The heat is on: How Artificial Intelligence is helping to ward off the Swedish winter chill

Ronnebyhus and Miljöteknik, Sweden **Case story**

A unique combination of tried-and-tested hardware and cutting-edge software – in the form of a self-learning algorithm – is revolutionizing district heating in Sweden. Described as the district heating equivalent of a self-driving car, this solution has the potential to help significantly reduce carbon emissions in the energy-intensive domestic heating sector.

Last October was so wet in Ronneby, a medieval town in southern Sweden, that the autumn market – where locals normally stock up on apples, pumpkins and honey – had to be cancelled. In previous years, the rain would have had the phones ringing all day at the publicly owned housing company Ronnebyhus.

“Because of the humidity, you get a feeling that it’s cold, even though the thermometer says it isn’t,” explains Kristian Olsér, Ronnebyhus’ operations chief, as we walk out into the drizzle from one of the housing company’s apartment blocks. “The maintenance guys, the girls on reception, they get a lot of calls from people saying ‘it’s freezing’, and that they want the heat on.”

This year the calls didn’t come. Olsér had instructed the IT company NODA, which installed its Smart Heat Building software in 50 of his buildings in November 2016, to boost indoor temperatures by a single degree for 30 days. The system, managed by a self-learning algorithm, then automatically calibrated the Alfa Laval IQHeat controllers in the buildings to meet the new goal, keeping Olsér’s customers warm and dry.

Before NODA got involved, the risk of accidentally overheating apartments would have been too high. But NODA’s system is much better at fine-tuning than the most skilled energy manager. Olsér likens it to a self-driving car.

“The telephone calls decreased a lot, and we saved time and money; if you have just one telephone call and send someone out, that costs you 1,500 Swedish kronor (€150),” he says.

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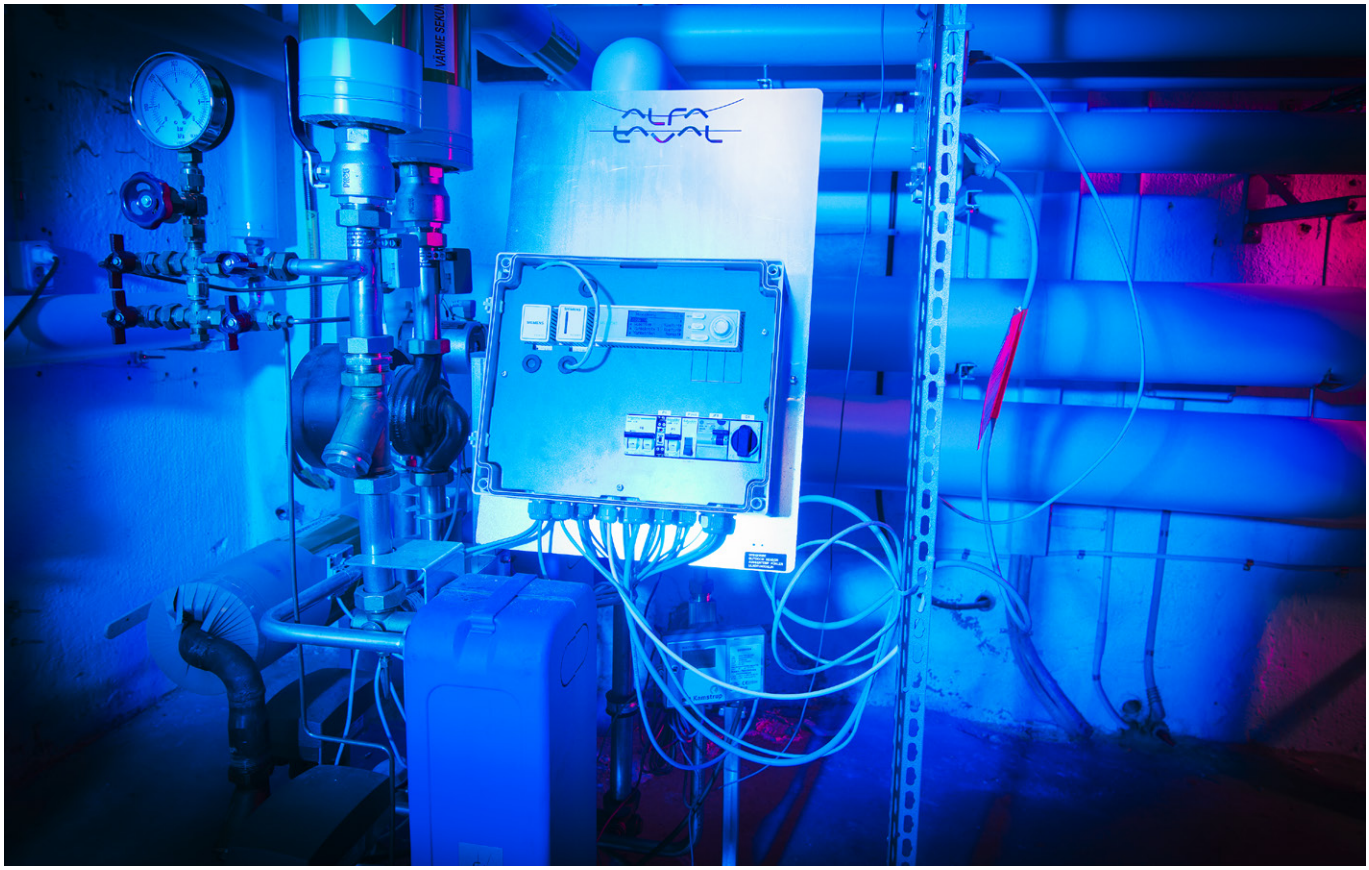


Ronnebyhus' apartment buildings are heated by a district heating network supplied by Miljöteknik, a utility, like Ronnebyhus, that is owned by the local municipality. Roughly half of all houses and apartments in Sweden are now heated by such networks, compared to just 10% in Europe as a whole – an important factor behind Sweden's relatively low carbon dioxide emissions, according to the country's Environmental Protection Agency.

The amount of heat supplied by district heating networks in Sweden increased by 49 percent in the 15 years from 1990 to 2015. During that period most networks shifted to carbon-neutral biofuels, thereby contributing to a 90 percent drop in greenhouse gas emissions from domestic heating in the country. This, in turn, helped the country to cut total greenhouse gas emissions by a quarter over the same period.

The European Union research project "Heat Roadmap Europe" estimates that expanding district heating in Europe could cut demand for energy for heating by between 30 percent and 50 percent, helping European countries meet two UN sustainable development goals of "affordable and clean energy", and "sustainable cities".

But Ronnebyhus' experience shows that even district heating networks have room to improve. Olsér takes us to the basement of one of his buildings where an Alfa Laval Midi Compact — with one heat exchanger for hot water and another for heating — sits alongside residents' bicycles.

"This was where the main heat exchanger was before," he says, pointing to an empty space. "Imagine that, but five times bigger."

Instead of one large heat exchanger for five large apartment buildings, each building now has its own. Olsér estimates that installing the new Alfa Laval system in 2013 cut his apartment blocks' energy use by 25 percent, hydraulic balancing reduced energy use by a further 10-12 percent, and installing the NODA software cut an additional 7-8 percent. "You can almost cut energy use by 50 percent," he says.

Patrick Isacson, NODA's chief executive, claims NODA can do still better: the average energy saving across the 2,000 buildings where the software is now installed was last year 11.6 percent, he says.

Fast facts:

District heating in Sweden

- Demand for heating in Sweden is around 100 TWh per year.
- Of this district heating covers around 51 percent.
- District heating dominates the business-to-business segment with over 90% of the market share for multi-dwelling buildings, and around 80% for non-residential buildings.
- Combined heat and power (CHP) contributed to 45 percent of district heating generation. Renewables, including wood pellets, wood chips, biomass and firewood, cover the largest share as a fuel for CHP with a share of 66%, followed by waste with 18 percent.
- The district cooling network in Sweden continues to grow and reached a trench length of 544 km and total sales of around 900 MWh in 2015.

Source Euroheat.org

Alfa Laval Midi Compact and IQHeat

Alfa Laval's Midi Compact district heating substation with IQHeat allows building managers to monitor and control heating and hot water across several buildings using a single web-based control panel.

IQHeat keeps continuous control over temperatures, flow volumes, circulation pumps and pressure in each building, sending an immediate alert whenever technical functions or parts of the system fail of face problems.

The IQHeat web server provides managers with a flow sheet displaying current temperatures on each side of the Midi Compact heat exchangers. This is available either on a desktop computer or smartphone. Temperatures can be adjusted remotely, saving managers from travelling to the building itself. All data is saved as Excel files for up to 20 years for future reference.

Managers who install IQHeat typically reduce energy use by about 10 percent.

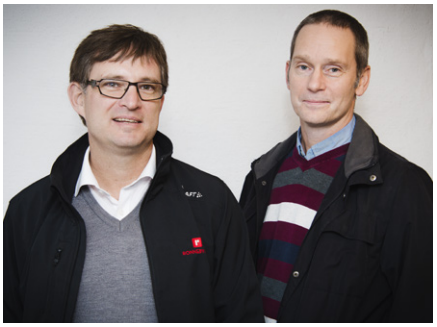
"The system gets a little bit better for each year. It will take three years to have it perfect. It's self-learning," he says.

The NODA system takes in data from all the buildings connected to it, using the data to create a detailed digital model of each one – learning about its physical construction, how it reacts to rain, wind or cold, to when it's empty or full of people, or at different times of the day – and then comparing it to similar buildings. The idea is to build up a model of the way each building stores heat, its heat inertia, and use that to better manage energy use. "We think a computer or an algorithm is a little bit cleverer in deciding how a building should be operated than a human," he says.

The Ronnebyhus contract marked the first time NODA's software has been connected to another company's – Alfa Laval's – hardware. "This is quite a beautiful marriage in many senses, because we have this very innovative but still traditional automation company in Alfa Laval that catches all this data that we need, and then we have this software as an add on, so we can very easily integrate it with quite a small investment," says Isacson.

NODA's founders had previously worked on a project at Alfa Laval's heat exchanger plant in Ronneby while they were doing research at the nearby Blekinge Institute of Technology. But the two companies only began cooperating again five years ago when they decided to combine their technologies at Ronnebyhus, which had already been in talks with Alfa Laval over replacing heat exchangers.

But more importantly, Ronnebyhus also marked the first time NODA had done a project with a housing company, Ronnebyhus, and a utility, Miljöteknik, at the same time. Miljöteknik has already installed Smart Heat Grid – NODA's system for district heating operators – and after testing, it is scheduled to begin operating in full scale in 2018. According to Isacson, this means Miljöteknik will gain all the benefits of what he calls NODA's "core idea".



Kristian Olsér, Ronnebyhus' operations chief and Mats Persson, Product Manager at Alfa Laval Heating and Cooling Systems

"The cool thing here comes when we combine a lot of buildings into a cluster and then use them as virtual capacity storage for a utility," Isacson explains.

The baseload heat generated by Miljöteknik – around 95 percent – comes from burning wood pellets which are close to carbon neutral. But when demand peaks during a sudden cold snap, or on a Monday morning, it has to use expensive and environmentally unfriendly oil-fuelled peak-load burners. NODA's idea is to use the heat inertia in Ronnebyhus's buildings instead, viewing them as "virtual heat storage".

When Olsér installed his new heat exchangers in the winter of 2013, the buildings were left unheated for eight hours, but the temperature inside the apartments dropped by just one degree.

When Miljöteknik starts operating Smart Heat Grid in January, NODA will begin to automatically cut off or reduce the heating in some or all of Ronnebyhus's 50 connected buildings to meet demand peaks, taking direct control of the IQHeat controllers.

It's already saving Miljöteknik money. When the utility connected Ronneby's airport to its district heating network in 2017, it decided to rely on the heat storage in Ronnebyhus' apartments. This, together with the large energy saving and return temperature decrease, made it possible to extend the network without having to build an extra peak-load boiler.

But the system, which was installed and tested live in all buildings the year before, will only be put to active use in Miljöteknik's operational system in 2018. Olsér doesn't believe his buildings' heat has yet been drawn on.

"Not that I would know anyway," he laughs. "The plan is that I shouldn't notice."

They probably don't know it, but the residents of the 40 apartment buildings with NODA installed have an algorithm to thank for protecting them from last year's autumn chill. From 2018, the self-learning system also promises to offer them lower energy bills and reduced carbon emissions.

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Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com

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