Ørsted transformation

Converting and operating flexible power plants

Ørsted

Vice President, Regulatory Affairs
Ulrik Stridbæk
15 June 2018

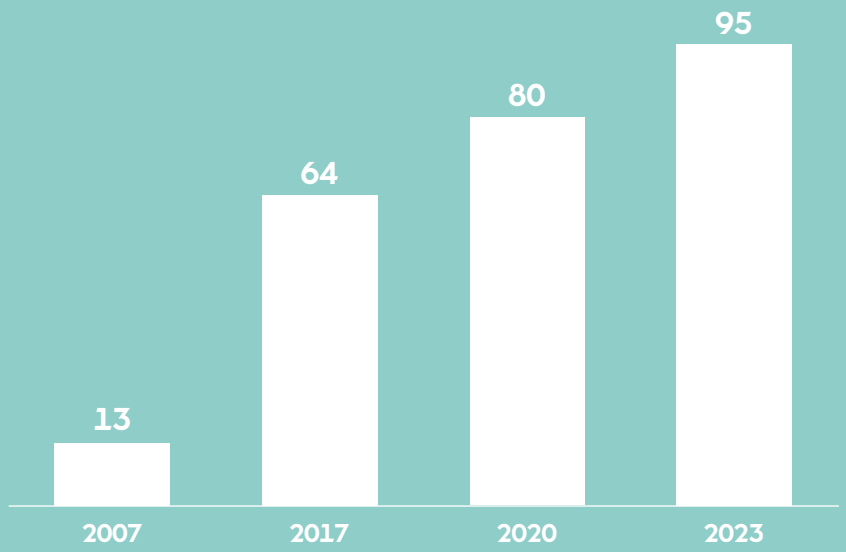
Ørsted today

Headquartered in Denmark
Listed in the Nasdaq OMX: ORSTED
5,638 employees
Revenue in 2017 DKK 59.5 bn (GBP 7.1 bn / EUR 8.0 bn)
EBITDA in 2017 DKK 22.5 bn (GBP 2.7 bn / EUR 3.0 bn)
Phase out the use of coal by 2023

Transforming from fossil to green energy

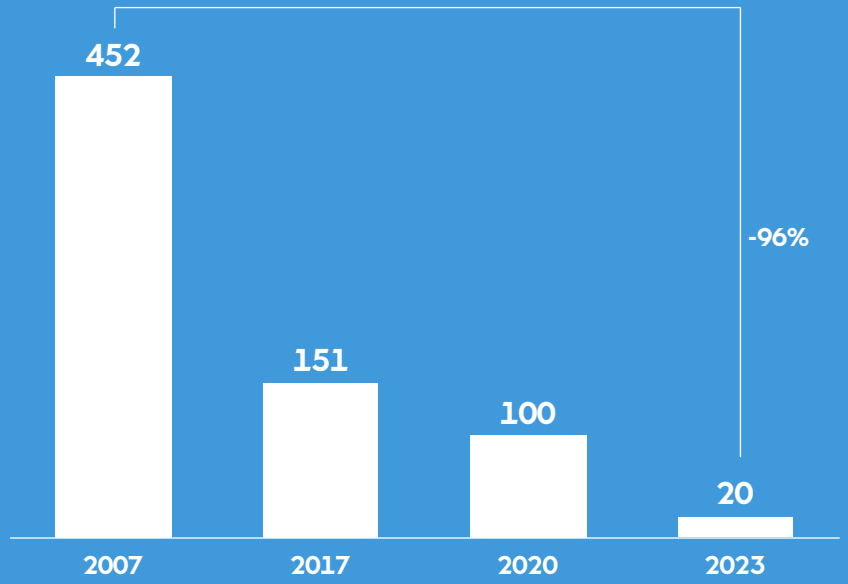
Share of green power

%



CO2-emissions

g / kWh



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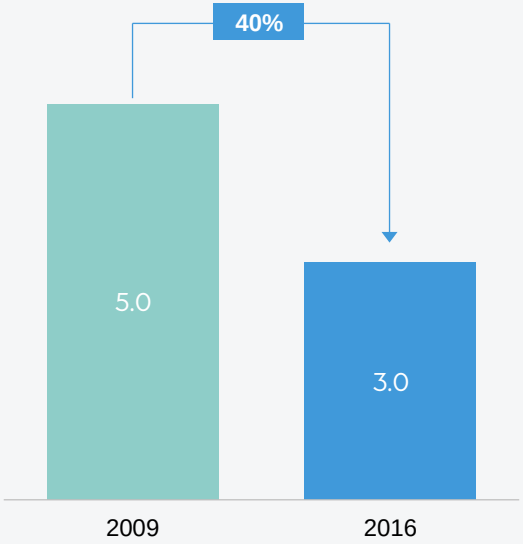
Conventional thermal business needed to adapt to the new energy system

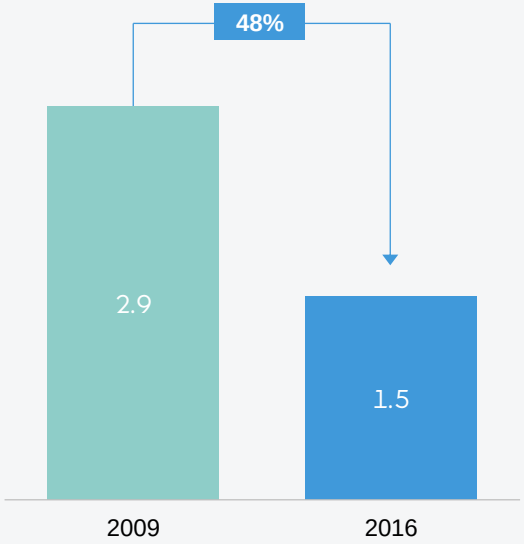
Major reductions in power generation capacity since 2009...

Danish portfolio of central plants (GWe)



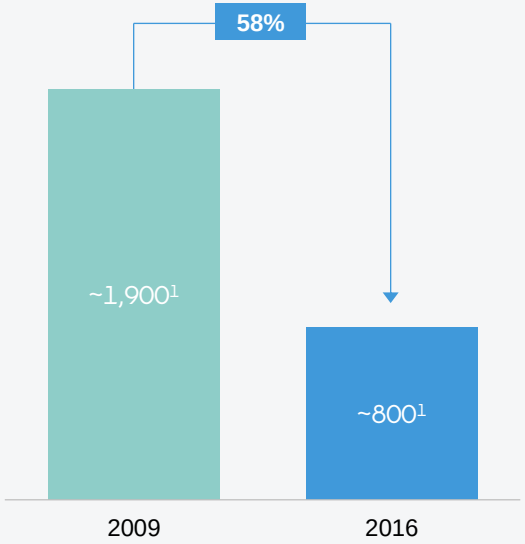
... as well as in OPEX spend...

OPEX (DKKbn)



...and FTE numbers

of FTEs



1. Adjusted for divested activities

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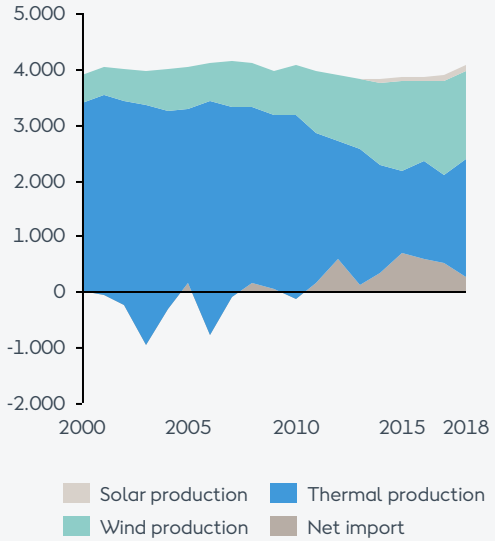
Investment in wind farm has reduced demand for thermal power without influencing security of supply

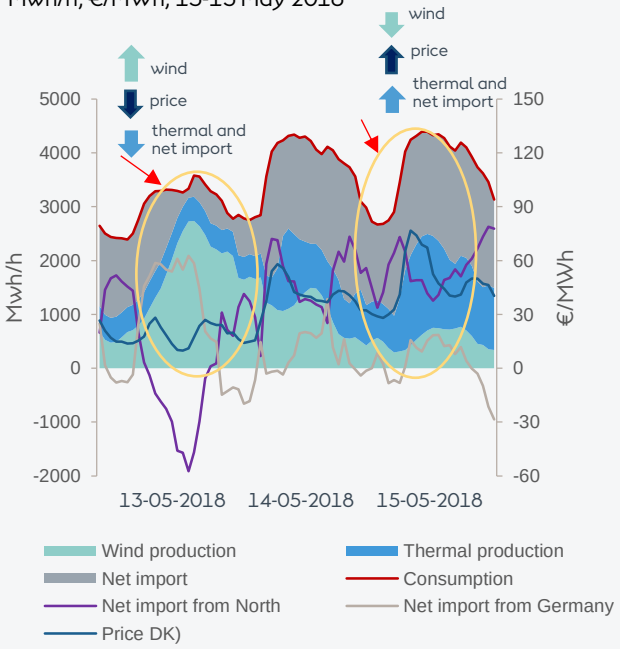
Production mix in Denmark's power system

Mwh/h, 2000-2018



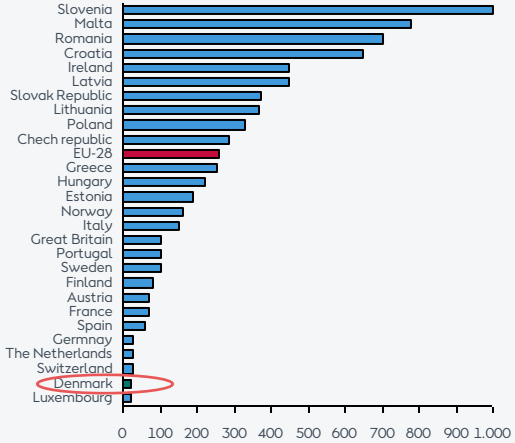
Production variability in the Nordic power grid

Mwh/h, €/MWh, 13-15 May 2018



Security of supply in Europe

Minutes lost per year per capita, 2014



Source: Energinet market data and CEER

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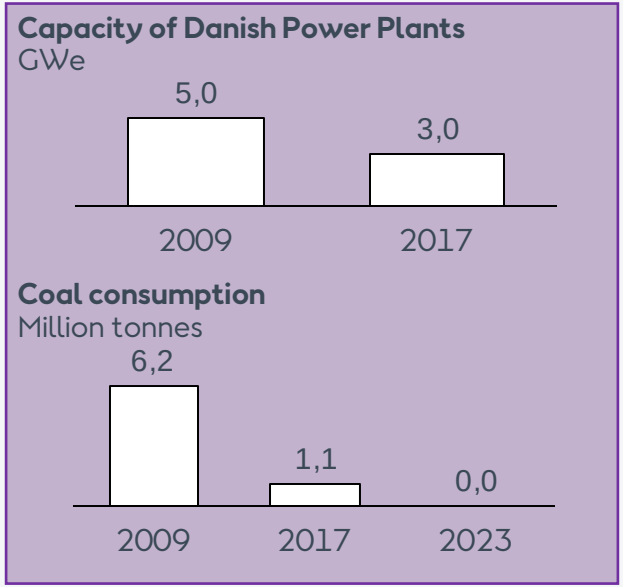
Business model for thermal plants turned upside-down

From

- Fossil fuels
- Power producer
- Heat as by-product

To

- Sustainable biomass
- Heat producer
- Power as flexible back-up



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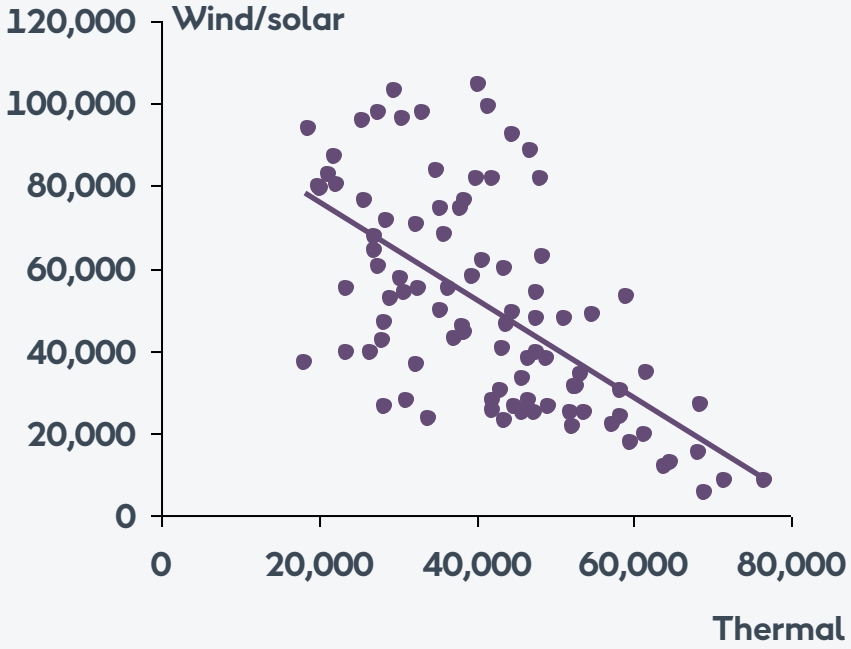
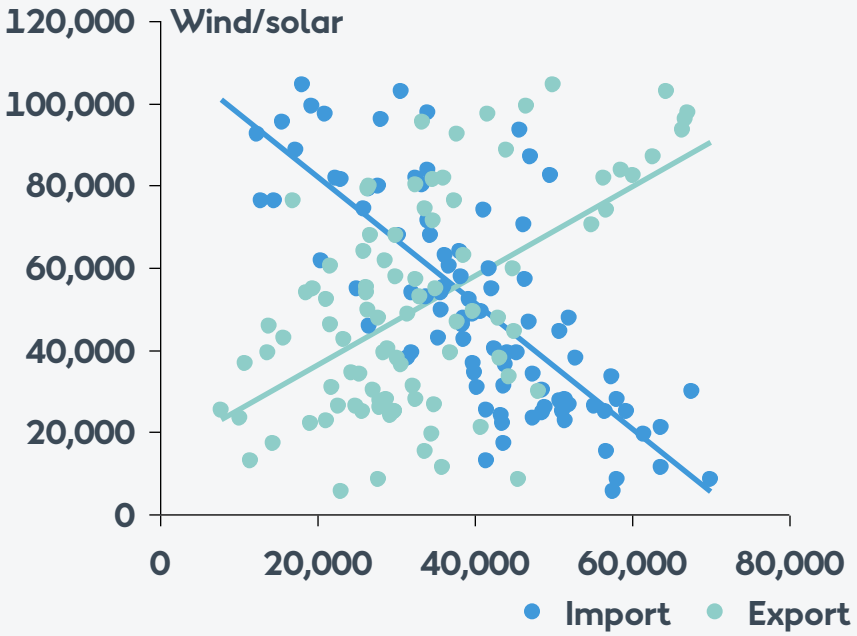
Flexible power plants and X-border trade balance variation in wind and solar production

Wind/Solar vs. thermal power production
Daily values, Q4 2017



Wind/Solar power production vs. import/export
Daily values, Q4 2017



Source: Energinet

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More flexibility in thermal plants – improved operation, improved infrastructure and minor investments

Examples of initiatives to improve plant flexibility

Flexibility between products	Turbine bypass and heat accumulators to decouple heat and power production
Minimum load	30% ⇨ 13% of full load (Avedøre 2)
Load gradients	4% /min ⇨ 8% /min (Skærbæk 3)
Minimum load with ancillary services	60 MWe ⇨ 20 MWe (Asnæs 2)

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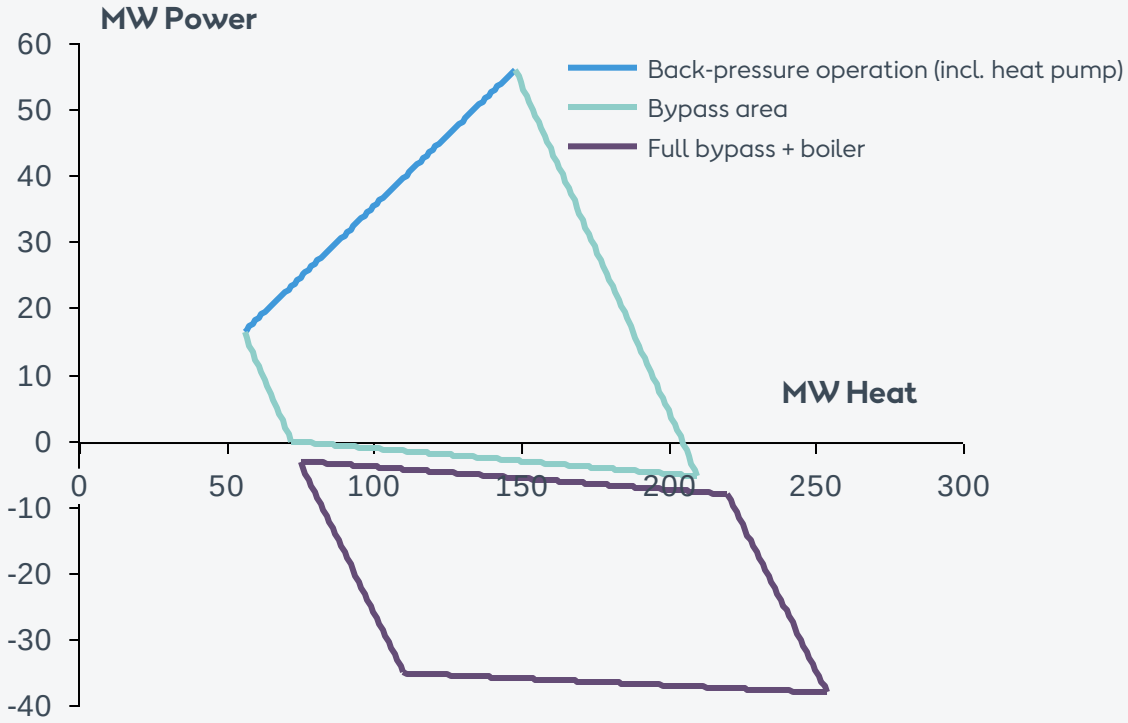
Building flexibility into a new biomass CHP in Esbjerg



Features of a new Esbjerg CHP
(FiD expected in 2019)

- The CHP co-produce heat and power in the range from 20-100%
- Heat pump driven by flue gas condensation increases heat efficiency
- Bypass (full and partial) opportunity makes it possible to only produce heat
- The electric boiler can make the plant a net electricity consumer
- Other possibilities such as GigaStorage and batteries for ancillary services are also considered

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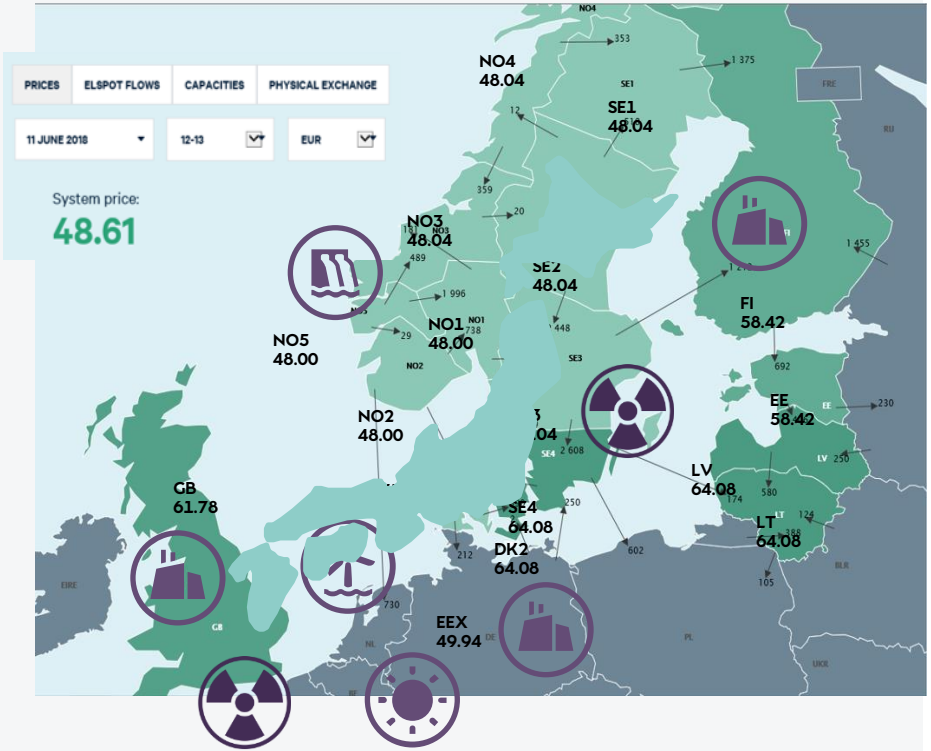
Seamless trade integrates wind and distributes flexible resources across the region

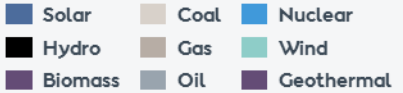


Sourco: Nordpollspot.com: https://www.nordpoolgroup.com/Market-data1/#/nordic/map

- Nordpool, EEX and other exchanges couples markets from North to South of Europe
- >70 % market share in Nordpool on the day-ahead market in 2017
- Connects hydro in Norway with the thermal plants and nuclear
- Zonal pricing in the Nordic Countries reveals grid congestions

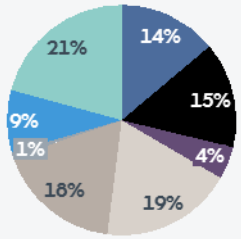
➢ **Many similarities between Japan and Northern Europe**

2016	The Nordics, UK and Germany	Japan
Capita	172 mill.	127 mill.
Power consump.	1250 TWh	1000 TWh
Power capacity	318 GW	290 GW (incl. nuclear)

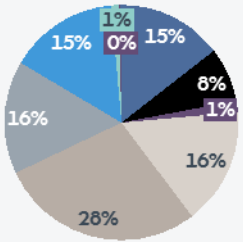


Share of capacity for electricity production
2016

The Nordics/ Germany/UK



Japan



Sourco: Bloomberg Energy Finance (nuclear capacity for Japan from 2014 from IEA "Energy Policies of Japan 2016",

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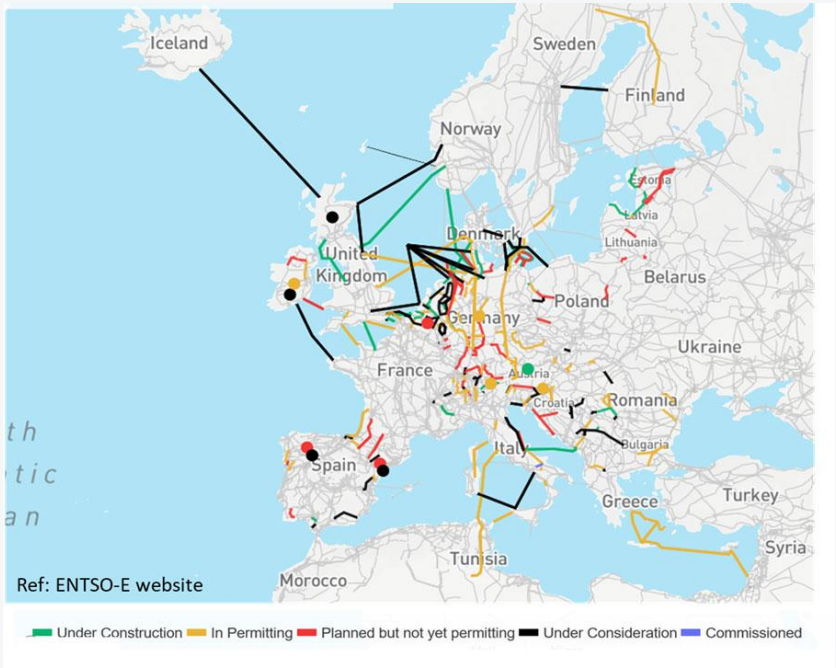
The Energy Union: Integrate and decarbonise

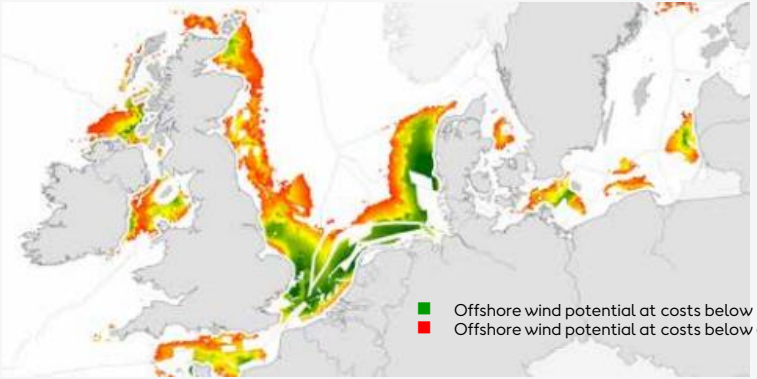
Build and utilise infrastructure

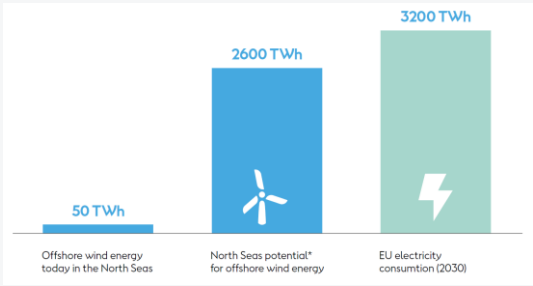


Source: ENTSO-E TYNDP (Ten year development plan). Overview of possible European energy futures up to 2040, based on energy scenarios.

Offshore wind potential in North Seas

Potential at costs below 65€/MWh by 2030, including transmission





Source: BVG Associates for WindEurope, 2017

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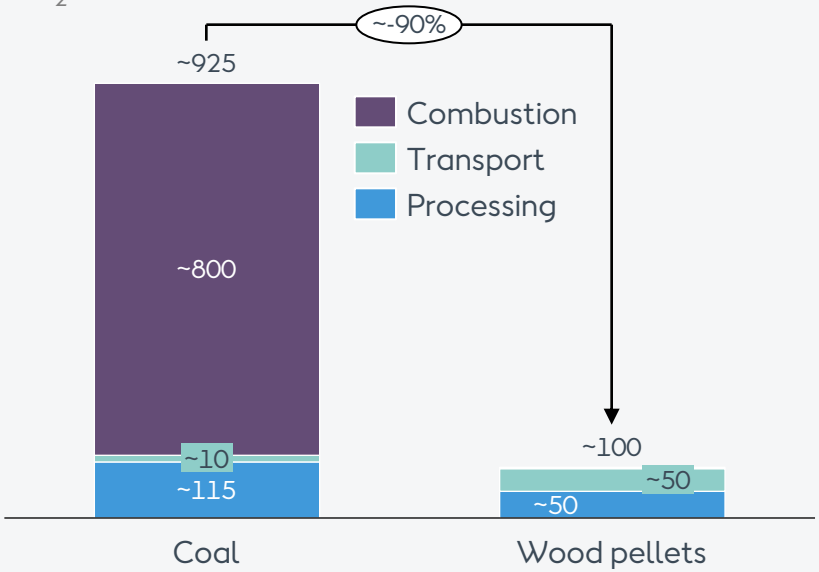
Thank you

Effective enforcement of biomass sustainability criteria ensures real decarbonisation

Ørsted ensure sustainable sourcing of biomass

CO_2 reductions from sustainable biomass-to-energy
gCO_2 / KWh



Biomass sustainability criteria

- ✓ Replanting of trees
- ✓ Use of waste wood and thinnings
- ✓ Independent certification and auditing
- ✓ Protection of high conservation-value habitats
- ✓ Biodiversity conservation
- ✓ Other sustainability criteria (incl. legal and regulatory requirements)

Sustainable Biomass Partnership

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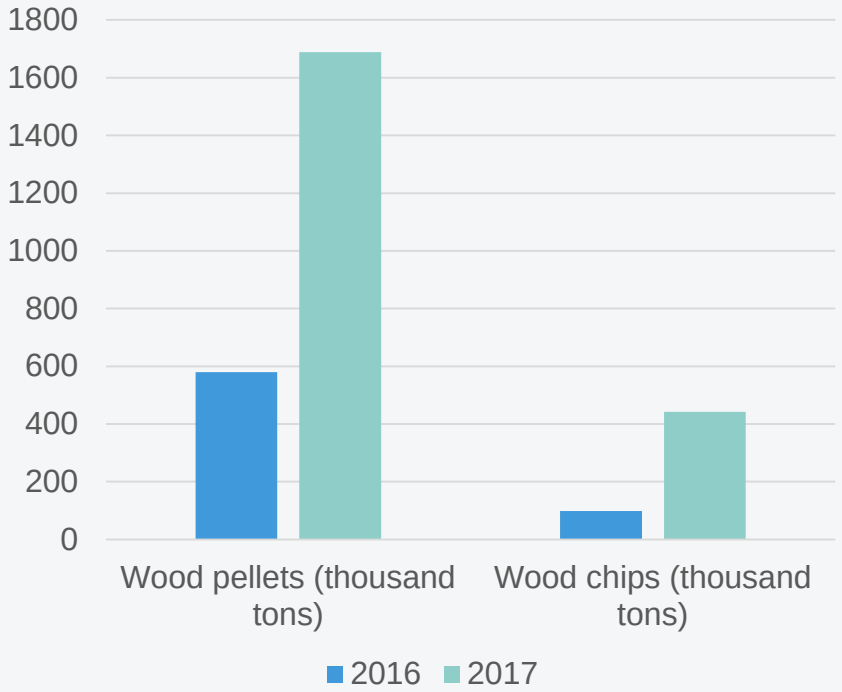
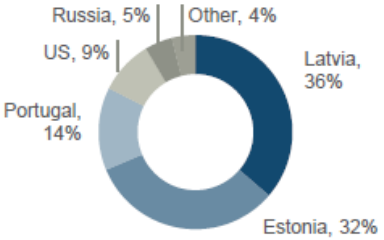
Biomass market are global



Diversified sources of biomass

Wood pellet origin, 2016



- Mix of contracts with different lengths (10-year, 2-3 year, annual and spot)
- Chips are sourced from Denmark and neighbouring countries, incl. the Baltics