PUBLICATIONS FOR A GREEN TRANSITION

From black to green – a Danish sustainable energy growth story

A case study of how an energy utility can transition from fossil fuels to renewable energy, and the enabling regulatory framework that made it possible

STATE OF GREEN

Connect. Inspire. Share. Think Denmark

Danish Energy Agency

Agenda

From both the policy- and energy company-side:

- **Timeline of events**
- **Learnings**
- **Recommendations**

Report can be found here:
https://ens.dk/sites/ens.dk/files/Globalcooperation/sog_fromblacktogreenreport_210x297_v08_web_spreads.pdf

STATE OF GREEN

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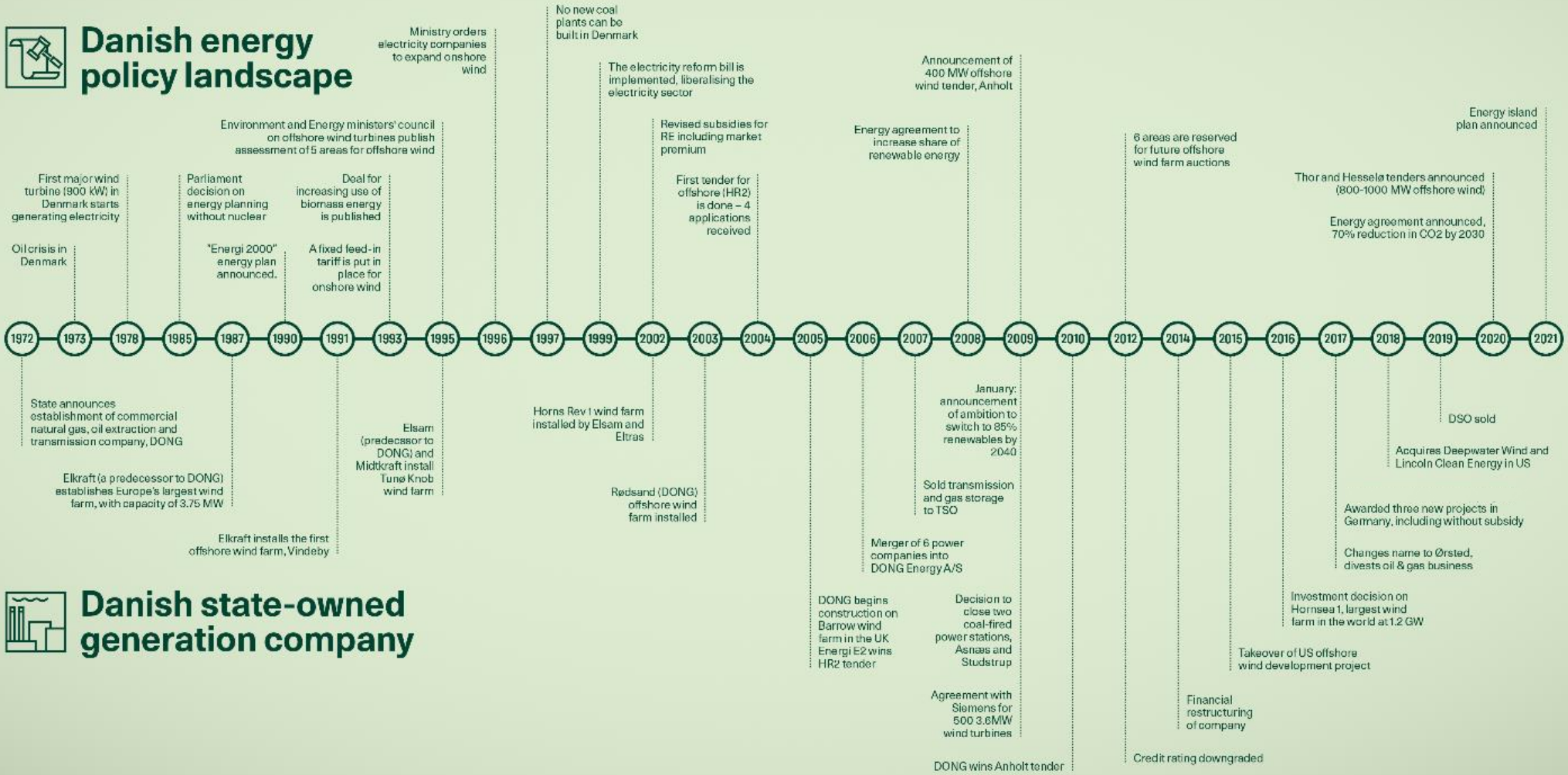
Danish Energy Agency

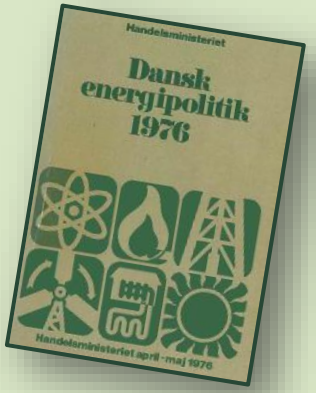
The Danish renewable energy journey



TIMELINE

1970s and 1980s

The oil crises call for new energy policies and technologies



1972
State announces establishment of commercial natural gas, oil extraction and transmission company, DONG

1973
Oil crisis in Denmark

1978
First major wind turbine (900 kW) in Denmark starts generating electricity

1985
Parliament decision on energy planning without nuclear

1987
Elkraft (a predecessor to DONG) establishes Europe's largest wind farm, with capacity of 3.75 MW

1972 1973 1978 1985 1987 1990 1991 1993 1995 1996 1997 1999 2002 2003 2004 2005 2206 2007 2008 2009 2010 2012 2014 2015 2016 2017 2018 2019 2020 2021

TIMELINE

1990 to 1995

Sowing the seeds of sustainable growth

1990
"Energi 2000" energy plan announced.

1991
Elkraft installs the first offshore wind farm, Vindeby

1993
A fixed feed-in tariff is put in place for onshore wind

1993
Deal for increasing use of biomass energy is published

1995
Environment and Energy ministers' council on offshore wind turbines publish assessment of 5 areas for offshore wind

1995
Elsam (predecssor to DONG) and Midtkraft install Tunø Knob wind farm

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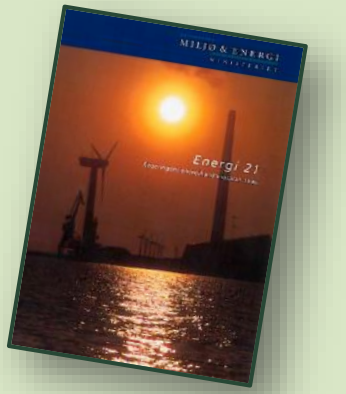
TIMELINE

1996 to 2000

Denmark at the forefront of change and the first EU provisions for a liberal internal market



1996
Ministry orders electricity companies to expand onshore wind

1997
No new coal plants can be built in Denmark

1999
The electricity reform bill is implemented, liberalising the electricity sector

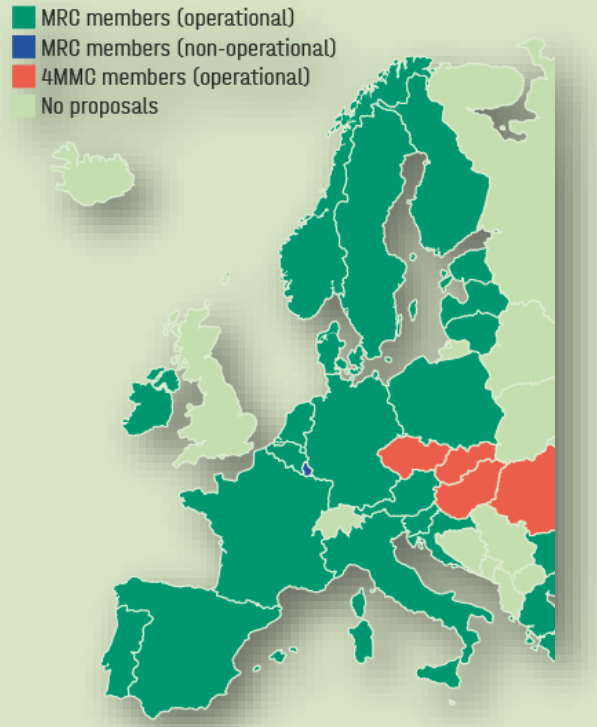
1972 1973 1978 1985 1987 1990 1991 1993 1995 1996 1997 1999 2002 2003 2004 2005 2206 2007 2008 2009 2010 2012 2014 2015 2016 2017 2018 2019 2020 2021

TIMELINE

2001 to 2006

A new era for the supply of electricity

The integration of day-ahead markets started with the liberalisation in 1999 and by 2021, 25 countries have fully integrated day-ahead markets, and an electricity demand of around 3,000 TWh/year (ENTSO-E). More information can be found at (ENTSO-E, 2021)



2002
Revised subsidies for RE including market premium

2002
Horns Rev 1 wind farm installed by Elsam and Eltras

2003
Rødsand (DONG) offshore wind farm installed

2004
First tender for offshore (HR2) is done – 4 applications received

2005
DONG begins construction on Barrow wind farm in the UK
Energi E2 wins HR2 tender

2006
Merger of 6 power companies into DONG Energy A/S

1972 1973 1978 1985 1987 1990 1991 1993 1995 1996 1997 1999 2002 2003 2004 2005 2206 2007 2008 2009 2010 2012 2014 2015 2016 2017 2018 2019 2020 2021

TIMELINE

2007 to 2010

DONG Energy pioneers the green transition in response to new, long-term political targets

2008
Energy agreement to increase share of renewable energy

2009
Announcement of 400 MW offshore wind tender, Anholt

2007
Sold transmission and gas storage to TSO

2009
January: announcement of ambition to switch to 85% renewables by 2040

2009
Agreement with Siemens for 500 3.6MW wind turbines

2009
Decision to close two coal-fired power stations, Asnæs and Studstrup

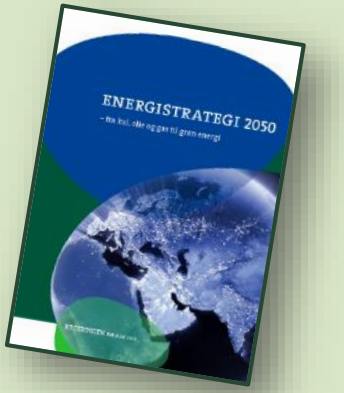
2010
DONG wins Anholt tender

1972 1973 1978 1985 1987 1990 1991 1993 1995 1996 1997 1999 2002 2003 2004 2005 2206 2007 2008 2009 2010 2012 2014 2015 2016 2017 2018 2019 2020 2021

TIMELINE

2011 to 2016

Denmark waves goodbye to coal
and DONG Energy expands overseas



2012
6 areas are reserved for future offshore wind farm auctions

2012
Credit rating downgraded

2014
Financial restructuring of company

2015
Takeover of US offshore wind development project

2016
Investment decision on Hornsea 1, largest wind farm in the world at 1.2 GW

1972 1973 1978 1985 1987 1990 1991 1993 1995 1996 1997 1999 2002 2003 2004 2005 2206 2007 2008 2009 2010 2012 2014 2015 2016 2017 2018 2019 2020 2021

TIMELINE

2017 to 2021

Heightened ambitions for
Denmark's green transition

2017
Awarded three new projects in Germany, including without subsidy

2017
Changes name to Ørsted, divests oil & gas business

2018
Acquires Deepwater Wind and Lincoln Clean Energy in US

2019
DSO sold

2020
Energy agreement announced, 70% reduction in CO2 by 2030

2020
Thor and Hesselø tender announced (800-1000 MW offshore wind)

2021
Energy island plan announced

1972 1973 1978 1985 1987 1990 1991 1993 1995 1996 1997 1999 2002 2003 2004 2005 2206 2007 2008 2009 2010 2012 2014 2015 2016 2017 2018 2019 2020 2021

Policy-side learnings

Planning – setting ambitious and reliable targets	Long-term, stable, inclusive and transparent energy planning procedures, supported by legislation, concrete reforms, and dialogue with the industry and with the public, are an essential part of the green transition
Demonstration projects	Demonstration projects provide invaluable regulatory, technical and engineering learning and boost investors' confidence, proving the scalability of the technology.
Economic incentives	Subsidies, taxes and CO_2 prices have proved instrumental, when designed in a transparent manner to reduce regulatory risk
Competition	An electricity sector built on the fundamental concept of competition creates incentives to innovate and lowers prices
Permitting and de-risking	Appropriate allocation of risk and the streamlining of permitting procedures reduce regulatory risk and potential delays

POLICY-SIDE LEARNINGS

Planning – setting ambitious and reliable targets

In order to achieve a clear, stable and transparent policy framework, energy planning should meet the following conditions:

1. **Be long-term.** By being designed with a long-term mindset, such plans provide a stable framework and the long-term horizon that industry requires to join the transition.

2. **Reflect transparency and stability**. If political decisions that significantly affect the business case for large investments are reversed, it will severely damage the government's credibility with developers and investors, leading to higher prices and slower market uptake of RE.

3. **Include dialogue with the future players at the early stages**: a transparent dialogue between government and industry can give the necessary inputs for designing the rules from parties involved. Denmark has used industry dialogue as a methodology for collecting input e.g., for designing auctions or for collecting technology data to use in long-term analyses (technology catalogue).

4. Be **supported by the legislation through concrete reforms**. The first step requires the development of a reliable plan with calculations of when and how to achieve the targets in accordance with socio-economic priorities. This will then be implemented by government institutions. An example is the EU 20/20/20 targets, set in 2007 and followed by targets that were enacted in legislation in 2009.

More info here

POLICY-SIDE LEARNINGS

Demonstration projects

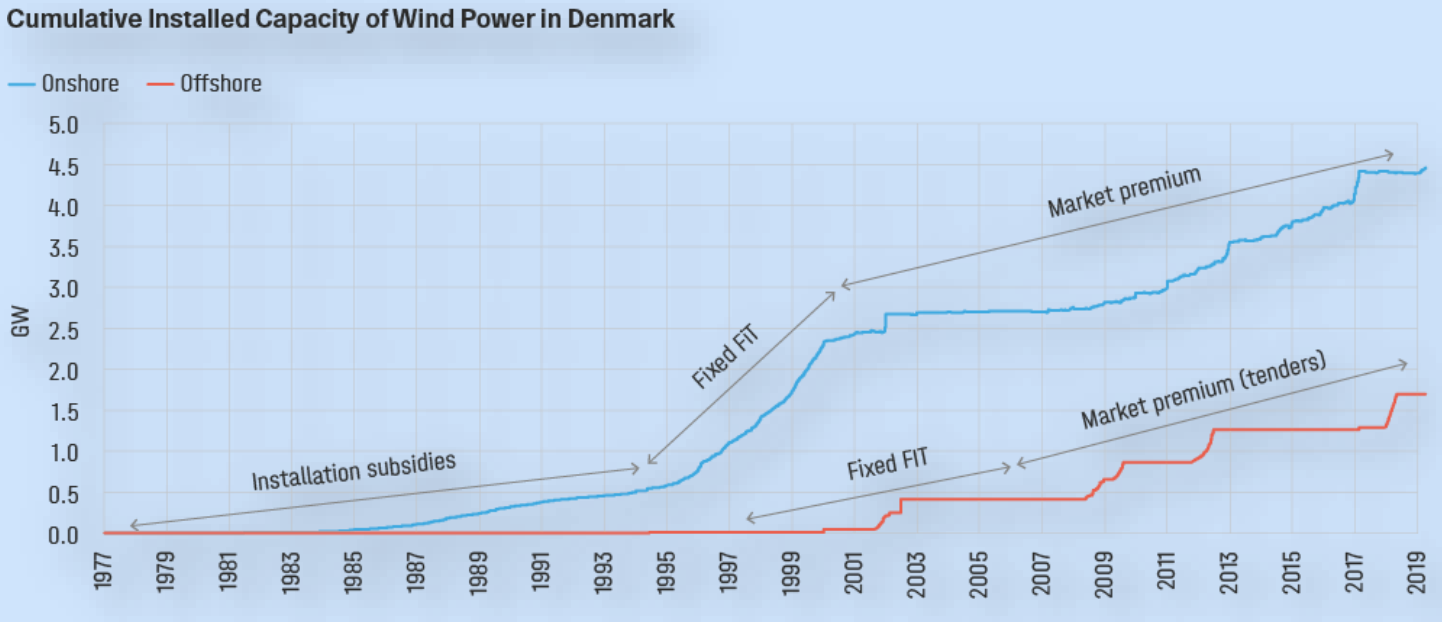
The first projects in any technology are more expensive than subsequent projects when the technology is more mature.

Demonstration projects were a key policy tool to kickstart the industry and gave the following key learnings:

- Myriad of technical and engineering learnings to develop the supply chain and reduce costs
- Environmental impact assessments – learnings from the offshore projects have helped shape the regulations around environmental impact assessments
- Investor confidence, as the projects showed that the technology was possible at scale
- Has underpinned the Danish wind industry as a first mover on offshore wind

POLICY-SIDE LEARNINGS

Economic incentives



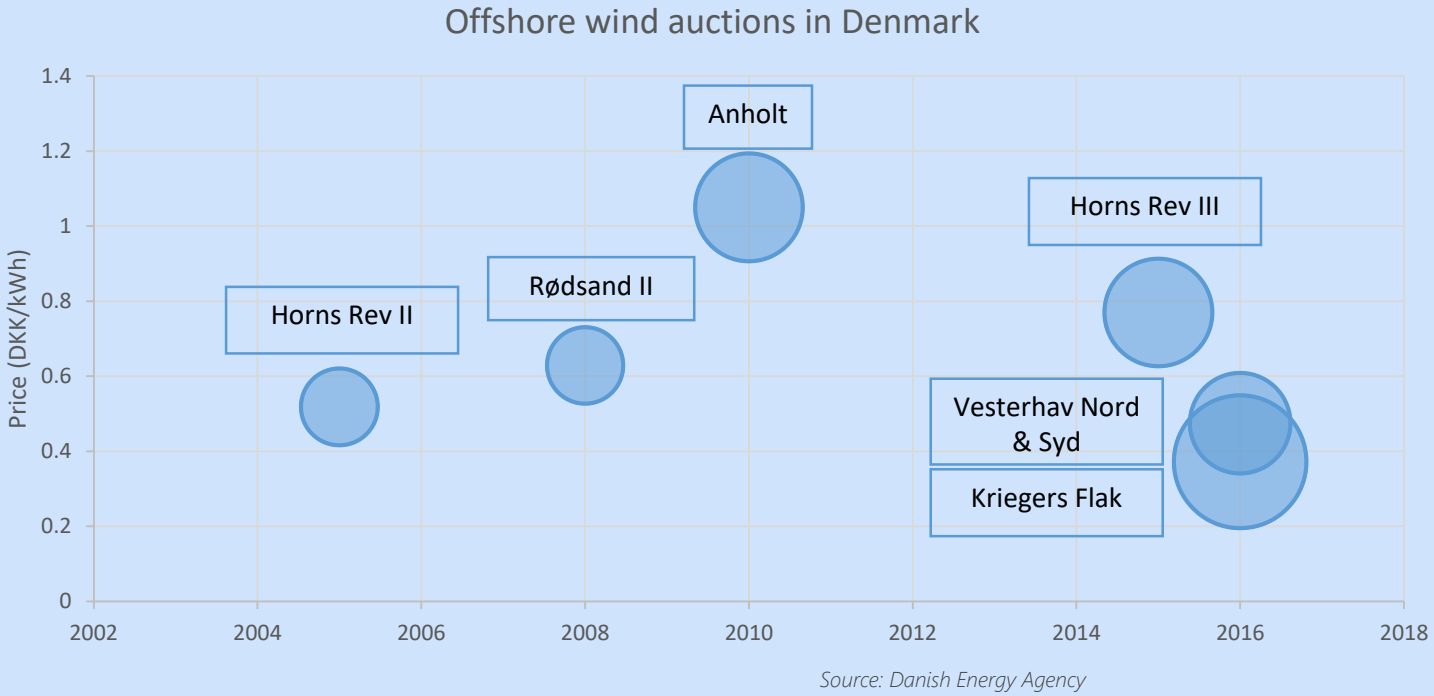
Changes through time, but importantly no retroactive changes to incentive schemes

Onshore wind grew rapidly in the 1990s in Denmark until the year 2000 saw market liberalisation, combined with reduced subsidies and low electricity prices.
Since then, the growth has resumed mainly due to replacing older turbines with newer, larger turbines.

Offshore wind turbines installed since 2004 have been through a competitive tendering procedure, whereas projects before this were demonstration projects through public-private partnerships with a Fixed FiT.
Note: the data does not include recently connected 600 MW offshore wind farm Kriegers Flak.

POLICY-SIDE LEARNINGS

Economic incentives



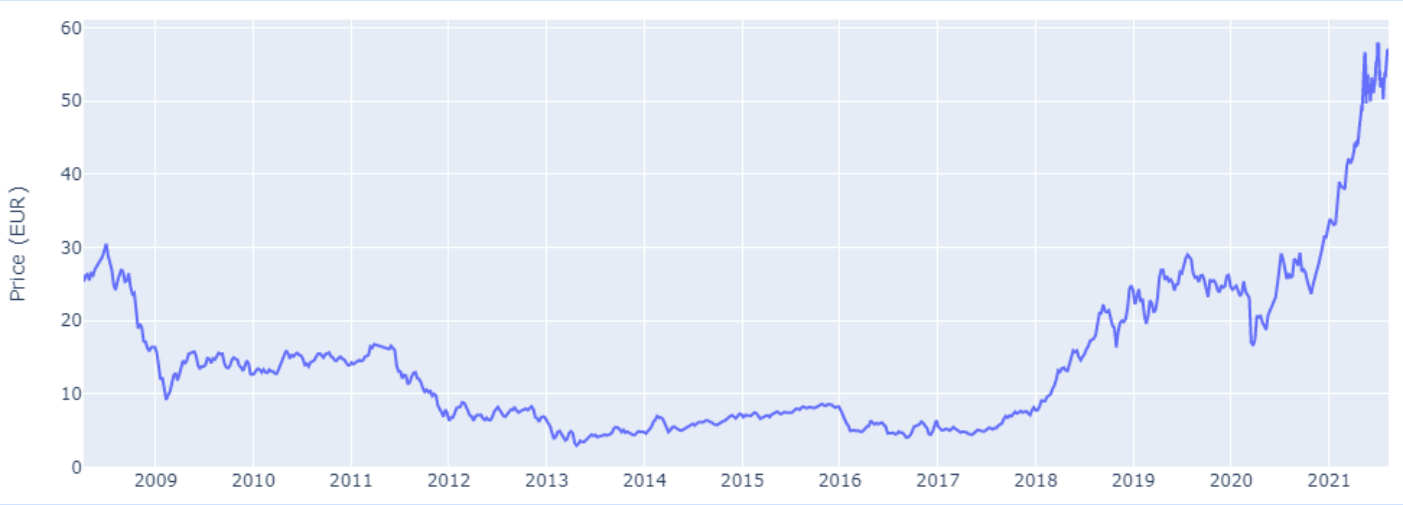
Source: Danish Energy Agency

Lessons through time in auction design process for offshore wind

More information can be found here: https://ens.dk/sites/ens.dk/files/Globalcooperation/the_danish_offshore_wind_tender_model_final.pdf

POLICY-SIDE LEARNINGS

Economic incentives



Source: Sandbag.be

The EU Emmissions Trading Scheme has been a driver since it was introduced in 2005, based on “cap and trade” principle.

Carbon prices are high again now. Even when they were low, such as from 2008-2018, Energy Companies such as DONG/Ørsted were forced to plan and make business decisions for scenarios with high carbon prices

CO2 taxes were introduced in 1992 in Denmark

POLICY-SIDE LEARNINGS

Competition

- Generators can focus on competing on generation cost
- After this focus on reductions in cost, they could compete in neighbouring countries' markets
- This has created a vibrant competitive offshore wind industry in Denmark (3 out of 6 bidders in Thor are at least partly Danish)

- State ownership at arm's length in terms of decision-making was essential to not unfairly influence energy policy
- Power plant package was necessary and included incentives for RE
- Electricity market opens up new opportunities – balancing flexibility, heat pumps, EVs, etc
- Liberalisation process told in more detail here

POLICY-SIDE LEARNINGS

Permitting and de-risking

- The regulatory framework for offshore wind (for example) should be designed in a way so as to properly allocate risk, with the goal of attracting competition in projects to achieve the best price.
- DEA acts as *one-stop-shop* – streamlining the consenting process, an important regulatory step to facilitate large offshore wind projects.

More information can be found on DEA's website on the one-stop-shop concept. https://ens.dk/sites/ens.dk/files/Globalcooperation/one-stop_shop_oct2020.pdf

POLICY-SIDE LEARNINGS

Permitting and de-risking

De-risking offshore wind

TYPE OF RISK	OWNER	EXAMPLES
Policy commitment	Government (policy makers, government agencies)	▪ Credible and realistic political agreements ▪ Certainty of targets ▪ Sanctity of contracts
Adequate project planning and permitting risk	Developer Government agencies	▪ Capability of developer to plan and time the project adequately ▪ One stop shop licensing ▪ Environmental studies carried out at the requisite level
Construction challenges	Developer Investors	▪ Technical and financial capability of project owner ▪ Competitive selection of suppliers and sub-suppliers ▪ HSE regulation
Operational risk	Investors Insurance companies	▪ Cost/quality balance to be struck in desired lifetime ▪ Adequate insurance
Offtake security and revenue support	Policy makers System operator Off-taker	▪ Priority access to the grid and transparent rules for curtailment ▪ Security of income by sale of energy (market, PPA) ▪ Revenue support
Financial and currency risk	Investors Insurance companies Government guarantees	▪ Asset should be tradable and transferable ▪ Cost of the financial loan package depends on the perceived risk of the project ▪ Capital expenditure guarantee e.g., government backed loan

Learnings from the energy company's business transformation

Creating a sustainable vision

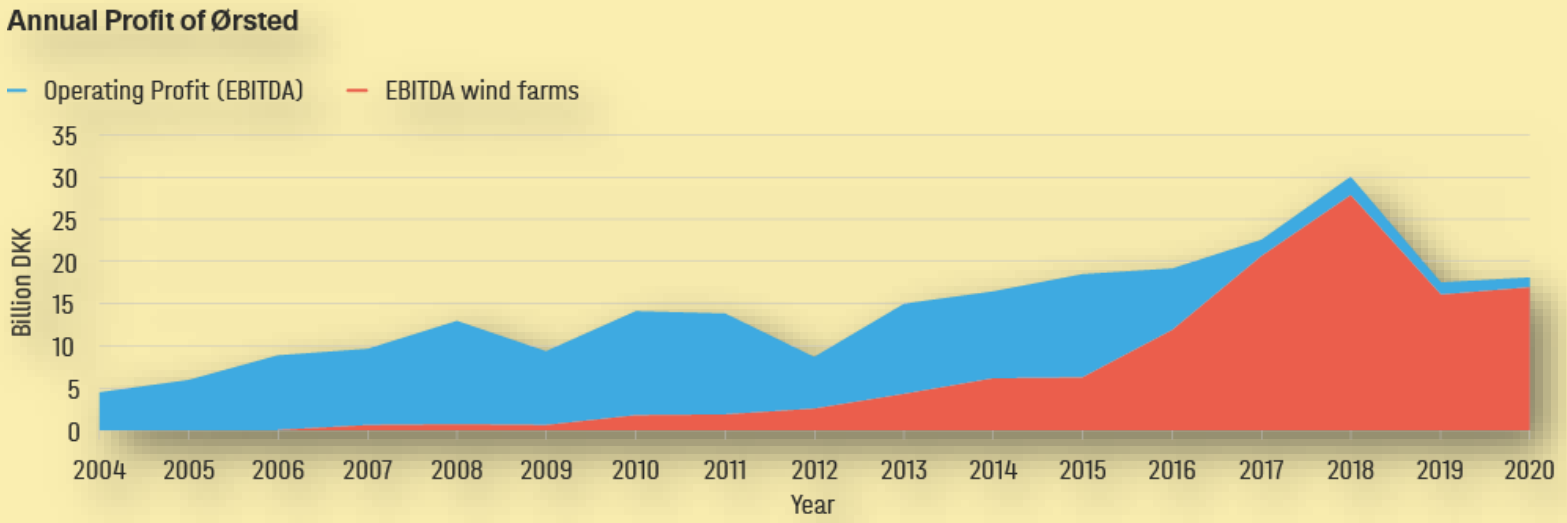
Exit strategy for fossil fuels

Entry strategy for renewable energy

2008 DONG energy		2019 Ørsted
Oil & gas exploration and production comprises roughly 40 per cent EBITDA		Divested to Ineos in 2017
Coal-fired thermal generation accounts for approx. 75 per cent of electricity generation & 25 per cent of EBITDA		Most coal-fired power plants have converted to biomass and plan to be completely coal-free by 2023. Engineers were either transferred internally to focus on offshore wind, or transferred to consulting firm Rambøll Engineering.
Sells the equivalent of approx. 20 per cent of Danish electricity demand of to end consumers		Divested to SEAS-NVE (now Andel) due to Ørsted's strategic focus on renewable energy
Accounts for less than 10 per cent of EBITDA and around 14 per cent of generation		Accounts for over 90 per cent of EBITDA and around 90 per cent of generation.
The Danish state owns 73 per cent		**The Danish state owns 50.1 per cent**

LEARNINGS FROM THE ENERGY COMPANY'S BUSINESS TRANSFORMATION

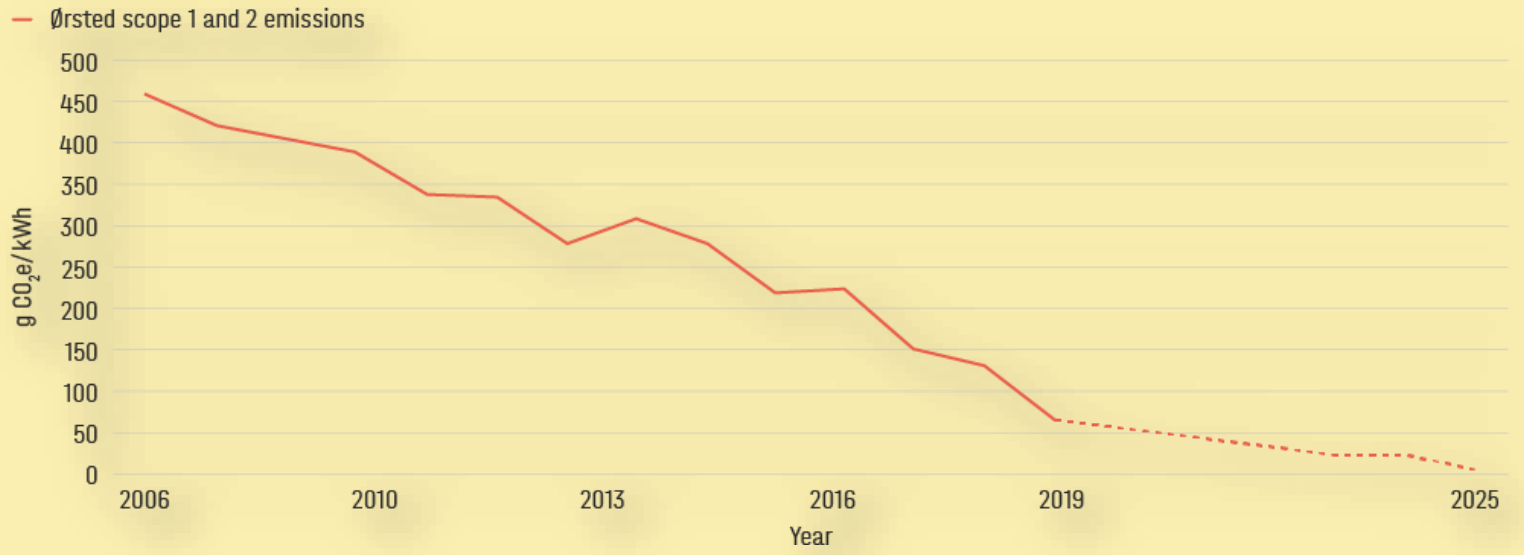
Creating a sustainable vision



Annual Operating Profit of DONG Energy / Ørsted over the years, and the share of profits from wind as a share of the total. The drop in 2019 was due to divestment.

LEARNINGS FROM THE ENERGY COMPANY'S BUSINESS TRANSFORMATION

Creating a sustainable vision



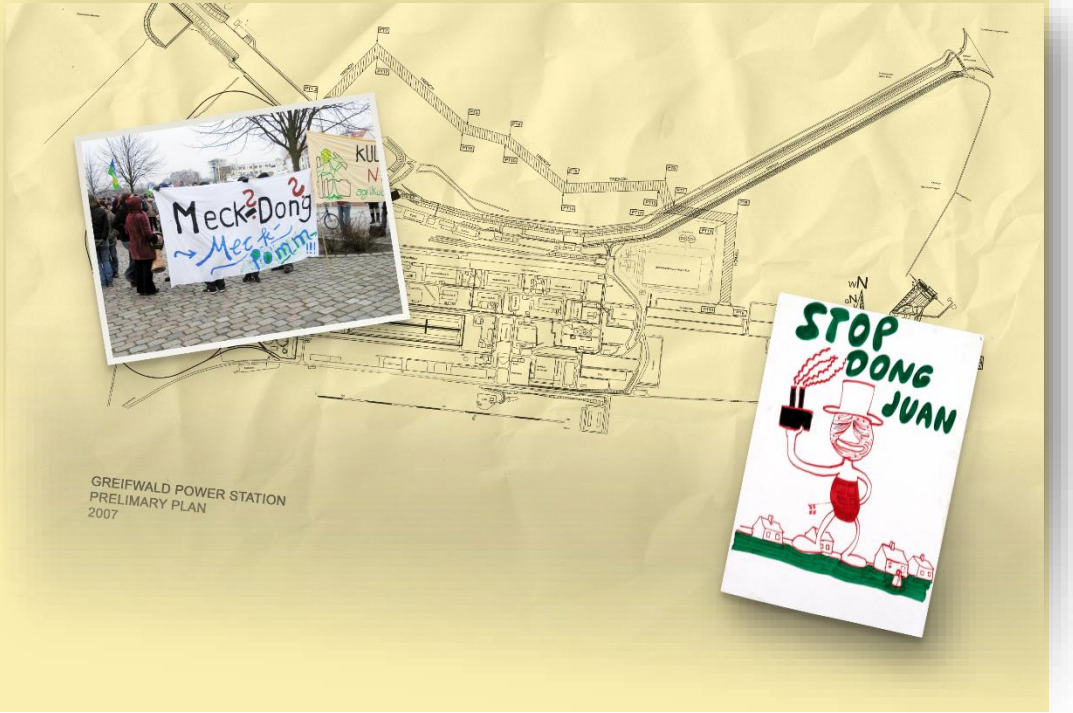
Specific CO_2 emissions. Actual and prognosis. Source: Ørsted.

LEARNINGS FROM THE ENERGY COMPANY'S BUSINESS TRANSFORMATION

Exit strategy for fossil fuels

The exit strategy for fossil fuels at Ørsted has taken place through a number of different steps:

- **Closure** of around 40 per cent of the company's CHPs
- A **conversion** to biomass with a favourable regulatory framework
- **Divestment** of assets and businesses that do not align with the green vision, or
- If all else fails, **abandoned** investments.
    - Greifswald coal-fired power station



LEARNINGS FROM THE ENERGY COMPANY'S BUSINESS TRANSFORMATION

Exit strategy for fossil fuels

Vattenfall abandoned a recently constructed coal-fired power plant in Germany. A decommissioning auction was facilitated by the German government

What is a decommissioning auction?

A decommissioning auction is a financial tool employed by some EU member countries to phase out coal from the national electricity mix.

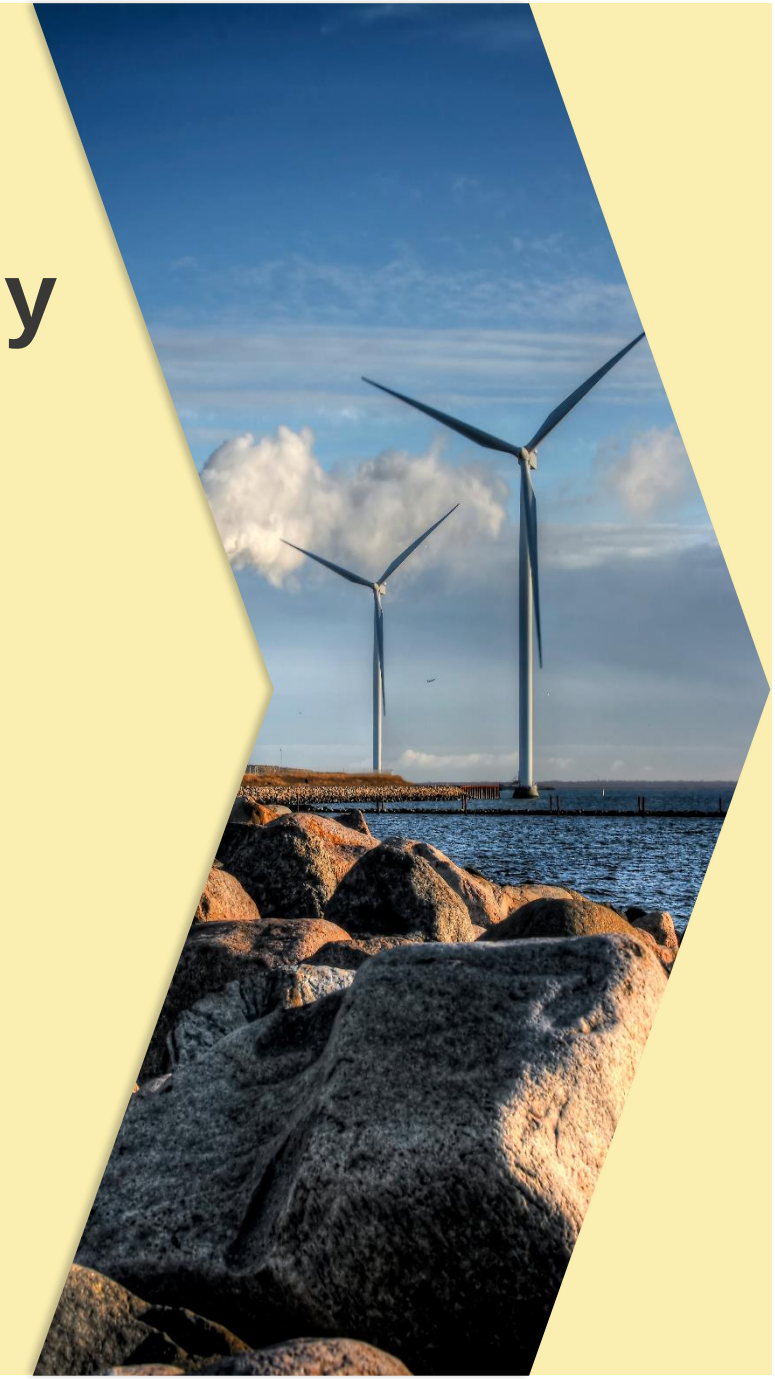
The local government organises an auction to compensate for the decommissioning of the black asset for companies owning and operating coal power plants. This type of auction has been introduced both for tackling the impact of coal on climate change targets, but also to meet halfway with existing large coal plant operators, which are currently struggling in the increasingly difficult market situation. The auction is structured to award bids based on the ratio between the asked compensation price and the resulting reduction in CO2 emissions. In special cases, the transmission grid operators can ask to spare some of the plants to be used as backup capacity reserve in “critical situations”. Nonetheless, the plants will not be allowed to participate in the electricity market remuneration mechanisms.

LEARNINGS FROM THE ENERGY COMPANY'S BUSINESS TRANSFORMATION

Entry strategy for renewable energy

Learnings in entering a new renewable energy market

- Cultural shifts within the company, use of internal talent and competencies:
- Supply chain as a key factor to reduce costs
- Joint ventures and investor engagement



LEARNINGS FROM THE ENERGY COMPANY'S BUSINESS TRANSFORMATION

Follow the growth

Examples of entry and exit strategies for Ørsted, as experienced in Denmark over the last 10-15 years in particular

	Entry strategy for renewable energy	Exit strategy for fossil fuels
Human resources	Cultural shift within the company. Build up human resources: harvest internal resources, retrain personnel, create synergies with existing base and attract new talents, increasing sustainable job opportunities.	Divest businesses that do not align with the new green vision
Technology strategy	Develop and test proof of concept projects, devise long term strategies with ambitious targets and scale up large-scale renewable projects. Then choose technologies based on their return and risk profile in a given regulatory framework, investigating the impact on players in the supply chain. Bring the technology to cost-competitive levels with the existing products, assessing the role of the new product in existing and new markets.	Convert directly, e.g., coal to biomass The same could be done with existing coal power plants, by using the land for hybrid solar and wind projects and re-using the existing transmission infrastructure.
Market forces & project choices	Invest in new projects. Joint ventures can be a good way to gain technical experience and knowledge, filling the gap with the missing technical competences to reach the objective. Institutional, national and international investors can be attracted to green projects with long-term returns and low risk. Investors and technical advisors which have been educated about the new technology and the mission are more likely to feel confident in approving co-investments.	Abandon projects Several coal-fired power plants have been abandoned in northern Europe as they are no longer profitable and attract public opposition.

Recommendations

NATIONAL ENERGY PLANS

CONCRETE LEGISLATIVE REFORMS

A NEW GREEN COMPANY VISION

EXIT STRATEGY FOR FOSSIL FUELS

ENTRY STRATEGY FOR RENEWABLE ENERGY

RECOMMENDATIONS

National Energy Plans

- Long term
- Transparent
- Stable
- Inclusive

RECOMMENDATIONS

Concrete legislative reforms

- Economic incentives
- Reforms to ensure an electricity sector based on competition
- Demonstration projects
- Permitting and de-risking

RECOMMENDATIONS

A new green company vision

- Make good use of the long-term planning policies in place
- Contextualise the strategy
- Develop a holistic vision within the dynamic landscape

RECOMMENDATIONS

Exit strategy for fossil fuels

- Engage actors and government agencies in the divestment plans
- Re-evaluate the asset to fit the future of the sector
- Abandon investments when regulations and public opposition hinder future opportunities

RECOMMENDATIONS

Entry strategy for renewable energy

- Attract finance to new renewable energy projects validating the proof of concept
- Engage, align and educate stakeholders
- Be a first mover: enjoy the benefits and be ready for the challenges
- Value joint ventures: share the skills
- Build up human resources: harvest internally, retrain personnel, create synergies with existing base and attract new talents

RECOMMENDATIONS

Transitioning from black to green energy

NATIONAL ENERGY PLANS

- Long term
- Transparent
- Stable
- Inclusive

CONCRETE LEGISLATIVE REFORMS

- Economic incentives
- Reforms to ensure an electricity sector based on competition
- Demonstration projects
- Permitting and de-risking

A NEW GREEN COMPANY VISION

- Make good use of the long-term planning policies in place
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EXIT STRATEGY FOR FOSSIL FUELS

- Engage actors and government agencies in the divestment plans
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ENTRY STRATEGY FOR RENEWABLE ENERGY

- Attract finance to new renewable energy projects validating the proof of concept
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