A combined heat and power plant under constant development.

MälarEnergi

Electricity and heat in an effective and environmentally friendly way.

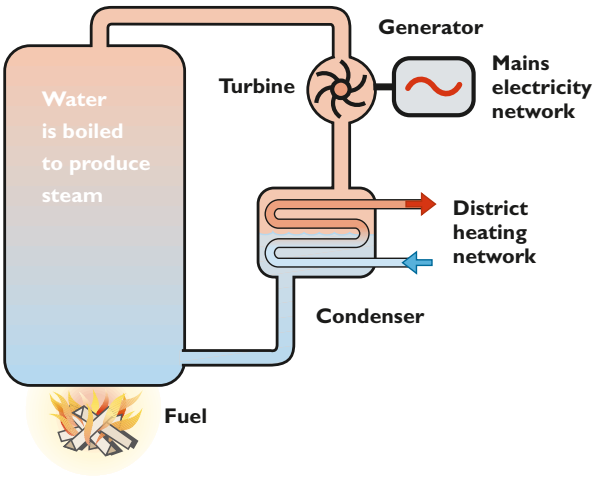
Västerås Heat and Power Plant is the largest in Sweden and one of the cleanest in Europe. Construction of the plant commenced in the 1960s in order for it to be incorporated in the town's district heating system. Oil was the primary fuel at that time. We are now endeavouring to use renewable fuels as far as possible.

The heat and power plant has been extended and converted in several stages. The most recent major extension was carried out in 2000 and comprised a new, modern biofuel boiler that is now responsible for the basic capacity in the plant, and which is operated all year round for environmentally friendly electricity and district heating production.

A combined heat and power plant produces electricity and heat at the same time.

The plant in Västerås is a combined heat and power plant that produces heat and electrical power simultaneously. The principle involves heating water to produce steam at high pressure and a high temperature in a steam boiler. The steam drives a turbine, which in turn drives a generator that emits electrical current, which is fed to the electric grid. After the steam has passed the turbine, the remaining heat energy is transferred to the district heating network via a condenser.

By producing electricity and heat simultaneously, a very high level of efficiency is achieved. A massive 90 % of the fuel's energy content can be utilised in the process. By way of comparison, a steam power plant that solely produces electrical energy only utilises around 40 % of the fuel's energy content.



One of Europe's cleanest heat and power plants.

Thanks to the heat and power plant, the city of Västerås and neighbouring communities - Skultuna, Tillberga, Hökåsen, Hallstahammar and Kolbäck - can be heated in an energy-efficient manner and without polluting the air. We have always been one of the first to invest in various systems for the treatment of flue gases from our boilers, and therefore consider ourselves to be one of the cleanest heat and power plants in Europe.

Effective cleaning technology minimises the amount of pollutants

There are primarily two ways to reduce the environmental impact of a combined heat and power plant: to fire with fuels that do not produce any carbon dioxide contribution, and to clean the flue gases of any harmful compounds. We are working consciously with both of these measures.

Carbon dioxide is formed during all combustion. Most carbon dioxide is released when firing with fossil fuels, which in the long term increases the greenhouse effect in the atmosphere. Biofuels produce no addition to the greenhouse effect, as the released amount of carbon dioxide is absorbed by the growing bio-crops in a natural ecocycle. Biofuels, including peat, now represent approximately 70 % of the heat and power plant's total fuel consumption.

When burning, sulphur oxides and nitrogen oxides are also formed. These contribute for example to the acidification of forests, arable land and lakes if they are released into the air. The flue gases from our boilers are effectively cleaned of these substances. 95 % of nitrogen oxides and 97 % of sulphur oxides are separated when firing with fuels containing sulphur. When burning biofuels, only negligible amounts of sulphur oxide are formed.

The boilers' cleaning systems also include filters for removing dust in the form of airborne ash, as well as residual products from the cleaning of sulphur oxide and nitrogen oxide. The degree of separation for dust is 99.97 %.

We prefer renewable fuels

A heat and power plant can be fired with many different types of fuel. We primarily use biofuels to fire the plant, i.e. renewable fuels from the forest products and waste that do not produce any carbon dioxide contribution when burned. This is in line with Mälarenergi's environmental focus, which is characterised by consideration for nature and the promotion of development that is sustainable in the long term. Firing with renewable fuels is also financially beneficial these days, thanks to the emission trading that is now conducted within the EU. The purpose of this trade is to limit the emissions of carbon dioxide into the atmosphere, thereby working to counteract climate change, the consequences of which are already becoming noticeable.

A complete facility with many

In total, the combined heat and power plant comprises four separate blocks as well as boiler 5. A block refers to a boiler and a turbine. Boiler 5 does not have its own turbine, but produces electricity via the turbine in block 4.

Production is primarily performed using renewable biofuels and amounts to 700 GWh of electricity and 1,800 GWh of heat annually.

Blocks 1 and 2

The plant's oldest production units were commissioned in 1963. Both boilers were converted from oil to coal in 1981, and have subsequently also been converted for firing using tall oil pitch, which is a renewable fuel. Boiler 1 can also be fired with peat. Both of these blocks now operate for peak loads.

Data: block 1
Fuel:
Tall oil pitch, coal, peat
Power and heat production:
40 MW of electricity and
100 MW of district heating

Data: block 2
Fuel:
Tall oil pitch, coal
Power and heat production:
40 MW of electricity and
100 MW of district heating

Block 3

Block 3 was commissioned in 1969 and is a combined heat and power and condensing plant. The boiler can only be fired with oil, and block 3 is therefore only used as a reserve and peak load unit.

Data: block 3
Fuel:
Oil
Power and heat production:
220 MW of electricity and
365 MW of district heating
Condenser operation
(solely electricity production):
250 MW of electricity

possibilities.

Block 4

Block 4 was commissioned in 1973 and is a combined heat, power and condensing plant that was originally built to be oil-fired. The boiler was converted in 1983 for coal firing and in 1998 for firing with tall oil pitch. Since 2002, it has also been possible to fire the boiler with wood pellets or peat. The operating time for boiler 4 is approximately 5,500 hours annually (approximately 33 weeks).

Data block 4

Fuel:
Tall oil pitch,
wood pellets, peat, coal
Power and heat production:
155 MW of electricity and
250 MW of district heating
Condenser operation
(solely electricity production):
180 MW of electricity

Fuel:
Oil
Power and heat production:
220 MW of electricity
and 365 MW of district
heating
Condenser operation
(solely electricity production)
250 MW of electricity

Boiler 5

Boiler 5 was commissioned in 2000 and, along with block 4, is responsible for the heat and power plant's basic production. The steam from boiler 5 and boiler 4 jointly drive the steam turbine in block 4, which is thereby utilised optimally for the production of electricity.

Boiler 5 has an operating time of 8,000 hours annually, which means that it is in operation all year round for electricity and district heating production, apart from 4 weeks when maintenance is carried out.

Data: boiler 5

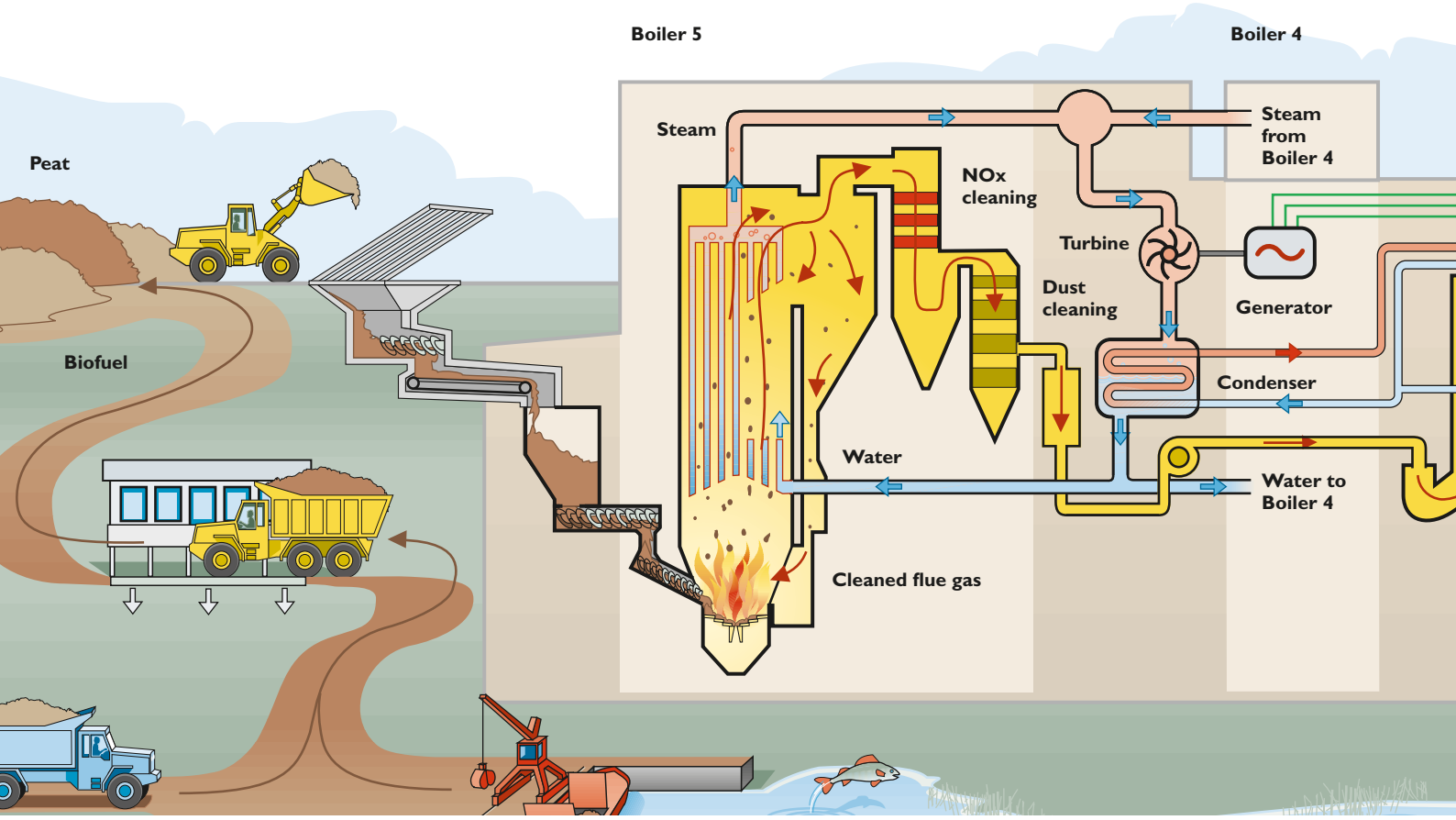
Fuel: Biofuel
Power and heat production (together with block 4):
210 MW of electricity and
400 MW of district heating
Condenser operation (together with block 4):
250 MW of electricity

District cooling

We also produce district cooling for some 40 large properties in Västerås, including the town hall and the hospital. Production amounts to approximately 25 GWh of cooling annually and takes place in two heat pumps and one absorption system. The combination of these two technologies makes it possible to optimise cooling production with regard to current costs for electricity and heating.

Data for the district cooling facilities

Heat pump 1:
10 MW of district cooling and 12 MW of district heating
Heat pump 2:
7 MW of district cooling and 15 MW of district heating
Absorption system:
7 MW of district cooling/driven with 9 MW
of district heating



Clean energy and good economy.

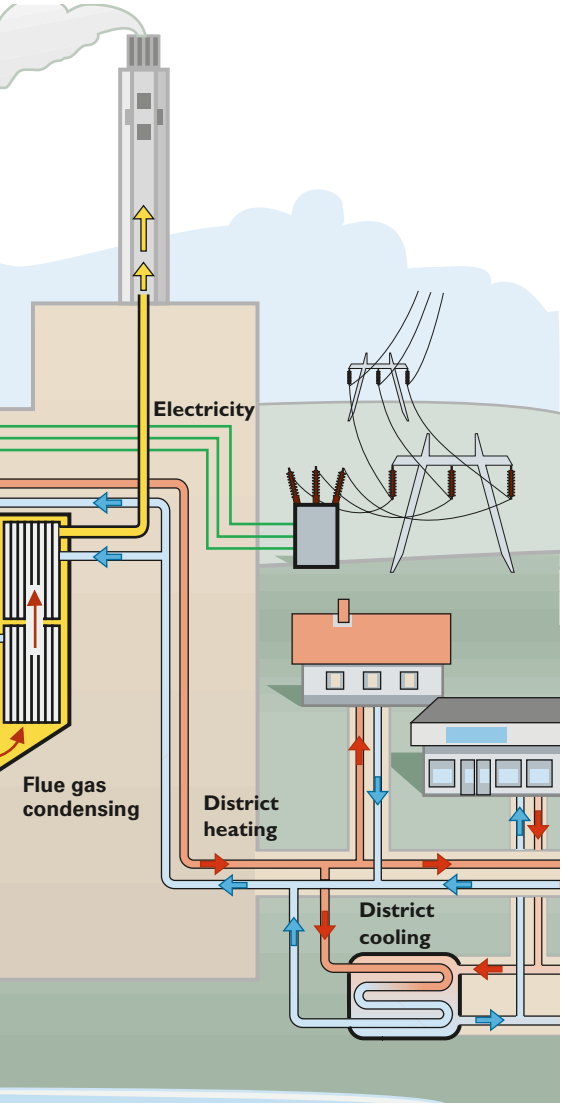
Boiler 5 is the heat and power plant's most recent boiler, and therefore also the most modern. It produces electricity and heat very effectively and with good economy. Our district heating customers can therefore enjoy a price level that is among the lowest in the country. The boiler is also very kind to the environment. Burning biofuel in combination with effective combustion and cleaning techniques means that the pollutants in the flue gases are well within the permitted values.

The boiler works in accordance with CFB technology (Circulating Fluidised Bed), a combustion technique that is well suited for biofuel firing. In addition to the combustion effect in the boiler itself, a further 48.5 MW of heat are extracted through condensing the water steam that is formed in the flue gases.

The CFB technique allows firing with fuel with a high moisture content and varying particle size, which provides considerable flexibility as regards the choice of fuel. The boiler is now primarily fired with wood chips, sawmill byproducts, recycled wood, energy forest and peat.

When the fuel enters the boiler house, it is divided into two fuel compartments and then transferred via worm conveyors forward to the fuel feeders at the bottom of the boiler. Combustion takes place in a floating bed where the biofuel is mixed with sand, which helps to produce even and efficient combustion. Air is supplied at several levels in the boiler, which causes the sand and ash from the fuel to be blown upwards along with the flue gases and on to the cyclones, where they are separated and returned to the bed.

The flue gases that are formed during combustion are routed upwards in the boiler house, before proceeding through the intermediate and final superheaters, dust cleaning and the flue gas condenser, and out through the chimneys. The flue gas temperature reaches a maximum of around 850°C



inside the boiler. When the flue gases leave the chimney, the temperature has fallen to around 35°C.

Joint operation with boiler 4 results in optimal electricity production

Electricity and heat are produced through a closed water and steam cycle. The boiler's walls contain an extensive system of piping, where the water is heated up to produce steam at a high pressure and a high temperature. The steam from boiler 5 is routed, together with steam from boiler 4, to the shared turbine where the energy in the steam is utilised for electricity production. Joint operation of boilers 4 and 5 means that the turbine can be utilised to its full capacity, which gives very cost-effective electricity production. After the steam has left the turbine, it proceeds to a heat exchanger (condenser) where it is condensed to form water and simultaneously provides heat energy to the district heating network. The water is then returned in the boiler's piping system, thereby closing the cycle.

24 hours a day, 365 days a year.

We need hot water in our taps in the summer as well. That is why the heat and power plant is always manned, 24 hours a day, 365 days a year.

The pictures tell the following story:

1. The fuel department takes samples of all fuel deliveries to determine moisture content and conduct an ash analysis.

2. Deliveries of fuel arrive every day by ship and truck. The ship cargoes normally contain peat, which can be tipped directly onto the fuel storage area or into the cleaning grate thanks to the nearby port.

3. The machine operators manage operations out in the facility.

4. The combined heat and power plant is run with continuous shift working comprising 6 shift teams. They are responsible for production and inspections of the facility. They also carry out maintenance work alongside the Maintenance Department. Monitoring takes place centrally from the control room.

TECHNICAL DATA FOR BOILER 5

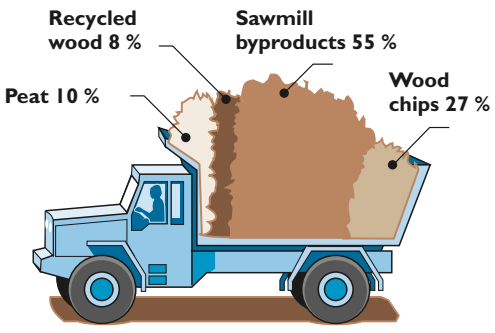
Boiler type:
CFB (Circulating Fluidised Bed) with intermediate superheating
Supplied fuel output:
170 MW
Steam pressure:
171/40 bar
Steam temperature:
540°C
Boiler efficiency:
91 %
Operational start-up:
December 2000
Condensing output:
48.5 MW
Chimney height:
120 metres
Flue gas cleaning:
Hose filter for dust particles, selective catalytic reduction for NOx, lime is mixed in in the sand bed when firing with fuels containing sulphur

Renewable best for the environment.

Renewable fuels refer to fuels that are continuously being produced. Examples of such fuels include solar, wind and water energy. For us at the heat and power plant, renewable fuels are synonymous with biofuels, i.e. fuels from the plant kingdom.

In view of the environment, we are endeavouring to use as much biofuel as possible. Biofuels currently make up 40 % of our total fuel consumption. Fossil fuels represent a further 32 % and peat 28 %. In total, the consumption of biofuel for boiler 5 amounts to a million cubic meters annually. Wood pellets or peat are preferable in boiler 4, and in the absence of these, coal is burned.

In order to handle the large fuel quantities, a well-functioning flow of materials is required. In parallel with the construction of boiler 5, a new facility was therefore erected for receiving, preparation, intermediate storage and transport into the boiler facility. The fuel arrives at the heat and power plant by rail, road and sea. In order to supply boiler 5 with biofuel, we receive 48 trucks per day, 365 days a year.



Distribution of biofuels in boiler 5.

We also supply district cooling.

Västerås was the first in the country to offer district cooling. The first district cooling customer was connected as far back as 1992, and the district cooling network has subsequently been extended to cover some 40 major properties in the city.

District cooling is produced in various ways: in two heat pump facilities and in an absorption system. By combining these two methods, cooling production can be optimised with regard to relevant costs for electricity and heat.

District cooling for increased indoor comfort

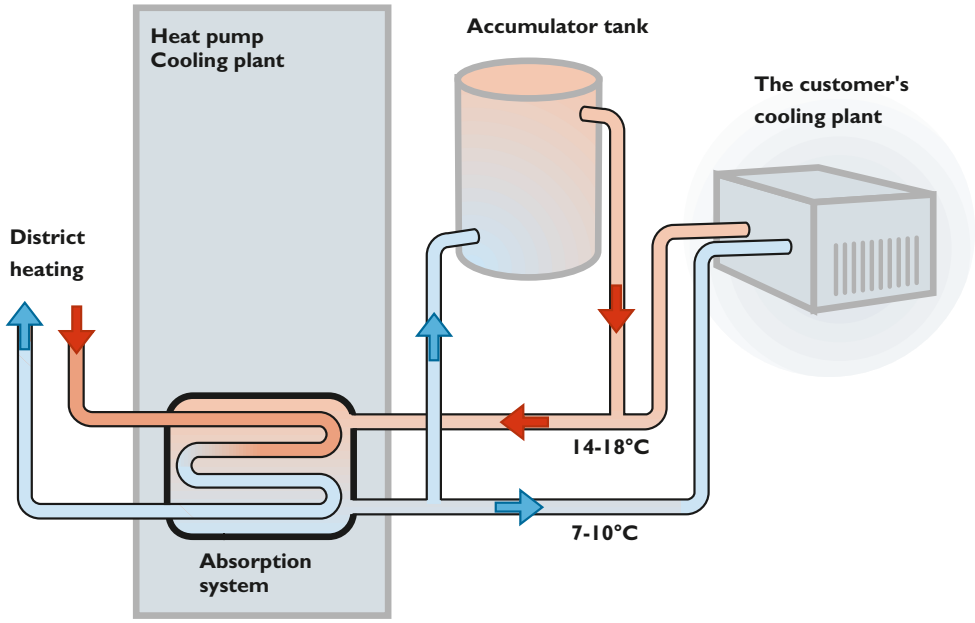
After passing the heat pumps, the wastewater has been cooled down to between 2-10°C. The cold is now utilised in the cooling plant, which is located adjacent to the heat pumps, and then transferred to the district cooling network in Västerås - a district heating network operating in reverse. In this way we gain even more benefit from the wastewater. With some of the electrical energy supplied, we obtain three parts heating plus two parts cooling.

There is also an absorption system for the heat pumps that produces cooling, primarily using district heating as the fuel. During the winter, when the temperature in Lake Mälaren drops below 8-10°C, the lakewater is used to produce cooling.

District cooling is primarily used to generate a comfortable indoor climate in offices and workplaces, in department stores and shops, and in public buildings.

The heat pumps utilise the energy in the wastewater

The heat pumps are located in the wastewater treatment works and make use of the heat content in the town's wastewater - heat that would otherwise be wasted in Lake Mälaren. The heat pumps work very efficiently. The amount of energy produced in the form of heat is three times as large as the energy supplied in the form of electricity. The heat energy is delivered to the district heating network.



The combined heat and power plant's control room for all production facilities.

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