



THE DANISH GOVERNMENT

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# Denmark: energy and climate pioneer

## Status of the green transition

Danish Ministry of Energy, Utilities and Climate

APRIL 2018

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# Preface

Denmark is internationally recognised as a leading pioneer in the fields of energy and climate. Through dedicated efforts over the past four decades, we have delivered impressive results and built a number of positions of strength.

Denmark has built a world-class green energy system, which provides improvements for everyday living and greener, more affordable energy, while ensuring security of supply. We have repeatedly been recognised as having the world's leading energy system.

We have created a valuable green energy sector that has made the country richer, providing greater welfare, growth and jobs throughout the country. Denmark's green energy sector has also bolstered the country's foreign policy standing.

No longer exclusively sectoral policy, energy policy is now a matter of broad societal importance, overlapping with other fields of policy, including foreign, security and business policy.

The strategic importance of the energy sector for Danish society has thus grown significantly throughout the years. The sector has undergone significant professionalisation, as major private players are increasingly pursuing business opportunities, including unprecedented investments in offshore wind.

Our role as a global leader didn't happen overnight. Our results are largely thanks to the collective efforts and visions of the Danish society – the population, decision makers and businesses – in connection with our green transition and energy policy since the energy crises of the 1970s.

We can be proud of these achievements – and we can be all the more proud if we continue our success in pursuing ambitious green targets for future generations, while delivering a strong economy in the present.

In 12 of the past 16 years, Denmark has had a centre-right liberal government, while continuing to strengthen its green position. Although this does not give us a patent on the green transition, it shows that others would also be wrong to make such claims.

Yet we cannot take our lead for granted. We face a big task ahead to achieve the goal of a low-emission society independent of fossil fuels by 2050.

Changes are happening in the energy sector, and the energy system will continue to undergo fundamental changes, incurring significant costs in the process.

Maintaining our high ambitions therefore requires a change of course – a conclusion echoed by the government's Energy Commission.



Denmark has created a valuable green energy sector that has made the country richer, providing greater welfare, growth and jobs throughout the country.



## We face a big task ahead to achieve the goal of a low-emission society independent of fossil fuels by 2050.

We can only be a pioneer for others if we show that it is possible to organise a cost-effective energy policy, where efforts in relation to the environment and climate go hand in hand with consideration for growth, competitiveness and employment.

With the agreement on the abolition of the PSO tax, the agreement on a new technology-neutral procurement model for wind and solar subsidies in 2018-2019, and the easing of the electrical heating tax, the first steps of a new energy policy have been taken.

The government will soon take the next steps and present a proposal for a new energy agreement.

The government aims to develop a more market-based and cost-effective policy approach to achieve the next ambitious steps in the energy conversion and the government's goal of at least

50% renewable energy in 2030. Thus we will continue our rapid pursuit of the government's long-term goal for Denmark: a low-emission society that is independent of fossil fuels by 2050.

The proposal represents an ambitious change of course, preparing the Danish energy system to meet the challenges of the future, while continuing to build our positions of strength, realise potential growth and maintain a high level of security of supply.

In everything we do, we must also take into account public finances, growth and the national economy – and making the lives of Danes less expensive.

The forthcoming proposal will form the basis for negotiations with the parliamentary parties about a new energy agreement. The goal is to reach a broad political agreement.



Minister of Energy, Utilities and Climate  
**Lars Chr. Lilleholt (Liberal Party)**



**In 2017 Denmark was ranked the world's number one country in the green energy transition – marking the second time Denmark topped the list.**

# 1. Danish results exceed most countries



In 2017 Denmark achieved a wind energy world record: **43,4%** of the Danish power was produced solely by wind energy.

Denmark's success in transforming into a sustainable, green society is widely recognised. Denmark is at the forefront of numerous international initiatives and collaborative endeavours. In 2017, for the second consecutive year in a row, Denmark won the World Energy Council award for the world's best energy system.

Denmark's energy and climate policy was also highlighted in 2017 by the International Energy Agency (IEA), as an international model because the country produces wind turbines, provides record low energy prices and good electricity connections to neighbouring countries.<sup>1</sup>

In 2017, Denmark achieved a world record of **43.4%** power produced solely by wind turbines.

Denmark can cover the largest share of its electricity production with green power from wind turbines.

Denmark is also a European leader in the export of energy technology, as exports of energy equipment account for a larger share of total exports than in any other EU country.<sup>2</sup>

**NOTES**

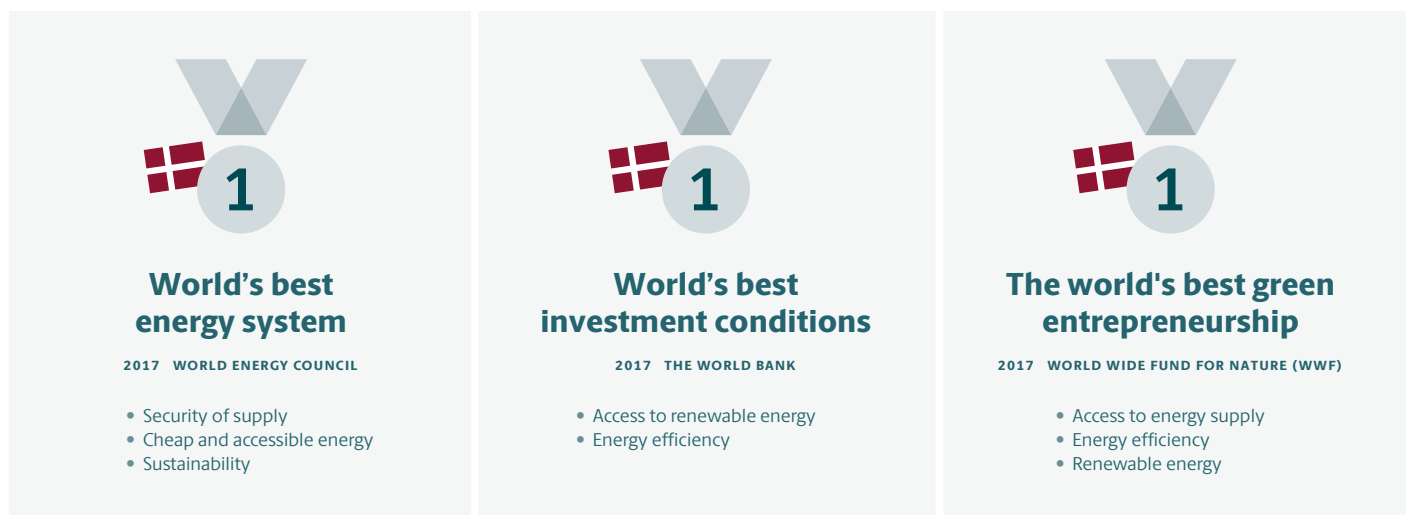
<sup>1</sup> Evaluation of the Danish energy system, the International Energy Agency (IEA), 2017.

<sup>2</sup> Export of Energy Technology and Service 2016, Danish Energy Agency, DI Energy and Danish Energy, 2017.



**Figure 1**

Denmark is number one in several international rankings in 2017





**The government has ambitious benchmarking for energy policy and stands to surpass a number of the EU's 2020 goals.**



# 2. The government's goals and stock-take of progress

## 50%

At least 50% of Denmark's energy needs will be covered by renewable energy in 2030.

The government has set ambitious goals that few other countries can match:

- **At least 50% of Denmark's energy needs must be covered by renewable energy by 2030.**
- **Coal must be completely phased out of the power supply by 2030.**
- **Moratorium on all exploration and drilling activities for oil, gas and shale gas on land and inland waters of Denmark.**
- **Denmark must be a low-emission society independent of fossil fuels in 2050.**

In addition, Denmark has committed itself to achieving a number of objectives set by the EU.

### "20-20-20" goals for 2020:<sup>3</sup>

- Greenhouse gas emissions from non-ETS (Emissions Trading System) sectors must be reduced by 20% compared to 2005.<sup>4</sup>
- EU energy consumption must be covered by 20% renewable energy.
- Increase energy efficiency by 20%.

### Annual energy savings in 2014-2020 of 1.5% of energy consumption.<sup>5</sup>

- The EU must reduce carbon emissions by at least 40% in 2030.<sup>6</sup>

- The EU must collectively reduce emissions in the EU emissions quota trading system by 43% in 2030 compared to 2005 levels.
- Denmark must reduce emissions in the non-ETS sectors by 39%, compared to 2005 levels.

Denmark has already met the EU goals for 2020 on renewable energy and is well on its way to meeting the targets for greenhouse gas emission reductions and energy savings for 2020.

Denmark has one of the highest Member State commitments of the EU Climate target for the non-ETS sectors, with a reduction target of 39% by 2030.

This target was established at the EU level, as part of the new 2030 targets for renewable energy and energy efficiency and the share of renewable energy in the transport sector.

It is the government's ambition that the goals will be achieved in a way that takes into account Danish jobs and competitiveness as well as maintaining a high security of supply.

### 2.1. Government initiatives

Since its election, the government has taken a series of initiatives that make a significant contribution to Denmark's strong leadership position on energy and climate policy.

Denmark is also an active and engaged participant in EU level negotiations regarding climate and energy. The government collaborates with

**Box 1**

### Examples of government initiatives to promote green energy transition

- PSO agreement abolishing the PSO tax. Initiates investments in coastal areas for offshore wind turbines and wind farms, such as Kriegers Flak.
- Investments of approx. 1 billion DKK in wind and solar in 2018 and 2019.
- Export Strategy for Energy, with an objective of doubling Danish exports of energy technology from 70 billion in 2015 to 140 billion DKK in 2030.
- Decision to build the world's longest electric cable, Viking Link, at a cost of approximately 11 billion DKK
- Over 500m DKK dedicated for energy research in 2018.

**Box 2**

### Examples of EU initiatives with strong Danish influence

- Reform of EU ETS market.
- Decision on burden-sharing of the EU 2030 climate goals for housing, agriculture and transportation.
- EU proposal for a liberalised electricity market, with the Nordic region as a model.
- New and improved energy labelling scheme.
- Working for higher 2030 goals for renewable energy in the EU.
- Denmark is hosting to the EU Infrastructure Forum.
- Danish chairmanship of the North Seas Energy Cooperation in 2018-2019.

other EU Member States to further an ambitious green and market-oriented policy agenda where a common electricity market is essential to handling the increasing amounts of fluctuating renewable energy.

The EU's climate and energy policy constitutes a central framework for Denmark's national efforts.

In the EU, we have just approved a comprehensive reform of the EU's carbon quota trading system, which increases the cost of carbon emissions and thus promotes investments in renewable energy.

The reform will eliminate billions of quotas from the market between now and 2030, which will increase the quota price, helping to phase out coal and promote renewable energy. The reform thus creates better coherence between Denmark and the EU's energy and climate policy, as it will contribute to the government's goals of at least

50% renewable energy and a complete phase-out of coal by 2030. The reform will also contribute to achieving the 2030 EU climate goals more efficiently.

#### **2.2. High growth and green transition have gone hand in hand**

Denmark has already come a long way with energy system conversion and with increasing independence from fossil fuels.

Since 1990, the Danish economy has grown over 40%. At the same time, Denmark has been able to achieve a reduction in greenhouse gas emissions. Denmark has thus shown that high growth and green ambitions can go hand in hand.

Few other countries in the EU or globally have achieved such large carbon emission reductions since 1990. Denmark is at the forefront of the EU, along with countries such as Germany and the UK.



# New figures for 2017 show that carbon emissions from Denmark’s power consumption are at their lowest ever.

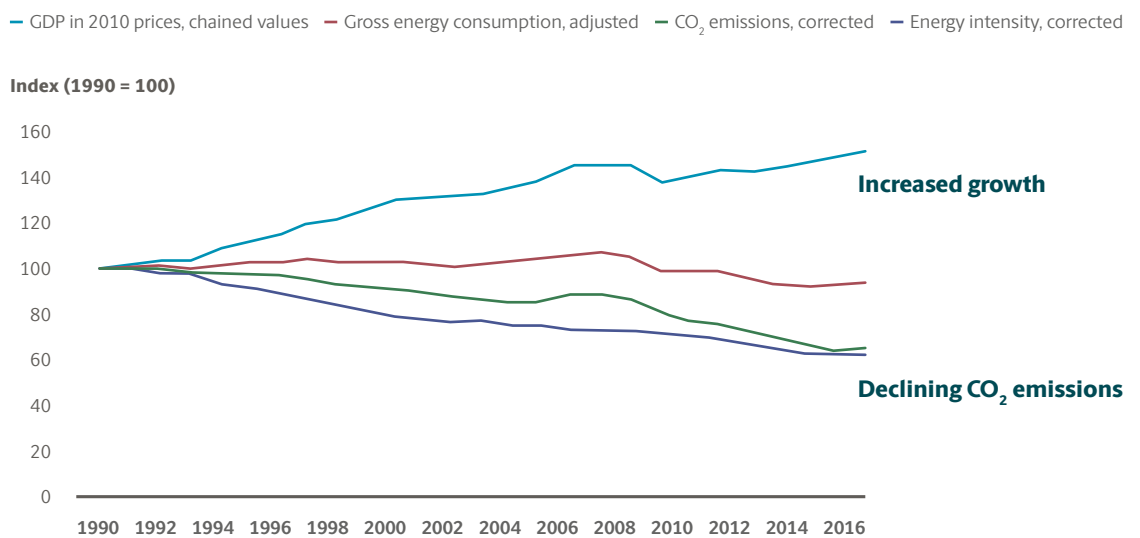


**Figure 2**

**Denmark has proven that green energy transition and economic growth can go hand-in-hand together**

GDP growth, gross energy consumption, carbon emissions and energy intensity.

Source Energy Statistics 2016, DEA.



New figures for 2017 show that carbon emissions from Denmark’s power consumption are at their lowest ever. Reasons for this include power plants switching from fossil fuels to biomass, and the expansion of wind and solar PV capacity.

Denmark expects to exceed its EU goals for the non-ETS sectors (agriculture, transport and buildings) in the period 2013-2020 by 14 million tons of equivalent carbon emissions. This despite the fact that Denmark, together with Luxembourg and Ireland, has the highest 2020 goals in the EU.

### 2.3. Rising amounts of renewable energy in the energy system

On the road to fossil independence in 2050, it is the government’s goal that at least 50% of energy consumption must be green by 2030. We are already off to a good start. The share of renewable energy is increasing and now covers more than 30% of energy consumption.

Developments in both wind power and solar cell capacity have undergone rapid expansion, exceeding expectations based on the 2012 energy agreement.

This is underlined by the increase in net capacity for land-based wind energy production as part of the energy agreement by 2020, which will be more than twice as high as expected upon conclusion of the agreement.<sup>7</sup>

By 2020, the Renewable Energy (RE) share is expected to amount to approximately 42%.<sup>8</sup> Denmark exceeds the targets EU target of 20% renewable energy in 2020 as well Denmark’s commitment to 30% renewable energy in 2020.

This means that approximately 10 percentage points of extra renewable energy are needed to achieve the government goals of at least 50% renewable energy in 2030. Denmark’s targets



Alongside the green energy transition, the Danish economy has grown by **40%** since 1990.

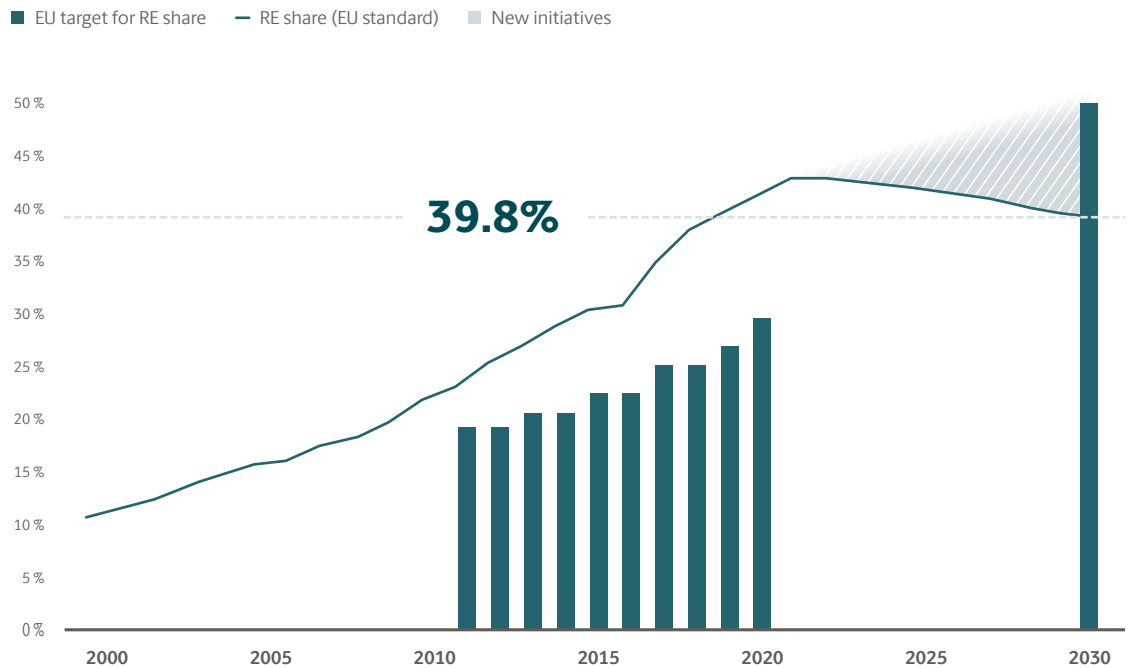


**Figure 3**

## Green energy comprises a larger share of the energy system

The proportion of renewable energy in total energy consumption.

**Note** The green line shows development from the Danish Energy Authority's Basic Projection for 2018 without a new policy. In the absence of new initiatives, the renewable energy share decreases from 2022 and onwards. This is due to declining RE expansion and rising energy consumption. The shaded area is not expressed reflection of how the 2030 goal will be reached, but rather illustrates the difference between RE shares of 39.8% in 2020 and 50% in 2030.

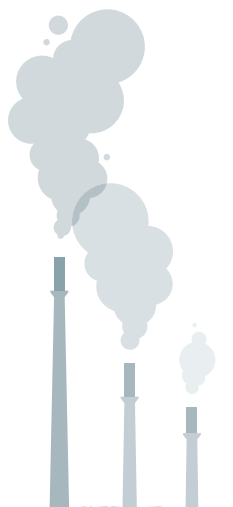


are thereby among the most ambitious of the EU Member States.

### 2.4. Denmark at the forefront of energy efficiency

Energy efficiency has been a key part of energy conversion since the energy crises in the 1970s. Denmark is one of the most energy-efficient countries in the world, and energy intensity is the second best among EU countries. Denmark is also well on its way to meeting the EU targets for energy efficiency by 2020.

Energy consumption for heating one square metre of housing has been reduced by almost 50% since 1975. In the industry sector, energy consumption per produced unit has been reduced by almost 60%<sup>9</sup> in relation to the gross production value.



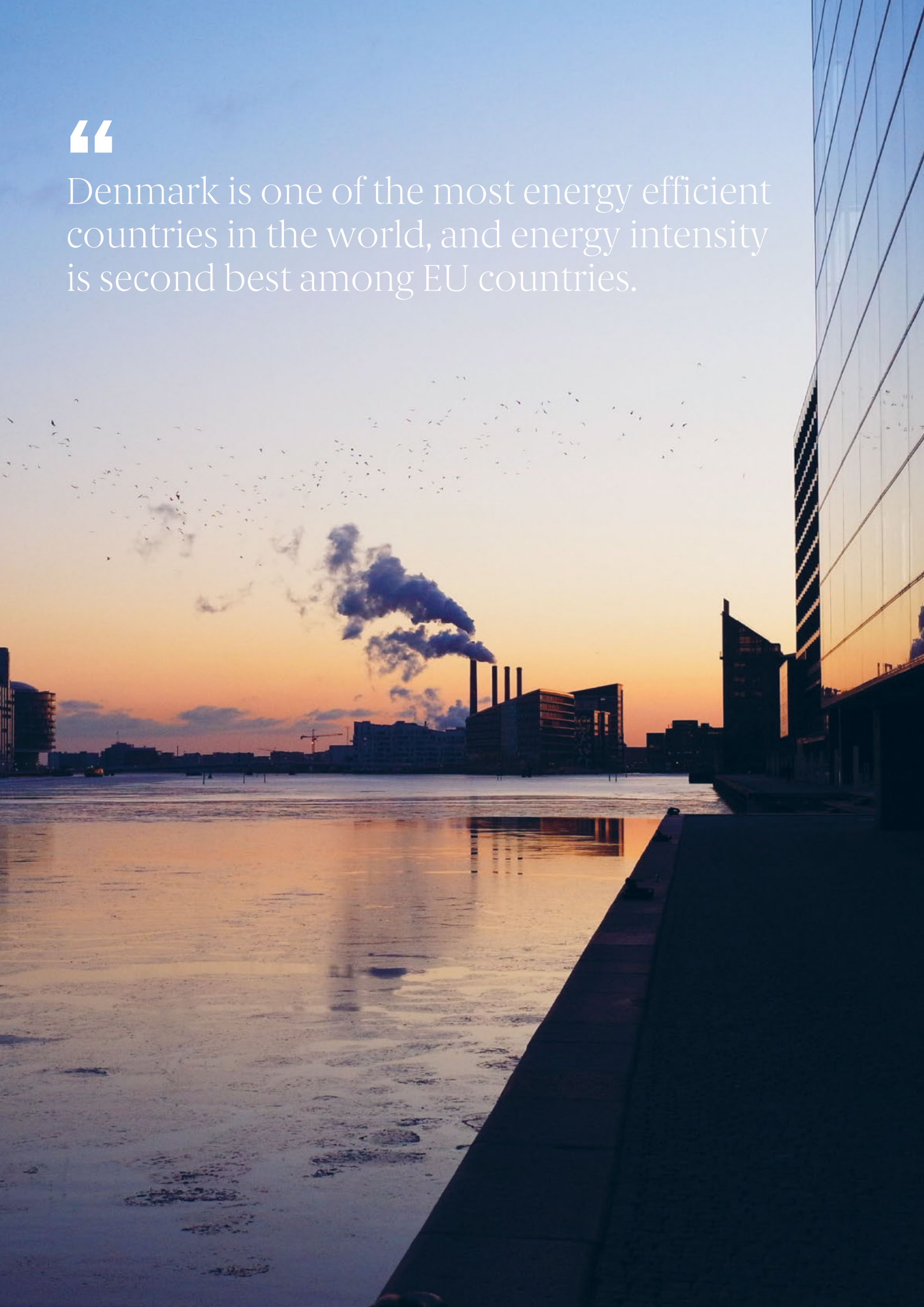
In 2017, carbon emissions per kWh of Danish electricity consumption were at the lowest level ever.

### NOTES

- <sup>3</sup> In 2007, EU heads of state and government adopted reduction targets for greenhouse gas emissions, increased renewable energy and increased energy efficiency. According to the current trajectory, targets will be achieved in 2020.
- <sup>4</sup> Non-ETS sectors comprise sectors outside the EU ETS, including agriculture, transport, environment and parts of the energy sector (primarily individual heating and process energy).
- <sup>5</sup> Targets are indicative for the EU as a whole and thus non-binding at the national level.
- <sup>6</sup> The 40% is a total reduction target for both the ETS and the non-ETS sectors.
- <sup>7</sup> The 2012 energy agreement called for a net expansion of 500 MW by 2020. By the end of November 2017, net capacity was 924 MW and it is estimated that this figure will rise to more than 1,250 MW by 2020. The net capacity increase for onshore wind production will thereby be more than twice as high as projected.
- <sup>8</sup> Basic Projection 2018, Danish Energy Agency.
- <sup>9</sup> Calculated as total energy consumption in the manufacturing sector, relative to the indexed production value in fixed prices.

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Denmark is one of the most energy efficient countries in the world, and energy intensity is second best among EU countries.



**Denmark has the next highest security of supply in the EU, close behind Luxembourg.**



# 3. How we will ensure high security of supply

As the energy supply becomes greener, it grows increasingly difficult to ensure a stable energy supply, due to fluctuations in solar and wind energy production with the changing weather.

Nonetheless, Denmark has the next highest security of supply in Europe, just behind Luxembourg.

The large volume of renewable energy has not affected security of supply in Denmark. Danes

have access to reliable power 99.996% of the time, corresponding to an average of just 19 minutes of power outages per year.

The strong security of supply is ensured by the major power plants, and to a growing extent through Denmark's close integration with surrounding countries.

Denmark has historically cooperated through the



**Figure 4**

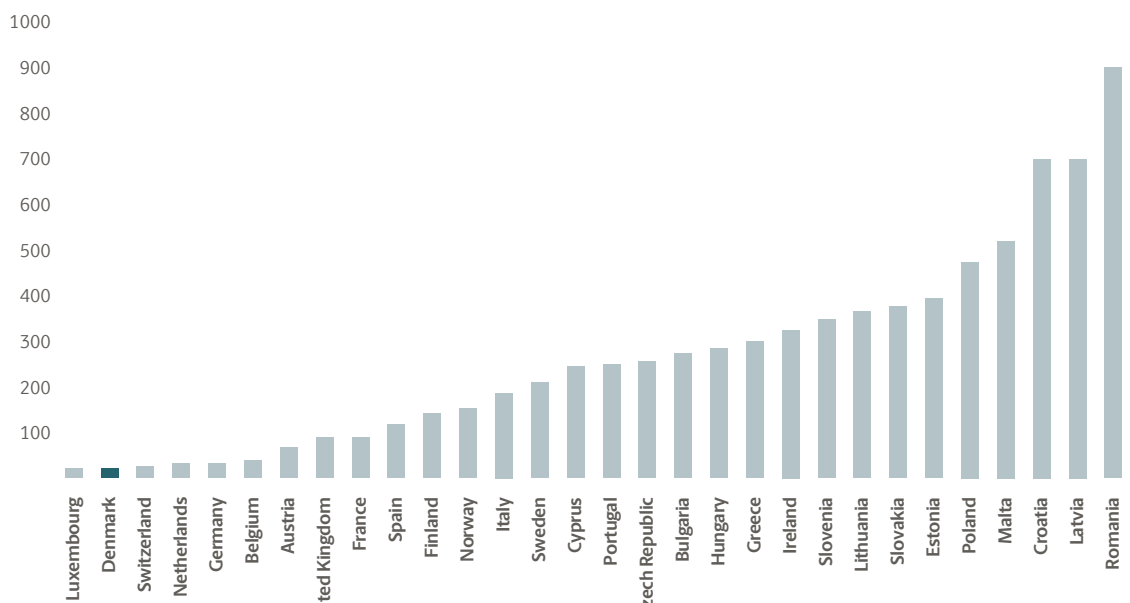
## Denmark's security of supply near the top

Average time (in minutes) of power outages experienced by consumers in different countries.

**Note** The latest data is from 2014. These figures have not increased in Denmark since then.

**Source** Energinet.dk, 2014.

**Power outages (minutes/year)**



common Nordic electricity market, which has served as a model for the EU's common electricity market.

However, Denmark's cooperation in the EU is growing rapidly as a result of the EU's proposal for an Energy Union. The Energy Union seeks greater integration of Member States' energy and climate policies.

Close cooperation, both regionally and in the EU, has been to Denmark's great benefit. It has contributed to a green transition with fewer costs, high

security of supply, and has allowed for the utilisation and sale of renewable energy to neighbouring countries.

Billions have been invested in both gas pipelines and power cables to neighbouring countries, and more investments are in the planning phase. The government recently decided to invest 11 billion DKK in the world's longest power cable, the Viking Link. This cable will provide significant economic benefits, ensure continued high security of supply, and increase the options for electricity trading in the future.

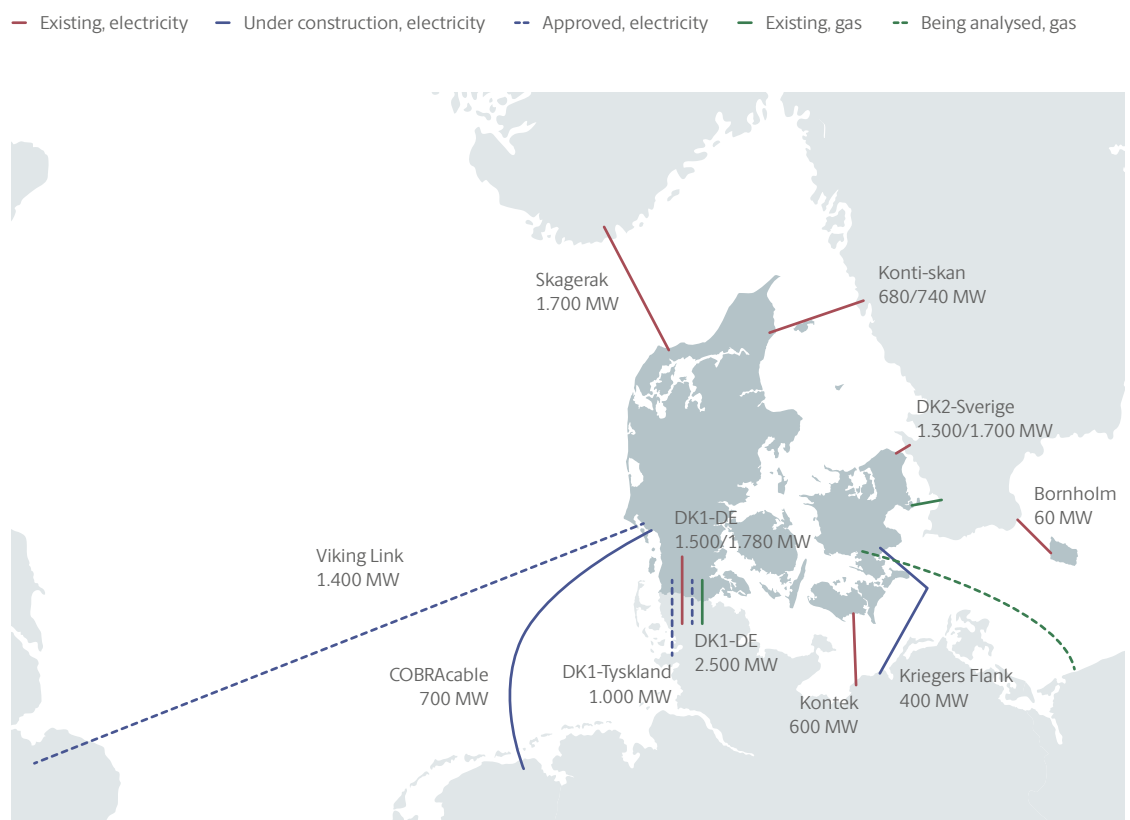


**Figure 5**

## Denmark is well connected with Nordic countries and Europe

International connections in the Danish energy system (electricity and gas).

Source: Energinet.dk, 2018.





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Close cooperation, both regionally and in the EU, has contributed to a green transition with fewer costs, high security of supply, and has allowed for the utilisation and sale of renewable energy to neighbouring countries.



# 4. How we will create cheaper green energy

**We have already made great progress in reducing the price of renewable energy. Electricity from new wind turbines is now cheaper than electricity from new coal power plants.**



The price of Danish offshore wind has decreased by **60%** in the period 2010-2017.

For economic growth and the green transition to go hand in hand, it is important that the market drives development and green energy gradually becomes independent of subsidies. Due to significant technological development and rising volumes of renewable energy, solar and wind energy prices continue to fall. This trend is expected to continue.

It is difficult to predict when technologies can handle market conditions. Many indications point to this capability emerging in the period between now and 2025.

Denmark has conducted offshore wind procurement processes for a number of years now, which

has contributed to falling prices, including an approximately 60% decline in bid prices for Danish offshore wind energy in the period 2010-2017.

In 2016, the offshore wind farm Kriegers Flak set a record with a bid price of just 372 DKK/kWh, the lowest at the time. By comparison, the bid price of Anholt Offshore Wind Farm in 2010 was 1.05 DKK/kWh.

The government is working to ensure lower prices, most recently with an autumn 2017 agreement with the Danish People's Party, which for the first time in Danish history introduces price competition between solar PV and wind turbines, ensuring the most green power for the money.



**Figure 6**

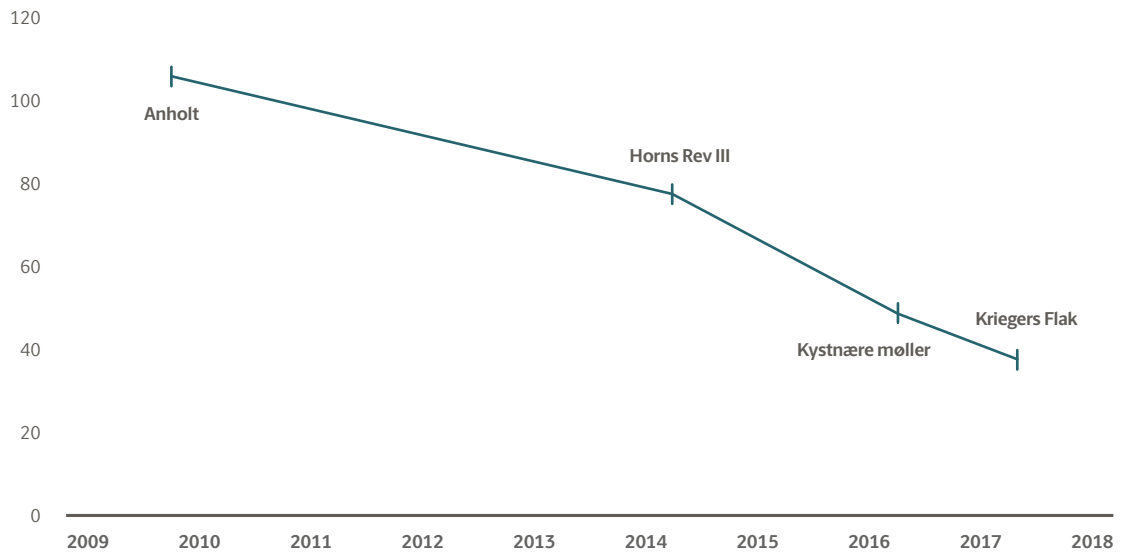
### The price of offshore wind has fallen significantly

Price development in Danish offshore wind farms (procurement 2010-2017).

**Note** The bid prices are given under different terms and conditions, e.g. coastal offshore wind turbines including grid connection. Therefore, reservations are made in terms of making a direct comparison. However, the figure shows a clear trend of falling bid prices in offshore wind energy production.

— Contract award

Bid price, CfD (DKK/kWh)



**Box 3**

### Falling prices of renewable energy

The price of solar cells has fallen by a third from 2011-2016. There is also a noticeable fall in prices for offshore wind. New price reductions for offshore wind production have occurred recently, including bids of zero in Germany, whereby the offshore wind farm is built without subsidies.

Shortly after, the Netherlands procured offshore wind farms without subsidies. Likewise, the price of land-based wind production has also fallen substantially and remains the cheapest renewable energy source in Denmark.

The falling prices of renewable energy means that new wind turbines both on land and at sea today are cheaper than new coal power plants.

Coal is therefore a relic of the past in Denmark's energy production. The government decided in autumn 2017 to join an alliance with 17 other countries, committing to phase out coal from electricity production by 2030.<sup>10</sup>

#### 4.1. Danish research and development efforts have created a number of positions of strength for Denmark.

Danish companies have made essential contributions to development and market demand in green technology. They have also contributed to the falling prices of green technology.

Through decades of investment by industry and the public sector, Denmark has strengthened a number of positions in green energy technology.

Measured on a number of different benchmarks, Danish research and development efforts in energy technology constitute innovative, competitive and cutting-edge solutions for the future, compared with other leading countries.

Denmark participates in Mission Innovation (MI), an international initiative where 22 countries and the EU have committed to a doubling of public investment in research and development in energy technology in 2020.

#### NOTES

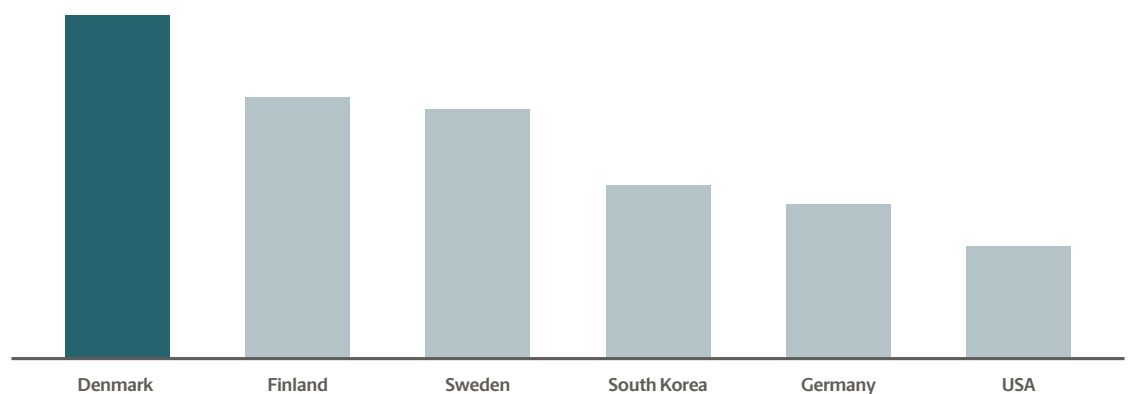
<sup>10</sup> In connection with COP 23, the government that took office on 16 November made a decision in 2017 to endorse a statement to phase out coal from electricity generation by 2030, including requirements for new coal power plants and restrictions on the support for new coal power, as part of the "Global Alliance to Power Past Coal".



Figure 7

### Denmark leads in funding for research and development of energy technology

Denmark's research and development efforts in energy technology compared to other leading countries.



**Note** The relative scores in the nine parameters (1-6, where 6 is best) are added together, and the pillars represent the total score of each country. The calculation is based on the six countries' relative strength in terms of (i) energy research funds as a share of GDP; (ii) total energy technology of research and development; (iii) international publication cooperation; (iv) industry publication cooperation; (v) publication impact; (vi) publications per capita; (vii) energy patents per capita; (viii) energy technology's share of total exports and (ix) prioritisation of energy in allocation of EU research funds.

**Source** Energy Commission, 2017.

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Denmark participates in Mission Innovation (MI), an international initiative in which 22 countries and the EU have committed to doubling public investment in energy technology research and development by 2020.





**The Danish energy transition generates exports and investments worth billions and lowers energy bills for consumers and companies.**

# 5. Impacts of the energy policy for Denmark and Danish companies

Over the past decades, there has been massive investment in the green transition. In terms of total capital, the energy sector is one of Denmark biggest, and contributes significantly to the Danish economy.

## 5.1. The green energy transition creates growth throughout Denmark

A new statement shows that employment in the Danish energy sector was 73,350 full-time positions in 2016, of which more than 31,000 were employed in the green part of the sector – an increase of approximately 3,300 since 2014. Employment growth in the green energy sector is thereby outpacing the Danish labour market as a whole by six-fold.

A majority of jobs in the green energy sector are in Jutland, with the municipalities of Ikast-Brande and Aalborg topping the list.<sup>12</sup> The five leading municipalities account for approximately 43%



Employment growth in the green energy sector is outpacing the Danish labour market as a whole by **six-fold**

of Denmark’s jobs in the green energy sector, of which more than 60% are in industry and manufacturing of energy-related goods.

## 5.2. Denmark is a magnet for green investments and a European champion in the export of energy expertise.

Denmark’s leading role in the green transition also creates growth by attracting foreign investment. Denmark’s green energy supply, competitive energy prices and high security of supply were key reasons why Apple chose to invest billions in new data centres in Viborg and Aabenraa.

Likewise, Facebook has decided to establish a data centre in Odense, and Google has followed suit with purchases of two large sites in Fredericia and Aabenraa. These developments are further propelling Denmark’s strong position as an attractive country for foreign investment, which thereby promotes domestic growth and employment.



**Box 4**

**The energy sector in figures<sup>11</sup>**

- Investments of approximately 780 billion DKK (2015).
- Revenue of approximately 380 billion DKK (2015).
- Value added of approximately 100 billion DKK (2016).
- Exports of 83.8 billion DKK (2016).
- Employment: 73,350 full-time positions (2016).

# 83.8 billion DKK

Denmark's green transition generated exports of energy technology and services totalling more than 83.8 billion DKK in 2016.

Denmark's green transition generated exports of energy technology and services totalling more than 83.8 billion DKK in 2016. Exports of green energy technology, such as wind turbines and heat pumps, have seen particularly strong growth in the last 15 years.

In 2016, green energy technologies accounted for over half (56.8%) of all energy technology exports.

Since 2010, exports of energy technology and services as a whole have grown 29.4%. Energy

technology exports currently account for 11.8% of Denmark's total exports, the largest such share of any EU-15 country.

The market also remains rich with potential, as many other countries are also pursuing a transformation of their energy systems.

According to the International Energy Agency (IEA), the 2015 Paris Agreement from COP21 will generate investments of 13,500 billion USD in energy efficiency and renewable energy from 2015

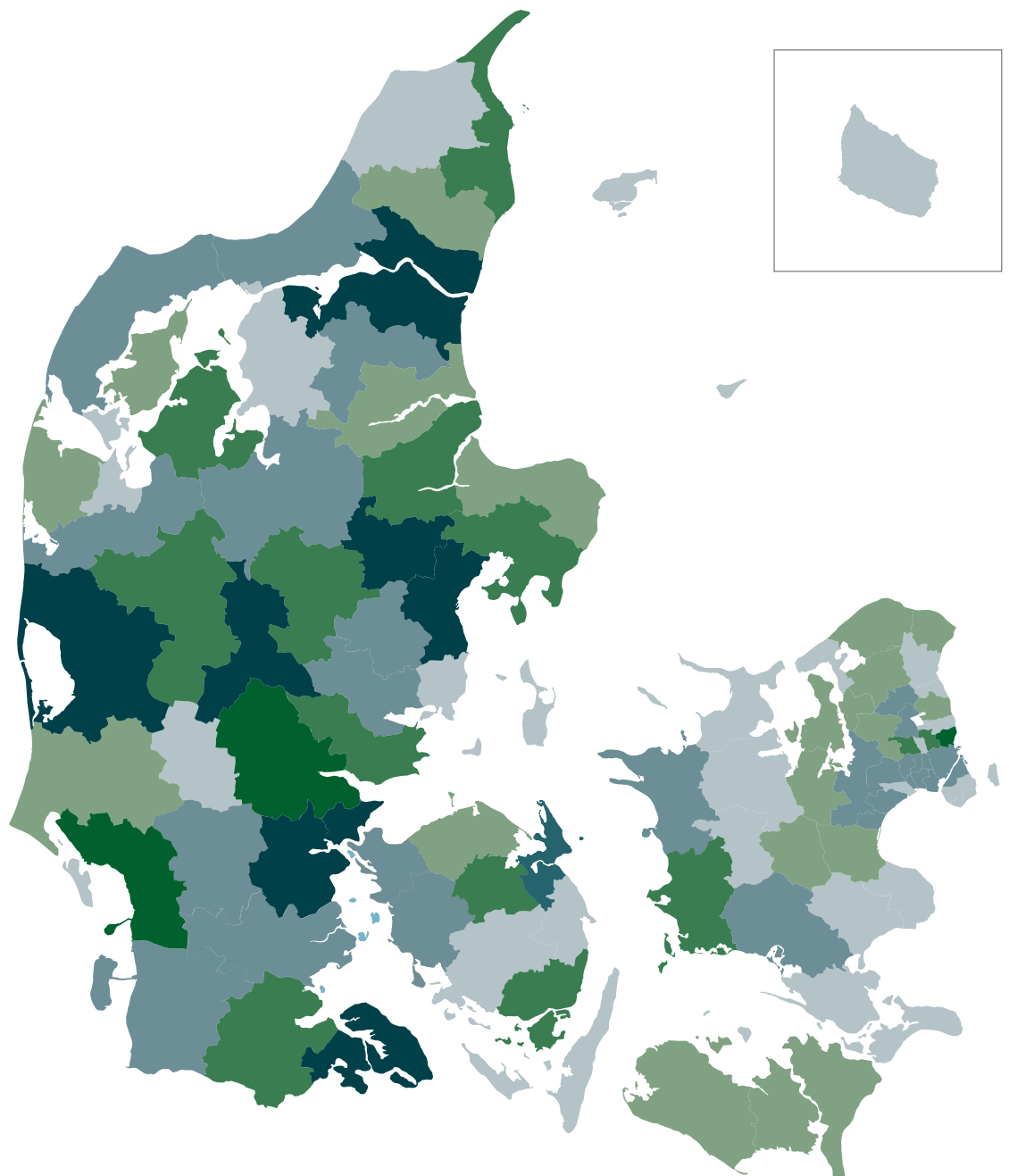


Figure 8

## Green energy sector jobs are spread through Denmark

Employment in the green energy sector, by municipality.

■ (0;50] ■ (50;100] ■ (100;200] ■ (200;500] ■ (500;750] ■ (750;1000] ■ Over 1000



Municipality	Share
Ikast-Brande	13 %
Aalborg	9 %
Ringkøbing-Skjern	8 %
Aarhus	8 %
Sønderborg	6 %

Share of total renewable energy employment in Denmark.





Green energy exports have grown **29,4%** since 2010.

## PG4

Partnering for Green Growth and the Global Goals 2030 – is a Danish initiative and an international, public/private network focused on sustainable development. So far 91 cities and 9 countries participate, among these Chile, Ethiopia, Kenya, Mexico and Denmark.



**China**  
Denmark assists the Chinese in integrating and increasing renewable energy.

to 2030. The UN's 17 Sustainable Development Goals are also expected to increase demand for green solutions.

To capitalise on the tremendous market potential, the government has launched an export strategy which aims to double energy technology exports by 2030 to more than 140 billion DKK.

### 5.3. Global cooperation advances Danish export opportunities

The Danish example is being replicated around the world, creating new export opportunities for Danish businesses.

Many countries are looking to Denmark to learn from our experience. Denmark has official collaborations in this field with 12 countries, including China, the US, Indonesia, Mexico, South Africa, Ukraine, Vietnam and India.

In many of these countries, technical support for energy planning and strategic work are of crucial importance for creating effective and long-term sustainable solutions.

Through these successful government programs, Denmark is spreading our energy model to some of the world's largest economies, whose nearly 4 billion energy consumers account for more than half of all global carbon emissions.

The government's cooperation agreement with China can assist China in achieving carbon emission reductions that correspond to Denmark's total carbon emissions in a year.

Denmark's advisory services enable countries to build more efficient energy systems and increase their use of renewable energy – reducing global carbon emissions and generating new export opportunities in the process.

Denmark's new global partnership initiative, Partnering for Green Growth and the Global Goals 2030 (P4G), acts as a growth engine that promotes partnerships between green businesses and governments, regions and cities – so far 91 cities and 9 countries are part of the initiative.

Denmark will be teaming with Sweden, Norway, Finland, the European Commission, and the Nordic Council of Ministers to host the world's largest energy conference from 21 to 25 May 2018, Nordic Clean Energy Week, which includes the Clean Energy Ministerial (CEM9) and Mission Innovation (MI-3). Ministers from the G20 countries and representatives from a number of leading global companies will convene in Copenhagen and Malmö to deliver solutions and progress in the international efforts following the Paris Agreement at COP21.

#### NOTES

<sup>11</sup> Damvad Analytics, 2018 and Exports of Energy Technology and Service 2016, Danish Energy Agency, DI Energy and Danish Energy, 2017.

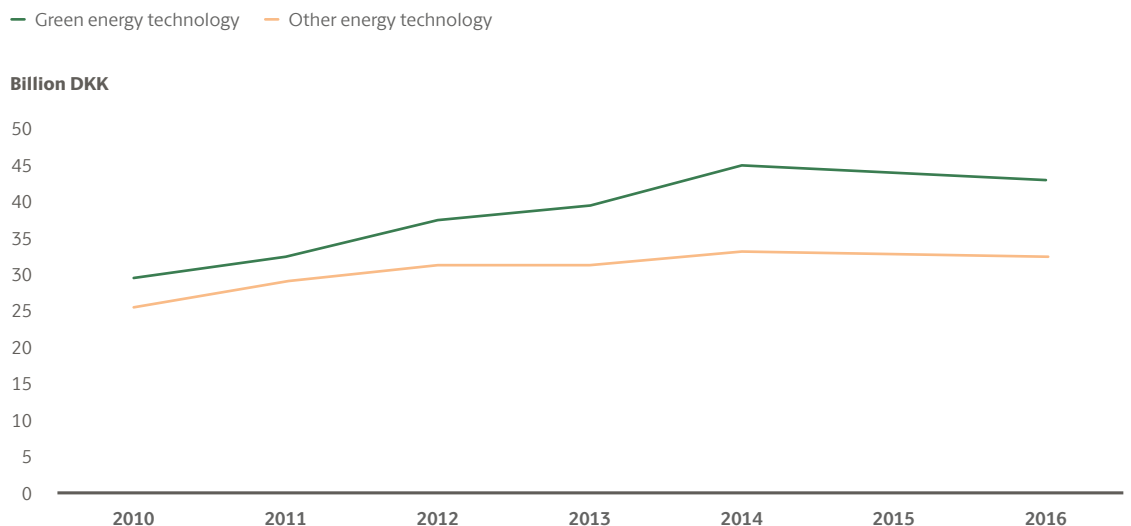
<sup>12</sup> Damvad Analytics, 2018.



**Figure 9**

### Green energy technology plays an important role in Danish exports

Denmark's exports of green technology and other energy technology.



**Source** Eurostat and calculations made by DI, Danish Energy and the Danish Energy Agency

**Note** Exports are listed in current prices and exclusive of drilling platforms. The data was audited in 2017.



## Box 5

### Data centres create green growth and digital solutions

Data centres offer a range of benefits, including:

- 1) Job creation within a variety of professions.
- 2) Showcase for the utilisation of Danish energy technologies, thereby boosting export potential.
- 3) Potential research collaborations in digital development and energy solutions (e.g. Apple's agreement with Aarhus University on biogas).
- 4) General contribution to digital development in Denmark.
- 5) Strengthens Denmark's green brand.



## Box 6

### Export cooperation with the US, Germany and the United Kingdom

The government's export initiative strengthens export opportunities for Danish energy companies in three important export markets: the US, Germany and the UK. Danish advisory services to public authorities in these countries open doors for exports in the fields of wind, district heating and energy efficiency –all of which are core Danish competencies.

Pittsburgh, Pennsylvania is one of the focus areas of the export scheme in the United States. A collaboration between the Danish Energy Agency, the Danish Embassy in Washington and a committee of key energy stakeholders in Pittsburgh is focusing on how Danish energy solutions can help the city achieve its green objectives, unleashing new commercial potential for Danish businesses.



Figure 10

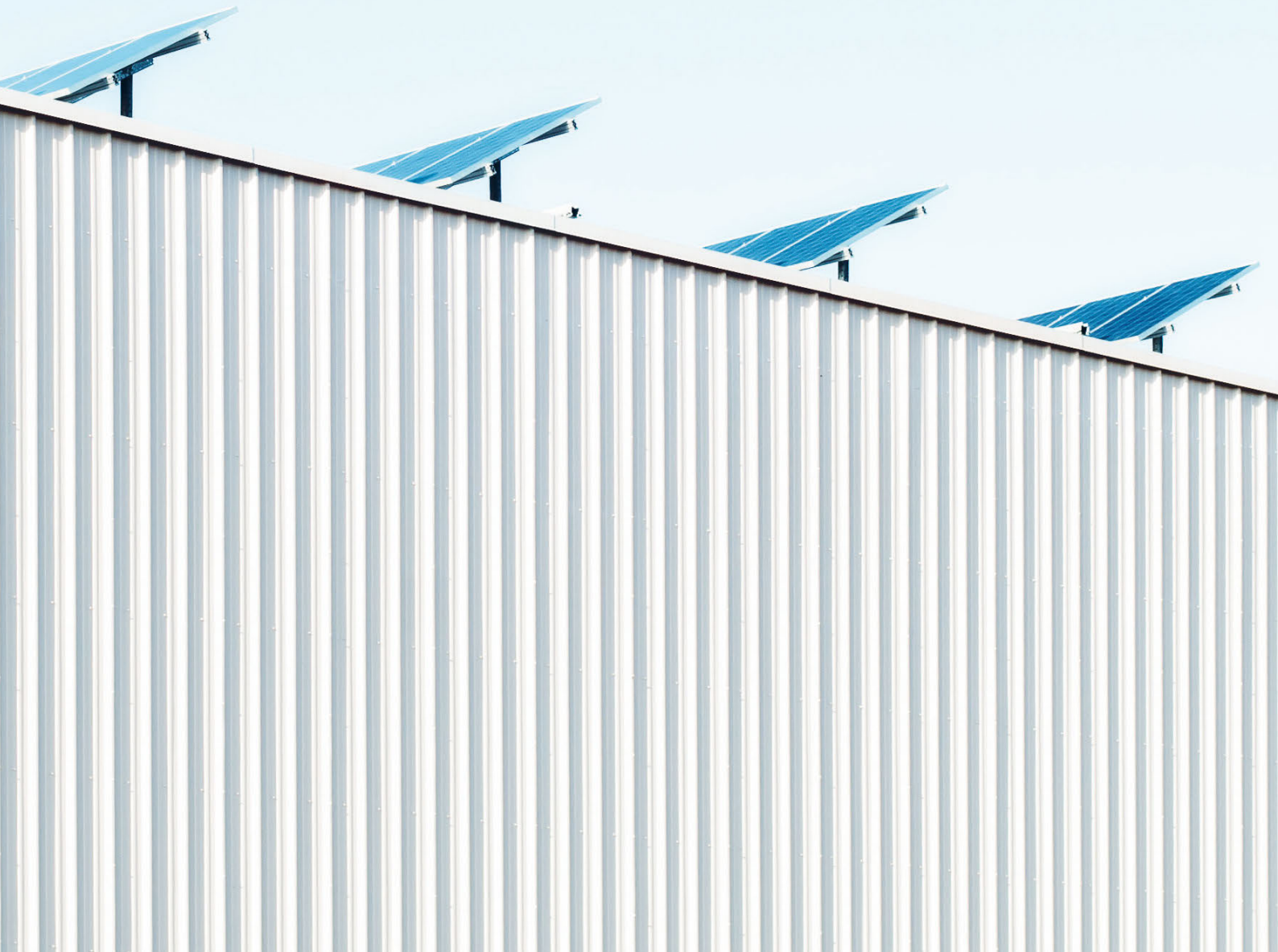
### We support the green energy transition in countries that collectively account for over 60% of global carbon emissions

Denmark's bilateral cooperation on transition of the energy sector.





In 2016, green energy technologies accounted for more than half (56.8%) of all energy technology exports.



# 6. How we will lower energy bills for businesses and citizens



For decades, businesses and consumers have significantly contributed to the green transition through their energy bills. These contributions must be structured so that Danish businesses can remain competitive in the international markets, and that citizens' energy costs are affordable.

When the PSO (Public Service Obligation) agreement from November 2016<sup>13</sup> eliminated PSO taxes for renewable energy, etc. from energy bills, with offset funding coming from the National Budget. The agreement delivered a historic, 2.7 billion DKK reduction in the energy bills of businesses.

The agreement also increases the disposable income of families between now and 2025. A model middle class Danish family will have an additional 2,500 DKK of disposable income in 2025.

Danish businesses will enjoy some of the EU's lowest and most competitive electricity prices when the PSO is fully phased into the National Budget in 2022. This will significantly improve the competitiveness of Danish businesses in European markets, and help attract foreign investment from companies establishing operations in Denmark due of its high security of supply, access to large volumes of green power and low electricity prices.

## 2.7 billion DKK

The 2016 **PSO Agreement** reduced the energy bills of Danish businesses by 2.7 billion DKK

### NOTES

<sup>13</sup> Agreement on the abolition of the PSO tax, November 2016.

<sup>14</sup> Energy Statistics (2016), Danish Energy Agency.



Danish businesses will enjoy some of the EU's lowest and most competitive electricity prices when the PSO tax is fully phased into the National Budget in 2022.”

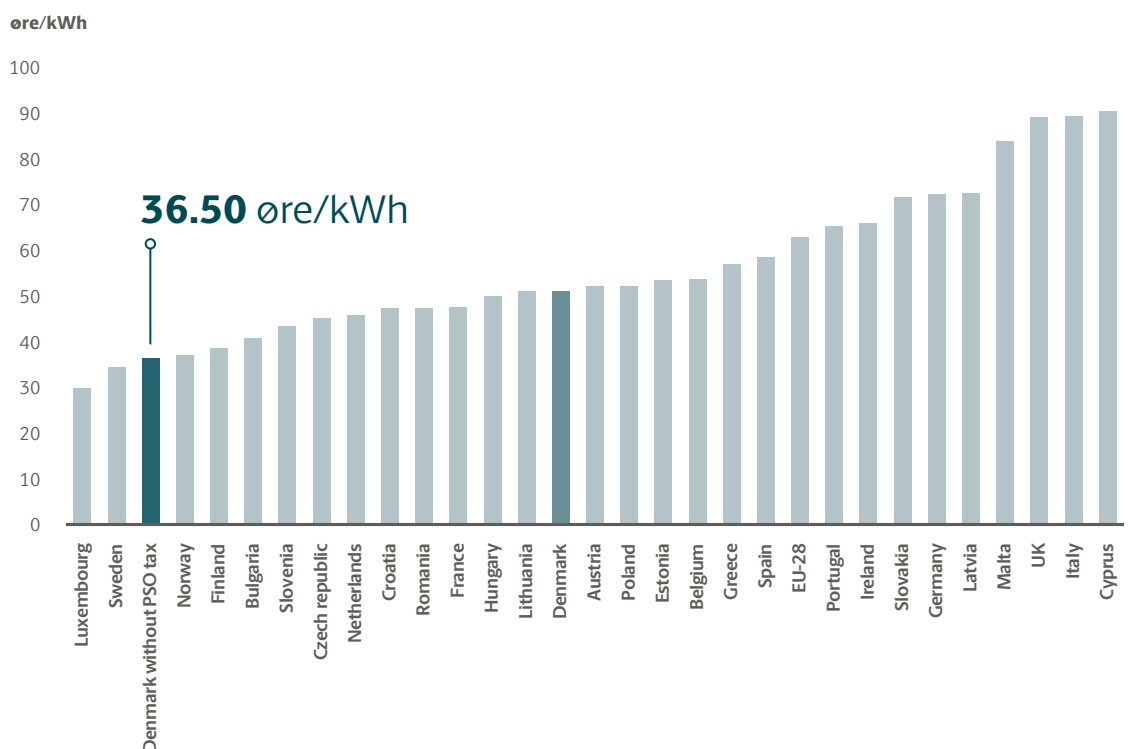


**Figure 11**

### Danish electricity prices for businesses are among the lowest in Europe

Electricity price for businesses in EU countries<sup>14</sup>

**Note** One Danish krone is subdivided into 100 øre



An aerial photograph of a vast solar farm. The image shows numerous long, parallel rows of solar panels stretching across a landscape. The panels are a deep blue color, and the rows are separated by narrow, light-colored paths. In the center-left of the image, there is a small, rectangular, light-colored structure, possibly a utility building or a water tank, situated near a small, dark pond. The overall perspective is from a high angle, looking down at the rows of panels, which create a strong sense of depth and repetition.

**New advancements are reshaping the energy system and challenging our established approach to energy policy planning and execution.**

# 7. New challenges for Danish energy policy

Denmark has a strong foundation and well-equipped energy system for maintaining its positions of strength and realising its green ambitions.

The ever-evolving energy sector has been rapidly changing in recent years. Development trends are fundamentally challenging our established

approach to energy policy planning and execution. To maintain our affordable, globally elite energy system, certain changes in our energy policy are required. The Energy Commission concludes that Denmark is facing a number of challenges that require new strategic choices.

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## Strategic choices<sup>15</sup>

1. The green transition must maximise benefits from the increased internationalisation of energy markets.
2. Technology and market development must be better leveraged for Denmark's benefit.
3. Imbalances caused by the tax system must be addressed.
4. Public support for renewable energy production must be reduced and, within the foreseeable future, phased out completely.
5. The energy system must be integrated.
6. Flexibility throughout the energy chain must be ensured by market conditions.
7. Energy efficiency will continue to make significant contributions, and energy efficiency efforts must be restructured for even greater impact.
8. Digitisation must strengthen the ties between consumption and supply, and provide a basis for new services to consumers.
9. In the EU and other international forums, Denmark will continue working for the establishment of common standards for renewable energy technologies, energy consuming equipment, etc.
10. Denmark must maintain and further develop its leading position in green energy technology research and development.

# Challenges

The forthcoming energy proposal will be rooted in the recommendations of the Energy Commission and present the government's vision of the course that is necessary for navigating Denmark's challenges. The most significant challenges are as follows:



## 1. The conversion will continue to require large investments

Over the years, significant investments have been made in the Danish energy system. It has brought us a long way and provided many benefits, but at a cost.

With the 2016 PSO agreement, the majority of green transition costs are transferred to the National Budget and are now an integrated part of the fiscal prioritisation process.

In the coming decades, significant investment will be needed to maintain our high ambitions. The green transition must be paid for, and it is ultimately funded by taxpayers and energy consumers.

Increased expenses can negatively impact the competitiveness of Denmark's businesses and the disposable income available to citizens, who have already paid much of the cost of the transition over the years.

Therefore, it is important that the transition is achieved at the lowest possible cost.



## 2. Existing rules and structures block modernisation and funding of the energy system

For many years, energy policy has been marked by highly detailed regulation and energy planning. Politicians have decided the structure of energy markets and the subsidies to be granted for specific technologies.

This approach is challenged by the fundamentally changing energy sector. Micromanaged policy is hard-pressed to capitalise on the benefits offered by major declines in technology costs, significantly increased integration with the surrounding world, and the introduction of new market players and solutions.

The results include price variance for renewable energy and an inability to account for the major decline in renewable energy prices anticipated in the future.

It also impedes our ability to push for renewable energy that can thrive on market conditions, and we all too easily end up paying too much for it. Experiences from the offshore wind sector, which is subject to competition, have shown the great benefits to be had from market-based solutions.

The current framework for the electricity market only allows power plants access to the market, preventing us from taking full advantage of new business models that can contribute to reducing costs through a flexible and integrated energy system – the very system that will be needed as renewable energy becomes the predominant source of energy.

Our tax structure is also from an era when electricity was based on fossil energy. The government's tax and subsidy analysis shows that much more can still be done to improve the design of our tax and subsidy system. The high taxes on electrical heating and electricity create barriers to the green transition by making it expensive to use the green electricity we generate ourselves, and prevent us from optimising energy policy in socioeconomic terms.

For example, we do not choose viable green solutions such as heat pumps for this reason. The high taxes also reduce the disposable income of Danish households.

Ultimately, we lose out on savings and benefits for society, businesses and the people of Denmark.

The electricity system is also changing, as increasing volumes of fluctuating energy are being connected to the grid.

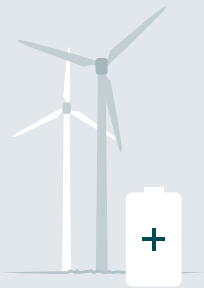


All things considered, there is good reason to reconsider the expediency of current tax legislation, and the possible need for an update. Flexible consumption is one of the relevant areas that should be examined.

Traditionally, the electricity system has been centred around the power plants. Increasing volumes of fluctuating green energy and connections with international grids are challenging power plants, whose earnings are declining under price pressures.

With the elimination of the basic amount – and thereby the subsidy previously provided to CHP plants for producing electricity – the sector's operating framework requires examination.

A modernisation of the district heating sector would give the district heating plants and consumers greater freedom, and thus the ideal conditions for making the right investments while taking consumption costs into account.



### 3. Increasing volumes of renewable energy are challenging the energy system

Expanding the utilisation of renewable energy has long been a goal of Denmark and our neighbouring countries. This is complicating efforts to optimally utilise this green energy, keeping costs high and putting security of supply at risk.

If Denmark fails to utilise the increasing volumes of renewable energy in a more flexible and integrated energy system, it will be unduly expensive to maintain today's excellent security of supply in the electricity, heating and gas sectors.

At the same time, the electricity market must be much more capable of adapting to new technologies, e.g. storage and off-grid solutions, by allowing these technologies into the market to help provide balance.

The energy sector is one of the areas where digitisation has yet to make a large-scale breakthrough. We risk missing out on significant benefits if we do not take advantage of the expected potential for digital solutions and commercialisation of data. Increased digitisation is expected to generate efficiency improvements in the energy supply and reduce the costs of making the energy system more flexible and integrated



### 4. When it comes to energy policy, Denmark is not an island

Wind and solar energy production is expected to more than double in northwestern Europe from 2020 to 2035.<sup>15</sup> The rapidly increasing volumes of renewable energy require even greater integration between national systems. Security of supply is evolving from a national matter to one where Denmark collaborates with neighbouring countries in situations of scarce supply.

We are greatly affected by the world around us. The price of wind power in Germany and the price of hydroelectric power in Norway now wield more influence over the price of electricity in Denmark than the electricity produced within our borders.

For 92% of 2017, west Denmark had the same electricity price as one of more of our neighbouring countries, while east Denmark shared the same electricity price with neighbours 96% of the year.

As the latest state subsidy rules from the EU Energy Union and the European Commission not only establish the framework, but increasingly also

the content of Member States' energy policies, significant steps are being taken towards the adoption of a common energy policy.

Current negotiations are seeking to establish ambitious new goals for renewable energy, energy efficiency and a greener transport sector. The vision of the Energy Union is a green EU where the market plays an important role, thus reducing the price of renewable energy and integrating the energy markets so that energy can flow freely across borders.

However, the various Member States have very different realities at present, which sets a certain limit on how ambitious the reforms can be. The energy systems of some Member States remain isolated. Others have not sufficiently expanded their energy infrastructure, and there are big differences in how far the countries have progressed in their respective transitions to a green energy sector.

#### NOTES

<sup>15</sup> Energy Commission, 2017..

<sup>16</sup> RE-Outlook, Danish Energy, 2017..





