Making progress in energy efficiency with EU funding

Final summary of and lessons learned from Heka's HELENA project 2020–2024

Helsinki

Heka

Contents

Energy efficiency supports reasonably priced housing

Thanks to funding granted by the European Investment Bank, Heka was able to improve the cost efficiency of its energy efficiency investments and thus secure reasonably priced housing.

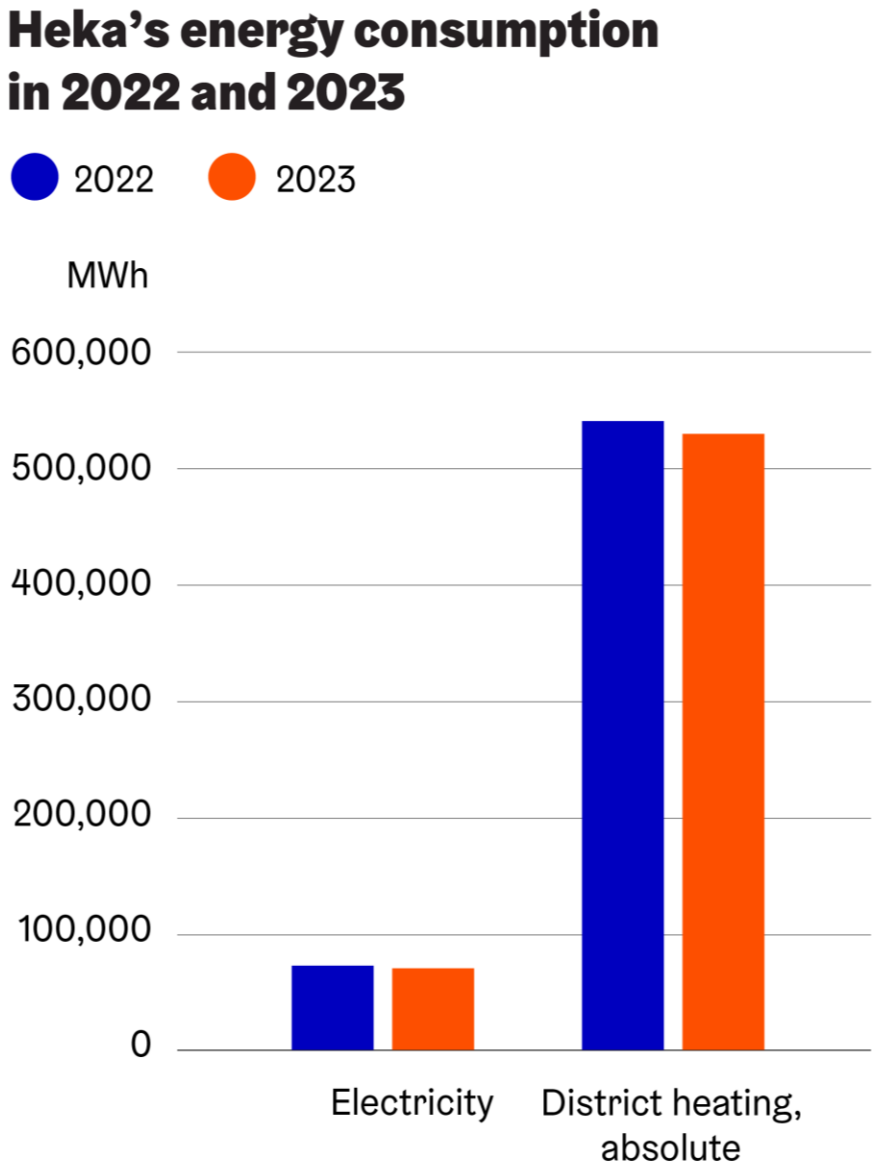
Value for investment money

Heka became the first Finnish organisation to receive ELENA funding from the EU. The HELENA project arose from this funding.

The funding application process was a significant effort, which enabled the HELENA project to bring new tools for energy efficiency work to Heka. We used the 1.8 million euros of funding to establish ways to improve energy efficiency in our renovation projects.

During Helena project Heka invested 66 million euros to energy efficiency in renovation projects. These investments enabled Heka to achieve a total of 8.9 GWh in annual energy savings.

Heka is a significant energy consumer (roughly 600 GWh/a), and energy is a significant expense for Heka. The project gave us permanent tools for energy efficiency work and thus supported our goal of reducing emissions and energy costs. This also contributes to Heka's most important goal: reasonably priced housing.

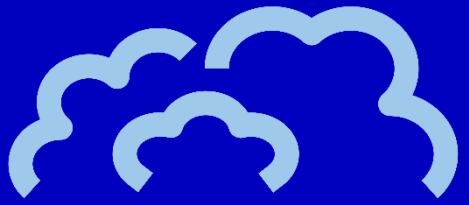


6 facts about Heka

A company wholly owned by the City of Helsinki that operates according to a cost recovery principle.

Nearly
100,000
tenants

Roughly every seventh
Helsinki resident is a Heka tenant



Roughly 54,000
rental apartments in Helsinki

More than 560
rental building locations

Roughly 670
employees (including in-house maintenance and cleaning)

Heka uses roughly
7%
of the district heating produced by Helen

What was the HELENA project?

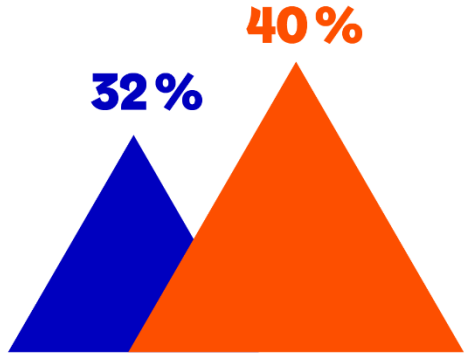
We worked towards lowering the lifecycle costs of energy investments particularly through Multi-Objective Building Performance Optimisations and an innovation programme, in addition to which we examined the suitability of the ‘energy as a service’ model for Heka.

Optimising efficiency

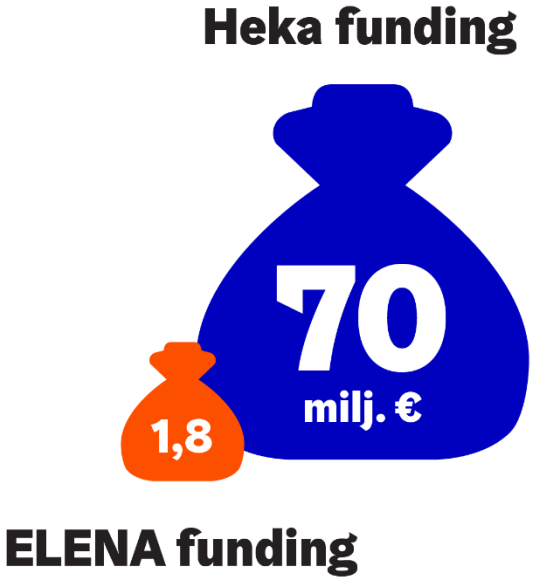
The HELENA project entailed increasing the number of energy efficiency investments with profitable lifecycle costs in Heka's renovation projects.

A key tool in the project was the use of Multi-Objective Building Performance Optimisations, which were used to establish the most viable measures in terms of lifecycle costs for buildings to be renovated.

When the multi-objective optimisations yielded proposals for very conventional energy efficiency solutions, an innovation programme was developed for further help. The programme was used to seek new innovations that could be applied in Heka's energy efficiency investments. The project also involved examining the suitability of the 'energy as a service' model for Heka.



The energy efficiency target for renovations was increased to 40 percent in the HELENA project.



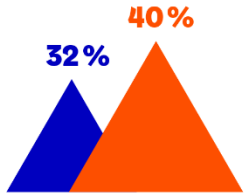
Roughly 1.8 million euros of ELENA funding enabled Heka to invest 70 million euros in energy efficiency in renovation projects.

HELENA in a nutshell

Energy efficiency investments
66 million

Calculated energy savings
8.9 GWh/year = 1.5% of Heka's consumption

Funding
Roughly 1.8 million euros of ELENA funding enabled Heka to invest 70 million euros in energy efficiency in renovation projects.



Energy efficiency goal
The energy efficiency target for renovations was increased to 40 percent in the HELENA project.

Lessons applied
to future renovations

Over 50 multi-objective optimisations (2021–2024)

21 renovations initiated (2021–2024)

New solutions through the **innovation program** with companies (2021–2022)

Project **mid-term roadmap** (2023)

Market dialogue on **energy as a service** (2024)

HELENA-hanke

Multi-objective optimisations – what is it and what is it for?

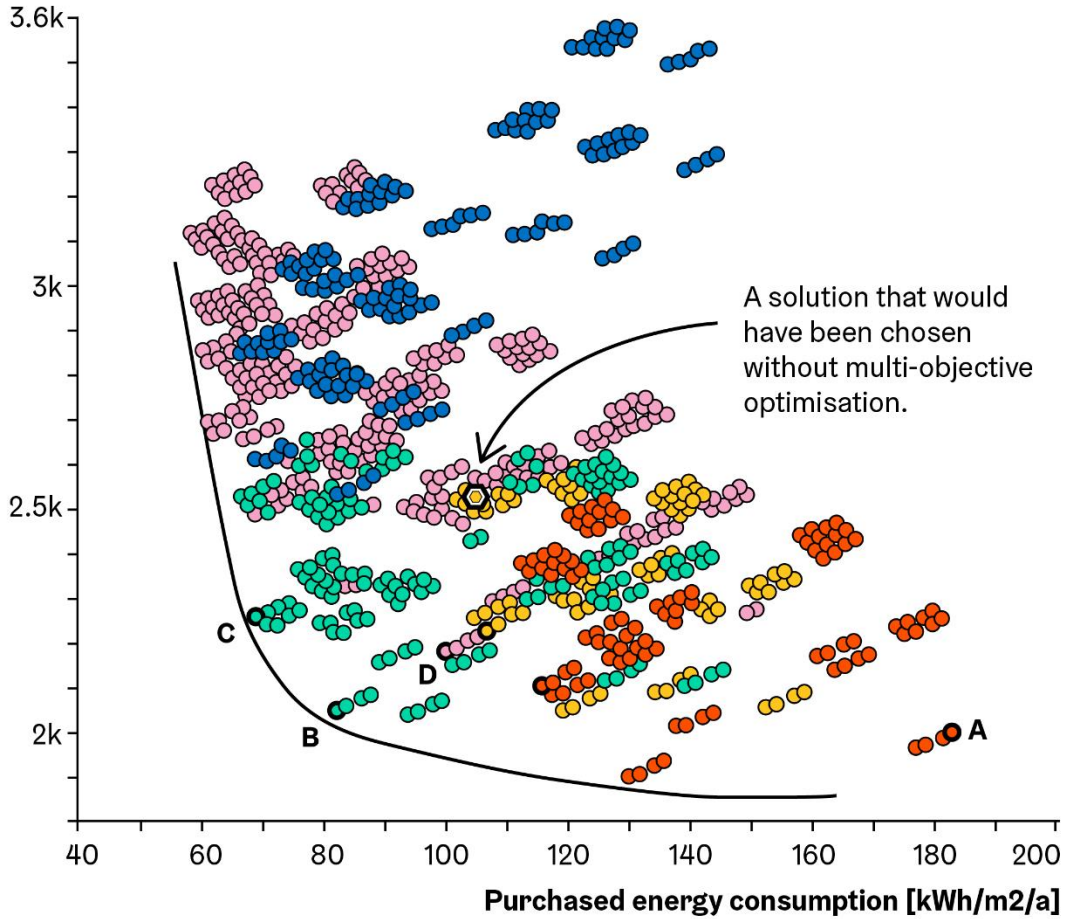
What is multi-objective optimisation?

Multi-objective optimisation is a tool that facilitates comparing objectives efficiently even if they are in conflict with each other.

The goal of multi-objective optimisation is to answer the following question: What solution is the most optimal with our goals taken into account? The objective of the HELENA project was to optimise lifecycle costs.

Finding the best combination from among numerous options is arduous if not impossible with conventional methods. The optimisation algorithm facilitates comparing thousands of alternatives quickly.

The optimisation process involves comparing the situation with the current state or a desired reference situation. The comparison can also take into account measures that will be carried out in any case in the renovation project.



Phases of the multi-objective optimisation process

1. Creating a 3D energy model of the building.
2. Optimisation by utilising the MOBO (Multi-Objective Building Performance Optimization) tool developed by Aalto University and VTT: the process involves choosing which aspects are to be optimised (e.g. lifecycle costs, usage costs or emissions) -> Heka chose to optimise lifecycle costs.
3. Calculating all possible measure combinations.
4. Selecting the most optimal set of measures from among all the solutions with the goals set taken into account.

Multi-objective optimisation in the HELENA project

The HELENA project involved carrying out more than 50 multi-objective optimisations. The companies carrying out the optimisation processes were Granlund, Sweco and A-insinöörit. For comparison, analyses were also carried out with the calculation model created by nollaE. The optimisation processes used 25 years as the lifecycle cost calculation period. The factors being optimised were the lifecycle cost and the investment cost. The carbon footprint of the measures was also calculated.

The aim was to base the optimisation premiss on Heka's actual electricity and district heating costs. For both, the reference rate was that the price would increase by two per cent per year. The prices varied by report, as reports were created in different years. During the project, prices also changed rapidly, and it was discovered that sensitivity analyses were an important part of the optimisation processes. Four per cent was used as the reference rate.

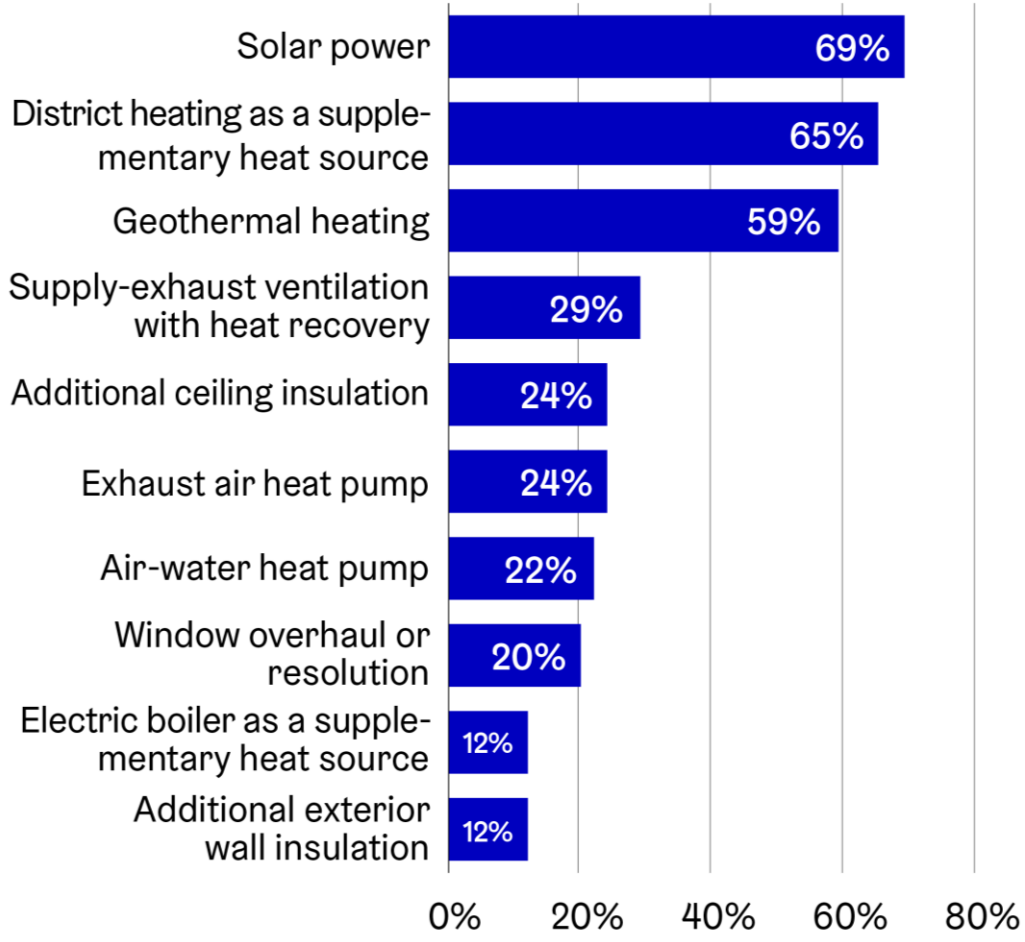
Some of the optimisation processes took the 40% energy savings objective of the project into account, whereby only measure combinations exceeding this target were considered.

The most typical multi-objective optimisation results

In the optimisation processes carried out in the HELENA project, solar power was clearly the most common measure proposal, and it was proposed for 70% of the measure combinations with the lowest lifecycle costs. Geothermal heating was proposed for nearly 60% of the buildings and various heat pumps for more than 80%. The most commonly proposed additional heat source to accompany a heat pump was district heating.

The investment costs ranged from 150,000 to more than two million euros. The average investment cost was 564,000 euros.

The measures that were included in the optimisation proposal with the lowest lifecycle costs:

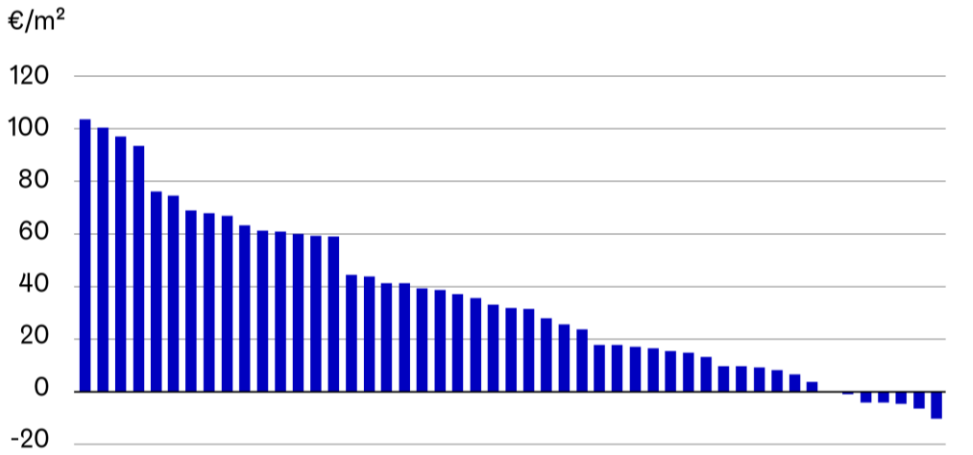


Source: 49 multi-objective optimisations

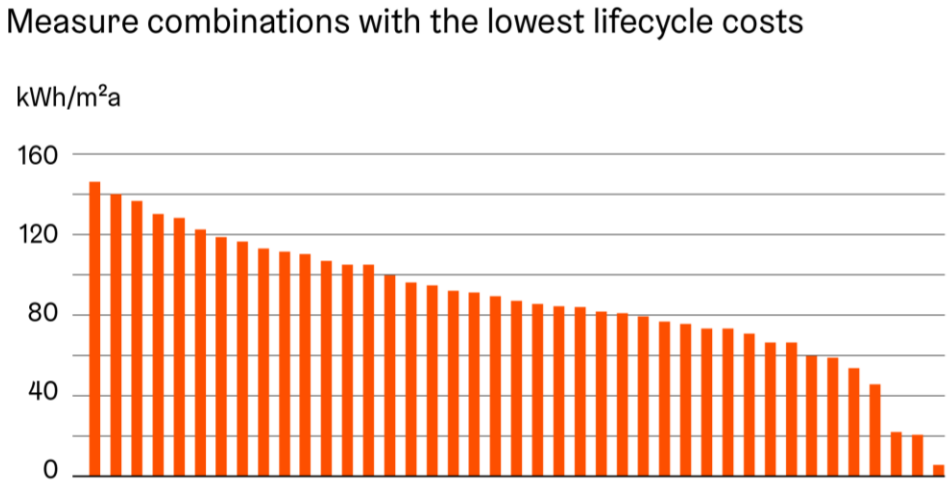
Profitability of the proposed measure combinations

Profitable measure combinations were found in the majority of the multi-objective optimisations. For seven buildings, even the lowest specific lifecycle cost was negative, which meant that the lifecycle cost would rise in relation to the comparison situation. Purchased energy consumption decreased in all optimisation processes in which the change in consumption was stated.

Specific lifecycle cost of the measure combinations with the lowest lifecycle costs



Reduction in the purchased energy consumption of the measure combinations with the lowest lifecycle costs



Checklist for procuring multi-objective optimisations

Great care should be taken when procuring a multi-objective optimisations to ensure that the analysis suits the objectives set.

- Agree upon the baseline values accurately and clearly: prices, interest rates, the U values of structures and other calculation references.
- If needed, commission surveys on the baseline information, such as thermal imaging or airtightness measurements.
- Think about what the goal of the project is and which aspect the measures are being optimised for: the lifecycle cost, carbon emission reduction, purchased energy reduction or a certain energy performance index.
- Decide what kinds of energy efficiency measures will be included in the optimisation process. For example, is the aim to utilise some smart solutions in addition to heat pumps and solar energy?
- Make sure that the optimisation process takes into account all renovation measures that will be carried out in any case:
    - For example, the renovation project will in any case involve implementing supply and exhaust ventilation with heat recovery or a window overhaul.
- Think about which aspects should be included in the reports. For example, should they include a breakdown of investment costs by measure or the impact on rent levels?
    - Demanding sensitivity analyses is also recommended. For example, changes in energy prices can be major and significantly affect the optimisation results.

An example of multi-objective optimisation: Salpausseläntie 12, buildings 1 and 2

A large complex with 12 buildings and nearly 400 apartments. Buildings 1 and 2 are tall apartment buildings from the 1970s.

Recommendationts from optimisation

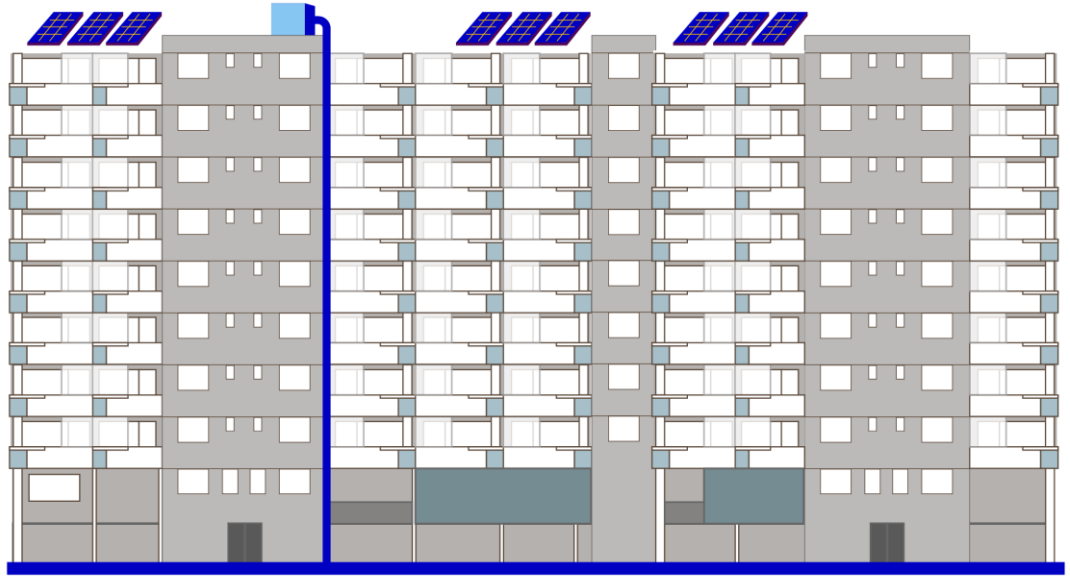
- An exhaust air heat pump 100 kW and district heating as supplementary heat source
- Solar panels 700 m^2

Result

- Purchased energy consumption reduced by 38%
- Carbon dioxide emissions reduced by 28%
- Usage costs reduced by 20%

Limitations

- Sales of electricity were not examined with regards to the solar panels



Salpausseläntie 12, talot 1 ja 2

Pihlajisto

1972	128
Year of construction	Apartments

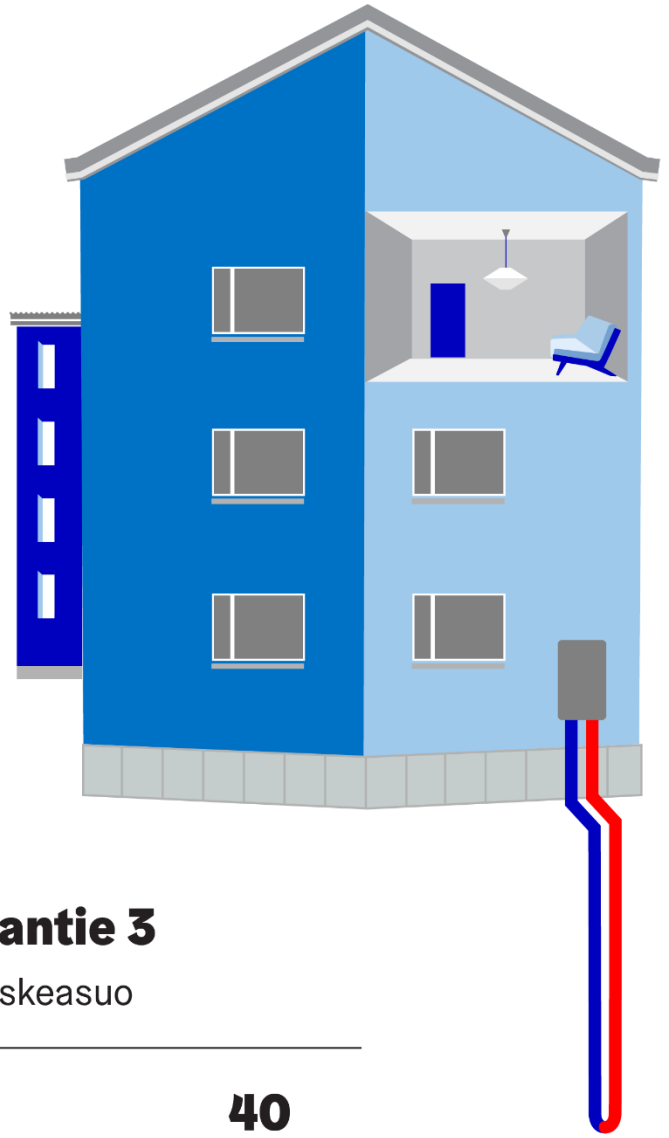
An example of multi-objective optimisation: Tenholantie 3

The location includes two apartment buildings from the 1950s, which have natural ventilation.

Recommendationts from optimisation
- Geothermal heat pump and an electric boiler
- Solar panels

Result
- Purchased energy consumption reduced by 62%
- Carbon dioxide emissions reduced by 63%
- Usage costs reduced by 24%

Limitations
- The building is protected, and panels could not be installed
- There is no room for geothermal wells on the property



Tenholantie 3

Vanha Ruskeasuo

1952
Year of construction

40
Apartments

ABCs of the ‘energy as a service’ model

What is the ‘energy as a service’ model?

In the ‘energy as a service’ model, the service provider makes the energy efficiency investments and installations and handles the maintenance and repairs throughout the contract period. For example, the service provider can install a heat pump into the property and sell heat to the client the same way that district heating is sold. The only difference is that the production takes place on the client’s own property.

The service model can be used to carry out energy efficiency measures with the client potentially not having to make any investments. Furthermore, the client will not have to take care of service and maintenance operations during the agreement period.

The HELENA project involved examining the service model, as making investments was challenging in the difficult economic situation. Heka’s objective was to find a model that would facilitate carrying out energy efficiency measures without making investments and that would achieve cost savings right from the start of the agreement period. The objective was also to ensure that the equipment of the properties would function in an optimal manner.

Clarity from market dialogue

Market dialogue enabled us to understand that Heka must first establish a clear vision regarding what kind of service model would be most suitable. This will make it easier for us to start the procurement process and negotiate the agreement in more detail.

The HELENA project involved having research-oriented market dialogue with nine companies offering an energy service model in the spring of 2024. The market dialogue revealed several significant factors that varied in the different companies' service models.

One of the most important aspects of the service model was the duration of the agreement period, which varied in the offers from six to thirty years. A long agreement period facilitates price reductions during the agreement period, but it also involves risks.

Another significant aspect of the agreement is the pricing model. In the market dialogue, the pricing basis offered was the price of energy alone or a fixed monthly price, as well as combinations of the two with different weightings. The prices were tied to different indexes.

One objective of the dialogue was to identify a model with lower costs than the current ones from the very beginning of the agreement period, without requiring any investments from Heka. Some of the preliminary offers met these criteria, making the service model a viable form of procurement in the future.

Checklist for purchasing energy as a service

Pay attention to at least the following in the procurement process

Pricing and costs

What fees (starting fee, energy fee, fixed monthly fee) are allowed and what can their propotion be?

Indexation of the pricing
- What index is used, and can it also result in a price reduction? Are fixed price increases allowed?

Who will be responsible for procuring electricity for the heat pump and the costs of the potential supplementary district heating?

Mutual warranty requirement regarding the amount of energy:
- The service provider will be able to sell enough energy and cover its costs. The purchaser will receive the guaranteed amount of clean energy.

Other agreement matters

The duration of the agreement period (short → higher energy price; long → lower energy price)

- Redemption prices and terms for different years during the agreement period and after it, and ownership of the system after the end of the agreement period
- Who will be responsible for any new electricity connections or increasing the connection capacity? Who will be responsible for changing the heat pump compressor at roughly 15 years?
- Boundaries of responsibility in installations, as well as maintenance and repairs
- Geothermal heat pumps: Dimensioning of the wells and how to ensure that the well field will stay operational after the agreement period?
- Will the system be connected to the owner's automation system?

Business partnerships as a byproduct of HELENA

We carried out extensive cooperation with different companies, developing aspects such as our reporting models and energy solutions. This supported Heka’s own strategic objectives and also facilitated the growth of new companies.

Partnerships increased know-how

No energy efficiency work is done without service providers.

During the HELENA project, we carried out diverse cooperation with different companies. The parties involved included consultants carrying out multi-objective optimisation processes and market dialogue, real estate companies performing audits on properties, and companies with new kinds of solutions found through the innovation programme. The business cooperation taught Heka a lot, and in turn, we have enabled companies to grow and develop.

The greatest cooperation efforts were made with the companies carrying out multi-goal optimisation processes. The project involved carrying out more than 50 multi-objective optimisation processes and developing Heka's reporting model further in cooperation with the partner companies. We now have a better understanding of how the optimisation processes can yield even more detailed results and what kind of reporting yields the greatest benefits for us.

The innovation programme supported Heka's strategic objectives, and we found new cooperation partners both through the programme and outside it. In the 'energy as a service' market dialogue process, we engaged in dialogue with nine companies and learned about their service models.

Case 1: Make a BIM – BIM 3D models from PDF files by using AI

The first step in the multi-objective optimisation process is creating a 3D model. As optimisation processes were carried out at a rapid pace in the early stages of the project, the model creation process formed a bottleneck that slowed down their completion.

Help was found in the form of Make a BIM, which was developing a proprietary AI for creating 3D BIM models of properties. The AI is able to create a 3D model from PDF schematics efficiently and faster than a human being. Models were created for roughly one hundred buildings in the project.

“Having Heka as a reference played a key role in Make a BIM finding funding and numerous clients. All this has enabled us to hire new employees and find a path towards growth.”

Leo Salomaa, Make a BIM Oy

Case 2: Recycled energy storage solution provided by Cactos

During the HELENA project, Heka got acquainted with Cactos, which builds property-specific smart electricity storage facilities. We piloted an electricity storage facility built from old Tesla batteries at Eskolantie 4. This building, located in Pukinmäki, was the first apartment building in Finland to test an electricity storage facility.

The electricity storage facility
- optimises the building's energy use
- limits the peak power
- provides backup power
- supports the frequency of the power grid through the reserve market.

In its first year of operation, the storage facility reduced the energy costs of the building, prevented three power outages and supported the frequency of the grid for more than 5,000 hours.

"The experiences gained from the project directly supported Cactos's growth in the residential real estate market. Furthermore, the publicity brought by the project increased our visibility and led to several new client contacts."

Oskari Jaakkola, Cactos

Key lessons learned from the HELENA project

The project introduced systematic energy management at Heka, helped us understand the possibilities and limitations of multi-objective optimisation and facilitated the purchasing of energy as a service in the future.

Systematic energy management thanks to HELENA

The resources brought by the HELENA project provided us with a new way to focus on improving energy efficiency in renovation projects. During the project, Heka hired energy efficiency specialists, who were able to also focus on other energy efficiency work outside the project. This brought systematicity and new perspectives to Heka.

For the most part, the multi-objective optimisation processes were deemed to be a good tool when planning renovation projects. However, their usefulness depended on the location and the timing of the optimisation. The late stages of the project involved piloting the same kind of energy planning in renovation projects as in the planning of new buildings. Even if multi-objective optimisations were not to remain a permanent tool at Heka, thorough energy planning has been integrated into Heka's renovation projects and will be continued after the project.

Heka's energy management work utilises the EnerKey system, to which an AI-based tool named Ines was added during the project. The Ines tool can be used to carry out deviation monitoring in a new way and enhance the identification of potential areas for energy efficiency improvements.

Multi-objective optimisation does not solve all problems

Even though multi-objective optimisation is a good tool for comparing energy efficiency investments, there were some challenges. The consultant used affected the results, and different consultants' calculations emphasised different measures.

It was discovered that the baseline values and assumptions had major impacts, as is the case with profitability calculations in general. We learned to agree on the baseline values for the calculations and report contents in more detail with the consultants. We also commissioned additional analyses for the purpose of having more accurate baseline values for the calculations.

The results of the multi-objective optimisations emphasised conventional measures: heat pumps and solar power. Heka also wanted to try other, more innovative ways to improve energy efficiency. To this end, we decided to organise an innovation programme in which we collected new innovations and new companies to cooperate with.

In the early stages, we assumed that carrying out plenty of multi-objective optimisations would help us find the most typical cost-efficient measures for buildings of certain ages and types. We discovered that such measures were difficult to find. Among the factors contributing to this were properties having different repair histories, and the differences in the results of the parties carrying out optimisation processes.

Energy as a service – a facilitator of investments

In the late stages of the project, we carried out research-oriented market dialogue with ‘energy as a service’ operators. We came to this decision because the difficult economic situation hindered making energy efficiency investments, and Heka was strongly motivated to also carry out energy enhancements at locations other than those to be fully renovated. We also wanted to find a model in which the service provider assumes responsibility for the operation of new systems.

We carried out research-oriented market dialogue in which we used indicative offers for two locations to discuss the technical solutions, pricing and agreement models of potential service providers. Through this dialogue, we learned that different companies’ service models vary greatly and an agreement model suitable for Heka needed to be found. We continued the work by drawing up an agreement template. The work considerably increased Heka’s capability to make procurements of this type.

We see the energy as a service model as an interesting alternative and a facilitator of investments. Based on the preliminary offers received, we discovered that some offers were cost-efficient compared to our current costs.

Checklist for the future

1. Project work brings about new perspectives and different activities, contributing to the development of energy efficiency work.

2. Project work brings about additional resources, facilitating testing new things.

3. On the other hand, project work also requires resources. It is recommended that an experienced consultant be used in applying for funding, organising the project, reporting and other administrative functions if the organisation does not have the right kind of know-how in house.

4. Business cooperation carried out in the project is beneficial to both parties and develops both parties' operations.

5. When commissioning multi-objective optimisations, it is important to agree with the service provider on the baseline values used and the reporting model.

6. The 'energy as a service' model can be competitive when compared to the price of district heating and serve as a suitable model for procuring energy efficiency solutions.

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