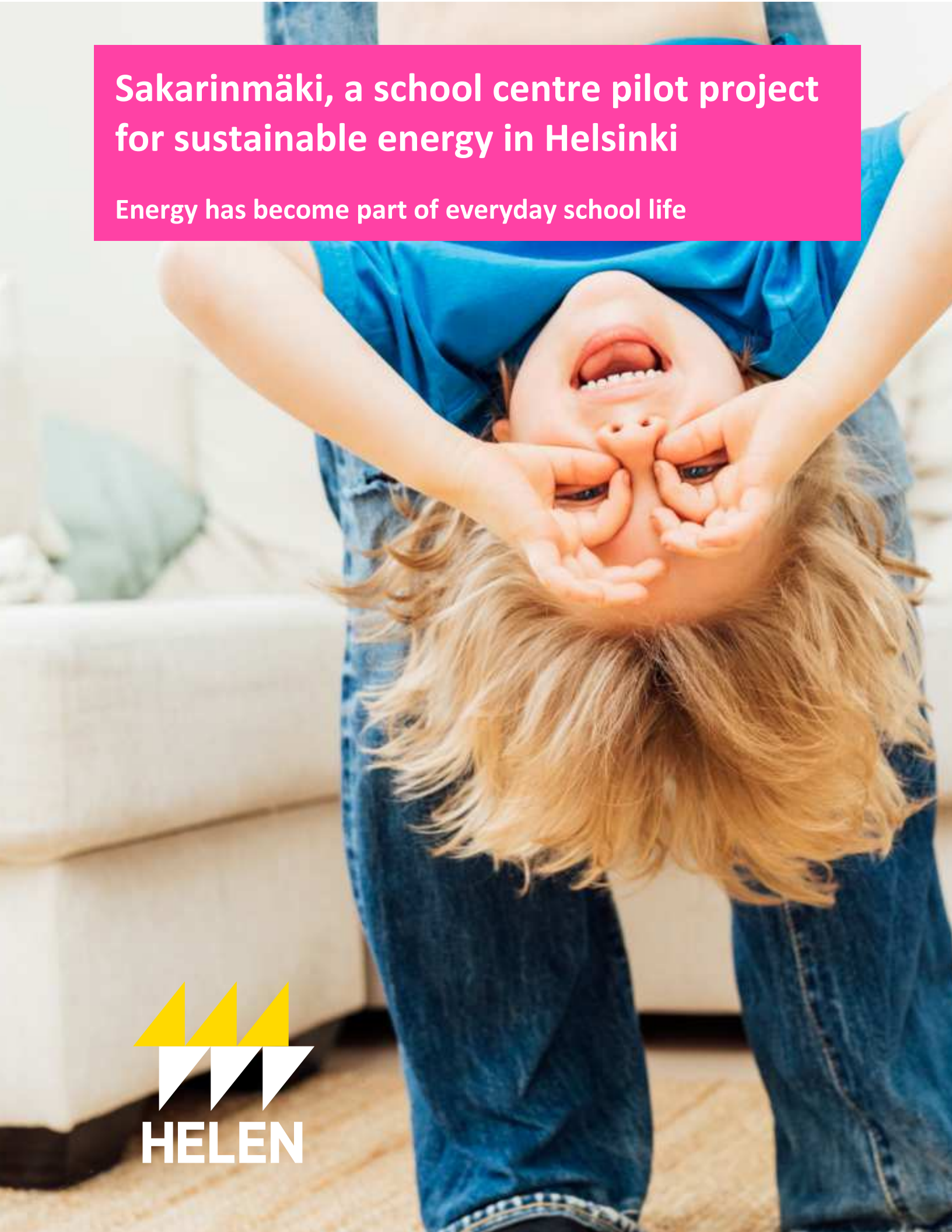
Sakarinmäki, a school centre pilot project for sustainable energy in Helsinki

Energy has become part of everyday school life



HELEN

Summary

Our entry for the 2017 Global District Energy Climate Awards in Out of the Box category is a locally, communally and educationally significant decentralised hybrid heating solution based on renewable energy. Three years ago, we upgraded the heating system of the Sakarinmäki School Centre, which is located in the district of Östersundom in Helsinki, Finland. As a result of the heating upgrade, we also initiated and involved the pupils and teachers in renewable heat production and consumption. There is now a wealth of interesting experiences and extensive knowledge available with regard to the construction and use of the pilot site and participation in the project.

The Östersundom area is being built into an internationally significant Nordic piloting area for a sustainable lifestyle and innovations, as well as an attractive location for cleantech companies. Ecological aspects have been taken into account in the planning of the area from the master plan to the town plan stage. Only zero energy buildings will be constructed in the area. Climate impacts are also accounted for in the community's energy production: a site for a hybrid power has been reserved. Moreover, the use of construction elements equipped with solar collectors or solar panels has also been envisaged for Östersundom.

The Sakarinmäki School Centre is located in an area of rural nature in Östersundom, which was recently annexed to Helsinki. For the time being, there is no district heating network in the area. Helen replaced the heating system of the school centre based on fossil fuel oil with a decentralised and renewable energy solution. The entity consists of a ground source heating system, solar heat collectors, a bio oil boiler, and a heat storage. The diverse entity is utilised in the heating of the school premises and hot tap water through efficient and flexible production and storage of heat. Heat is transferred to the school premises on the principle of low-temperature district heating. The hybrid system piloted at Sakarinmäki is perfectly suited for an energy solution in large properties, such as schools and hospitals, especially when an energy company wants to expand its energy services to totally new areas with no district heating network, which is popular in a dense urban structure.

The new heating system was introduced in October 2014, and it has already exceeded expectations in its first years of operation. Ground source heat pumps and solar heat collectors produce about 85 per cent of the annual heating energy needed by the school centre. Oil consumption has fallen by as much as 100,000 litres per year as a result of the new heating system. Currently, the annual bio oil consumption totals only about 18,000 litres.

The use of bio oil has increased the share of renewable energy to one hundred per cent. As a result of the ground source heat pump operated by wind power, the carbon dioxide emissions of the heating system have fallen to zero despite the fact that the cubic volume of buildings at the school centre has increased by over 40 per cent on the original volume due to the extension built at the same time. The new solution is also more economically advantageous than the old one.

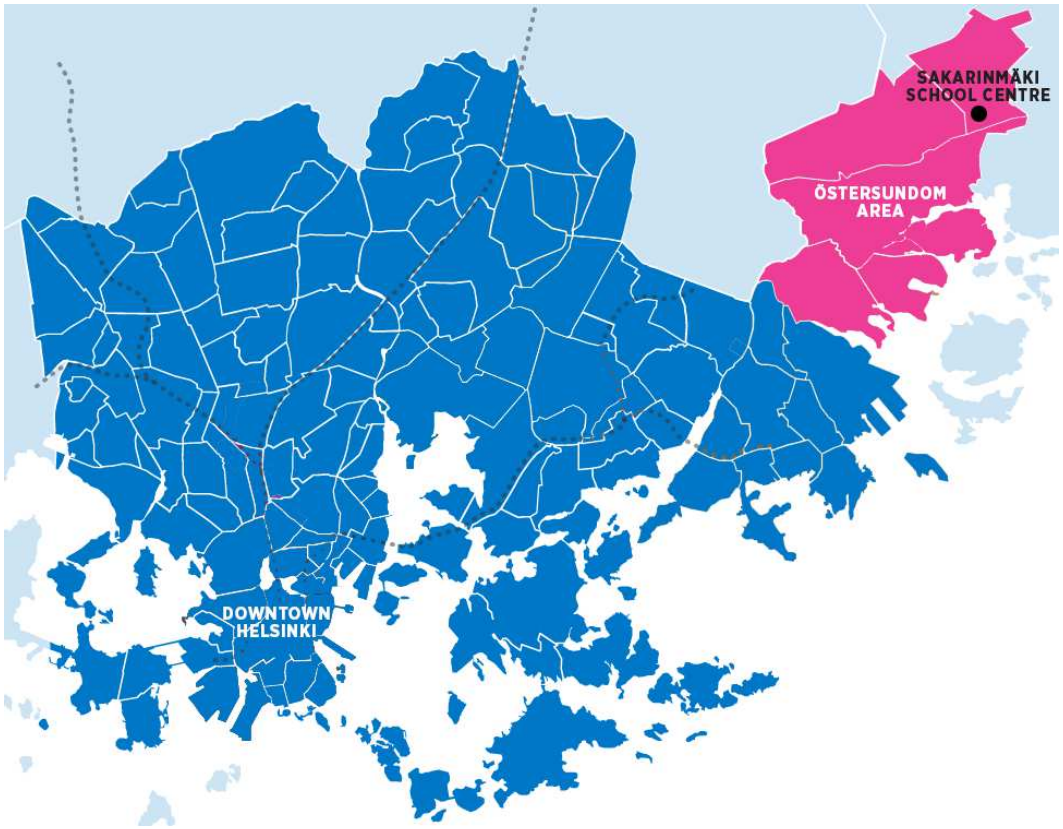
What makes our Sakarinmäki project particularly special is that the main users of the building – the pupils and teachers – have been involved in the project from the word go. We have joined forces to bring renewable energy into the everyday life of the school and curriculum. Sensible energy use and energy awareness are active topics of conversation during the school year.

"The TV screen in the school canteen shows heating consumption and solutions used for producing the heating energy needed at any given time," describes eighth-grader **Lauri Saario** in the interview in our customer magazine.

Sakarinmäki school is part of an ecological community of the future

Background to the pilot project

Sakarinmäki is part of the new, rapidly growing area of Östersundom. Homes for up to 70,000 residents and 20,000 workplaces are planned for the area.



In support of the planning and construction of Östersundom, the City of Helsinki and the Finnish Innovation Fund Sitra have drawn up the Smart & Clean vision, according to which the area will undergo smart development based on sustainable lifestyle. The objective is regional resource efficiency based on a circular economy, providing opportunities for companies to utilise the derived currents of their own main processes and those of other companies. At the same time, a concept supporting environmental research, training and business innovation is also being developed for the area.

One of the main themes of the smart and clean vision is renewable energy. The pockets of new construction areas have been selected as the basis for energy solutions in Östersundom. District heat distribution is planned and implemented as separate satellite networks.

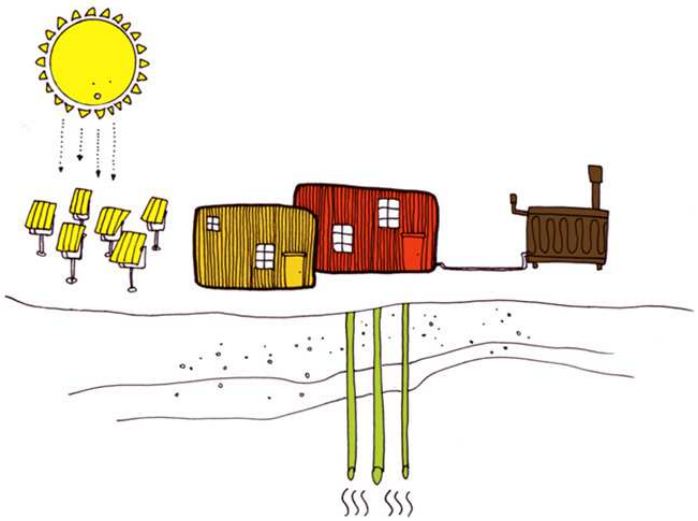
The Sakarinmäki School Centre is the first building entity of the new Östersundom. It is a learning environment for almost 800 children and young people. The pilot project for local renewable energy implemented at the school centre puts into practice the envisaged energy future in an excellent way, offering new kinds of district heating solutions. The concept can be replicated in other residential areas and connected to an expanding district heating system at a later date.

Sakarinmäki School Centre in winter.

What makes the pilot project unique is the engagement of the local community in renewable energy solutions as part of a sustainable lifestyle. Due to the multidimensionality of the project, this time we are taking part in the competition in the Out of the Box category. This also emphasises our desire to respond to the growing shift taking place in the customer interface and the resulting change in the customers' needs.

From the very beginning, the schoolchildren and teachers have taken an active part in the planning of utilising the energy solution of a new era in everyday learning. We have carried on ground-breaking cooperation with the end users of energy, created new operating models for introducing energy issues in school lessons and translated words into action. Our cooperation continues, and the energy solutions of the school centre will be added by local solutions related to energy production in the future.

In 2015, our combined district heating and cooling solution won first prize in the Expansion category of the Global District Energy Climate Awards. We gained recognition for our energy-efficient solutions that utilise the dense urban structure and improve the quality of life among residents. The district cooling system in Helsinki, a system that is among the largest in Europe, enables large-scale utilisation of surplus energy of properties and local renewable energy. The innovative combination of district heat and district cooling and the recycling of waste energies are a tremendous success story. In Sakarinmäki, too, the use of renewable local energy and the recovery of surplus heat are our key targets, and they show that we want to offer energy partnerships also in areas not yet covered by our solutions. Over the years, our energy network has expanded from these kinds of smaller satellite sections of the network into one single, larger entity.



Education innovation: cooperation between an energy company and schoolchildren

What is special in the Sakarinmäki heating reform is the close and novel cooperation between the school and the energy company. Indeed, Sakarinmäki has become a national model school and a venue for international visitors. As a result of the cooperation, the model was selected as one of a hundred educational innovations in Finland in the HundrED educational innovation project as part of the centenary of Finland's independence. The knowledge and experience produced by the innovations are available for teachers throughout the world.

At Sakarinmäki, energy issues are an integral part of teaching. The pupils have become acquainted with, for example, heat consumption in different seasons and the operating principles of various heating methods, and they have studied spreadsheet and interpretation of statistical data using the energy data of their own school.

"We have used the data on the heating system, for example, in mathematical problems in thermodynamics in physics and in statistical mathematics," explained eighth-grader **Lukas Virtala** in our company's customer magazine in spring 2017.

We launched cooperation with pupils and teachers already well before the construction of the new heating system was started. In autumn 2012, the pupils gathered in workshops to discuss how the heating need varies according to seasons and where the energy needed for heating can be obtained from. This project attracted a lot of publicity, e.g. in the national news.

In the workshops, children learned about the impact of seasonal variation on heat consumption and local production forms.

In spring 2013, we planned the integration of energy issues in the school's curriculum together with the teachers. The planning work produced a package of support material that the teachers can use during lessons.

Real-time heat production data is shown on two monitors at the school, and the data can also be downloaded from our company website. The screens bring heat production as part of the school's everyday life in a natural way. On the screens, one can monitor how consumption increases in the winter when the temperature drops. We designed the monitors together with the pupils to ensure that they are easy to understand and interesting from a child's point of view.

The solar collectors and geothermal wells located in the schoolyard are equipped with information signs, and the solutions have been demonstrated to the school's pupils. The curriculum supports regular teaching of energy issues by means of phenomenon-based learning used in Finland, going beyond subject boundaries. Youngest students measure indoor and outdoor temperatures and keep a record of the number of sunny days. Also, they study weather forecasts and watch how strong climatic variations impact on heat consumption.

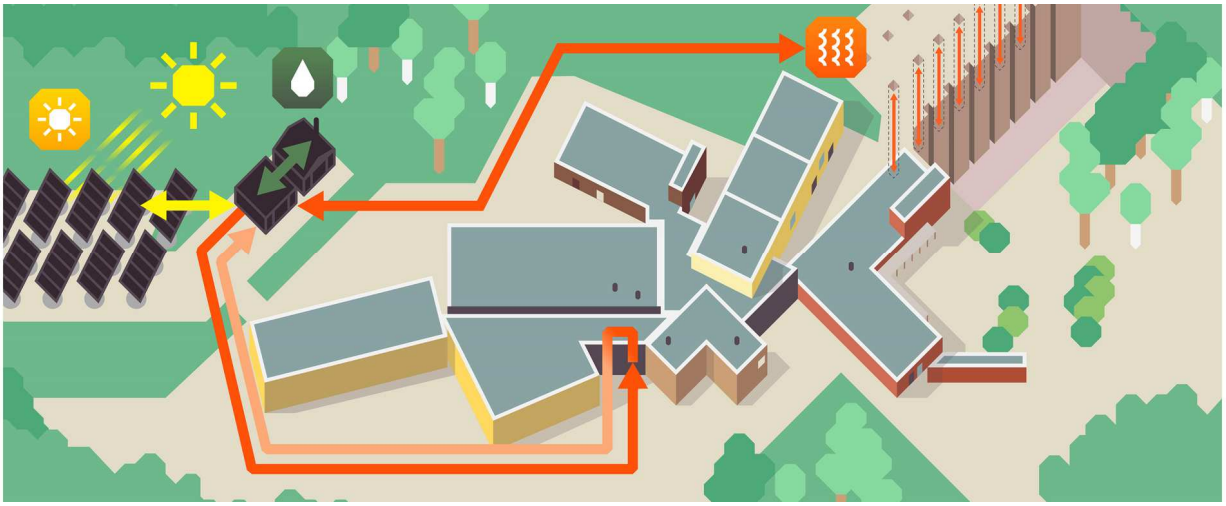
The solar collectors in the schoolyard in Sakarinmäki.

Older pupils learn how the energy obtained from the geothermal wells and solar collectors heats the school, and analyse the differences between renewable and non-renewable energy production methods and the advantages and disadvantages of various heating methods. In the upper grades, the pupils' understanding of energy issues develops further. Older pupils build a circuit of tasks for younger ones around the solar collectors and ground source heat pipes and utilise the actual production data in the STEM classes.

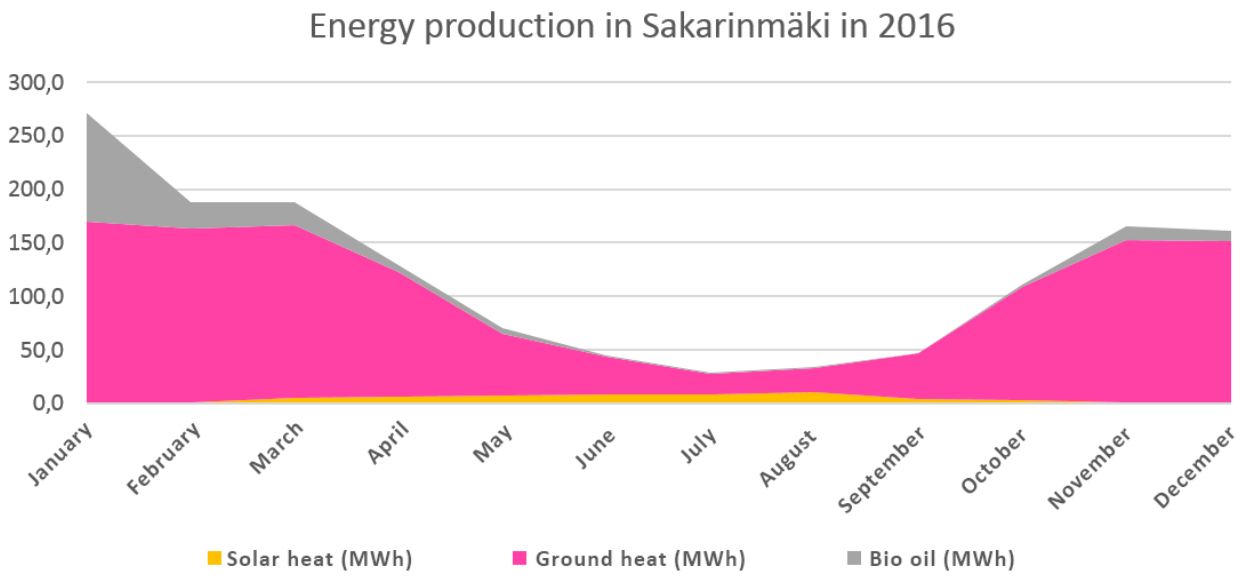
Renewable decentralised hybrid heating solution

Project description and technical implementation

The energy solution at Sakarinmäki is a diverse combination of heat production methods that support one another. The solution strongly utilises local, renewable energy sources. Previously, the school was heated with light fuel oil only.



The heating system is built on four pillars: ground source heat, solar heat, a bio-oil fired heating plant and heat storage. Therefore, the decentralised heating system in Sakarinmäki can be called a hybrid system. The heat is transferred into the school premises with a water-circulated heat distribution system.



Sakarinmäki has 16 solar collectors, and the energy recovered by them is used for heating the tap water of the school. The collectors also produce hot water for heat pumps to achieve higher efficiency. The total area of the collectors is 160 square metres and their thermal output is 150 kW. Surplus solar energy obtained in the summertime is stored in hot-water tanks or in the ground for later use.

The majority of heating and all of cooling are managed with heat pumps. A total of 21 geothermal wells, connected to a heat pump with electric output of 280 kW, have been dug under the sports ground of the school. They are holes bored to a depth of 300 metres with a pipe inside them. Non-freezing bioethanol circulates in the pipes, collecting thermal energy from the ground surrounding the bore holes.

In the coldest winter months when even the southernmost part of Finland is covered with snow and ice and there is very little sunlight, a bio-oil fired heating plant is needed in support of heating. The thermal power of the plant is 1,200 kW, which meets the heating need even during the coldest spells.

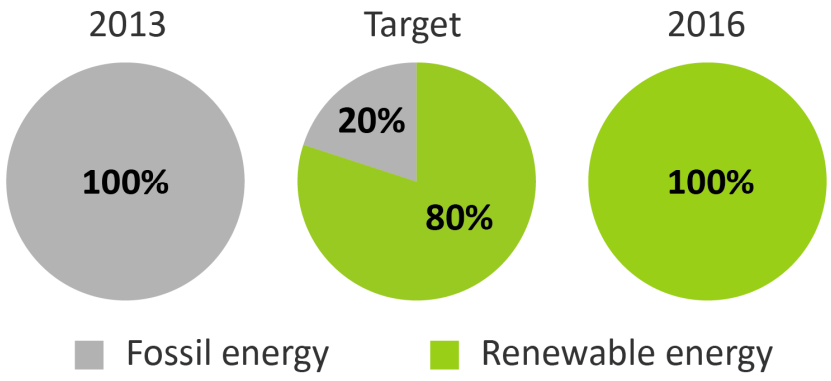
The scalability and integrability were taken into account already in the planning of the heating system. It is possible to integrate the system into the expanding district heating network of the community of Östersundom in the future. The solution can also be easily copied for similar new areas.

Significant reduction in emissions

Achieving energy-efficiency and environmental targets

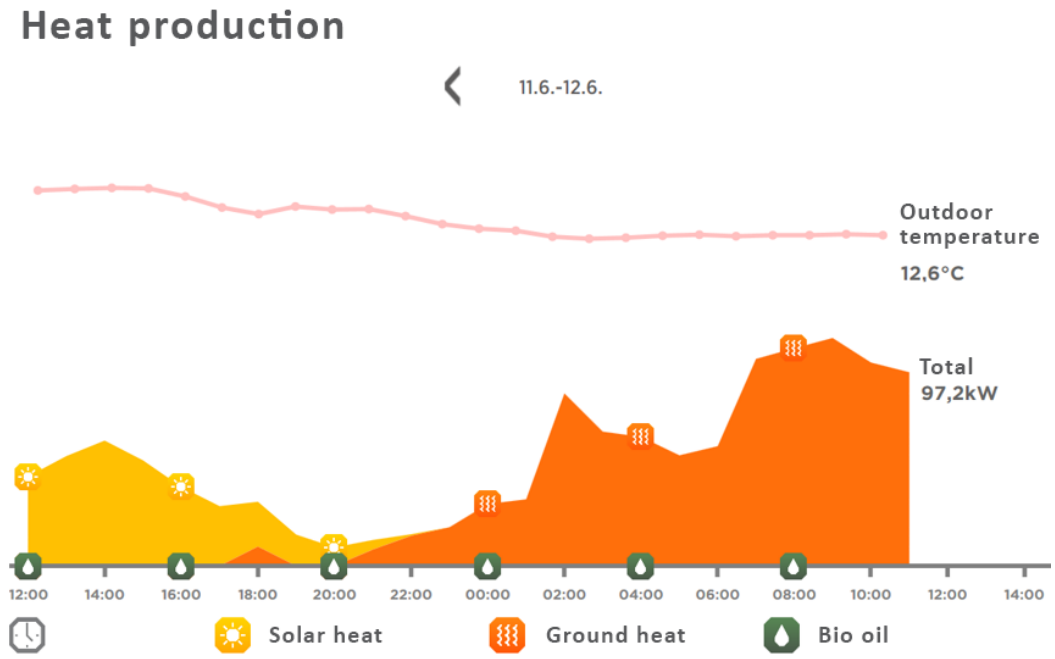
When planning the Sakarinmäki heating system, we set as a target that 80 per cent of the heating energy needed at the school will be produced with renewable energy. Another target was a 100 per cent security of supply, which is extremely important in the northern conditions.

After two full years of operation it can be said that we have indeed exceeded the set targets. Already during the first full year of operation in 2015, the school was heated with completely renewable energy. In 2016, ground source heat accounted for 83 per cent and solar heat 4 per cent. The fact that bio-oil was substituted for fossil fuel oil in the heating plant increased the share of renewable energy to one hundred per cent.



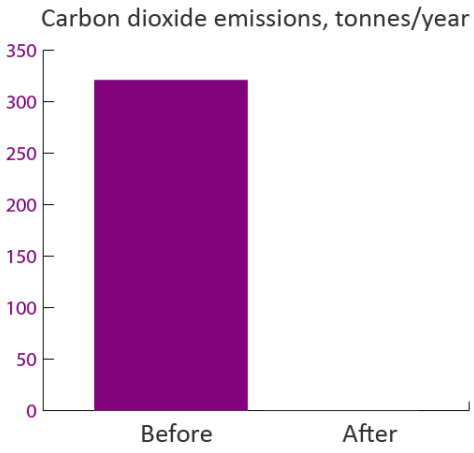
The utilisation of solar energy will increase once the school premises will be taken into active use also during weekends and school holidays. Currently, some of the solar energy is stored into geothermal wells. The system also utilises low-temperature solar heat; the thermal fluid circuit is heated with solar heat whenever the temperature of the solar collectors is higher than the temperature of the collecting loop. This arrangement improves the efficiency of the entire system.

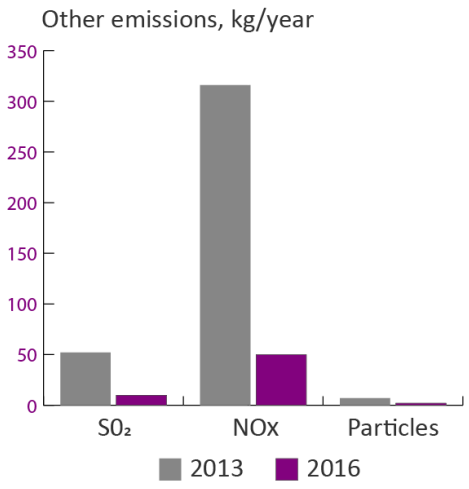
We have also invested in energy efficiency. At Sakarinmäki, heat supply is implemented on the principle of fourth-generation low-temperature district heating. This corresponds to more energy-efficient heat distribution than normal. In low temperature district heating networks, the temperature of supply water is 65–75 degrees Celsius instead of the usual 70–115 degrees. The lower temperature of the water reduces heat losses in the district heating network and improves the energy efficiency of heat distribution. In addition to the efficient production and distribution of heat, the building has been constructed according to the Finnish energy efficiency regulations, which are advanced compared to regulation used even in European countries.



In the summer, a significant proportion of heat in the school comes from the sun.

Before the heating system reform, about 15 tank trucks full of light fuel oil were needed each year. As a result of the introduction of renewable energy, the use of fossil oil needed for heating ceased completely. At the same time, the carbon dioxide emissions fell to zero. Emissions having an impact on air quality also reduced to a significant extent.





Additional information

The Sakarinmäki School Centre hosts a comprehensive school covering grades 1 to 9 as well as nursery school, a library and some leisure time activities. The school has about 550 pupils and the nursery school has places for 126 children.

A multifunctional School Centre adapts to changing needs. Ecological materials were used in the construction of the school. The main construction material is wood, which has maximum carbon dioxide efficiency. The walls have wood cladding and, for example, the pillars in the indoor areas resemble living trees.

The school building was completed in 2005 and the extension in 2014. The original area was 5,800 square metres, increasing to 8,250 square metres after the extension was completed. As a result of the extension, the volume, which is even more significant than the area in terms of the heating need, increased over 40 per cent.

In Finland, and also in Östersundom, the weather conditions vary a great deal according to seasons. The outdoor temperature can drop to almost -30 degrees Celsius on the coldest winter days, while in the middle of the summer the temperature may be as high as +30 degrees. Over the past ten years, the average temperature in the coldest month of the year (January) has been about -5 degrees Celsius and that of the warmest month (July) about +19 degrees.

Helen Ltd is and one of the largest energy utilities in Finland. Helen's energy production is awarded as the most efficient in the world. The company has almost 400,000 customers throughout Finland. Helen produces district heat covering over 90% of Helsinki's heating needs and is expanding energy-efficient district cooling in Helsinki. Helen aims to achieve 100% carbon neutrality in its energy production.