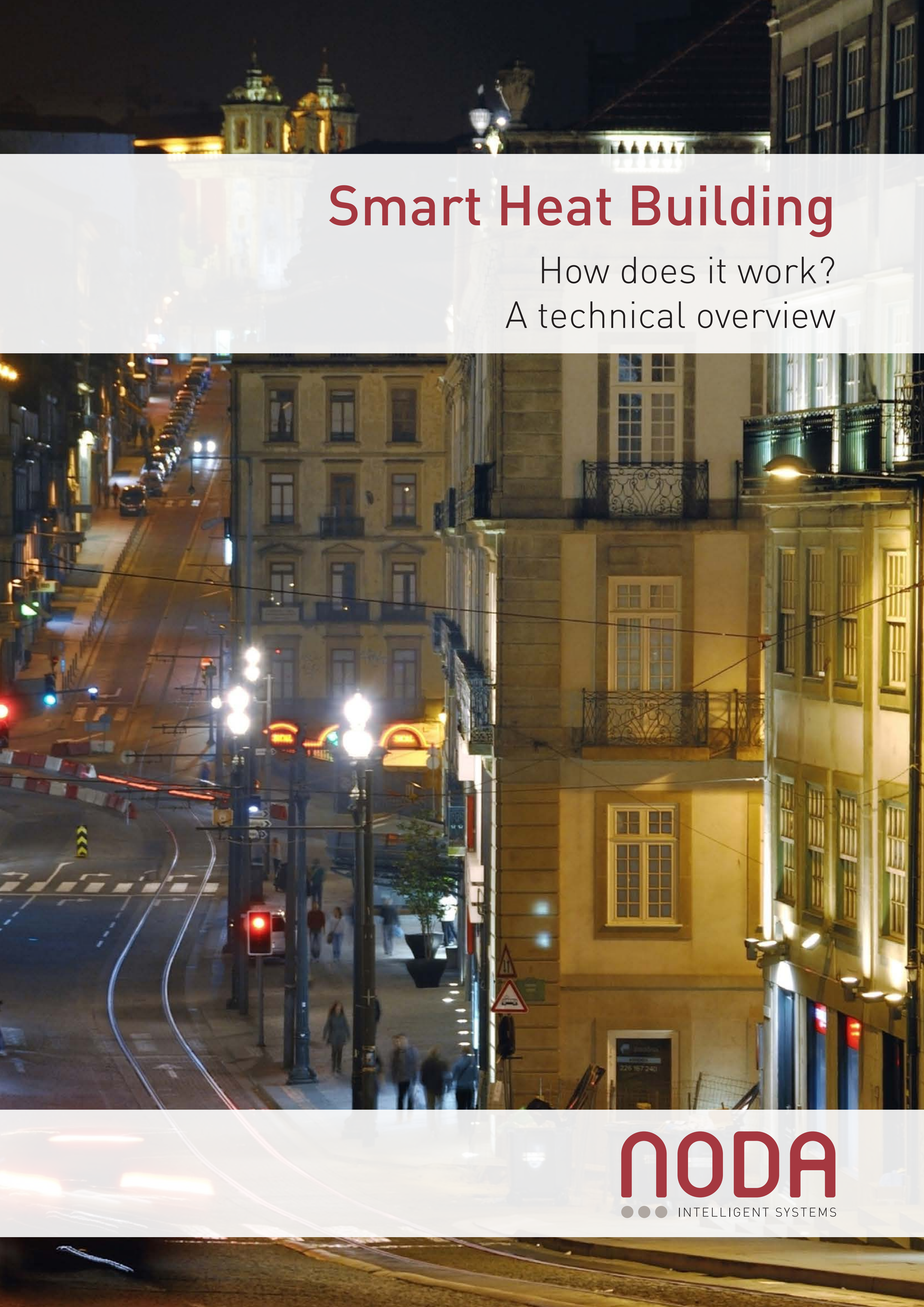


Smart Heat Building

How does it work?
A technical overview

NODA
INTELLIGENT SYSTEMS

What is Noda Intelligent Systems?

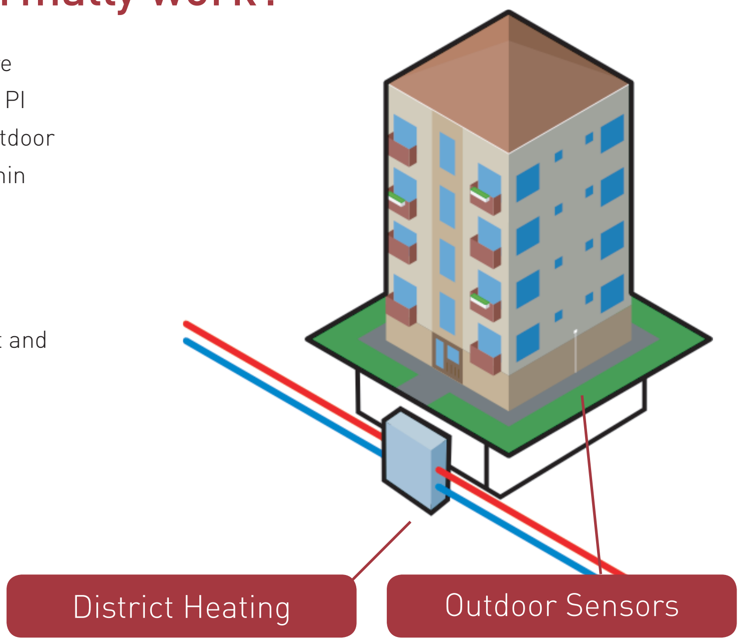
Noda Intelligent Systems was founded in 2005 to develop intelligent systems for energy efficiency and system-wide energy optimisation for both energy companies and property owners. **Noda Intelligent Systems** has a background based in internationally renowned research in computer science. Headquartered in NetPort Science Park in Karlshamn, Sweden, **Noda Intelligent Systems** has business partners and customers around Europe, including energy companies, property owners, automation companies and municipalities. The principal owner is the Swedish Sixth AP Fund.

Noda Intelligent Systems develops and provides **Noda Smart Heat Grid** to optimise district heating systems, and **Noda Smart Heat Building** to maximise energy efficiency in buildings. With over 1,000 affiliated buildings **Noda Intelligent Systems** is the leader in its field.

How does a substation normally work?

Normally a heating system uses a sensor to measure outside temperature. The control circuit then uses a PI (or sometimes a PID) algorithm to coordinate the outdoor temperature with the required flow temperature within the heating system.

This is a rather basic system that fails to take into account a lot of the actual influences on the thermal behaviour of buildings, which means it's not efficient and results in unnecessarily high energy costs.



What affects the indoor temperature?

There are a variety of things that affect the indoor temperature of a building, such as the heating systems, the sun and the way people use the building. Some events cause the indoor temperature to rise, whilst others cause it to fall. The thermal characteristics of a building can be represented by an energy balance model.

To create a more effective and energy-efficient heating system, all these factors have to be continuously monitored. Additionally, the construction of a building, including its exterior construction, plays an important role in the energy consumption of the building. The situation is further complicated because the thermal characteristics of a building are never static, but constantly change over the seasons. None of these vital factors are handled correctly by the conventional PI/PID control systems.

Heating

Radiator Systems
Exposure to the Sun
Social Behaviour, etc.

Outdoor Climate

Indoor Temperature
Humidity Level
Air Quality
Ventilation

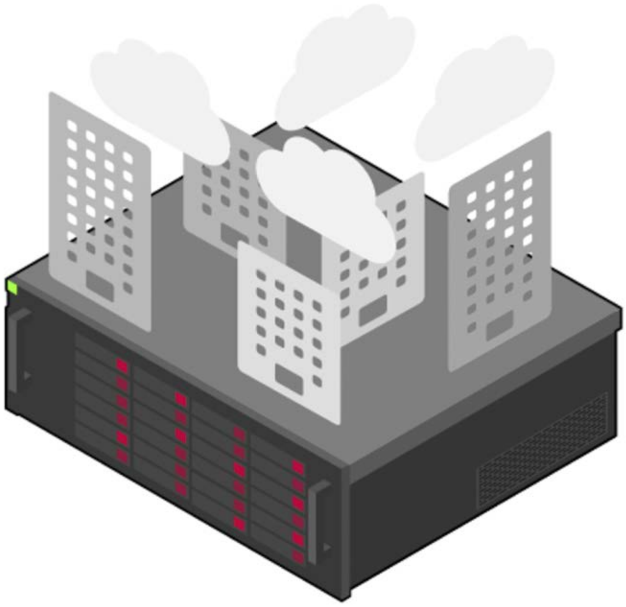
Cooling

Outdoor Temperature
Status of the Building Shell
Ventilation Requirements
Social Behaviour
Wind and Precipitation, etc.

A Complex Situation

All these factors together give rise to a very complex situation. From a one perspective, it's quite easy to understand the connection between the output of the heating system and the building's average temperature. On closer inspection however, it's nearly impossible to predict the chaotic behaviour of a building's indoor climate.

Because of all the factors affecting a building's indoor temperature, even in a building with a well balanced heating system there is always a difference of several degrees between the warmest and coldest areas. You might think that this variation would be handled by the radiator thermostats, but the fact is that they are designed not be affected by these fluctuations. Even a modern thermostat needs to 1.5 - 2 degree difference in the indoor temperature to notice any change. All this creates a lot of noise in the measurement data. However, it is precisely this noise that makes it possible to save energy!



How do we keep track of this complex behaviour?

Noda Smart Heat Building uses sensors to continually measure the indoor temperature, as well as utilizing a mathematical model that predicts the impact of various different scenarios. This combination creates a system that provides an excellent estimation of any building's unique indoor temperature behaviour.

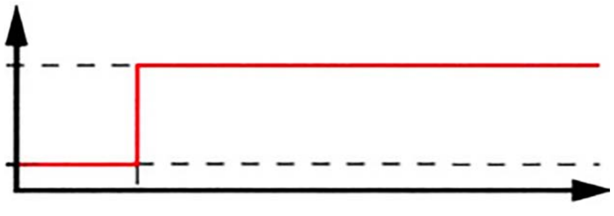
Noda Smart Heat Building employs a self-learning and adaptive model to continuously calculate the energy balance of the property, making it possible to combine several climatic zones within the same building.

How is it possible?

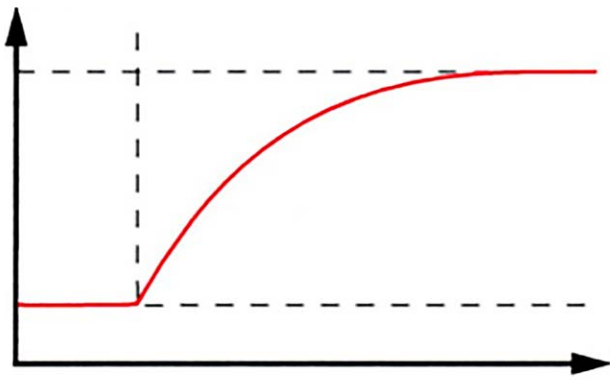
Imagine the following scenario: You are watching the world cup on TV when the power is cut. You're going to react pretty quickly and do something about it, right? Now imagine that the power is cut off from the radiator instead. Eventually you'll notice and probably do something, but the time from realising something has happened to doing somethi8ng about it will take a lot longer.

In the case of the radiator, there is inertia in the process, which means there is a window of time between cause (change in heat output from the radiator) and effect (a person reacting to the temperature change). It is this thermal inertia, in combination with the noise in the indoor temperature, which enables the system to save energy.

Our smart system exploits this thermal inertia by making small unnoticed temperature changes, while keeping these changes "hidden" in the building's indoor temperature noise. By adding all these small changes together over time, significant energy savings are created.



Orsak – förändring av värmeeffekten



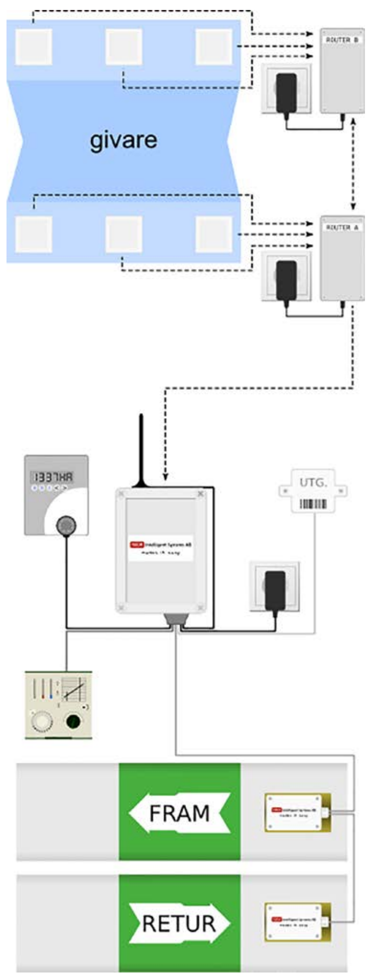
Verkan – förändring av inomhustemperatur

Noda Smart Heat Building – hardware

The system uses an indoor room sensor that continuously measures the indoor temperature and humidity. On top of this, the system also takes the substation into account. The substation measures both the primary heating circuit (district heating network) and the secondary heating circuit (the building itself).

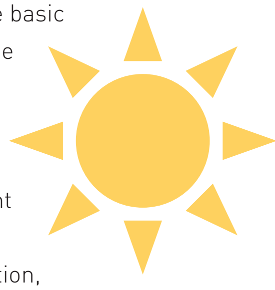
The system uses an outdoor sensor to manage the existing control system. This means there is no need for expensive alterations or replacement because the system uses what is already available on the spot.

Where different levels of complexity exist, **Noda Smart Heat Building**-system can also be connected directly to the existing control system using 0-10V.

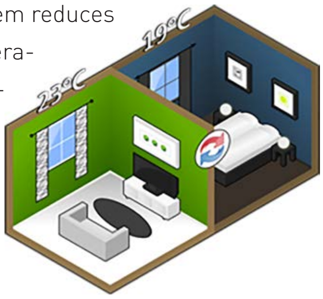


Noda Smart Heat Building – Software

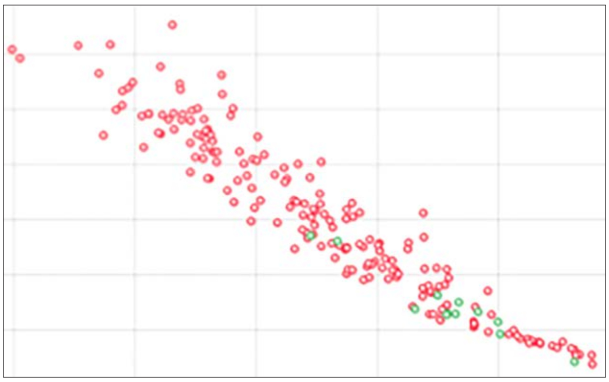
The overall software architecture is based on a modular design where several types of control methodologies coexist. The system uses three basic components to save energy: the heating system, the indoor environment and the outdoor environment. Outdoor climate – the system takes into account weather forecasts and uses "free" energy from solar radiation, which is primarily effective during the spring, summer and autumn.



Indoor climate – the system reduces unnecessarily high temperatures, evens out temperature variations and divides the building into specific temperature zones.



The heating system – the system ensures that unnecessary power peaks are avoided and works with adaptive and predictive models of energy use. The system also coordinates energy consumption with the actual thermal demand.



Noda Smart Heat Building – People

The foundation of **Noda Smart Heat Building** is the intelligent automation system, but in addition we also use real people as part of the service. Each installation is continuously monitored by energy experts at Noda.

This is done to ensure full functionality of the system and to maximize energy savings in each individual property.

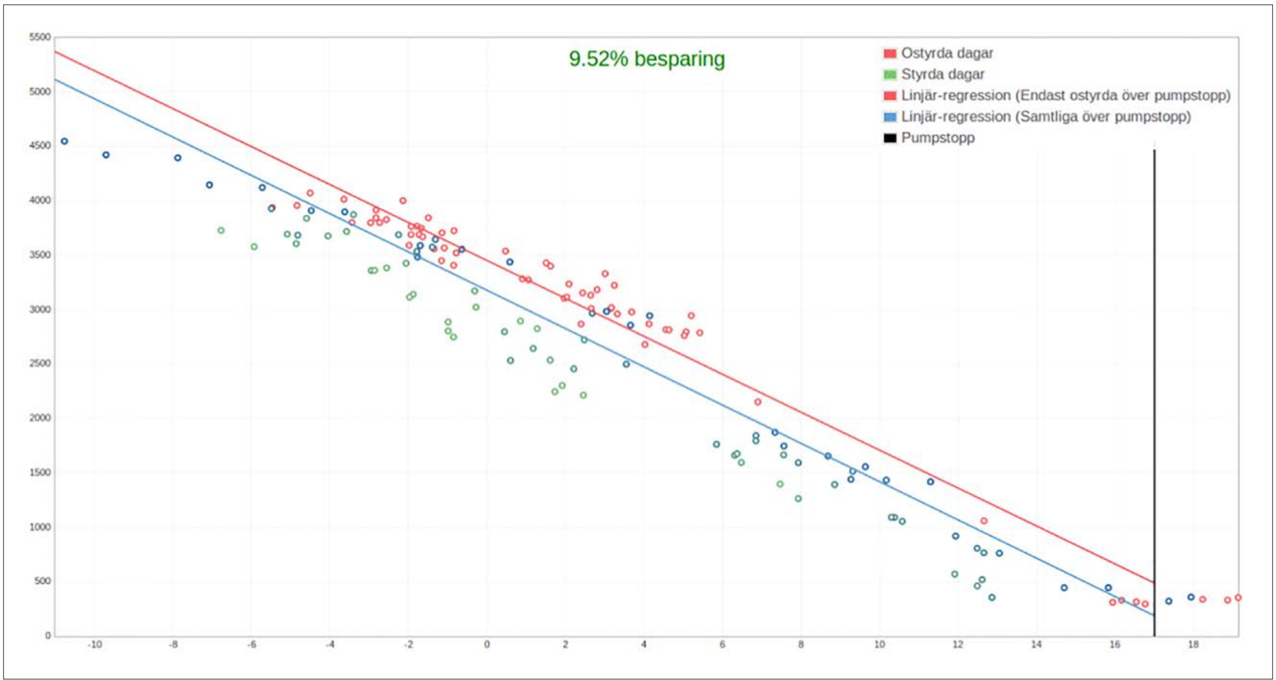
Noda's customer centre interprets and analyzes operational data to support you in your ongoing work with a building's heating system. Noda continuously monitors and delivers an annual report outlining seasonal energy savings and explaining how the system works.

How do we calculate the energy savings?

Accurately calculating the full extent of the energy savings not only allows a complete analysis of the initial investment, but it's also an invaluable tool in the continuous effort to increase the energy efficiency of a building. Naturally this is not as simple as merely comparing heating bills from one year to the next.

Fluctuating weather, changes in the way people use the building and the combination of temperature dependant and non-temperature dependant heat load (heating and tap-water respectively), make it hard to evaluate energy savings. There are several different ways to do this, but the most mathematically sound is an energy signature analysis.

An energy signature analysis allows us to build an energy balance based on actual billing data. It is also not necessary to separate out non-temperature dependent heat load because this is done automatically. This requires no manipulation of data – the savings are plainly evident.



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