DONG energy

DONG ENERGY
STUDSTRUPVÆRKET

Studstrupværket is one of DONG Energy's ten central power stations. In 1968, Studstrupværket was established at its present location at Kalø Bay north of Aarhus. The CHP plant consists of two units – 3 and 4 – commissioned in 1984 and 1985. Units 1 and 2 were scrapped in 1998 and 1999. Studstrupværket has approximately 130 employees.

Studstrupværket uses coal and straw as fuel for production of power and district heating. Fuel oil is used for start-up and in special operating situations. The CHP plant produces power for the overall power grid and district heating for 90% of the inhabitants in Aarhus and a number of neighbouring municipalities.

Studstrupværket, units 3 and 4, are designed for combined heat and power production. This means that Studstrupværket can produce power without producing heat – or produce both power and heat. Furthermore, Studstrupværket has a storage tank for district heating. This makes it possible to produce district heating at suitable times during the day and use it when the demand for both power and heat is large – typically on a winter's morning.

The advantage of co-producing heat and power is first and foremost lower fuel consumption per produced MW meaning reduced emissions of CO_2 and other environmentally hazardous substances.

Technical key data

Commissioned	1984 / 1985
Maximum net power output	350 MW
Maximum district heating output	455 MJ/s
Coal consumption at full load	120 t/h
Oil consumption at full load	73 t/h
Steam pressure	250 bar
Steam temperature	540 °C

THE PROCESS
FROM FUEL TO HEAT AND POWER

Studstrupværket's mode of operation and production of power. The coal is transported from the coal yard to the coal silos from where it is led into the coal mills to be pulverised.

A mixture of air and coal dust is blown into the burners and combusted in the boiler furnace. Likewise, straw is cofired by blowing finely cut straw into the burners to be cofired with coal.

The furnace is enclosed by boiler walls which are panels of pipes through which water is pumped. The water is heated by the combustion in the furnace and is converted into steam. As the pressure in the boiler pipes is very high, the steam can be superheated to a high temperature (540 °C) and is thus highly energised.

The steam flows from the boiler to the high-pressure part of the turbine. The turbine starts rotating, and the steam releases part of its energy. The steam is then returned to the reheater of the boiler and is further energised. The steam is now led back to the reheater part of the turbine and into the low-pressure part where the last part of the energy is generated.

When the steam has passed through the turbine plant, it is condensed. The condensation takes place by leading the steam from the low-pressure part of the turbine into the condenser.

The condenser is a large steel box in which cold seawater flows through more than 15,000 pipes. The steam is cooled when it gets in contact with the cold pipes – and becomes water again. The water is pumped back into the boiler via the feedwater system. The water/steam circuit is established.

The three turbine parts and the generator are placed on the same shaft. Via the turbine blades, the energy of the steam is transformed into a rotating motion, which is converted into power in the generator. Power can be produced without producing heat.

Heat

Power and heat can be co-produced by extracting part flow of steam from the intermediate-pressure part of the turbine. This part current is led to the two district heat exchangers of the power station.

The district heat exchangers function as the condenser. However, the water flowing through the pipes is cold. The hot extraction steam heats the pipes, thus heating the district heating water.

The hot district heating water is pumped to the customers or stored in a tank for later use, and the condensed extraction steam is re-supplied to the boiler.

The heat production may vary according to the demand. However, heat cannot be produced without producing power as the steam passes through the turbine on its way to the district heat exchangers.

Flue gas cleaning

The flue gas from combustion in the boiler is thoroughly cleaned before it is led to the stack and into the atmosphere.

Ash goes to the bottom of the boiler already during the combustion process. The bottom ash is led to silos for later use in the industry.

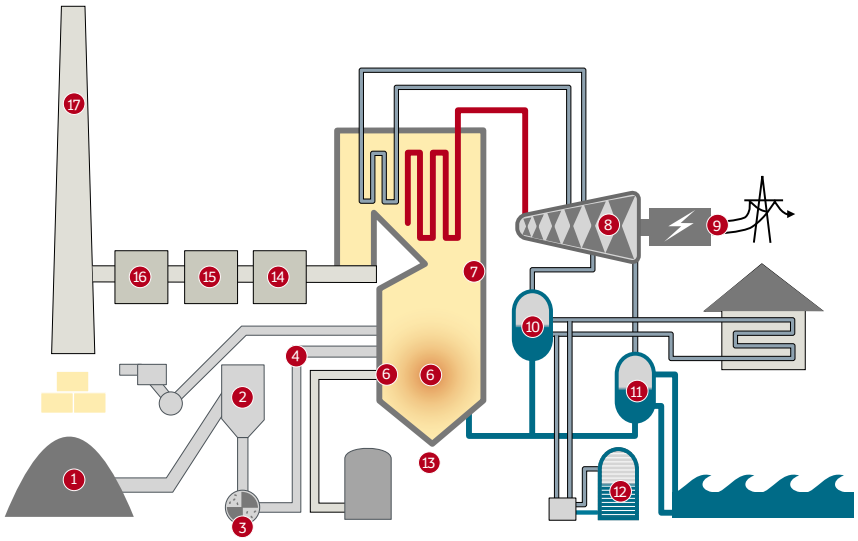
The flue gas is then led through the deNO$_x$ plant where the content of nitrogen oxides is converted into nitrogen and water.

The flue gas is then led through the electrostatic precipitators where it is purified of solid particles called fly ash.

Then the flue gas is purified of sulphur in the desulphurisation plant which is of the absorption type.

The desulphurisation process is made by leading flue gas through a fog of slaked lime. This binds the content of sulphur dioxide in the flue gas, and a dry powder Spray Dry Absorption Product (SDAP) is formed. The bag filters retain the SDAP which is stored in the by-product silos for later use.

Finally, the flue gas – the temperature of which is now approximately 80 °C – is led into the atmosphere through the 190-metre high stack.



Workflow

1. Coal
2. Coal silos
3. Coal mill
4. Air and coal dust
5. Burners
6. Furnace
7. Boiler walls
8. Turbine
9. Generator
10. District heat exchanger
11. Condenser
12. Storage tank
13. Bottom ash
14. DeNOx plant
15. Electrostatic precipitator
16. Desulphurisation plant
17. Stack

Power production

The total power production from Studstrupværket is sold on market terms. This means that production may vary much from one year to another.

The power production is determined solely 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 from wind turbines or high hydroelectric power production in Norway, Studstrupværket reduces its production.

The power produced at Studstrupværket is sold on a daily basis at The Nordic Power Exchange, Nord Pool where the price is set by supply and demand.

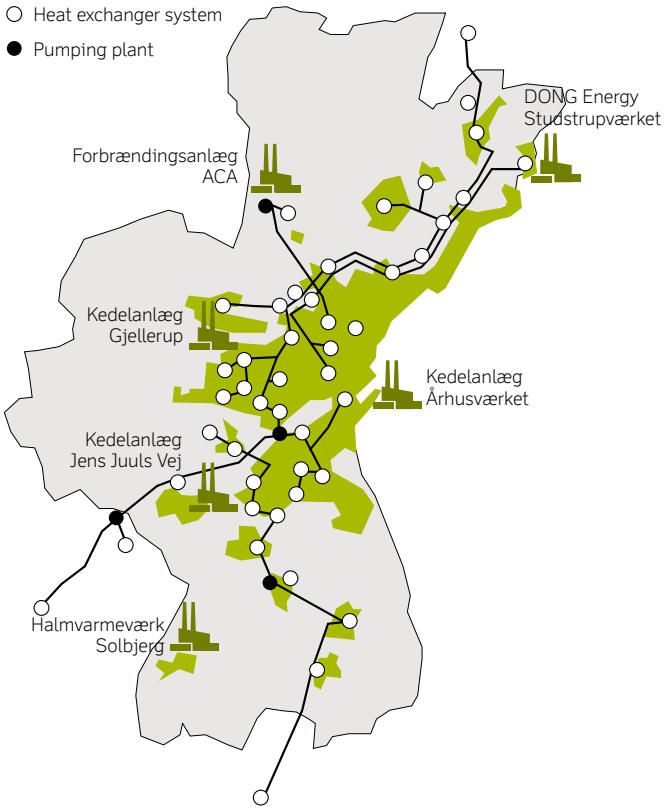
District heating

Studstrupværket uses the excess heat from the production of power to produce district heating to be sold to the municipal district heating companies in the town of Aarhus.

The district heating water is either sent directly into the district heating grid or stored in the storage tank. Studstrupværket has the world's largest pressurised storage tank for storage of district heating water, which makes it possible to produce heat and power at all hours to make optimum environmental and economic use of the fuel.

The excess heat produced in periods where the production of power is high may subsequently fulfil the need for heat in periods where the power production is low – for instance at night.

Transmission system in Aarhus



STUDSTRUPVÆRKET
SEEN FROM ABOVE

1. Boiler house/unit 4: The boiler house contains boiler plant, fans and air preheaters.

2. Empty boiler house, unit 2: Unit 2 has been taken out of operation.

3. Coal silos: The silo buildings contain coal silos, coal feeders and coal mills.

4. Straw plant: The straw plant is capable of handling and processing 20 tonnes of straw per hour at co-firing.

5. Gas turbine plant: To be able to manage a start-up phase at "dead grid", a 12MW emergency start-up plant has been installed for production of unit "start-up current".

6. Turbine hall: The two units have one common turbine hall which contains turbine and generator plants with auxiliary plants as well as district heating systems.

7. Control room: The units are monitored and controlled from the control room located at the upper floor of the building.

8. Auxiliary steam boiler: The auxiliary boiler produces the necessary amount of steam for internal heating purposes, primarily for start-up of plants.

9. Water factory: The water factory contains plant for production of demineralised make-up water for Studstrupværket's boilers and the district heating system.

10. Waterworks and reservoir: Studstrupværket is supplied with water from its own wells supplemented by water supply from the municipal watersupply.

11. District heating pipes: These pipes are connected to the district heating grid from the west front of the CHP plant where two set of pipes with a diameter of 1 m come from units 3 and 4.

12. Storage tank: The storage tank holds approximately 30,000 m^3 district heating water.

13. Outdoor station: Connection to the power grid is made via the outdoor station where unit 3 is connected to a 150 kV line and unit 4 is connected with a direct feeder to a 400 kV line.

14. Electrostatic precipitator: The coal-fired boiler plants are equipped with an electrostatic ash separation plant for removal of solid particles from the flue gas – a dry powder called fly ash.

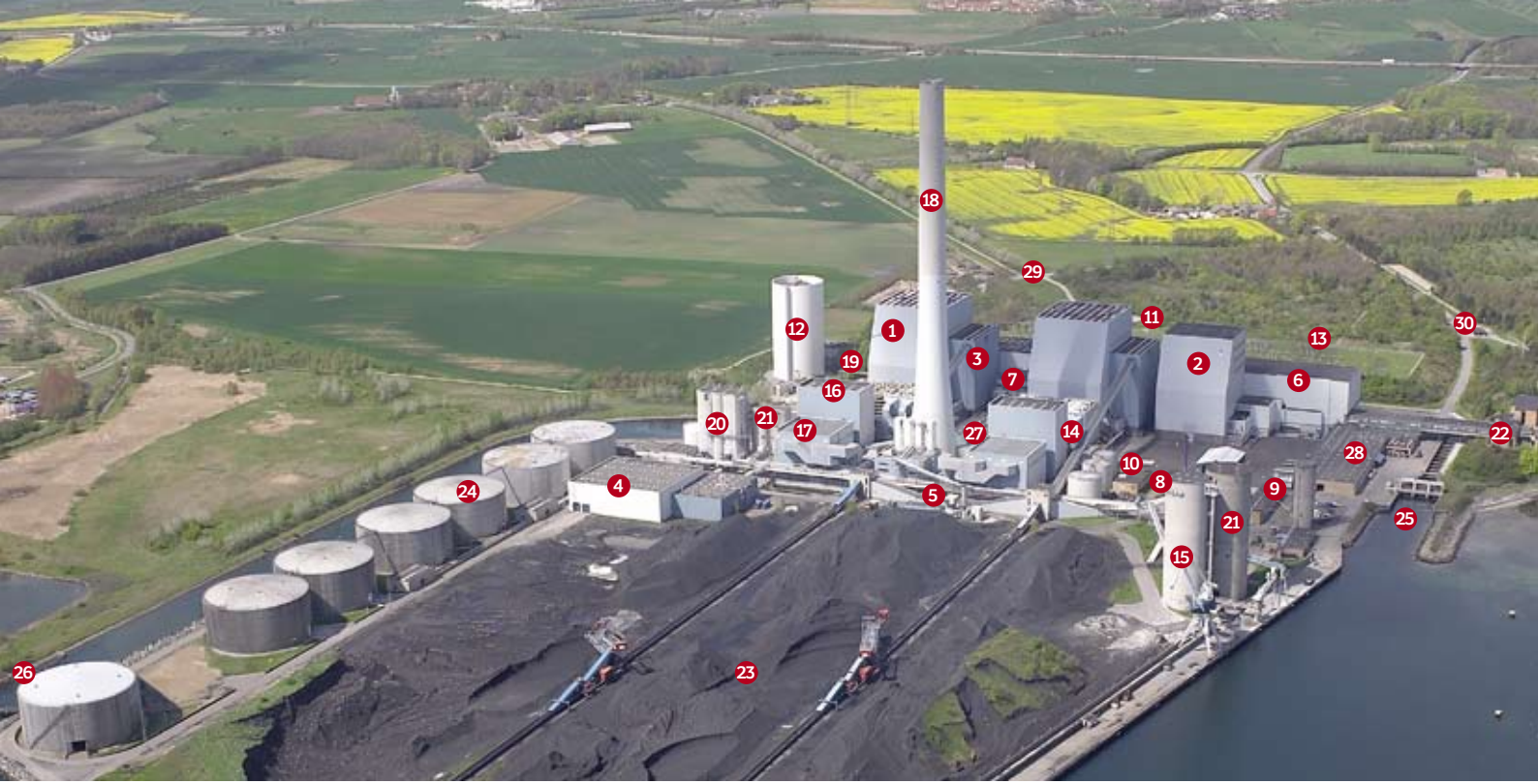
15. Lime silo: The desulphurisation process requires approximately 200 tonnes of lime per day.

16. Desulphurisation plant: The units are equipped with desulphurisation plants which remove more than 95% of the sulphur content from the flue gas.

17. Bag filter: After the flue gas desulphurisation process, dust particles are collected in bag filters.

18. Stack, units 3 and 4: Units 3 and 4 have a common 190-metre high stack which contains two flue gas pipes, each with a diameter of 5.3 m. The concrete housing has a diameter of 27 m at the bottom and 12 m at the top.

19. Bottom ash silos: Each of the coal-fired units has a bottom ash silo for storage of the bottom ash which is continuously scraped from the bottom of the boiler.



20. SDAP silos: The gypsum-like by-product (calcium sulphite) from the desulphurisation plant is stored in silos to be used in the desulphurisation process at other CHP plants.

21. Fly ash silo: The fly ash is stored in silos until it is transported by ship, tanker or lorry. To be transported by lorry, the ash is moistened prior to delivery. The fly ash is reused in the cement, concrete and asphalt industries.

22. Reception

23. Coal store: The coal yard has an area of 90,000 m^2 and has a capacity of 800,000 tonnes of coal, corresponding to a normal 7-month consumption.

24. Oil store: The oil tank installation consists of seven tanks with a capacity of 25,000 m^3 placed along the cooling water outlet.

25. Cooling water inlet

26. Cooling water outlet

27. Service building: This building contains mechanical workshop and, workshops for electrical installations and instruments.

28. Workshop and store: Contain machining workshop, laboratory and store.

29. South gate

30. Main gate

ENVIRONMENTAL RESPONSIBILITY

The environment

All processes at Studstrupværket and the related stores for storage of mineral products are subjected to regulatory control. Changes of existing plants as well as construction of new plants must be in accordance with the applicable Danish laws and the guidelines laid down by the municipality of Aarhus. Furthermore, the supervisory authority, being Miljøcenter Aarhus, must approve and lay down rules and conditions for layout and operation of the plants at Studstrupværket.

It is continuously controlled that Studstrupværket meets applicable laws and conditions. To a great extent, the control is made by self-regulation which means continuous collection of Studstrupværket's data for consumption and operation. The data are reported to Miljøcenter Aarhus and other relevant authorities on a monthly, quarterly and annual basis. Furthermore, Studstrupværket is subjected to the rules for the preparation of Green Accounts which relates to the previous year in detail – especially in relation to observance of applicable laws and conditions.

Studstrupværket's emissions and other environmental impact are further subjected to the requirements laid down in ISO14001:2004 according to which the power station is certified.

Working environment

The working environment affecting the staff working at Studstrupværket, is also certified according to the requirements laid down in OHSAS18001/BEK 87. It is obvious to everybody that working at a power station may be dangerous if the safety requirements are reduced.

Therefore, serious efforts are made to make Studstrupværket a safe and secure workplace with as few accidents as possible. The efforts have been successful as the number of accidents continuous to fall and at the same time, serious accidents only happen very rarely.

Loading and unloading of ships

Loading and unloading of bulk carriers are certified according to the requirements specified in ISO9001:2000. This ensures that the work is performed as safe as possible and that the individual activities are continuously monitored and improved, where possible..

CO_2 monitoring

Studstrupværket's largest raw material is coal, the consumption of which inevitably causes large emissions of both CO_2 and fly ash. However, by replacing approximately 10% coal by straw as fuel, the CO_2 emission can be reduced. And by continuously optimising the utilisation of the fuel, the emission to the atmosphere is reduced to a minimum.

The CO_2 emission is monitored and verified according to applicable law on CO_2 monitoring.

Large efforts are made to make Studstrupværket a safe and secure workplace

Controlroom

Recycling of water

Water is another raw material. Instead of using drinking water in the desulphurisation plant, Studstrupværket uses purified waste water from the municipal waste water treatment plant.

This effects a saving of drinking water resources, and the marine environment is spared discharge of the recycled waste water.

Mineral products

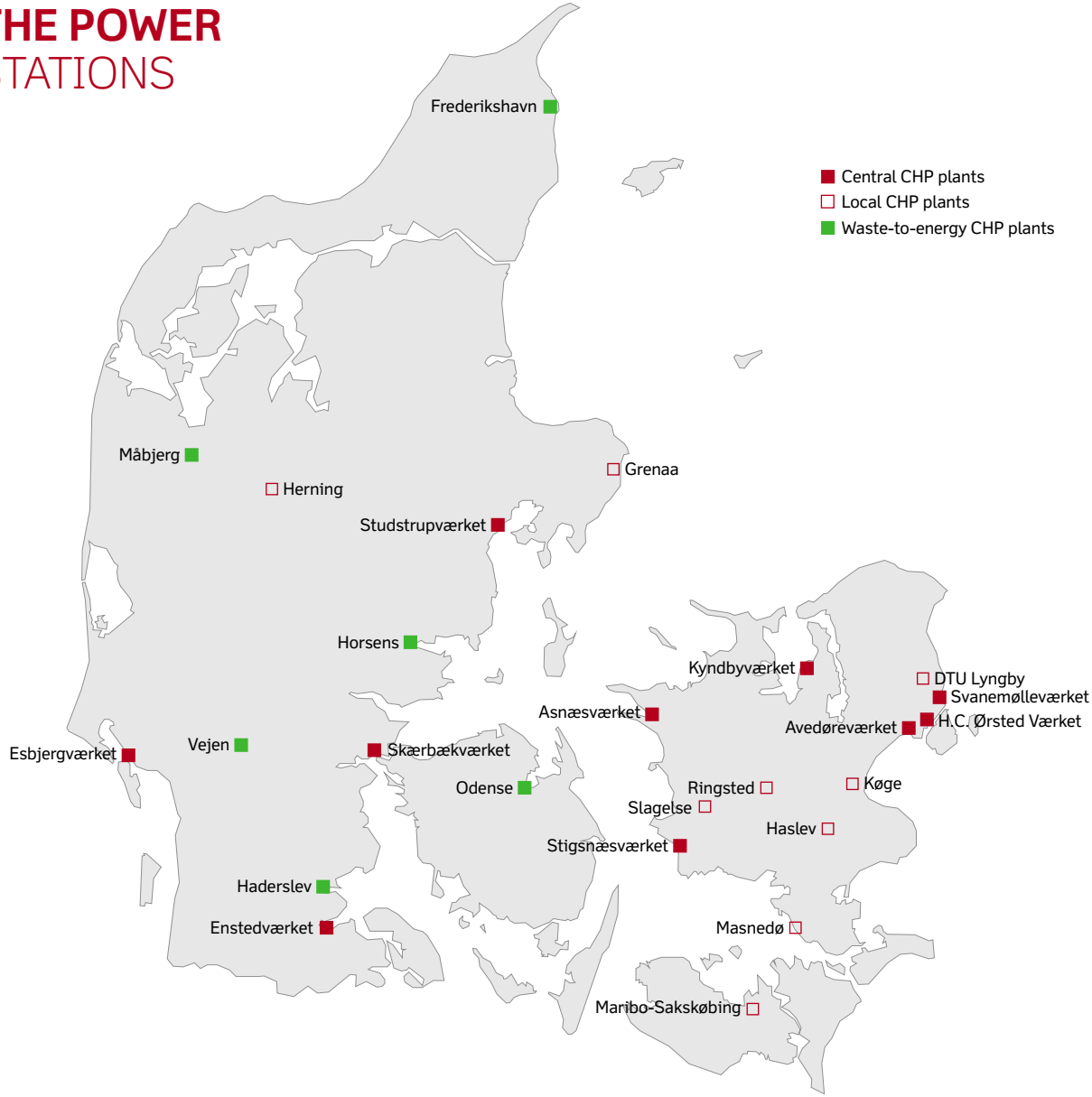
All fly ash and bottom ash as well as the desulphurisation product SDAP (spray-dry absorption product) from the heat and power production – so-called mineral products – are by and large used for industrial purposes.

Fly ash and bottom ash are sold to the industry whereas SDAP is used to improve the desulphurisation process at other power stations. Part of the SDAP is also used in the industry.

Waste

Waste from repair works, retrofitting etc is sorted and disposed of to obtain the best possible recycling.

THE POWER STATIONS



DENMARK'S NEW
ENERGY COMPANY

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

DONG Energy is active in all phases of the energy supply chain – from offshore oil rigs in the North Sea, power plants producing heat and power, and wind farms, until we market 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 stations 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 customers' preferred supplier.

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

www.dongenergy.com

Pay a visit to Studstrupværket

Studstrupværket is pleased to arrange visits for groups and schools for a tour of our heat and power producing facilities.

If you would like to have more information about the visits, please contact Studstrupværket on e-mail studstrup@dongenergy.dk.

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