

The brilliance of a district energy system



Heating, cooling, electricity and wood pellets
in a smart combination for the next generation



Name of system: Västermalmsverket

Location: Falun, Sweden

Owner: Falu Energi & Vatten AB

Type of ownership: Municipality-owned company

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THESE FOUR INGREDIENTS MAKE OUR PLANT A COMBINED BIOENERGY PLANT - IT IS UNIQUE DUE TO SIMULTANEOUS PRODUCTION OF HEAT, COOLING, ELECTRICITY AND WOOD PELLETS.

Summary

HISTORY

Falu Energi & Vatten (Falun Energy & Water) is taking responsibility by developing the community of Falun, county Dalarna. Our cooling & heating plant is situated on the brink of the world heritage, Falun Copper Mine, which for many centuries was one of Sweden's foremost business activities. That is a tradition we are carrying on.

CLIMATE IMPACT

Falun's investment in climate neutral production of heating, cooling and electricity has globally reduced CO₂ emissions by 145 000 tonnes/year. This is equal to emissions from 47 000 cars!

Large investments have been made to replace fossil energy and reduce the global CO₂ emissions with renewable power production. Since 2007 the annual production has doubled.

THE SYSTEM

Over the past five years Västermalmsverket has evolved from being solely a combined heat and power plant. By investing in an absorption cooling machine we have reduced the use of electricity for conventional cooling installations. At the

same time we are able to increase the production of electricity at Västermalmsverket.

We have built a wood pellet factory which helps us to produce more renewable energy during the warmer period when the need for heat is at its lowest. By doing so we have increased our electricity production and we get wood pellets to use in our district heating production during the winter. These four ingredients make our plant a combined bioenergy plant - it is unique due to simultaneous production of heat, cooling, electricity and wood pellets. And by the end of summer 2014 the system will include district heating being transported through a line between the cities of Falun and Borlänge. This increases our possibility to maintain district heating as a competitive product.

OPPORTUNITIES FOR THE FUTURE

In order to develop a sustainable district heating industry there is a need to spread knowledge about district heating's minimal environmental impact. This knowledge needs to be transferred not only to customers and the public. It is also important that politicians, policy makers, officials and industry understand total systems and the large picture.



FALUN - OUR PLACE ON EARTH

Falun is Dalarna's largest municipality with 56 000 inhabitants. It is the county town and center of culture and sports in Dalarna.

The river Faluån runs right through the town and cuts it into two parts. On one side lies Falun Copper Mine, which for many centuries was one of Sweden's foremost business activities as the copper was very important to the national economy. The smoke from the many furnaces made it impossible for plants to survive on the gruesome side. The other side of the river, where rust smoke did not reach, was much greener and therefore it is called the sweet side. The mining area is since 2001 on the World Heritage List.

Just as the great mining era had influence on technical development and evolved infrastructure, such as water for power, Falu Energi & Vatten also wants to encourage technical development and supply the citizens with electricity, district heating, district cooling and wood pellets. This mix of production makes Västermalmsverket a combine bioenergy plant.

For the last century the community and Falu Energi & Vatten has together with industry worked hard and purposefully to develop the community into a successful place to live in and a

flourishing place of business. Always with a focus on the next generation and with a responsibility for the climate and environment.



FALU ENERGI & VATTEN

Our part in the development of Falun is to take a holistic approach to energy production in the region. The past decade we have invested heavily not only in district heating but also electricity with a single goal: Create wealth for the next generation and reduce emissions of greenhouse gas.



	GWh
Forrest fuel	372
Recycled wood	55
Liquid gas	12
Fuel oil	5
Landfill gas	0,7
Electricity	0

	GWh
Electricity	80
District heating	399
District cooling	2
Wood pellets	77

Figure 1 Energy input and output to/from Falu Energi & Vatten AB, 2012

The brilliance of a Combine Bioenergy Plant

District heating, district cooling, electricity and wood pellets in a smart combination for the next generation.

DISTRICT HEATING

30 years ago Falun started to extend its district heating, using waste heat from an acid plant. In 1993 the acid plant was closed down and investments had to be made in a new bio fuel-based Combined Heat and Power plant (CHP).

Expansion continued in 2006 an additional biofuel-based CHP block was built in Falun. The biofuel is transported to the plant from a radius of 70 kilometres.

Nowadays it is stated in the municipality's energy goals that district heating is preferable as a heating source and that energy production shall be based on renewable fuel, which is also in line with the EU's climate strategy.

Many properties with direct heating have been converted which have led to production of more "green" electricity in the CHP.

THE GRID

Falu Energi & Vatten has extended its district heating in the energy-densest parts of Falun. Over 90 % of the customers are homeowners, yet they represent barely 10 % of energy sales.

In addition to the large district-heating grid in the urban areas of Falun there are smaller grids in the small communities of Bjursås, Grycksbo and Svärdsjö (located in the radius of 20 kilometres of Falun). The district heating in these grids is pro-

duced by wood pellets in boilers. The wood pellets is since 2011 produced at Västermalmsverket at our wood pellets factory.

WOOD PELLETS

A factory was built in 2011 which produces wood pellets from March to October. This results in more efficient usage of the CHP during the warmer season and enables us to store energy in the wood pellets to be used during the colder period. In 2012 16,22 GWh of district heating was used in the process to heat the air that dries sawdust for the wood pellets. The increased production of district heating meant that we could produce 4 GWh of more "green" electricity which replaced the usage of electricity from non-renewable sources.

DISTRICT HEATING TRANSPORT LINE BETWEEN BORLÄNGE AND FALUN.

To improve the production of district heating even more an 18.4 kilometres long transport line between the two cities of Borlänge and Falun is being built. Borlänge mainly produces district

heating using waste as fuel but also waste heat from industries. The direction of the water will be determined by which fuel is most profitable to use. It will have a capacity to transfer 30 MW and transit 120 GWh of energy yearly. The collaboration between the two energy companies is expected to result in further advantages involving staff,

maintenance, purchasing etc. It will be completed during the summer of 2014.

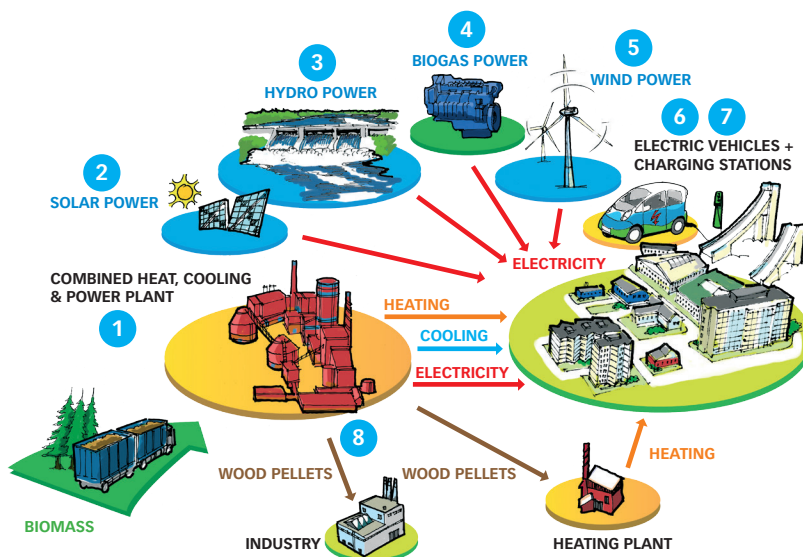
DISTRICT COOLING

In 2008 Falun took the forward-looking decision to invest in district cooling.

By investing in the project "Natural power, heating and cooling in Falun" and using >>



>> absorption cooling machines we produce cooling from district heating. This creates a larger heating basis for the production of electricity during the summer. We offer problem-free and cost-efficient cooling to property owners, companies, shopping centres and the regional hospital. Environmental and climate consequences were also regarded as important. A reduction in the use of electricity for cooling in properties by approximately 1 500 MWh per year, increased our production of electricity by 500 MWh per year. There is a reduction in emissions due to a reduction in the use of electricity when district cooling replaces conventional cooling installations.



FACTS AND FIGURES:

- The district-heating network is 180 kilometres long including three small nets
- Approximately 2 500 properties are connected
- More than 90 % in the urban areas and more than 50 % of all households in the municipality get their heating from us
- Approximately 2,6 million square meter of buildings/customer facilities served
- Resource efficiency 0.07
- Climate impact 20 gCO₂ekv/kWh
- Bio fuel share is 99 % (chippings, bark, sawdust, slash & burn and wood pellets), 1 % landfill gas and liquefied gas

ELECTRICITY

The last couple of years we have made some large ventures within renewable power production. Since 2007 we have doubled the annual production from 50 to almost 100 GWh.

The mix of different renewable power production in Falun municipality replaces fossil energy and reduces the global CO₂ emissions.

The production is sustainable and makes both the power system and community less sensitive to disturbances and price peaks. Through our power lines we deliver a high quality renewable product to the citizens of Falun 24/7/365.

GREEN ENERGY MIX

- 1 Production of electricity from local bio fuels in our two CHP plants.
- 2 One of the largest solar panel systems in Sweden is on top of the fire department in Falun.
- 3 We own five hydro power plants in the municipality.
- 4 At the sewage treatment plant in Främby we take care of biogas from the sewage. The gas is burned in a gas-powered engine that generates both electricity and heat.
- 5 We own three wind turbines in the municipality. The local wind power production corresponds to 10% of the annual electricity demand in Falun.
- 6 We have invested in seven electric cars to be used by employees and the general public.
- 7 Infrastructure of the future - charging stations for electric vehicles which we deliver free wind power to.
- 8 A wood pellets plant produces wood pellets for our own production during the winter and for industry use.

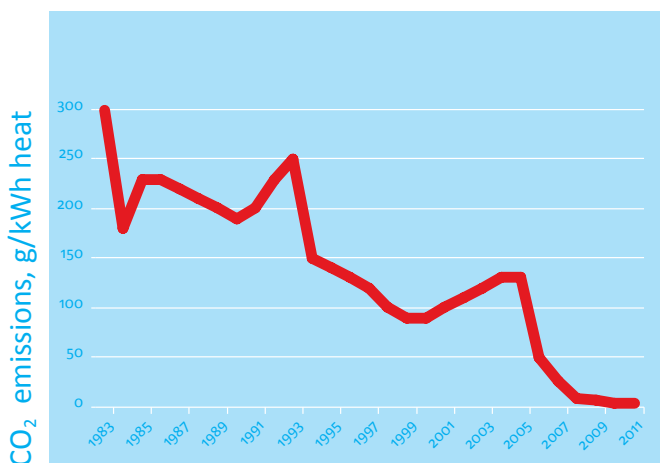
Saving the climate - the facts to back it up

EMISSIONS

District heating & cooling is a wise choice when it is produced from environmentally friendly bio fuel. The combustion of fossil fuels leads to emissions of fossil CO₂. By choosing bio fuel the direct emissions of fossil CO₂ are reduced to zero. In Falun our production is based on fuel from the forest. Since 1998 we return the ash to the forest and we work hard to find new usage for our waste products.

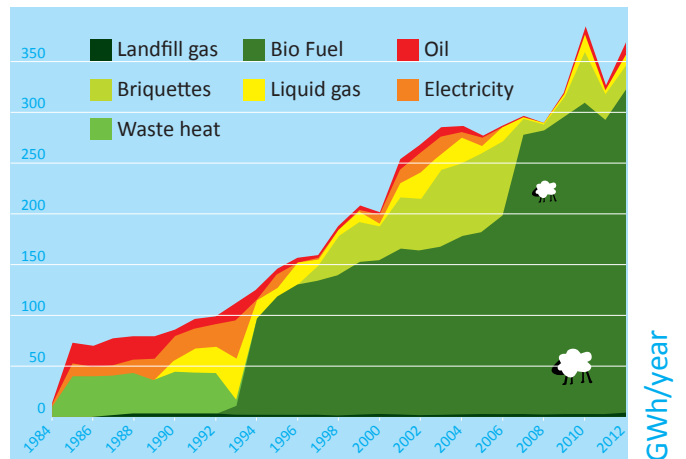
Steering and regulating principles for the injection of ammonia in the bio fuel pump at Västermalmsverket have resulted in the reduction of CO₂ emissions and a reduction in usage of ammonia.

The use of and need for emissions rights, the so-called black certificates, have reduced from 8 000 to 300. If you choose district heating instead of oil the primary energy consumption is reduced by 54 %. The overall operations lead to a net reduction in emissions. The figure shows how Falu Energi & Vatten's investment in climate neutral production have reduced the CO₂ emissions by 145 000 tonnes/year. That is equal to 47 000 cars! That is as many cars that will fit on Sweden's land area!



Further statistics worth mentioning regarding emissions is NO_x 60 tonnes per year, SO₂ 2 tonnes per year and particles 0,357 tonnes per year.

Figure 2 shows the trend towards more eco-friendly fuel in the plant.



POSITIVE IMPACTS WITH CHP

There are many benefits from district heating compared to individual heating. By replacing individual heating systems emissions are concentrated in one place for treatment by organizations with the necessary expertise and equipment. The combine bioenergy plant, producing heat, cooling and wood pellets, have reduced the use of electricity for conventional heating and cooling installations and is able to increase the production of "green" electricity.

A NEW WAY TO PRESERVE AND STORE

Falu Energi & Vatten has developed a completely new way to preserve and store the excess energy arising from the production of electricity with a steam turbine.

The production of electricity gives us excess water that hold a temperature of about 90 degrees. During the cold part of the year this water runs into the district heating system. During the summer, however, heat demand is so low that there is no provision for the warm waste water. To utilize the energy in the 90-degree water Falu Energi & Vatten has built a facility where the hot water is used to heat the air that dries the sawdust for wood pellets. Thus, Falu Energi & Vatten's power plants fulfill their potential to produce electricity even during the summer. The pellets produced may be used as fuel during the cold part of the year. >>

>> The pellet plant has a maximum annual volume of 45 000 tonnes, to be used in the company's own heat system or sold to the regional industry. The pellet production provides heat for about 9 000 homes. The excess water can be utilized even in summer. And we can produce more electricity, estimated at 10 GWh per year.

INNOVATIVE SOLUTIONS AND STRATEGIES

We have built cleaning equipment for the liquid gas condenser. The waste heat in the condenser is used for heating Falu Energi & Vatten's head office before it is released to the container to reduce the environmental impact on discharge to lakes and watercourses.

We actively work to improve combustion in the bio fuel boiler at Västermalmsverket and now have more stable combustion and lower emissions of CO₂ and NO₂.

The incineration of local demolition wood waste in Falun, through co-incineration with bio fuel from the forest, is a good example on how we try to improve and give customers incentives to sort out their waste at the local recycling facility.

Production and maintenance planning have led to increased accessibility (over 99 %), and almost no use of fossil based reserve capacity.

We regularly participate in local energy and environment fairs to inform people about district heating and the saving of energy. One of the key elements in our activities is to be involved in Falun municipality's energy and climate program.

SUPPORT FROM THE SWEDISH ENVIRONMENTAL PROTECTION AGENCY - GOOD ENVIRONMENTAL CHOICE

Falu Energi & Vatten is the first company in the world to deliver district heating, district cooling and electricity with Good Environmental Choice labeling. This labeling places extremely high demands on the products which are approved and is often called "the world's toughest environmental labeling". This is part of our climate work and we are happy to show our customers that our products are a good choice for the environment and the climate.



The Swedish Environmental Protection Agency has chosen to support us and nominated our district cooling efforts as particularly good and effective measures for limiting greenhouse gas emissions.

FINANCING

In the early development of district heating, there was an opportunity to develop with public funds. In the following years, most investments have been made through own resources. Now and then the government issues programs that eg. reduce emissions of CO₂. We have received some funds from these kinds of programs including our investment in district cooling.

Customers – together we can develop the community and reach the goals

CUSTOMER RESPONSIBILITY

Falu Energi & Vatten AB is in the forefront of putting the customer at the center of business and to develop the community. By close collaboration we try to find new ways to make life easier for the consumers. Our flexibility gives us an advantage to find ways to satisfy customer needs. We give special focus on our larger customers, by partnering with them, to build long-term co-operations and relationships. >>

>> Also, we are entering the system of Price dialogue which means that we meet regularly with representatives of our larger customers to discuss next year's prices and forecast what will happen with the prices within the next few years. Every second year we carry out customer surveys, measure the satisfied customer index and create plans of action based on these.

ENERGY CONSERVATION AND ENERGY SERVICES

It is central to us that our customers are satisfied with district heating, both in terms of comfort, but also the price. Therefore, we have abandoned the fixed charges completely. This provides a good incentive for energy saving, which in turn leads to reduced CO₂ emissions. The standard price list for larger customers has been adapted so that high levels of cooling lead to lower costs which reflect the actual reduction of production costs. We offer our customers visits where we together with the customer inspect the property and household and develop proposals on energy efficiency, all free of charge.

Our customers have access to free web-based monthly energy statistics to make them become more aware of their consumption and take action to save energy. At our website and in our company magazine we provide information on energy-saving tips to make our customers more conscious when it comes to energy matters.

SERVICE AND MAINTENANCE

We offer our customers maintenance guarantee which means that qualified staff visits the property every third year for an inspection. Customers with a maintenance warranty can contact our service technicians for a visit at no extra cost.

Falu Energi & Vatten also offers a concept called Färdig Fjärrvärme™ (eng. Easy district heating), which makes district heating even easier. Falu Energi & Vatten owns the heat exchanger, provides service regularly and the customer doesn't have to make an initial investment.

ANNUAL MEETINGS

Falu Energi & Vatten was one of the first companies ever to be certified with Reko certification. Every year we have information meetings to discuss energy and prices and listen to guest lecturers. About 1 000 people have attended these meetings so far, which is quite good considering we have about 1 800 customers.

The quality-assurance system Reko District Heating has been developed by the branch organization Svensk Fjärrvärme (Swedish District Heating Association). Reko District heating means that we live up to high expectations on openness, comparability and trust, which provide our customers with security.

Renewable energy – replacing fossil fuels

Electricity can be produced close to the end user of renewable and non-emitting resources, e.g. from the CHP. Each revolution on one of our wind turbines provides enough electricity to power an electric car for 10 kilometres. The transport sector is almost entirely dependent on fossil fuels and contributes to a significant part of the climate-damaging emissions of CO₂ and particulates. We are willing to take our share of the costs and risks to be able to revolutionize our vehicles in order to make humanity less dependent of oil. In 2009 Falu Energi & Vatten started an electric car project. We aim to take a leading role in the introduction of new and eco-friendly vehicles. Driving future vehicles with renewable electricity from our CHP plants, wind turbines and hydro power plants is a natural and intelligent part in Falun's future energy systems.

As the first company in Sweden Falu Energi & Vatten introduced the new electric car Mitsubishi i-MiEV. Today, we own seven electric cars from different manufacturers e.g. Think City >>

>> and Volvo V60 plug-in hybrid which is the first model that combines diesel and electricity. Four of them are used in our own activities to reduce overall emissions from our operations. The other cars are outsourced to the community to let more inhabitants try the electric car for their needs and in their everyday lives. For example is one of our electric cars used by the organization behind the Ski World Championships 2015 in Falun, to give the event an environment and climate-aware character. After all, this is the most climate neutral skiing event ever, using district heating and our "green" electricity.



INFRASTRUCTURE FOR CHARGING

In the center of Falun we have provided some of the most attractive parking lots with charging stations for electric vehicles. The electricity is free for all electric vehicles and is origin marked with wind power. Since our community contains rural areas, we have also made sure to install charging stations outside the city of Falun.

One pine can take you from Falun to Paris and back in an electric car and heat a household for two months

Six pines can take you from Falun to Paris and back and down to Paris again, while it provides a household with heat and electricity for one year!

We believe that electricity will play an important role in the future supply of fuel for cars. It is simply impossible to ignore all the benefits of electric motors in front of fossil fuels.

Improving life in Falun community

AN ITALIAN MEETS SWEDISH CHP

Erik Westholm, professor in cultural geography, has a friend who is a professor of sociology at the University of Cosenza in southern Italy; Ada Cavazzi.

Ada is a curious person. She is also quite critical of what is not sensible. She pointed to the CHP plant's fuming chimney. Erik told her that the plant heats the entire city. It is based on renewable fuels and produces electricity as well.

–Hm, said Ada, who owns it?

–The ones who live in this town, the professor replied.

–Take me there, said Ada, I want to see that place immediately.

They drove up to the entrance and were well received. They learnt that the CHP plant in Falun provides 315 GWh heat and 63 GWh of electricity using renewable fuels, most modern treatment technology. The fuel comes from forests around Falun, about a 70 kilometres radius and the ashes are returned as nutrients to the forest. The smoking chimneys emit mostly water vapor. >>



>> Ada Cavazzani was speechless before this demonstration of how to build environmentally friendly technology systems with local resources: this is very clever.

The professor described how it looked 25 years ago when he and his family moved to Falun; Thousands of chimneys were emitting disgusting sulphurous smoke that lay like a heavy lid over the city. Now the only chimney that smokes is the CHP and it releases only water vapor. When Ada comes back from yet another cross-country skiing on the lake she asks: how can the snow be so white, day after day? Doesn't the snow get dark and dirty when it lies on the ground? No, not if you do not pollute it.

Challenges and opportunities for the future

CHALLENGES

The district heating industry faces no immediate crisis, but must prepare itself for new marketing opportunities in the future. It faces a depression of confidence which is about price, environment and no possibility to choose supplier.

The district heating sector is at a crossroads where market conditions are changing.

District heating is today for the most part made from renewable or recycled energy and has over the past 25 years reduced the Swedish CO₂ emissions by 11 million tonnes. Excess heat from power plants and waste incineration is used in heating networks so that we get more out of the energy supplied. All of Europe could be heated only by making use of waste heat from the existing condensing power plants.

In order to develop a sustainable district heating industry there is a need to spread knowledge about district heating's minimal environmental impact. This knowledge needs to be transferred not only to customers and the public but also to politicians, policy makers, officials and industry.

We can't just look at the building and its energy efficiency (kWh/m²) as part of the EU directive says. We need to see the big picture and commit to what's most resource-effective and right for the climate and Mother Earth.

OPPORTUNITIES

To adjust pricing and termination terms for the customer is a way to gain trust. We have abandoned the fixed charges completely which provides a lower sensation of a monopoly system. The possibility for external producers to contribute with heat to the grid is an opportunity to develop the industry.

By working together with industry, politicians, construction and building industry we are able to change the perception of district heating. We have therefore begun having active and regular meetings with those in power, key individuals and organizations to take social responsibility and thereby start the journey to improve the climate.

Through the energy efficiency that customers are undertaking, we notice the lower heating needs. Therefore we are trying to find new ways to get rid of heat. For households there is a possibility to use district heating for their household appliances such as dishwashers, washing machines and tumble driers.

For the last hundred years Falu Energi & Vatten has produced electricity using hydro power. In 1984 district heating was started and in 2008 we built absorptions cooling, both enabled a continuation and expansion of electricity generation. In 2011 we built a wood pellet factory which helps us to produce more renewable electricity in summer when the need for heat is at its lowest. At the same time we have increased our electricity production and we get wood pellets to use in our district heat production during the winter.

Now that's a smart energy system!

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