



A STORY FROM  
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# KARLSTADS ENERGI

the heat is on



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We accept the challenge!



# THE HEAT IS ON

(and it is fossil-free)

Karlstads Energi AB is serious about district heating. The last thing the 89,000 people in the municipality of Karlstad need during a severe cold snap is to run out of heat. Their new ANDRITZ BFB biomass boiler ensures sufficient electricity and heat for years to come.

The municipality of Karlstad in Sweden has a long history of generating its own electricity and district heating. It also has a number of firsts under its belt: the first city in Sweden to have district heating and the first city with a biomass-fueled Combined Heat and Power plant (CHP), which was fed by residue from a nearby sawmill as early as 1948.

More recently in the 1970s and 1980s, oil was the fuel of choice for Karlstad's boilers, mainly due to lower prices. But, corresponding with a relocation to a new site in Hedvågen on the outskirts of the city in 1986, a move was made to waste-to-energy production. Following that in 1992, a biomass CHP plant (Heden 2) was started up.

The decision was made by Karlstads Energi and the local municipality in 2012 to go with totally fossil-free fuels in the total production mix for district heating – generating power

and steam using local biomass. The company now supplies electricity to the national grid, and most importantly, district heating to the municipality that is totally fossil-fuel free.

ANDRITZ was chosen as the main technology supplier for Karlstads Energi's latest project, Heden 3. The project includes a Bubbling Fluidized Bed (BFB) boiler capable of generating 127 t/h of steam equal to 88 MW of thermal power.

## Committed to renewal

Johan Thelander was Karlstads Energi's Project Manager for Heden 3. "We are committed to renewing and updating the equipment at our power plants," Thelander says. "We have a cycle of about 22 years where we make a complete replacement. This is mostly due to the operating wear and tear on the equipment, but it also enables us to keep ahead of changes, for instance in climate or population growth, which will require more power and heat."

According to Thelander, "We have a zero tolerance for not meeting the heat demand on the district heating grid at any given moment. That just does not happen. We make sure we have options for whatever scenario is thrown at us."

And scenarios do come. In 2010, the region saw back-to-back winters that pushed the plant hard. Thelander says, "2010 was a dramatic year – two bad winters in a row. We set a production record with big volumes during the very low temperatures. We suddenly became very busy."

## Technology and performance winner

With unpredictable weather patterns, volatile fuel prices, and ever-changing customer demands, the Heden 3 project had to be a winner in terms of its technology and performance. There were also rewards in the form of green electricity certificates, as well as lucrative rebates for reduced NOx emissions, which provided commercial benefits. Going fossil-free with the best environmental technology would produce economic, social, and environmental benefits. There is the added advantage that all the biomass fuels are locally sourced.

Thelander says, "We projected the income from the green certificates and we could see a really good result, so in 2012 we conducted a feasibility study and started discussions with the Karlstad city council. We carried out the usual project risk analysis, discussed with all parties involved, had a series of discussions with the authorities, and managed to do all this in a relatively short time."

"When we got the decision approved, we spoke with a number of technology suppliers and looked at their various reference sites," says Thelander. "But I have to say that ANDRITZ was the supplier that really seemed to 'get it' by really understanding our needs and what our requirements were. But it turned out there was some pioneering new technology needed to maximize the power plant's efficiency to the desired level."

## Trailblazing with pioneering technology

According to Markus Slotte, Area Sales Manager for ANDRITZ's Power Boilers in Scandinavia, "During our discussions, it be-



▲ (Left to right): Johan Svartvik, Plant Manager; Markus Slotte, ANDRITZ Sales Manager; and Johan Thelander, Project Manager, for Karlstads Energi inside the biomass boiler building.



▲ The feedwater tank in the ANDRITZ BFB boiler.

came clear to us that a high priority for Karlstads Energi was to increase the electricity-to-heat ratio from the plant to be able to produce as much electricity as possible at a given district heat demand. For this, we worked with them to develop a tailor-made solution to boost the electrical output without increasing the steam parameters in the plant."

The boosting of electricity production is accomplished with ANDRITZ's Cyclex system (previously called a Heat Shift System). By utilizing certain features of the Cyclex system, it is possible to replace the bleed steam from the turbine that was formerly used for preheating condensate and instead use this steam for maximizing the turbo-generator's electrical output.

"In addition to making the process more efficient, it also made the boiler plant design simpler, and improved control of the boiler process," says Slotte. "With the Cyclex sys-

tem, you don't need flue gas-to-air preheaters. This gives added flexibility and simplifies the layout. Also, it was possible to use a low-dust catalyst after the bag filter, which is a very cost-effective way to reduce NOx emissions."

The plant has a flue gas condenser system after the flue gas fan, and a combustion air humidifier upstream from the combustion air fans. This way, the latent energy in the flue gas is recovered and transferred to the district heating water. "This plant is really optimized for maximum overall efficiency as well as electric output," says Slotte. "It produces as much district heat as possible, and then uses the remaining district heat load demand to produce as much electricity as possible."

## Win-win-win

ANDRITZ delivered the complete boiler island, from fuel bin to flue gas fan outlet. The BFB design is efficient at burning wood-based fu-

els including forest residuals, sawmill chips, and bark.

The new plant has created a number of win-win-win scenarios when it comes to NOx emissions and puts Karlstads Energi right up there with the top producers in the country. Thelander says, "We are now one of the top five plants in Sweden for efficiency. This year we will be below 10 mg/MJ of NOx emissions, which rewards us with about SEK 3 million (EUR 300,000). ANDRITZ really helped us to achieve this with the Cyclex and Selective Catalyst Reduction systems."

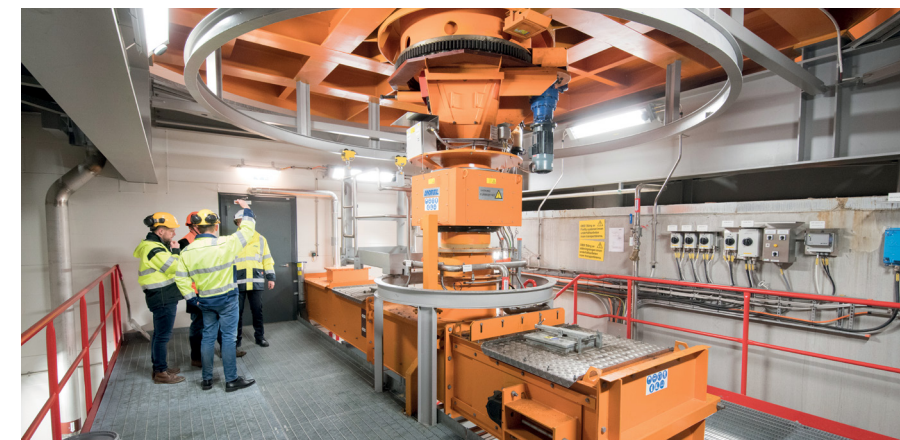
The project ran very smoothly. "We were spot on with this installation from the very beginning," Thelander says. "We are also delighted that the overall project came in at about 15% lower than we budgeted for."

"The installation and commissioning was challenging in that there were a number of suppliers on-site at the same time," says Hannu Ylönen, ANDRITZ Project Manager. "Making sure that work was conducted safely and that everything came together took considerable planning and good collaboration with Johan's team and the other suppliers."

Ylönen noted the project flow and on-site cooperation with the customer's team. "Karlstads Energi was well organized and the project was conducted in a very friendly and constructive atmosphere. Suppliers and subcontractors worked well with each other. I would like to take this opportunity to thank the whole project team."



▲ Hannu Ylönen, ANDRITZ Project Manager for Heden 3



▲ Shown is a fuel discharging system at the bottom of one of the day silos. The plant is equipped with two such systems for redundancy reasons.

### 3D modeling for project management

Karlstads Energi decided to bring in some state-of-the-art project management tools to make sure that any potential interferences or clashing scenarios were seen way in advance by the use of 3D modeling. "The 3D modeling was a real plus for this project," says Thelander. "We combined the 3D models from all the suppliers into one common 3D model and could see where all their different pipes, wires, and hardware were to be positioned. By doing this in a virtual way, we could sit together and make adjustments before the installation began. It was also a fantastic tool when it came to the health and safety of the project."

### The results

Heden 3 started production in the summer of 2014 and Karlstads Energi took over the full running of the plant on December 23, 2014. Johan Svartvik, Plant Manager, says, "It has been over a year now since we took over the full running of the plant, and the availability of

the boiler has been at 99%. There have only been minor stops, and none of them to do with the boiler. Really, it has performed well from day one."

The fuel for the plant all comes from the local area. About 80% comes in the form of forest residuals (seasoned branches and tops) as well as residue from local sawmills. There are occasionally some logs which have to be chipped. The plant also takes rejected logs from Stora Enso's Skoghall Mill located near Karlstad.

"We are very pleased with the ease of stop and start, and the maintenance is straightforward," says Svartvik. "There was a big learning curve, but from the start it was our baby. Our veteran operators have a lot of expertise here, and we have several new people, so nothing has phased us so far."

And how is Heden 3 performing in terms of

output? Says Thelander, "Today we are running at full load, which is about 89 MW. No problems. With the ANDRITZ technology, we have the functionality at this plant to always optimize depending on the fuel."

When the guarantee period is over, Karlstads Energi will look to push production a little further. "We have already reached 93 MW during a performance test," Thelander says. "We can certainly push the boiler a little bit harder. We will only be limited by the capacity of the turbine."

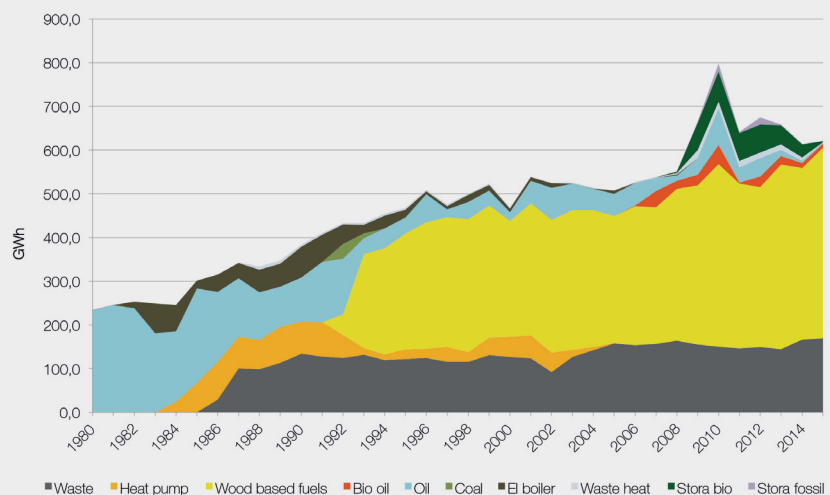
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#### ANDRITZ delivery to Karlstads Energi

- Complete biomass boiler (including boiler house)
- Bag filter and SCR catalyst
- Cycllex system
- Solid fuel feeding and ash removal systems
- Water treatment plant
- Reserve condenser for district heating
- Complete automation/electrification/instrumentation
- HP steam distribution to turbine and pressure reduction stations for emergency condenser/process steam

#### The Evolution of Heat Production: Karlstads Energi



▲ This chart illustrates the changes in fuel sources for Karlstads Energi's Heden plant. The benefits of applying high steam parameters and the Cycllex system are higher electricity-to-heat ratios (28.2 MW / 52 MW = 0.54). The downstream flue gas condenser ensures a very high overall efficiency of 116% (calculated using the effective heat value of the fuel and excluding auxiliary power consumption).

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