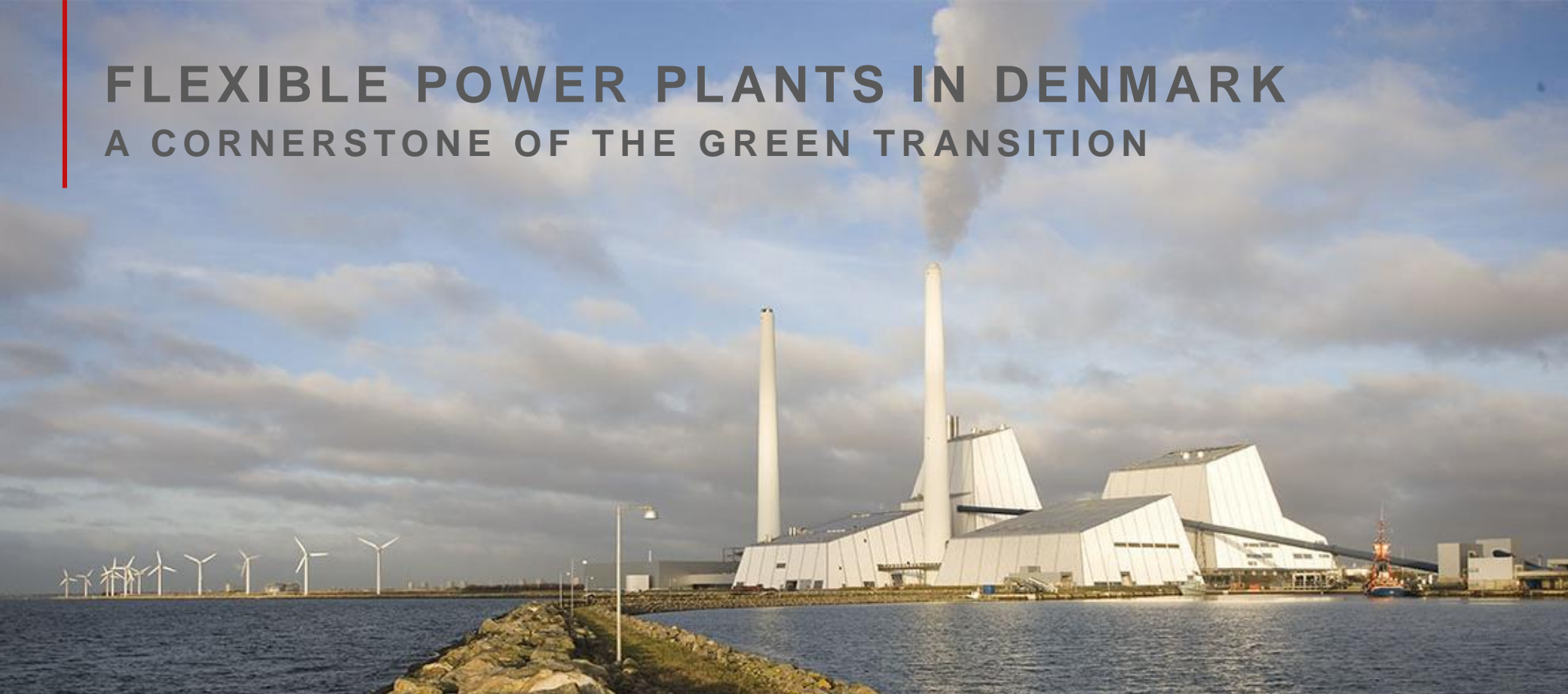


FLEXIBLE POWER PLANTS IN DENMARK

A CORNERSTONE OF THE GREEN TRANSITION



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November 2017, Berlin

DONG
energy

Ørsted

DONG Energy at a glance

- Headquarters in Denmark
- Listed on the Copenhagen Stock Exchange
- Majority owned by the Danish state
- 6,200 employees (including Oil & Gas)
- Revenue in 2016 DKK 61.2 bn
- EBITDA in 2016 DKK 19.1 bn
- Phase out the use of coal by 2023

80%* Wind Power

- Develops, constructs, owns and operates offshore wind farms in Denmark, Germany, the Netherlands and the UK.
- Development projects in Taiwan and the USA

4%* Bioenergy & Thermal Power

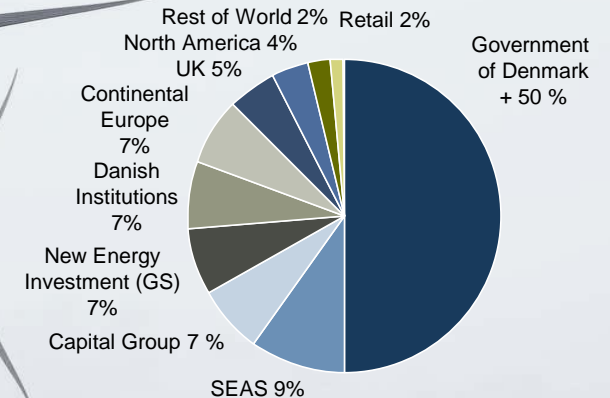
- Generates and sells power and heat to customers in Denmark and Northwestern Europe

12%* Distribution & Customer Solutions

- Power distribution grid on Zealand and sale of power and gas to customers in Northwestern Europe

4%* Oil & Gas (discontinued operations)

- Produces oil and gas from fields in Denmark, Norway and the UK

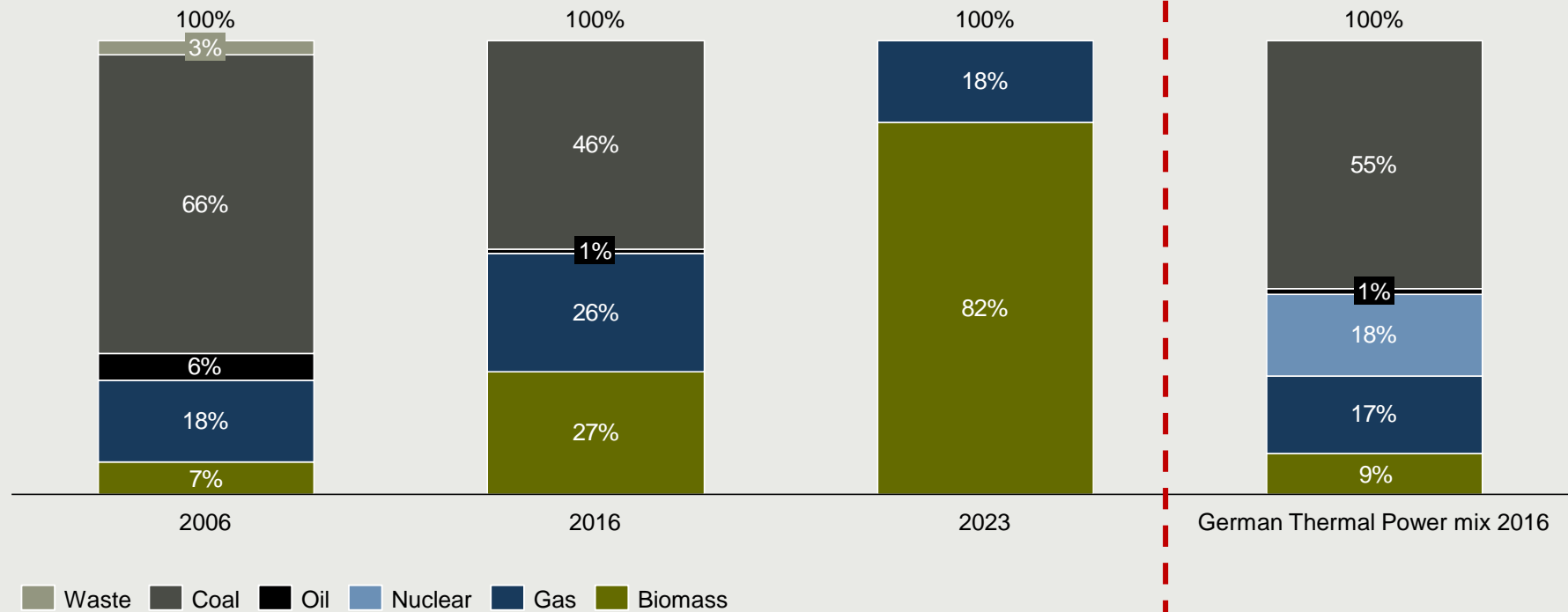


* Share of the Group's capital employed

Transformation of the business model

Biomass conversions well underway – coal will be fully phased out by 2023

DONG Energy fuel composition, %²



1. Continuing operations

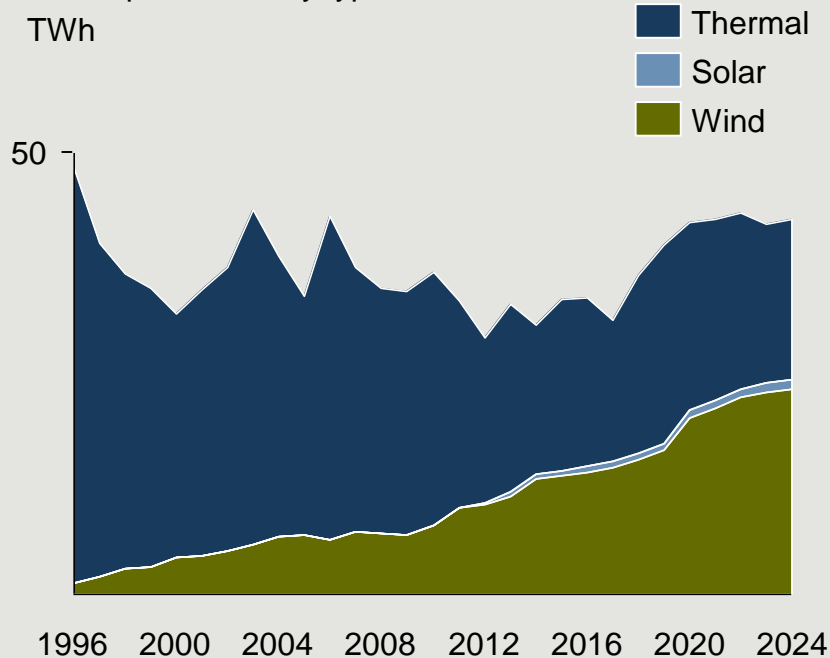
2. Excluding one-offs and Gas Distribution EBITDA

Flexible power plants balances variable renewable energy sources

The green transition of the Danish power system

Power production by type

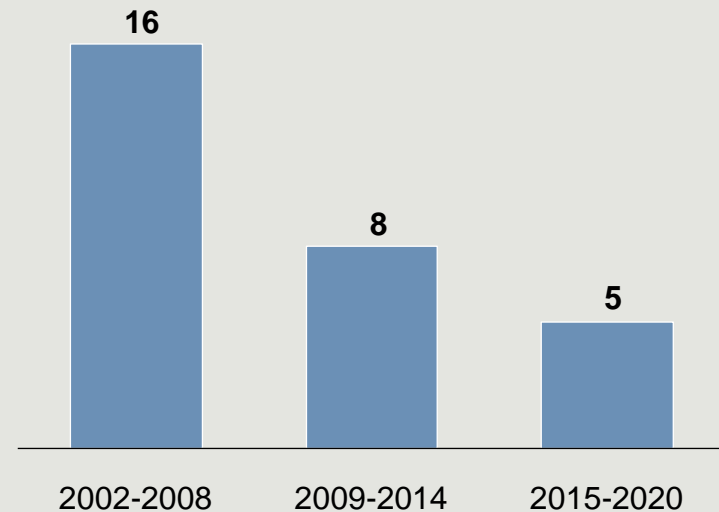
TWh



Margins from power sales in decline

Green Dark Spreads in Denmark

EUR/MWh, average



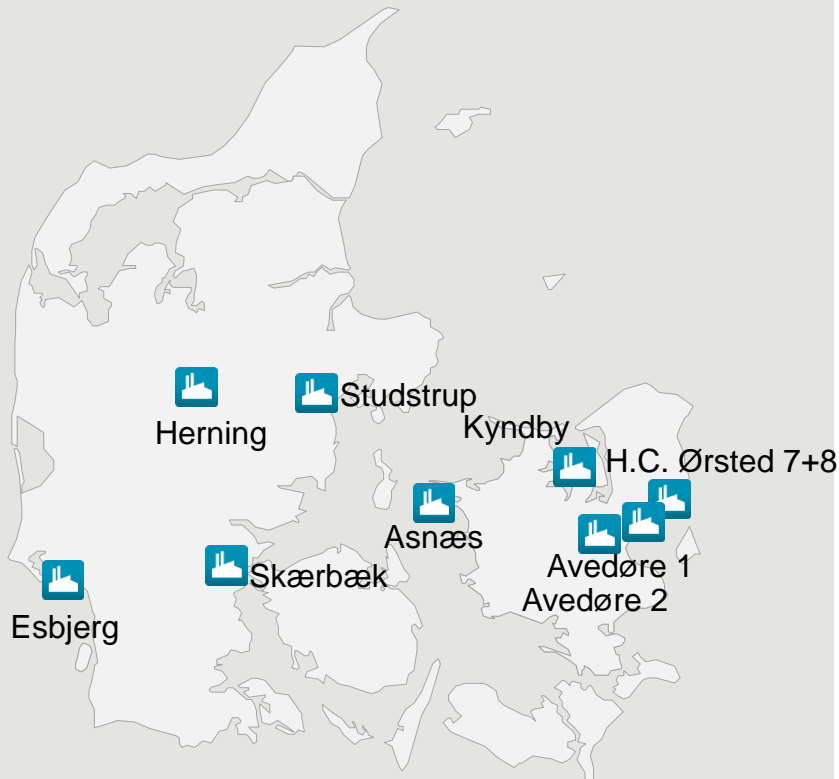
➤ District heating has gone from waste product to core product

Source: Energinet.dk, DONG Energy



DONG Energy position in the Danish thermal market – district heating is the foundation for flexible power

DONG Energy thermal assets

 CHP plants

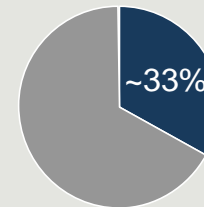


Key figures

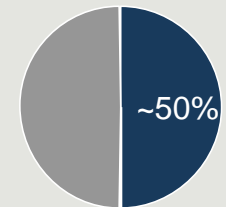
 DONG Energy  Other

DK market position

Share of district heat production



Share of thermal power production



Energy Facts:

	<u>Denmark</u>	<u>Germany</u>
Installed capacity (el)	14 GW	200 GW
Electricity consumption	30 TWh	550 TWh
District heating	30 TWh	60 TWh

Increasing flexibility through minor investments and carefully optimized operations

Continuous work to improve plant flexibility

POWER

Reduce minimum load

Low as possible power production (while still running)

Increase load gradients

How fast power production can ramp up/down

Lower start/stop time and costs

Automatize and optimize start/stop procedures

HEAT

Bypass and heat accumulators

Bypass of power turbine and use flexibility of heat storage

Electric boilers for heat production

Use of electric boilers for heat production if too much power production (due to RES)

Additional:

Cost-efficient and swift delivery of other ancillary services



Converted power plants can retain flexibility capabilities

Converted biomass plant retain flexibility benefits

Studstrup plant flexibility before and after conversion

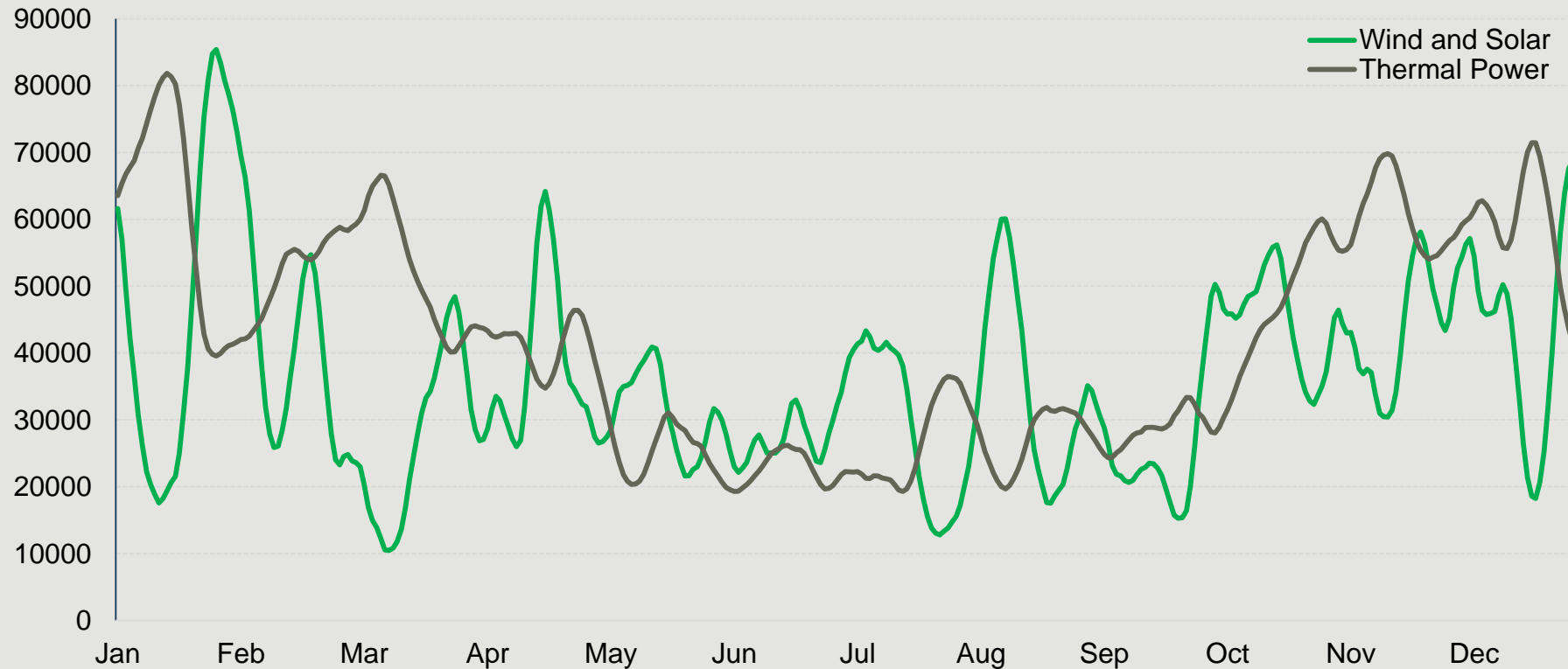
<u>Parameter</u>	<u>Attributes</u>	<u>Retained?</u>
High efficiency	~40% power ~90% CHP	✓
Load gradients	4-5% per minute	✓
Start time	Cold: 9 hours Warm: 3 hours Hot: 2 hours	✓
Minimum load	~15%	✓



Flexible power plants balance variation in wind and sun in Denmark

Power production over a year (2016)

MWh/day (10-day moving average)



Source: Energinet.dk

Transmission interconnectors allows for sharing flexibility across borders

Grid build-out must follow the build out of RES

Project time are normally longer for grid connections than for new RES production capacity





Link production across weather lines

Wind: West-East

Solar: South-North



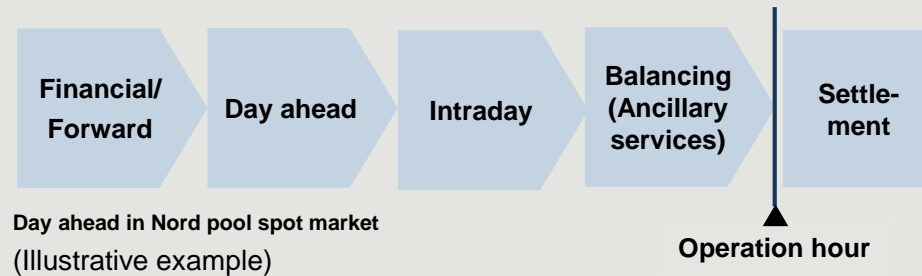
Link different energy production mix

-  Hydro in Norway
-  Wind in Denmark
-  Nuclear in Sweden
-  Thermal as backup

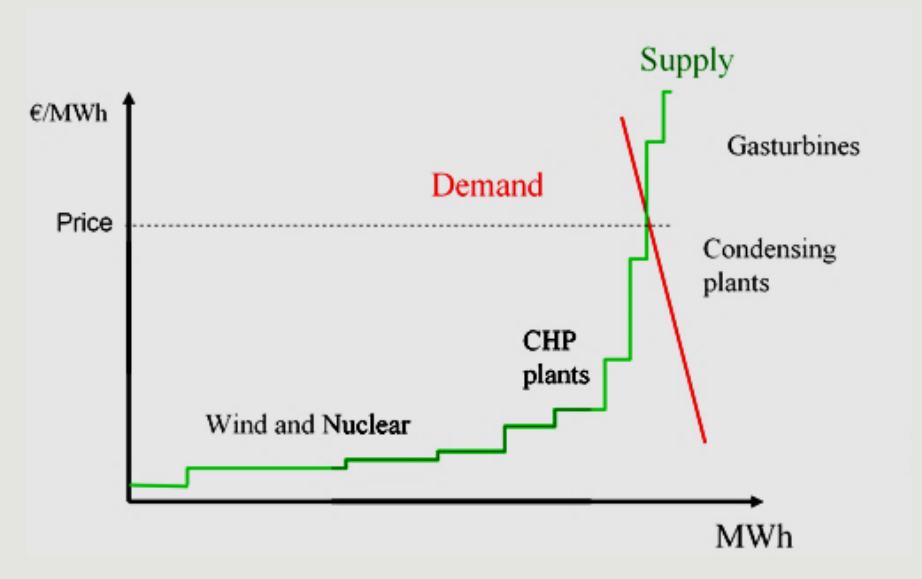


Market infrastructure is the glue

Wholesale market: Different steps create price signals



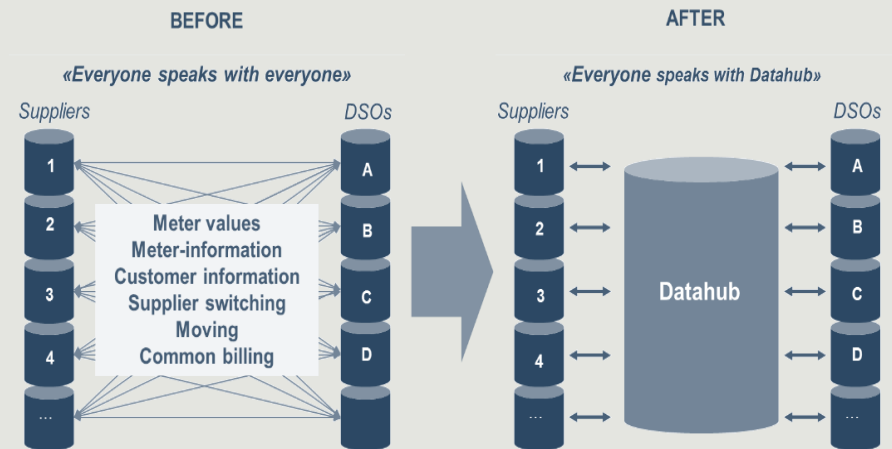
Day ahead in Nord pool spot market
(Illustrative example)



Retail market: Smart meters and shared energy data help new energy service products

Supplier-centric model and datahub

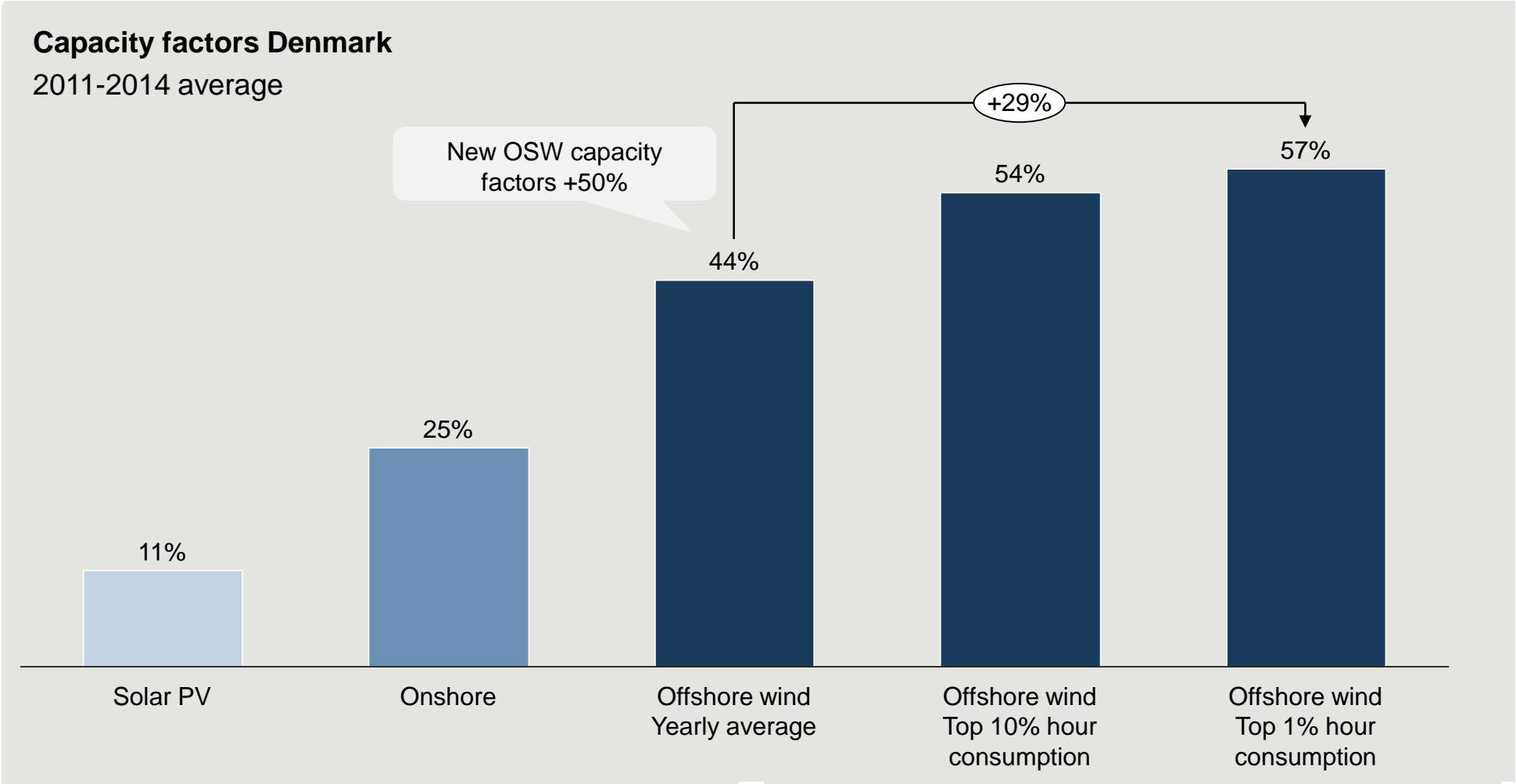
Denmark has implemented a supplier-centric model where shared data can increase competition and stimulate the development of new products and services to the consumers



SMART meters and new consumer products

Hourly electric meters in all Danish homes by 2020

Important to integrating renewables suitable to country demand profile, to enable rational power mix build-out



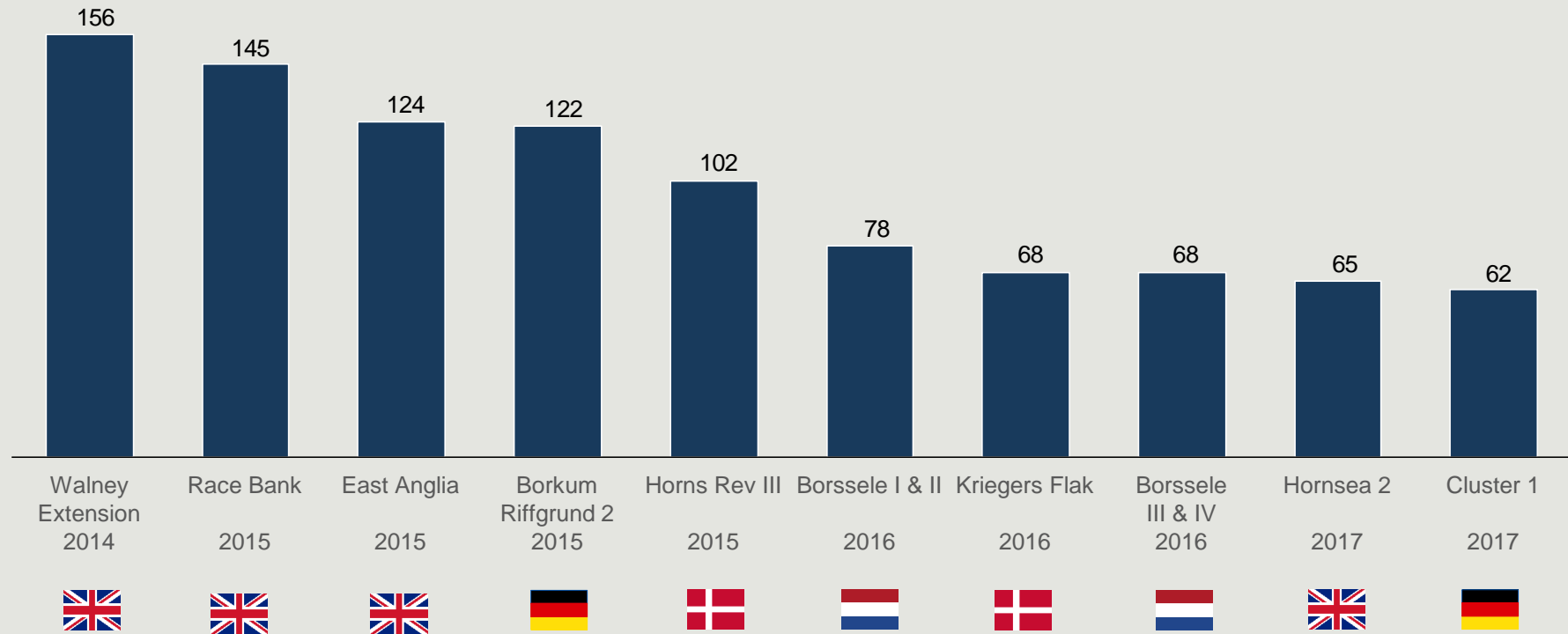
Source: Agora

1. While wind energy content (i.e. how windy a year is) varies year to year the wind's energy content is remarkably stable - Over the past 33 years annual variations have not exceeded the average value by more than +/-10%



High capacity factors offshore wind costs has decreased dramatically, enabling sound build-out near base load renewables

Levelised revenue of electricity, incl. transmission costs
 EUR/MWh¹, 2016-prices



Sources: DECC; Danish Energy Agency; Energinet.dk; NEV (Dutch Energy Scenarios), Bundesnetzagentur

1. Levelised revenue (price) of electricity over the lifetime of the project used as proxy for the levelised cost to society. It consists of a subsidy element for the first years and a market income for the whole lifetime. Discount rate of 3.5% used to reflect society's discount rate. Market income based on country specific public wholesale market price projections at the time of contracting where available else an average of 5 analytics is used. For comparability across projects and because there is no transparency round the TSO costs of transmission a generic scope adjustment (incl. transmission and extra project development costs) have been applied. Due to the specific DC transmission set up in Germany cost estimates from the Offshore Netzentwicklungsplan 2017 have been applied.

A utilities' perspective on power plant flexibility

- ✓ Secure, affordable and sustainable energy is possible
- ✓ Flexibility is the enabler for further build-out of variable renewables
- ✓ Flexible power plants can balance variation in wind and solar production
- ✓ Improved flexibility of power plants can be obtained by minor investments
- ✓ Grid connections need to be strengthened together with build-out of renewables
- ✓ Demand side response is an important future source of flexibility
- ✓ Price signals on wholesale and retail markets are necessary to get flexibility mechanisms to work

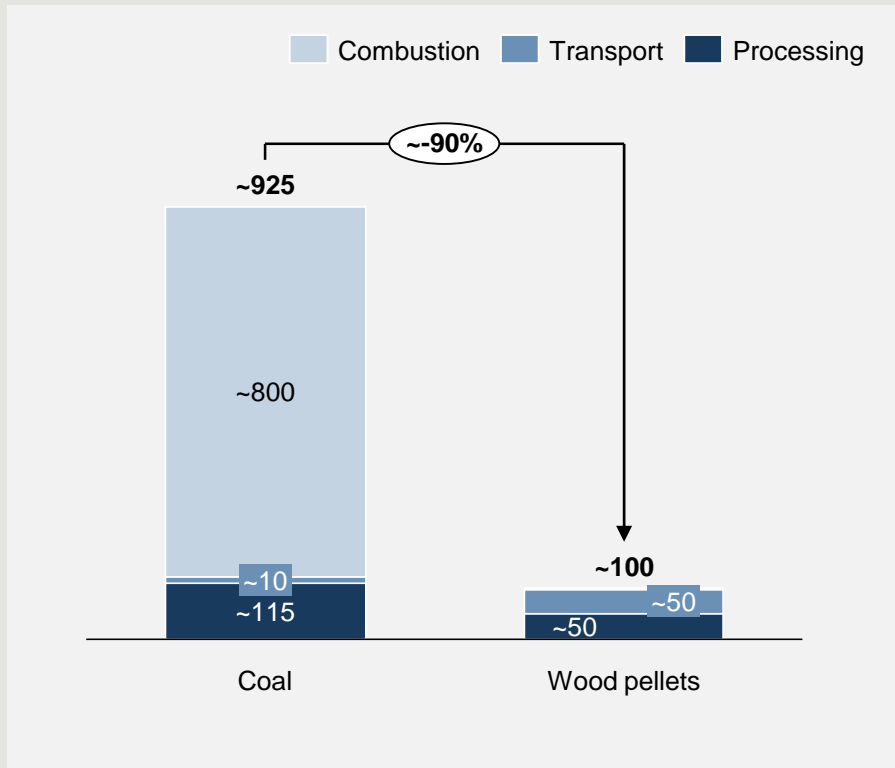




Backups

Flexible generation also needs to be green, and sustainable bio-energy delivers significant CO₂ reductions

CO₂ reductions from sustainable biomass-to-energy gCO₂ / KWh



DONG Energy ensures sustainable sourcing of biomass

DONG Energy sustainability criteria:

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

Sustainable Biomass Partnership underpins these criteria

