aranet

WIRELESS TEMPERATURE MONITORING FOR ENERGY EFFICIENCY OPTIMIZATION

A PROJECT WITH **LEANHEAT BY DANFOSS** AND **OPTIWISE**

Energy efficiency is not only a reduction of the energy consumed. It also implies achieving an equal result with lower consumption. Besides the heat energy savings, the quality of indoor climate is important, too. Unfortunately, it is often achieved by increasing energy use.

A major challenge is to find a solution that would benefit both needs. Therefore in Latvia, the Jelgava City Council as their part of the development of smart urban environment is actively working not only towards improving the energy efficiency, but also ensuring high indoor air quality in the buildings of the city.

Energy management company SIA Optiwise in cooperation with Jelgava City Council performed a pilot project in a school building installing next generation heating control optimization system based on indoor climate feedback using Aranet IoT solutions.

Object

Name of the object:	Jelgava Secondary School No.6
Area of the building:	9 334 m^2
Building plan:	3 stories and a basement

The building is insulated: all of the windows are replaced with new, plastic ones. The building has a one-pipe heating system with no local room regulation options. Natural ventilation.

Average specific heat energy consumption: 59 kWh/m^2

Challenge

Although the school building is insulated, it has an outdated one-pipe heating system with no local room regulation options. Uneven temperature distribution can be observed, however it is difficult to find a solution for it that doesn't require big investments. Therefore, critical points dictate the temperature levels throughout the building.

The regulation of heating controller parameters in the building is carried out by a third-party supplier without an initiative to improve the situation or conserve energy. People in rooms, the building's thermal inertia, sun and wind are constantly affecting and changing the conditions in the building. However, the ability of the building manager to respond to these changes is limited.

The Jelgava City Council in the context of smart urban development is not only actively supporting the efforts to improve the energy efficiency in buildings, but also ensuring high indoor air quality in them. It is also planned to introduce indoor climate and air quality monitoring systems in school buildings.

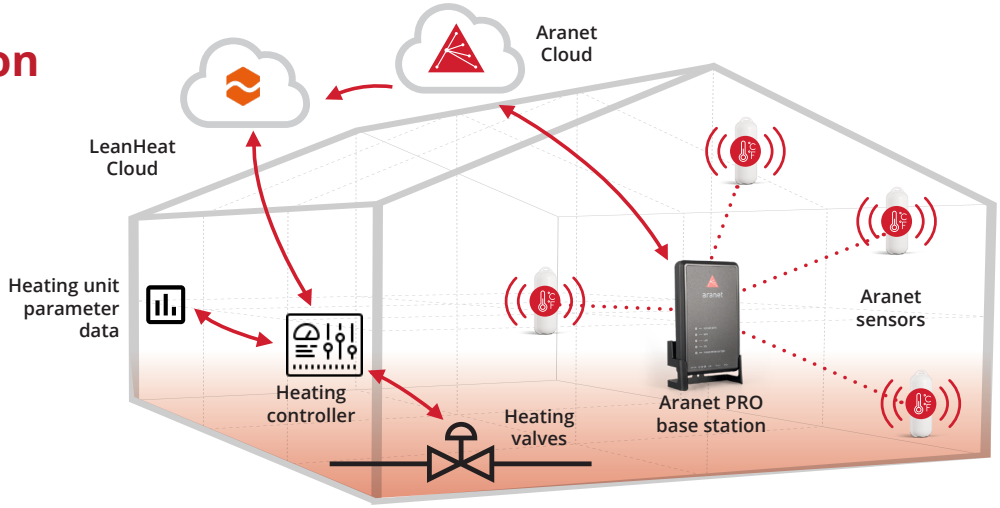
Indoor air quality is a particularly important aspect in teaching institutions, as recent studies show that it has a direct impact on people's cognitive abilities. Poor quality of air in spaces that lack proper ventilation and high concentration of carbon dioxide can potentially impair human cognitive abilities by up to 50%.[1]

There are two main goals:

- Find opportunities to reduce energy consumption using feedback from constantly changing indoor climate and external conditions
- Maintain optimal room temperature while the building is being actively used

[1] https://dash.harvard.edu/bitstream/handle/1/27662232/4892924.pdf?sequence=1

Solution



Automatic heating control system by Leanheat was chosen as a solution. The system operates on a continuous feedback link between the actual indoor situation and the heating unit parameters.

The Leanheat solution uses artificial intelligence to predict, manage and monitor the building's heating system. Data from heating unit is combined with the data from wireless temperature sensors on the premises.

Artificial intelligence processes the obtained data for optimal control of heating in the building, considering the current weather conditions and forecasts for the coming days and building usage schedule.

Setup and configuration were done within **2 business days**. The system in the building has been in operation since December 1, 2019.

65 Aranet wireless temperature and relative humidity sensors were installed in the building, ensuring continuous monitoring in all active-use spaces. A new heating controller ECL 310 was installed in the heating unit. Both the controller and the sensor base station were equipped with a wireless GSM Internet connection.

The main reasons for Optiwise choosing Aranet to implement this project were:

- Extensive wireless network coverage – allowing the entire school building to be covered with only one base station,
- Simple setup – does not require additional resources and time,
- Easy maintenance – the only requirement is replacing the battery once every seven years,
- Aranet Cloud service – allowing the system to be easily integrated into Leanheat software.

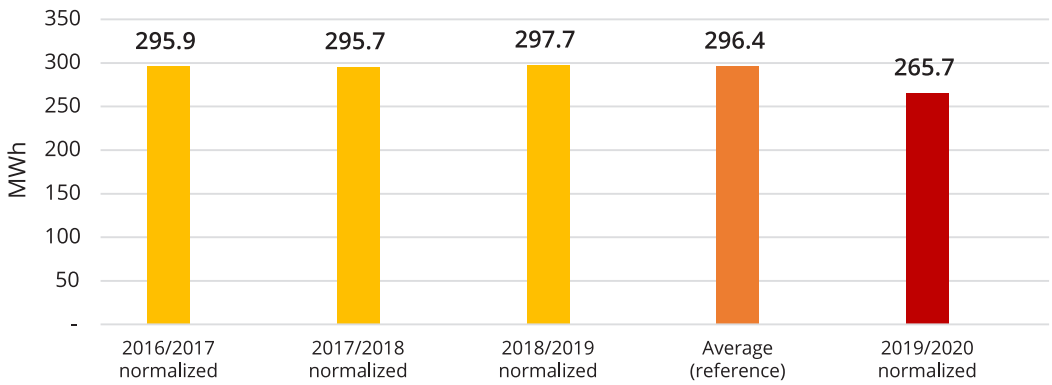
Results

In order to assess the improvements, a reference point was first established for both the thermal energy consumption and the average indoor temperature.

For reference, historical 3-year average heat consumption was used. In order to assess the impact of historical and future climate, climate normalization was used: i.e., it was determined how much energy the building would consume under equal climate conditions each year using degree days.

Throughout November the temperature was monitored in the building. Measurements were performed during the heating season for 4 weeks without the new control system in place to determine the average reference temperature in the building. At the same time, system's machine-learning algorithm adapted to the unique conditions in the building.

Weather normalized heating energy consumption comparison (Dec 1st - Mar 1st)



The new control system was launched on December 1st and it was aimed towards maintaining the selected average temperature of the rooms as stable as possible during the active-use time. After 3 months of operation, the data showed **30,7 MWh or 10,4 % of reduction in thermal energy consumption compared to reference**. Based on the average outdoor air temperature of these months, **absolute energy savings reached 26,2 MWh**. It should be noted that since the 2nd week of January the schedule for active-use period of the school building changed from 7:00-14:00 to 7:00-17:30. If the previous schedule of active-use didn't change, the estimated savings would be even higher.

During this time, the underlying principle of using room temperature for controlling heating reached an average of **48,0 % savings** compared to the reference. This is significantly higher than heating energy consumption reduction during the same period in similar buildings where heating system control is based on setpoint, not actual temperature in the rooms, and thus lead to compensating internal heat gain loss (from people, equipment, lights etc.) Second half of the March and April the data was not used in comparison, as this would not reflect the same conditions as compared to the previous years due to the emergency situation and quarantine.

Conclusion

Introduction of the Leanheat system achieved the main objective of reducing energy consumption and achieving a maximum cost reduction without any additional investments from the school, optimizing the functions of the existing heating system.

In addition, the new system ensures:

- Energy and overall financial savings,
- Indoor climate monitoring system at the cost of energy saved during the process,
- Identification of strategic heating system upgrades needed to improve unevenness of the heat distribution systems (helping to determine the best strategy for heat balancer placement in the future),
- Potential for CO_2 monitoring in the future.

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