0 mill.	DKK 104.0 mill.	DKK 101.3 mill	+1,3 pct.

Table 1: Examples of increases in energy costs in 2020 with the strategy in place

By far the majority of households will have several options to maintain their heating bill at an unchanged level

A stable energy costs framework for Danish households

The government's new energy policy initiatives, and the financing of these, affect households in two ways. Firstly, energy saving efforts will be enhanced and there are a number of initiatives to promote conversion; initially away from oil, and later away from natural gas. This will require investment, but it will also reduce heating costs. Secondly, households will have to contribute to financing the green transition through slightly higher electricity and heating bills.

Under all circumstances energy costs will increase as a result of amongst others the growth in oil prices on the world market. However, the new initiatives in the strategy mean that households will have to pay slightly more for the energy they use because of the gradually increasing taxes on energy for heating, gradually increasing PSO costs for renewable energy as well as gradually increasing grid tariffs as a result of enhanced savings efforts.

The government's strategy has been planned so as to ensure that households' total bills for electricity, heating and transport develop reasonably over the next few years. Increases in taxes and tariffs will be gradual. This means, that households will be able to react, for example by fitting additional insulation, replacing windows, converting to other types of heating or by buying more energy-efficient appliances when they need replacing.

Costs of households for heating and electricity

Considered in isolation, households' expenditure on heating will increase, although modestly, as a result of the gradual phase-in of the security of supply tax on fuel for heating. By far the majority of households will have several options to maintain their heating bill at an unchanged level, and in some cases even reduce it; with the additional benefit of simultaneously reducing consumption of fossil fuels.

All else being equal, a detached house heated by oil, natural gas or district heating based on CHP will have increased heating costs in 2020 of approximately DKK 900, corresponding to 4-5% compared with the current cost. Similarly, all else being equal, houses heated by wood pellets will have almost double the increase, although this will still be a financially attractive type of heating.

Energy consumption for heating could in many cases be reduced cost effectively in connection with renovation, replacement and purchase of new equipment. Enhanced efforts to promote energy savings are therefore expected to result in the average household using 5% less energy for heating in 2020 than it would otherwise have done.

At the same time, worn out oil furnaces can be replaced with heat pumps, and this reduces heating bills considerably more than replacement with a new oil furnace. Natural gas installations will also benefit from replacement with heat pumps in many cases. In smaller district heating areas, introduction of free choice of fuel provides an opportunity to convert to biomass-based district heating, and this can reduce the price of heating because of lower taxation on biomass. In large district heating areas, amended regulation can reduce the price of heating because there is an incentive to increase the use of biomass, in that producers and buyers obtain freedom of contract in setting the price of heating, and thereby share the advantages of lower taxes when using biomass.

In 2020, the strategy will lead to an increase in the price of electricity of approximately DKK 0.06 per kWh, including VAT, corresponding to an increase of approximately 3% compared with an expected price of electricity in 2020 of approximately DKK 2.15 per kWh, including taxes. For an average detached house with an annual electricity consumption of 4,000kWh, this corresponds to additional costs of DKK 250 including VAT per year in 2020.

En fuldt finansieret og erhvervsvenlig omstilling

The example is based on two families. Both families live in a detached house of 150 m², with average insulation, and with an annual electricity consumption for light, appliances a.o. of 4,000kWh.

For both families, the new taxes and tariffs involve a gradual increase in energy bills up to 2020, when the

increase will be greatest. In 2020, the increase will amount to approximately DKK 1,150 including VAT per year, compared with a situation without this strategy. Of this, support for renewable energy and energy savings amounts to about DKK 250, whereas the remaining amount is attributable to the new security of supply tax on heating.

Energy bill (electricity and heating), DKK per annum, VAT incl.		2010	2020			
			Without proposal	With proposal	With proposal and savings*	With proposal and heat pump**
House heated by oil	Heating	17.300	20.900	21.800	21.100	13.800
	Electricity consumption	7.900	8.650	8.900	8.900	8.900
	Total	25.200	29.550	30.700	30.000	22.700
House heated by district heating from natural-gas-fired CHP plant	Heating	16.800	16.800	17.700	17.200	15.200
	Electricity consumption	7.900	8.650	8.900	8.900	8.900
	Total	24.700	25.450	26.600	26.100	24.100

*after amortisation of additional investment for energy improvements

** after amortisation of additional costs of a heat pump

The family with the oil furnace can save approximately DKK 700 per year on energy consumption, if it at the same time reduces heat consumption by 5% through energy improvements when replacing old windows, roofing, etc. (after amortisation of additional investment for energy improvements). If, when it is worn out, the oil furnace is replaced with a heat pump, the family can save additionally DKK 7,300 per annum (after amortisation of the additional expense for a heat pump).

The family with district heating can save approximately DKK 500 per annum on energy consumption by reducing its heating consumption by 5% (after amortisation of the additional investment on energy improvements). If the district heating plant converts production from natural gas to biomass, expenses for heating may be reduced by a further DKK 2,000.

Box 5.2 Economic consequences for two families in 2020 with the proposal



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– from coal, oil and gas to green energy
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