

# Our dream - a city free from fossil fuels

Application – First Global District Energy Climate Awards



## Production of district heating, district cooling, electricity and biogas

Borås Energi och Miljö AB, Sweden

**Borås Energi och Miljö AB**, is a municipally owned company and part of Borås Stadshus AB.  
**Contact:** Jonas Holmberg – Head of Marketing, +46 33 35 72 20, [jonas.holmberg@borasenergimiljo.se](mailto:jonas.holmberg@borasenergimiljo.se)

[www.borasenergimiljo.se](http://www.borasenergimiljo.se)

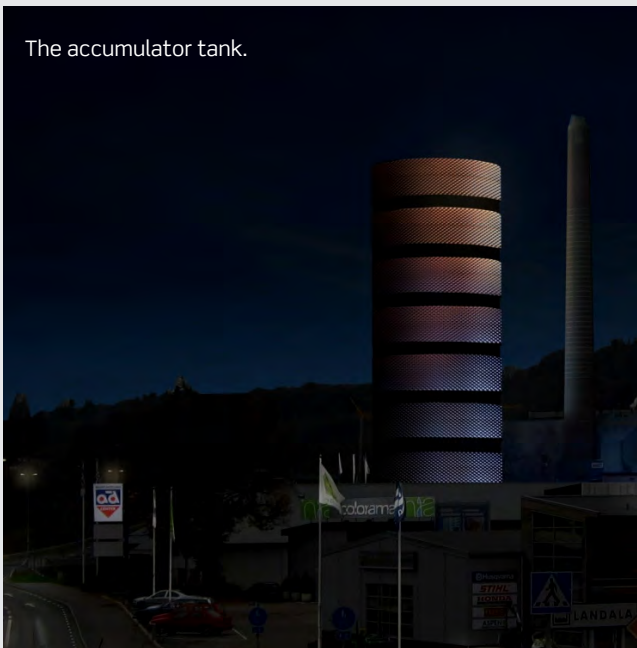
**Borås is Sweden's 13th largest municipality. Around 64,000 people live in Borås City, and over 100,000 throughout the municipality.**

**Borås Energi och Miljö AB (BEM) is a municipally owned company that handles refuse and the production of district heating, cooling and electricity in the municipality of Borås. The company has a vision of a city free from fossil fuels.**

**BEM runs a number of facilities and services, all of which contribute to the reduction of greenhouse gas emissions in one way or another. The term "emissions" used in this document usually refers to greenhouse gases.**

**First off, please watch our company movie for a quick tour of our company. [Click here](#) to watch the movie.**

The accumulator tank.



### **We harness all energy streams**

Today Borås City is a pioneer when it comes to working in harmony with the biological cycle, and we look on combustible household refuse as a valuable energy resource – energy that would otherwise be wasted.

Whenever they sort their household waste, travel on biogas buses, relax at home with comfortable district heating or spend time at an office with pleasant district cooling, the inhabitants of Borås play an important role as part of the biological cycle.

# System descriptions

Borås inhabitants sort their domestic waste into differently coloured plastic bags – white for combustible waste and black for biodegradable waste. Recyclables, e.g. packaging such as metal cans and plastic bottles, are separated and deposited at one of the company's recycling centres.

When the black bags and white bags arrive at the Sobacken waste management plant, they are automatically optically separated. The white bags are used as fuel for generating e.g. district heating, while the contents of the black bags are converted into biogas.

## District heating, cooling and electricity generation

### District heating

BEM has several different district heating plants. The main unit, Ryaverket, is a combined heat and power plant. It has two biofuel boilers, two waste boilers and two generators. There is also an electrical heater plus two propane/biofuel/oil-fired boilers used as back-ups.

The biofuel boilers are grate-fired steam boilers. The biofuels mainly comprise forest fuel, i.e. fuel made from left-over materials from the forestry industry. Flue gases are cleaned by electrical filters connected to each boiler. Ash from the boilers is used as a forest fertilizer.

The waste incineration plant has two fluidized bed boilers using the latest technology. They burn the combustible portion of domestic waste (the white bags) and combustible waste from non-domestic sources. To ensure incineration is complete and to guarantee low emissions, the boilers are fitted with start-up and support burners. The waste boilers are connected to a flue gas cleaning system, in which slaked lime and activated charcoal are used to reduce pollutants. Particulates are then collected in a textile filter before the flue gas is passed to the chimney. Once metals are sorted from the bottom ash the ash is used as construction material at the BEM landfill. Fly ash is sent to Norway for treatment and permanent storage as a part of an environmental project.

Construction at Ryaverket began in 1965 and over the years the plant was modified several times towards more eco-friendly production. In the beginning, production was mainly based on fossil oil and a small percentage of waste.

In 1984 the two large oil-fired boilers were converted to burn solid fuel (biofuel, 75%, and coal, 25%). A dryer was installed in 1994 to increase efficiency and allow boilers to be run on biofuel alone.

The first two waste incineration furnaces were opened in 1966, and a third was installed in 1972. The first two furnaces were shut down in 1987 for environmental reasons. The third boiler remained in operation until 1991 and was then closed.

At the beginning of the 21st century the City of Borås decided to build a new waste incineration plant at the same location as the old one. The plant, with its two fluidized bed boilers and modern flue gas cleaning technology, was opened in 2004.

To ensure a sufficient amount of energy in the district heating grid there are six smaller back-up and support plants located along the grid. The most frequently used is located at Ryaverket and consists of two boilers. Both boilers can run on propane but in 2007 one was converted to also run on bio oil. The remaining five plants, which run on fossil fuels, are only used in very cold weather or during scheduled and unscheduled maintenance at Ryaverket.

Figure 1 shows plant trends toward more eco-friendly generation.

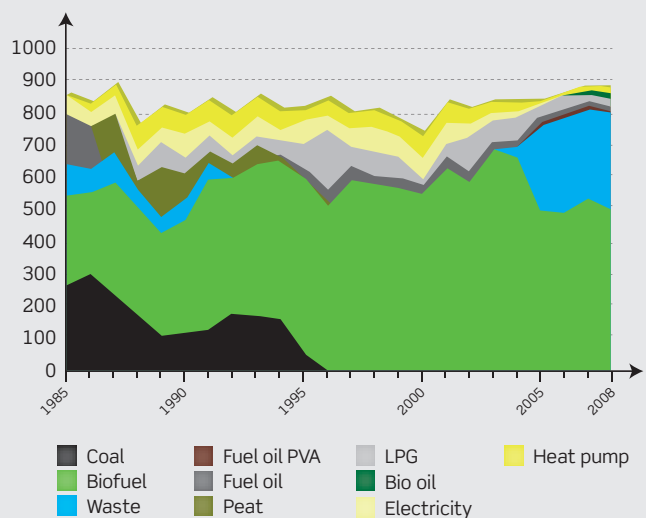


Figure 1. The proportions of fuels used to generate district heating, cooling and electricity from 1985 to 2008.

There is also a heat pump used as a support plant; it extracts heat from sewage water at the local sewage treatment plant.

### **District heating grid**

District heating is distributed via underground pipes to homes and other properties in Borås and is used partly to heat water circulating through radiators, and partly for heating tap water.

Construction of the Borås district heating grid began in 1959. Today there are around 300 km of district heating piping. There were 3,992 customers at the beginning of 2009, compared to 1,892 at the beginning of 2000. Approximately 35,000 inhabitants rely on district heating.

In addition to the large district heating grid in the centre of Borås there is also a smaller grid in the small community of Fristad (located about 15 km north of Borås). The district heating in this grid is supplied by its own hot water plant with four biofuel boilers and two oil-fired boilers used as back-up. Previously, the company had facilities similar to the Fristad plant in the communities of Sandared and Dalsjöfors. These areas were connected to the central grid in 2006 and 2008 respectively, and resulted in the more efficient generation of district heating and a reduction in emissions.

### **District cooling**

In 1996 BEM built a district cooling grid to provide its customers an eco-friendly, economically-viable alternative to air conditioning. Today it produces up to 7 MW of district cooling via the central grid. District cooling is produced mainly at Ryaverket. There are two absorption chillers run by water from the district heating grid instead of electricity; only small amounts of electricity are needed for pumps and fans etc. Brine is used to transfer the heat between the different media. There are also three machines using conventional technology where cooling is produced by the use of electricity, and there is a small conventional cooling unit used as back-up on another site in the district cooling grid.

District cooling is produced in absorption chillers from surplus heat from the waste boilers. When no surplus is available, conventional technology is used. Two of the three conventional cooling units include heat recovery technology in order to exploit heat extracted from various buildings. This means that all the heat transferred from customers to the district cooling water is recovered in

the district heating grid, including heat from the electric compressors in the conventional unit.

This variety of cooling plant options enables us to provide district cooling in the most economical and eco-friendly manner possible.

The district cooling grid supplies industries, offices, shopping centres and the local hospital with cooling to create comfortable indoor environments.

In addition to Ryaverket there are two other production sites in the city that provide cooling to two locations not connected to the central cooling grid. One of these is at the local hospital and consists of an absorption pump and two conventional units, the other is at an office centre and uses a conventional technology unit.

### **Electricity**

Electricity is generated at Ryaverket and four different hydropower plants.

The two Ryaverket generators are driven by steam produced by the combustion of biofuel and waste. The generators were built in 1965, but were rebuilt and renovated in 2008 to obtain a higher electricity/heat ratio. In 2007, 134 GWh were generated at Ryaverket, and 44 GWh by the hydropower plants.

Electricity generated at Ryaverket and the four hydropower plants is sold to Nord Pool, the Nordic electricity market.

The Ryaverket plant.



## Biogas – an alternative to fossil fuels

Sobacken is a waste treatment plant owned and run by BEM. Several operations take place at the plant, but in respect of the climate, the production of biogas is the most interesting.

Biodegradable household waste is mixed with biodegradable waste from non-domestic sources and placed in a digestion chamber. Raw biogas is given off during the digestion process.

Domestic waste is collected by the company's refuse trucks. At the end of 2008, 80 per cent of domestic waste was collected by trucks running on biogas, and the goal is for as many trucks as is technically feasible to run on biogas. One factor holding this development back is a lack of choice regarding adequately sized biogas vehicles. By the end of 2008, 28 local buses were running on biogas, and 87 per cent of Borås City bus routes were covered by buses running on biogas.

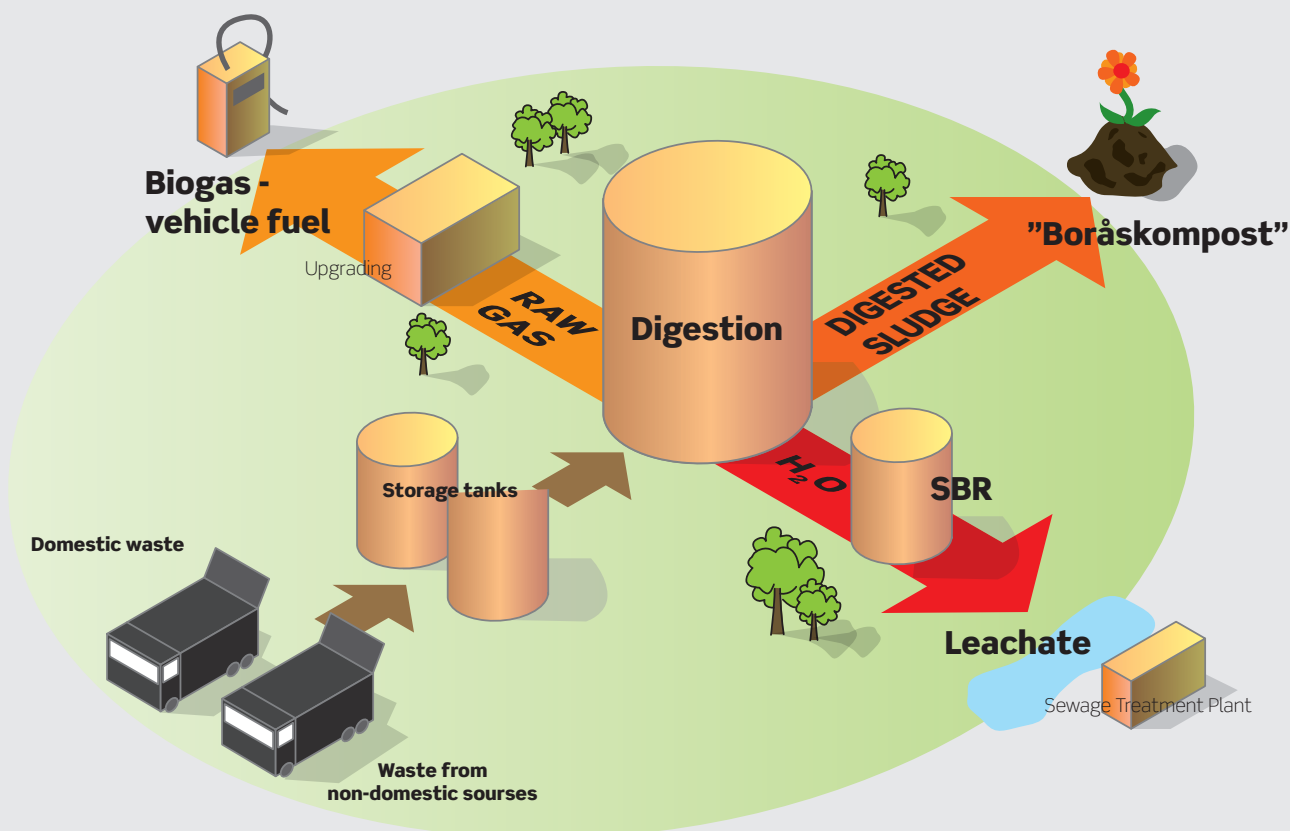
Digested sludge is mixed with garden waste and manure to produce a soil improvement product called Boråskompost (Borås compost), in many cases used to replace artificial fertilizer. Because the production and transport of artificial fertilizer is energy intensive, the



distribution of Boråskompost contributes to a reduction in greenhouse gas emissions.

Biogas is distributed at four different filling stations in Borås. Two of these are open to the public, one is located at the local bus garage and the other at the Sobacken plant for filling BEM's vehicles.

The current biogas production facility at the Sobacken plant was opened in 2004. The first public filling station was opened in 2003, the filling station at the local bus garage opened five years later, and the second public filling station was opened in June 2009.



## Energy services

In addition to the operations described above, BEM also provides a number of services to help with the reduction of energy consumption and the emission of greenhouse gases.

### Energy Status

An energy status report is a summary of a property's specific energy consumption, based on existing data. The aim is to assess the property's potential for energy savings. The tool allows the owner of multiple properties to compare different buildings and apply measures where they will have the best effect.

### Energy Analysis

In an energy analysis, a property's energy consumption is plotted and proposals made for cost-effective measures aimed at energy savings and climate improvement. The analysis can be seen as a complement to the energy status service. If the client wishes, BEM can request and evaluate tenders for the measures proposed.

The results can be used by the property owner whenever energy and climate-related decisions are taken with regard to the property.

### Energy follow-up with KeepAnEye

The KeepAnEye tool ensures that the property owner always has up-to-date energy statistics concerning the property, and it allows the property owner to continuously monitor the costs and consumption of heating, cooling, electricity and water.

### Climate Service

Through continual monitoring and maintenance a property owner can rectify faults, damage and leaks before acute problems arise. With Climate Service, BEM carries out checks and maintenance on that part of the district heating/cooling distribution system inside the property, i.e. the part for which the property owner bears responsibility for checks and maintenance.

### Climate contract

Under a climate contract, BEM works together with the facility owner to optimize energy use in the facility. Work begins with an energy analysis to determine what can be done to optimize energy use in the property, and tenders for proposed measures are reviewed. If the client wishes to proceed, BEM takes on the role of project leader for the entire project.

This allows facilities owners who otherwise lack the time or expertise necessary for the analysis to find the best solutions for optimizing their energy use.

### Energy declaration

According to Swedish legislation (based on EU-legislation) an energy declaration must be prepared whenever a house is built, sold or rented out. The declaration must be prepared by a qualified energy expert, such as those at BEM. Since BEM already has knowledge of the properties we are able to help owners with their energy declarations in the most effective way.

## Other climate saving activities

### Collection of recyclables

BEM runs a large number of recycling stations and five recycling centres. Borås inhabitants can deposit recyclables i.e. packaging and paper, at the recycling stations, while various other types of waste such as hazardous substances, demolition waste, green waste from gardening and recyclables can be handed to recycling centres. The different types of waste are then transported to treatment facilities.

The provision of a place to dispose of their sorted waste gives Borås inhabitants an incentive to recycle e.g. plastics instead of discarding them together with non-recyclable waste. By enabling the recycling of such things as plastic bags and cardboard boxes, BEM contributes to a reduction in the need for raw materials and a corresponding reduction in energy consumption and emissions.

### Collection of landfill gas

Gas has been collected from the landfill at the Sobacken plant since the spring of 2009. Were we not to make use of the gas it would seep away to atmosphere. The gas collected is used to fuel the process incinerator at the biogas plant, thus making more biogas (currently being burned) available for refining and use as vehicle fuel.

# “Proof”

## Energy use and CO<sub>2</sub> emissions

The figures presented in this section are based on activities for the year 2006 as compiled by Profu in the report “Klimatpåverkan från Borås Stads energisystem” (Climate Impact, Borås City Energy System).

This section contains information about the conversion of energy from input to product and the emissions produced and saved from BEM's main operations – the production of biogas and the generation of district heating, cooling and electricity. Benefits arising from the use of the BEM products biogas and district heating, cooling and electricity will be described in a later section.

The use of e.g. petrol in company cars is not included; neither is the production and transport of chemicals required for processes.

### Energy usage in BEM operations

Figure 2 illustrates input and output energy streams at BEM. The figures describe conditions in 2006. The main energy sources were forest fuels and waste. The remaining fuel types were used as support fuels when outdoor temperatures were particularly low. In 2006 BEM used 948 GWh in processes that generated outputs equivalent to 731 GWh.

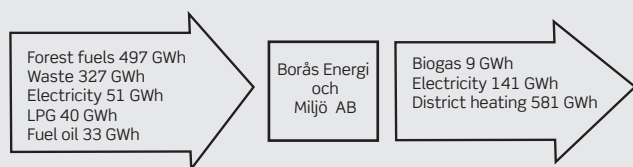


Figure 2. Energy input and output at BEM during 2006.

### Emissions from the production of biogas and district heating - contributions and savings

Emissions result from both the production of biogas and the generation of district heating, cooling and electricity. But overall, BEM operations lead to a net reduction in emissions. The figures are based on operations in 2006.

The use of fuels to generate district heating, cooling and electricity, leads to emissions. By making decisions based on awareness of the environment, the size and effects of those emissions can be reduced. The combustion of fossil fuels unavoidably leads to emissions of fossil CO<sub>2</sub> and, depending on choice of fuel, N<sub>2</sub>O emissions. The choice of biofuel reduces direct emissions of fossil CO<sub>2</sub> to zero, but with some remaining N<sub>2</sub>O emissions. By choosing

locally-produced fuels that do not involve energy-consuming production processes, emissions resulting from production and transportation can be reduced.

A certain amount of CH<sub>4</sub> leaks away during the production and distribution of biogas.

Production and transportation of fuel  
Use of fuel  
Total emissions

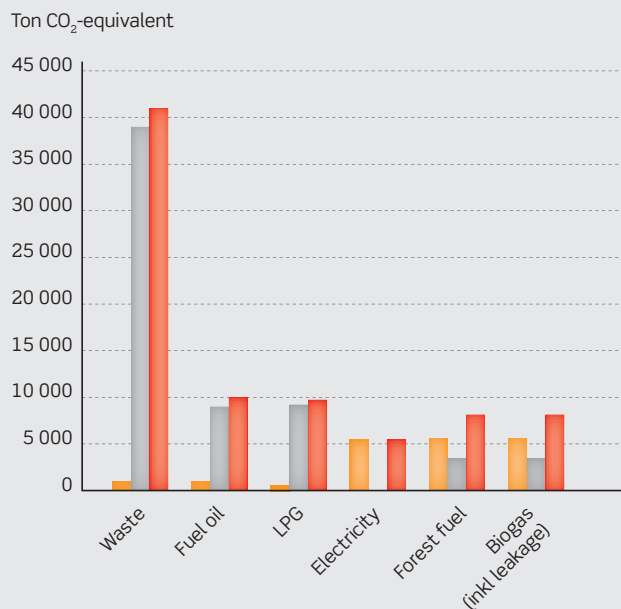


Figure 3. Emissions from the production, transportation and use of the different fuels used by BEM in 2006.

As shown in the chart above, the major proportion of emissions comes from the use of the fuel itself. The exceptions are electricity and forest fuel. Electricity does not produce emissions at the point of use, and forest fuel emissions are carbon neutral, although the transportation of forest fuel does often include the use of petrol or diesel.

The largest source of emissions is the combustion of refuse. Although refuse makes up almost 35 per cent of the energy input and emissions avoided by this operation, as can be seen below, this does not mean that refuse is a bad fuel. Refuse is presumed to contain a certain amount of fossil materials such as plastics.

In Sweden, the amount of trees being planted exceeds the number being harvested, therefore the use of forest fuel is not seen as a threat to the environment. The cleanest fuel with the lowest climate impact from greenhouse gas emissions is forest fuel. Forest fuel makes up more than 52 per cent of the energy input, but leads to emissions of greenhouse gases that are lower than those from fuel

oil or LPG, which only make up 3 and 4 per cent of energy input respectively.

In taking care of waste products and converting them into something useful, BEM has a positive effect on emissions.

By using biodegradable waste to produce biogas instead of dumping it in the landfill, BEM avoided emissions amounting to 10,000 tons of CO<sub>2</sub> equivalents, and in using combustible waste as an energy source instead of dumping it in the landfill BEM avoided emissions amounting to 50,000 tons of CO<sub>2</sub> equivalents. By producing electricity from non-fossil fuels, the need to produce electricity elsewhere by using fossil fuels is reduced, thus reducing emissions. As shown in figure 4, BEM had a net electricity production of 90 GWh in 2006, which contributed an emissions avoidance amounting to 15,000 tons of CO<sub>2</sub> equivalents.

The chart below shows the amount of emissions avoided by BEM operations. Secondary benefits such as the replacement of petrol with biogas, and individual heating with district heating, are not included.

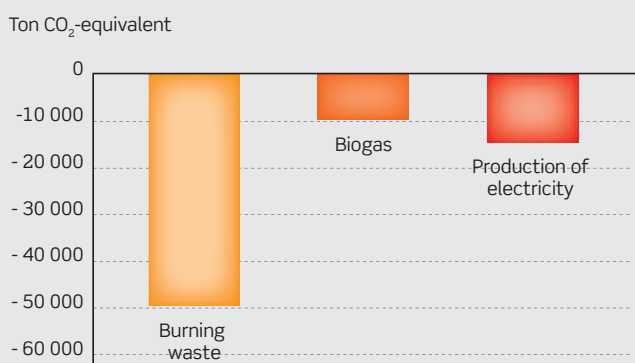


Figure 4. Emissions avoided by BEM operations in 2006. Secondary benefits from e.g. district heating not included.

In summary, BEM operations for 2006 led to a net avoidance of approximately 1 kiloton of CO<sub>2</sub> equivalents, excluding secondary benefits from the replacement of petrol with biogas and individual heating via district heating.

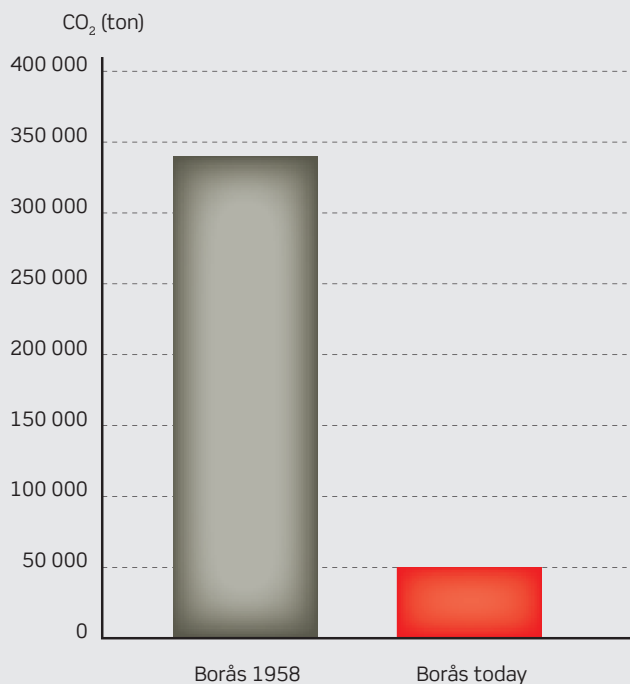


Figure 5. Comparison: CO<sub>2</sub> 1958/Present day. The 1958 figures have been extrapolated to reflect a larger demand for district heating.

## Benefits of district heating and cooling

### General benefits

There are many benefits from district heating compared to individual heating, both for the environment and the consumer.

- By replacing a number of individual heating systems, e.g. oil or wood furnaces, all emissions are concentrated in one place for treatment by organizations with the necessary expertise and equipment, which results in more advanced, efficient flue gas cleaning and pollution control.
- Ryaverket is a combined heat and power generation plant, which makes it more energy efficient than individual heating systems due to simultaneous production of heat and electricity.
- This provides a stable heating/cooling system that requires less effort from the customer. The customer does not need to purchase and transport fuel.

The benefits from district cooling are largely the same as those from district heating. Moreover, district cooling solves the problem of environmentally harmful CFCs often found in air conditioning units.



## Emission benefits

Figure 6 shows the contributions and savings in emissions arising from the production and use of district heating and cooling in 2007. The information is an extract from the Profu report – “Klimatpåverkan från Borås Energi och Miljö’s fjärrvärmeproduktion”.

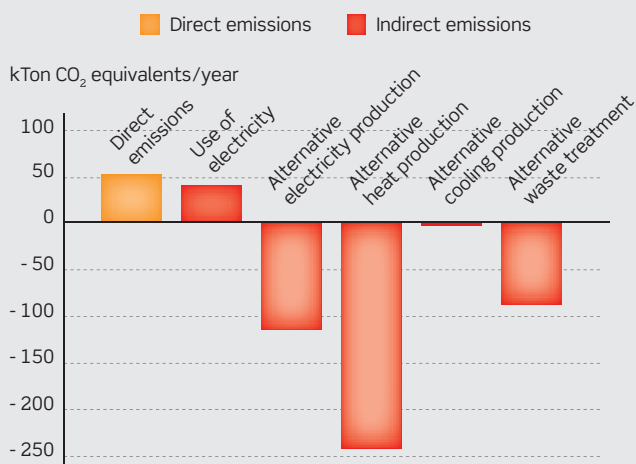


Figure 6. Direct and indirect emissions from BEM's production of district heating and district cooling in 2007.

## The benefits of biogas

The use of biogas reduces demand for conventional fossil fuels and leads to reduced fossil CO<sub>2</sub> emissions.

Biogas is about 20 per cent cheaper than conventional fuels. Biogas-fueled cars park free of charge in Borås City.

# Environmental compliance strategies

## Innovative technological solutions and development strategies

An accumulator tank construction project for the BEM district heating grid will be completed in the autumn of 2009. The accumulator will reduce the requirement for fossil fuel as it can be charged when the demand for heat is low and discharged when demand is higher, resulting in a reduction in the requirement for support heating. Another benefit is that the accumulator enables an increase in the generation of electricity of about four per cent.

## Availability

The Ryaverket production plant comprises several different boilers connected to the same grid, which means that backup is always available, and that the plant, viewed as a single production unit, never suffers an outage.

The Ryaverket plant comprises several boilers; the table below shows availability per boiler.

| Boiler             | Availability 2007 | Availability 2008 |
|--------------------|-------------------|-------------------|
| Waste boilers      | 93 %              | 97 %              |
| Biofuel boilers    | 96 %              | 98 %              |
| Electricity boiler | 100 %             | 100 %             |

Availability is calculated as followed: hours in operation / total hours in period.

Scheduled maintenance times and planned construction work not included.

# Customer relations

## Customer Satisfaction Surveys

In recent years, Borås Energi och Miljö has made large investments in an effort to place the customer at the centre of business. Results were made plain in a customer survey aimed at new customers during 2008, in which grades were 4.47 on a scale of 1 to 5. Borås Energi och Miljö also makes annual customer satisfaction surveys regarding all customers. In 2009 the rating was 4.21 on a scale of 1 to 5.

The surveys are used to identify areas with potential for improvement. One aspect that emerged was that customers found the invoice and charging system to be too complex, and this led to a change in the charging system. Instead of charging customers in advance based on estimated consumption, customers are now charged in arrears according to actual consumption.

## Annual Meeting

In order to increase customer satisfaction further, all customers are invited to an annual meeting where they are informed about events during the past year and what to expect in the coming year.

## Environmental Customer of the Year

In 2008, all of the company's 100 environmental customers (any customer who combines one of the company's basic services, e.g. district heating, with at least one of the company's energy services) were invited to various information sessions. Each customer was given an environmental certificate and one was nominated "environmental customer of the year" (Södra Älvsborg Hospital).

## Service and maintenance

To further increase customer satisfaction concerning district heating Borås Energi och Miljö own the distributing system at our residential customers. This means that BEM takes care of system service and maintenance.

## New customers

New customers receive a welcome gift, and all customers moving into houses with district heating receive a letter with important information on prices and the benefits of district heating. These efforts are made to ensure customers get off to a good start with district heating.

## 100,000 people working toward the same goal!

The key to achieving our dream of a fossil-free city is for everyone who lives and works in the city to be committed and participate in this environmental effort. This can involve everything from sorting recyclable waste, using district heating and cooling for their properties and using

biogas to run vehicles. It is also important for residents to use energy efficiently so that we can reduce the size of the energy channels flowing into the city.

In recent years, we have provided information that is targeted to everyone who lives and works in the city. Recycling and sorting information has been sent to all households. In 2009, our environmental public relations person visited all 5th graders in the city, and we have had just over 1000 visitors at our facilities on study trips.

In 2009, we put on a Recycling Day in Borås. The purpose of the event was to generate interest and participation in climate and environment issues. One activity during the day was a run competition, Kretsloppet, that attracted almost 3000 participants. A success! The goal is for Recycling Day to become a recurring event in Borås!

We are also involved with several trade associations. We are on three different committees at Svensk Fjärrvärme-Swedish District Heating Association: the Environmental Committee, the Communications Committee and the Technology Committee. At Avfall Sverige – Swedish Waste Management, we are represented on the board of directors and in a number of working groups. At Biogas väst, we are involved in a number of different working groups. Waste Refinery is a joint association including several companies, University College in Borås and SP Technical Research Institute of Sweden that is trying to develop various uses for waste. We hold the chairmanship of Waste Refinery.

