ASV6 Bio. New Biomass fired unit at Asnaes power plant.
Ørsted develops energy systems that are green, independent and economically viable

- Revenue (2017): € 8bn\(^1\)
- EBITDA (2017): € 3bn\(^1\)
- ~5,600 employees
- Active in Scandinavia, United Kingdom, Germany, The Netherlands, USA and Taiwan

Major Shareholder:
- Danish State 50.1%

Wind Power

- Global leader in offshore wind with 5.1 GW installed and another 3.8 GW project pipeline
- Ambition of 11-12 GW installed offshore wind capacity by 2025

Customer Solutions\(^2\)

- Developing green, innovative and cost-efficient solutions for B2B customers
- Manage and optimise Ørsted’s energy portfolio

Bioenergy & Thermal Power

- #1 in Danish heat and power generation
- Converting heat and power plants from coal and gas to biomass

1. Revenue and EBITDA reported in DKK. Revenue: DKK 59.5 bn; EBITDA: DKK 22.5 bn
2. Divestment of Ørsted’s Danish power distribution and residential customer business and the City Light business is expected to take place in 2019
Our geographic footprint

- **February 2018**

Ørsted Bioenergy is the largest player in the Danish heat and power market

**Assets and geographical position**

- CHP plant
- Peak-load power plant
- Heat plant
- Biogas plant

**Share of DK production**

<table>
<thead>
<tr>
<th></th>
<th>Heat</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ørsted</td>
<td>25%</td>
<td>32%</td>
</tr>
<tr>
<td>Other</td>
<td>75%</td>
<td>68%</td>
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(heat 2016, power 2017)
The full bio-conversion of our power stations is progressing as planned...

**CHP conversion data (MWe/MWth)**

1. Biomass capacity after conversions. MWe refers to power production capacity after conversion. MWth refers to heat production capacity after conversion.
2. Max. capacities that can not necessarily be reached simultaneously.
3. Installation of flue gas condensation.

**Herning (75/200)**
- COD: 2009 / 2019
- Primary fuel types: Gas / Wood chips / Wood pellets

**Avedøre 2 (401/535)**
- COD: 2002 / 2014
- Primary fuel types: Natural gas / Straw / Wood pellets / Straw

**Studstrup 3 (362/513)**
- COD: 2016
- Primary fuel types: Coal / Wood pellets

**Avedøre 1 (258/370)**
- COD: 2016
- Primary fuel types: Coal / Wood pellets

**Skærbaek 3 (95/320)**
- COD: 2017
- Primary fuel types: Natural gas / Wood chips

**Asnæs 6 (25/140)**
- COD: 2019
- Primary fuel types: Coal / Wood chips

**Esbjerg 4 (56E/214E)**
- COD: 2022
- Primary fuel types: Coal / Wood chips

**Total:**

1,272 MWe
2,292 MWth
... and we’re saying goodbye to coal in 2023

**Coal (million tons)**

- **2006**
  - 6.2

- **2017**
  - 1.1

- **2023**
  - 0

**CO₂-emissions (g / kWh)**

- **2007**
  - 452

- **2017**
  - 151

- **2020**
  - 100

- **2023**
  - 20

-96%
Asnæsværket. The way to ASV6 Bio

Asnæsværket today

- Asnæsværket consists of two coal fired units - Unit 2 and 5.
- Blok 2 commissioned in 1961 and has a capacity of 142 MWe and in total 193 MWth district heating and process steam.
- Blok 5 commissioned in 1981 and is the biggest power plant unit in DK with a capacity of 640 MWe and 308 MWth district heating and process steam.
- No coal from 2023. Final status of unit 2 and 5 to be decided when the new unit 6 is in operation.

The new ASV6 Bio

- The new wood chip fired stand alone unit will be designed for a capacity of 25 MWe (net), 65 MWth district heating and 66 MWth process steam.
- Commercial operation December 2019.

Long-term agreement to supply district heating and process steam

- Ørsted, Novo Nordisk, Novozymes and Kalundborg Forsyning made in June 2017 a 20 year long term agreement for supply district heating and process steam.
- Symbiosis between industry, medical and biotech companies maintained.
ASV6 Bio. New Biomass fired unit at Asnaes power plant.
ASV6 Bio. Overall project data

Concept:

ASV6-Bio project includes a complete new biomass fired power plant unit consisting of:

- Fuel logistic,
- Biomass boiler,
- Flue gas cleaning, combustion air moistening, flue gas condensation
- Back pressure turbine for production of electricity, district heating and process steam for nearby industries.

Overall Design data:

- Fuel: Input 140 MJ/s (Wood chips)
- Storage: max. 80,000 m3 storage (manual)
- Electrical production: 25 MWnet
- Process steam load: 20 bar, 66/137 MJ/s (nominal/peak)
- District Heating load: 65/85 MJ/s (nominal/peak)
- District heating temperature: 50/80 °C nominal
- Steam parameters boiler: 100 bar/540 °C / 50 kg/s

Mobile unloading
Conveyor to unit/storage
Direct transportation to unit
Open Working storage for woodchips
Open Secondary storage for woodchips
Day silo

Alternative biomass supply with truck

District heating
District heating
Flue gas-condensation
Flue gas-treatment
Boiler

Process steam
Steam turbine

Absorbent
SNCR

Ammonia water
Light fuel oil

Make-up water preheating
Make-up water preheating

Generator
Start-up burners

Waste water to boiler
Demi. water
Condensate water treatment
Condensate to air humidification boiler
Residue products
Bottom ash

Waste water
Demi. water

DH Return
Demi. water

Top ash
Residue products

Waste water to boiler
ASV6 Bio. Fuel flexibility

- Design fuels: woodchips and woodchip-like fuels (and future reservation for straw)
  - Woodchips
    - whole trees without roots, stemwood, logging residues, chemically untreated wood by-products and residues
  - Woodchip-like fuels
    - whole trees without roots, stumps/roots, bark (from forestry operations), segregated wood from gardens, parks, roadside maintenance, vineyards, fruit orchards and driftwood from freshwater
  - Straw (future reservation 10 %-energy)
    - cereal crops (e.g. wheat, barley, rye, oats), grasses (e.g. seed grass, miscanthus), oil seed crops (e.g. rape)
ASV6 Bio. Suppliers

Lot 1. Fuel logistic. BMH
Lot 2. Boiler Plant. Valmet Technology
Lot 3. Turbine Plant. Doosan Skoda

Lot 4. Civil
Lot 4.1 Building maturation. NCC Construction
Lot 4.2 Foundation and concrete. Per Aarsleff
Lot 4.3 Harbour renovation. MT Højgaard

Lot 5. Electrical Plant. ABB
Lot 6. Control Plant. Valmet Automation

Lot 7 BoP
Various

Logistic and Crane - Shipping.dk
ASV6 Bio. BMH. Biomass fuel handling system. 
Overview from 3D model
Mobile crane lifts the fuel from a ship to the receiving hopper. In the bottom of the hopper is located a drag chain reclaimer that transports the fuel to the quay belt conveyor.

The line capacity from receiving hopper to daysilo is 1000 m$^3$/h.
From the screening station the fuel will be transported with belt conveyor to a 5000 m³/day silo. In the end of the belt conveyor is located spillage scraper conveyor which collects the fuel that drops from belt. At the silo top is located fuel spreader that spreads fuel equally to day silo and makes thus the filling grade of the fuel better in the day silo.

- The line capacity from day silo to boiler is 300 m³/h.
- Almost 300 m long straight line conveyor to boiler buffer silo
ASV6 Bio. Valmet. Boiler plant
Bubbling Fluidized Bed (BFB) boiler

- **Steam**: 140 MW\(_{th}\)
  - 50 kg/s
  - 100 bar(a)
  - 540 °C

- **Fuels**: Woodchips, woodchips-like fuels, future reservation for straw (10% of energy input)
ASV6 Bio. Valmet HYBEX™ Boilers

HYBEX™ Boiler references

35 years of experience: ~200 new boilers and conversions delivered
ASV6 Bio. Valmet. HYBEX™ Boilers

Bubbling Fluidized Bed (BFB) boiler

- Video:  [https://www.youtube.com/watch?v=KcR62W2z8KE](https://www.youtube.com/watch?v=KcR62W2z8KE)

**HYBEX™ boiler**

- HYBEX™ is the trade name for Valmet BFB boilers
- Valmet have delivered BFB boilers since 1979
- The first BFB with a Hydrobeam floor was delivered in 1995

**Bubbling Fluidized Bed process**

- The sand bed is fluidized with air from the bottom
- Solid fuel is introduced into the hot bed
- Flue gas recirculation is used for bed temperature control
- An optimized staged combustion air system includes secondary and tertiary air levels higher up in the furnace
ASV6 Bio. HYBEX™ Boilers
Hydro beam floor – water cooled hydro beam → HYBEX™

– Totally water cooled air beams
– Primary air nozzles
– Open bottom construction for coarse material removal
ASV6 Bio. Valmet. Boiler Plant
Overview from 3D model
Flue gas treatment system is used for

- Emission control (Particles, HCl, SO₂, NH₃)
- Flue gas heat recovery to district heating water

Condensate treatment system

- produces demineralized water from flue gas condensate
ASV6Bio. Valmet HYBEX™ Boiler
Layout of Flue gas treatment system
Superheater test material installations

Installation of test tubes to the hottest part of the tertiary superheater:

- TP310HCbN (main material)
- The test tubes are installed to the outermost tubes of the three middle elements of the tertiary superheater (one tube / element)
  - TP347H (1.4912)
  - TP347HFG (1.4908)
  - SUPER 304H (KA-SUS304J1HTB)
Double casing DST-G20 backpressure steam turbine

- Disconnectable LP turbine part (SSS clutch)
- Without reheat, two bleeds and one controlled extraction between casing
- Downward exhaust
- Nominal speed 5500 rpm
- 18 operating modes
ASV6 Bio. How far are we? Pictures from site 03.12.2018
Our vision
Let’s create a world that runs entirely on green energy