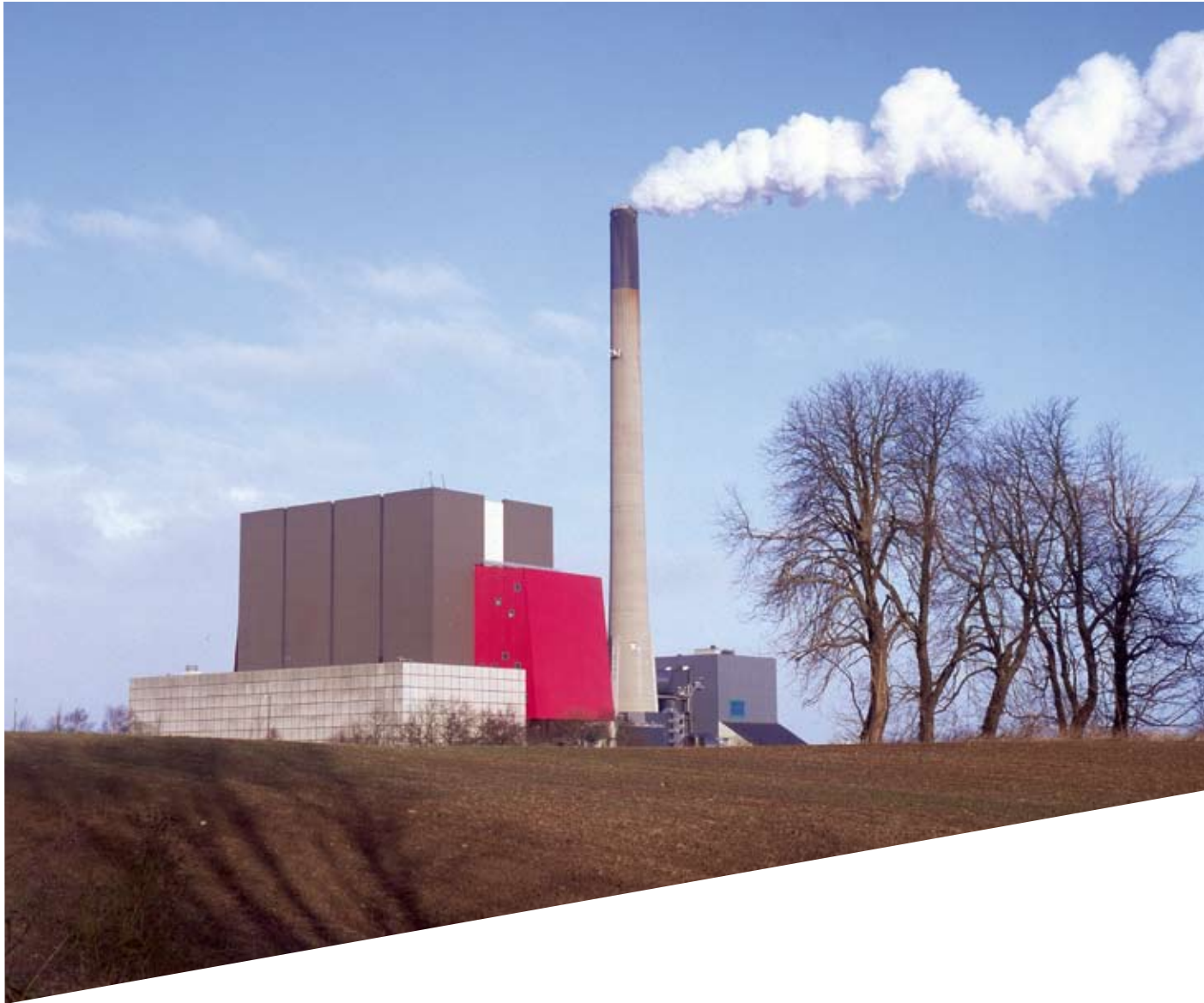


THE ENSTEDVÆRKET CHP PLANT



DONG
energy

DONG ENERGY THE ENSTEDVÆRKET CHP PLANT

The Enstedværket CHP plant is one of DONG Energy's ten central power plants. It was commissioned in 1979 and is situated at the head of Aabenraa Fjord outside Aabenraa.

The plant consists of the coal-fired and oil-fired unit 3 commissioned in 1979. Unit 3 is Denmark's largest combined heat and power unit. The straw-fired and wood chip-fired bioboiler was commissioned in 1998, and the plant has a total design output of 626 MWe and a maximum net output of 660 MWe.

Enstedværket is placed on a 29-hectare area by Aabenraa Fjord. The area is former bayside soil which has been elevated above the water level by filling it up with 1.5 million m³ sand from other places in Aabenraa Fjord.

Enstedværket has Northern Europe's largest coal and oil harbour with a depth of up to 18 metres. This enables fully loaded 150,000-tonne tankers and coal vessels with loads of up to 180,000 tonnes to moor. In connection with the coal yard, a conveying system for shipping of coal to DONG Energy's other power plants is established. The coal is shipped in special coal barges with a carrying capacity of 10,000 tonnes.



Technical key data

| | |
|-------------------------------|---------|
| Unit 3 commissioned in | 1979 |
| Maximum net power output | 660 MW |
| Maximum district heat output | 76 MJ/s |
| Coal consumption at full load | 208 t/h |
| Oil consumption at full load | 133 t/h |
| Steam pressure | 200 bar |
| Steam temperature | 535 °C |

Technical key data for bioboiler

| | |
|--------------------------------------------|----------------|
| Bioboiler unit commissioned | 1998 |
| Straw consumption | 120,000 t/year |
| Wood chip consumption | 30,000 t/year |
| CO ₂ neutral share at full load | 38 MW |
| Steam pressure | 200 bar |
| Steam temperature | 542 °C |



THE PROCESS FROM FUEL TO HEAT AND POWER

Coal fired boiler (unit 3)

The boiler at Enstedværket, unit 3, is a Babcock Wilcox boiler of the Benson type, using coal and oil as fuels in all ratios. At full load and 100 % coal firing, approx 200 tonnes per hour are combusted. The coal is pulverised in six coal mills and subsequently blown into the boiler furnace through 36 burners. The boiler is composed of more than 500 km pipes, and while passing through the pipes, the steam temperature reaches 540 °C. The steam pressure in the boiler outlet is 200 bar.

When the steam has supplied power in the turbine, it is condensed into water in the condensers and pumped back into the boiler for renewed heating. It is a closed loop.

Bio-fuel boiler (unit 2)

In 1997, a combined straw-fired and wood chip-fired plant was built in the existing buildings. The plant consists of two coherent boilers. The first boiler uses straw as fuel, heating the steam to 470 °C. The steam is then led to the wood chip-fired boiler where the temperature is increased to 542 °C before the steam turns into heat and power in the unit 3 turbine plant.

Turbine plant

The turbine is a Siemens turbine which consists of one high-pressure turbine, one intermediate-pressure turbine and two low-pressure turbines operated by the steam from the boiler. A generator is installed on the same shaft. The generator rotates by 3,000 revolutions per minute and has a gross output of 670 MW, corresponding to 900,000 hp. The generator is designed for a maximum output of 800 MW.

Part of the turbine steam is bled and used for district heat production which can be maximum 76 MJ/s. The steam is also used for internal heating and operation of a 20 MW feedwater turbine.

Leaving the turbine plant, the steam is cooled down to water in two condensers. Water from Aabenraa Fjord is used as cooling agent. Approx 85,000m³/h are used at full load.

Environmental plants

To meet the intensified national and international environmental requirements for removal of sulphur oxides (SO_x) and nitrogen oxides (NO_x), a flue gas cleaning plant has been installed on the plant. The nitrogen oxides are removed in a deNO_x plant based on a so-called High Dust SCR process where ammonia is added to the flue gas in a reactor. This converts the nitrogen oxides into free nitrogen and steam. The above process removes approx 92 % of the nitrogen oxides, corresponding to approx 8,000 tonnes on an annual basis.

Sulphur oxides (SO_x) has a negative impact on the environment because it is converted into acid rain in the atmosphere. Nitrogen oxides (NO_x) are very toxic. The sulphur oxides are removed in an absorber where a lime solution is ejected into the flue gas. Sulphur dioxide then combines with lime and turns into gypsum. An annual lime consumption of approx 30,000 tonnes produces approx 90,000 tonnes of gypsum. The gypsum is of such a high quality that it can be used as raw material in other industries. With an efficiency of approx 98 %, approx 30,000 tonnes of sulphur oxides are removed annually.

Power production

The total power production from Enstedværket is sold on market terms. The power production is solely determined by supply and demand on the Nordic power market and by the relation between fuel and power prices. If the power price is low due to a high domestic power production by wind turbines or high hydro-electric power production in Norway, Enstedværket reduces its production. This means that production may vary much from one year to another.

The power produced at Enstedværket is sold on a daily basis at the Nordic power exchange, NordPool where the price is set by supply and demand.

District heating

Enstedværket uses part of the excess heat from the production of power to produce district heat to be sold to Aabenraa Fjernvarme (district heating company) supplying district heat to the town of Aabenraa.

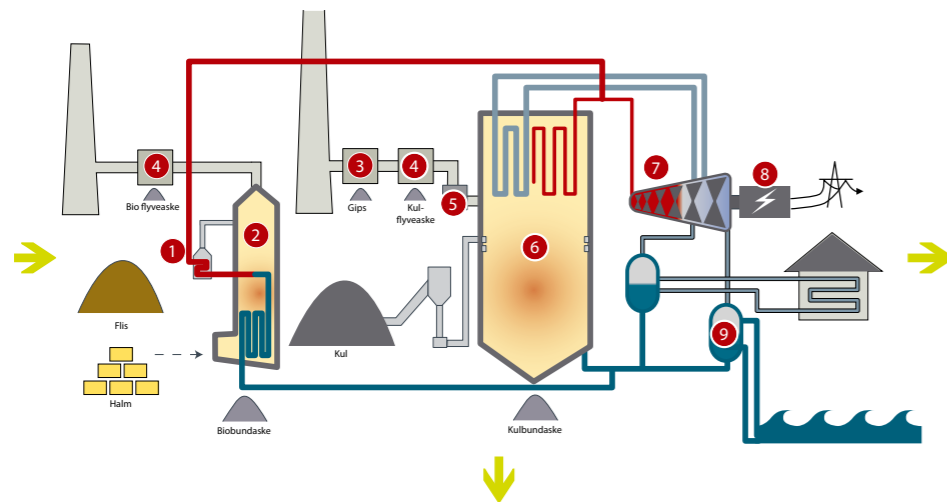
When Enstedværket, unit 3, does not produce power, di-

strict heat is normally produced at the straw-fired and wood chip-fired plant. Colloquially, this is called “mono-operation of the bioboiler”. This means that only the straw boiler is in operation and steam data are reduced to a temperature of up to 470 °C and a pressure of 100 bar.

DONG Energy’s and thus Enstedværket’s vision as to production and commercial conditions is largely based on responsibility to our common environment. Therefore, we continuously plan and work on developing new technological solutions that can bring the plant a step further on the future energy market.

Biofuel replaces coal

Our future aim of the straw and wood chip-fired plant is to replace coal by biofuels for the production of power. As combustion of coal entails a relatively high CO₂ emission, there are great eco-advantages of using biofuels. Combustion of biofuels is CO₂ neutral as the CO₂ emitted corresponds to the CO₂ absorbed from the atmosphere when growing biomass.



Workflow

1. Wood chip superheater
2. Straw boiler
3. Desulphurisation plant
4. Electrostatic precipitator
5. DeNOx plant
6. Unit 3 boiler
7. Turbine
8. Generator
9. Condenser

Combustion of straw involves many technical difficulties as the high contents of potassium and chlorine in the straw entail a risk of corrosion on the hottest boiler pipes. Therefore the plant consists of two boilers; one for combustion of straw and one for combustion of wood chips. A former coal-fired boiler house is reused for the bioplant.

Reuse of by-products

Slag and ash from the bio-fuel boiler plants are separated from the other by-products. This ensures that the fly ash

from Enstedværket’s coal-fired plant can be used in the cement industry.

The slag from the bio-fuel boiler is used as fertiliser in the fields. Due to a high content of cadmium, the ash cannot be reused and is thus disposed of.

As to environment and working environment, Enstedværket is certified according to the international standards ISO 14001 and ISO 18001.



ENSTEDVÆRKET SEEN FROM ABOVE

1. Boiler house/unit 3

The boiler house contains boiler plant, fresh air fans, air preheaters and coal mills.

2. Turbine hall

The turbine hall contains steam turbine and generator plant, emergency power generating sets as well as 20 MW feedwater turbine.

3. Flue gas desulphurisation plant

Unit 3 is equipped with a flue gas desulphurisation plant which removes up to 98 % of the sulphur in the flue gas. The flue gas cleaning process produces approx 90,000 tonnes of gypsum annually to be used in the industry.

4. Gypsum silo

The gypsum is stored in the gypsum silo until it is moved by ship or lorry.

5. Oil storage

The oil storage consists of four tanks with a total capacity of 320,000 m³. Each tank is 16 metres high and has a diameter of 18 metres.

6. Coal storage

The coal storage is placed on a 13-hectare area and holds 2 million tonnes of coal. Part of the coal is exported to other DONG Energy power plants. The coal storage is one of the largest in Northern Europe.

7. Coal harbour

Ships of up to 180,000 tonnes can call at the coal harbour. On the harbour there are two cranes capable of unloading

48,000 tonnes per day. The crane grab on one of the cranes can unload 20 tonnes of coal at a time. The water depth at the quay is 18 metres.

8. Straw/wood chip boilers

This building contains straw boiler and wood chip boiler which produce steam. 120,000 tonnes of straw and 30,000 tonnes of wood chip are used annually. This corresponds to 7 % of Enstedværket's total production.

9. Straw storage

The straw storage can hold 1,006 straw bales, corresponding to approx 24 hours' production.

10. Shipping quay

This quay is used for shipping of coal to be barged to other power plants. Each barge can carry 10,000 tonnes.

11. Ammonia storage

The ammonia storage tanks hold approx 300 tonnes of ammonia used to neutralise the nitrogen oxides in the flue gas.

12. Fly ash silos

The fly ash is stored in the silos until it is removed from the site by lorries. The fly ash is used in the cement industry.

13. Cooling water inlet

14. Cooling water outlet

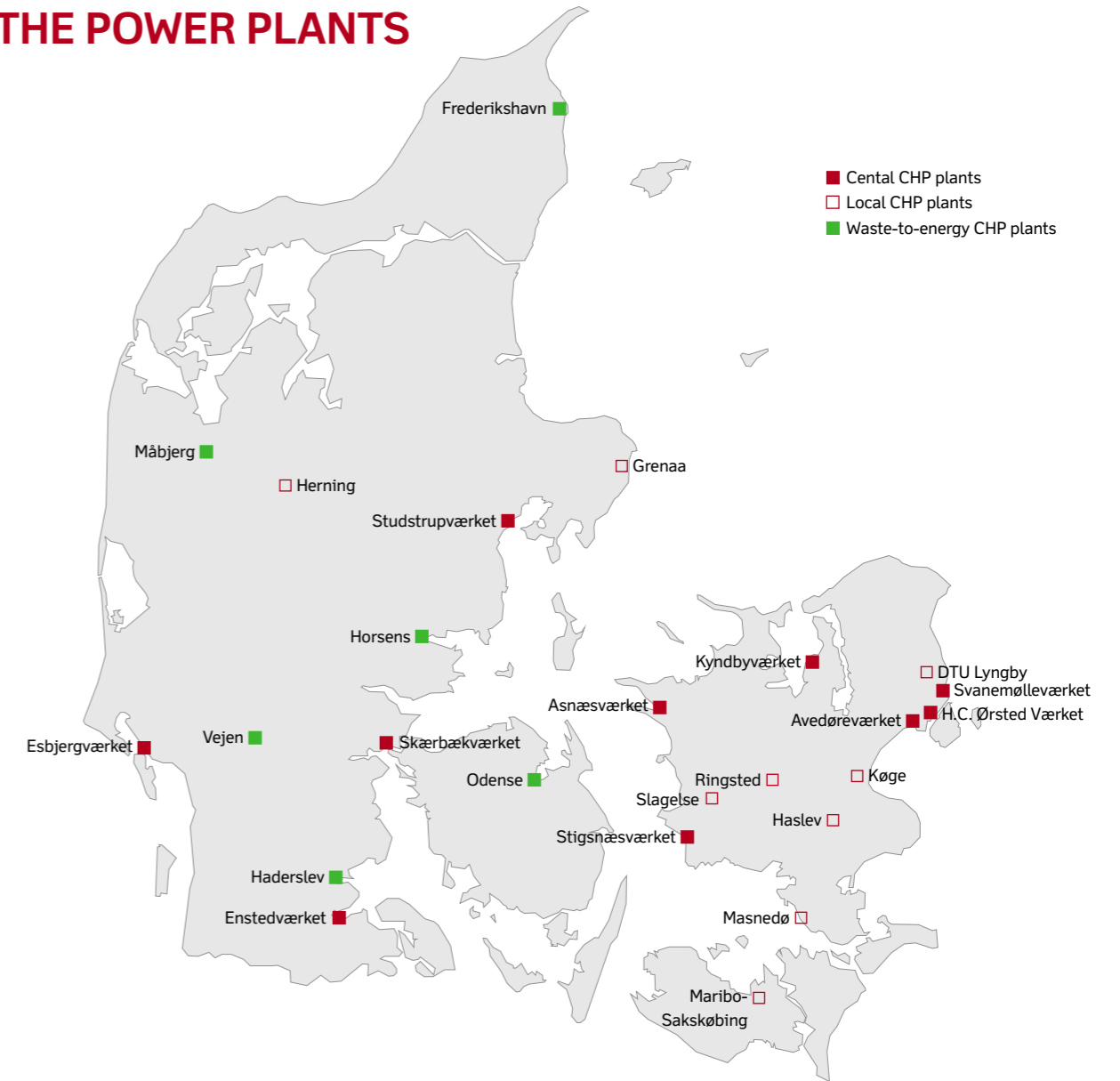
15. Lime store

This store holds lime used in the flue gas desulphurisation process. Approx 25,000–30,000 tonnes are used annually.





THE POWER PLANTS





DENMARK'S NEW ENERGY COMPANY

DONG Energy is Denmark's new energy company established in 2006.

DONG Energy is active in all links of the energy supply chain – from offshore oil rigs in the North Sea, power plants producing heat and power, and wind farms, until to marketing the energy and transport it all the way to our customers' doorsteps in Denmark and abroad.

This ensures a highly reliable supply of energy and gives us the necessary expertise for developing our company for the future.

DONG Energy has many years of experience. For more than a hundred years we have been supplying power to the Danish consumers and developed the special Danish tradition of combining the production of heat and power.

Since the beginning of the 1980s, we have also supplied oil and natural gas to the Danish consumers.

Innovation is a natural part of how we work. We have been involved in the extraction of the North Sea's reserves of oil and natural gas for 25 years, and our power plants are some of the most efficient and eco-friendly in the world.

We are also at the cutting edge in the development of renewable energy, not least in the establishment of offshore wind farms.

DONG Energy has increased its international activities significantly and is now an international energy company focusing on the North European energy markets. On the liberalised market the customers are free to choose their energy suppliers and DONG Energy competes every day against other energy companies to be the consumers preferred supplier.

Yet, still being a small player on international scale, DONG Energy is rapidly developing its activities in all aspects of energy supply to be well-positioned for future competition on the energy market.

www.dongenergy.com

Pay a visit to Enstedværket

Enstedværket welcomes groups and schools and invites you to participate in a tour of our heat and power producing facilities.

If you would like to have more information about the visits, please contact Enstedværket at tel. +45 74 31 41 41 or send an e-mail to ensted@dongenergy.dk.

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