Path to carbon-neutral Helsinki by 2030
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Helen in brief

Number of employees in the Helen Group

1015

Net sales of the Helen Group in 2021

1,318 EUR mill.

Total of

1409 km

of district heating network

Total of

6,200 km

of electricity network

In Helsinki, our security of electricity supply is among the best in the world:

99.999%

We offer world-class expertise

We produce district heat, district cooling, electricity and services for microgeneration of energy, electric traffic and more efficient energy use.

Helen is carbon neutral by 2030

Over a hundred years of urban energy

The electricity company of the City of Helsinki was established in 1909 in order to create a safer and more environmentally friendly way to produce energy in a smoky city.

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Towards carbon-neutral energy production

We aim to meet the energy challenges of today and tomorrow. We aim for a carbon-neutral, cost-effective and reliable energy system.

1909
Helen has been leading the way throughout its existence, constantly seeking and piloting new energy solutions.

In 2030 we will be a carbon-neutral energy company

Currently
Helen replaces coal through recycling of heat, energy storage and bio-heat.

2023
Hanasaari power plant will be decommissioned by 1.4.2023 at the latest. Helen will raise the share of renewables in energy production to 25 per cent and cut carbon dioxide emissions by 40 per cent.

2024
Helen will phase out the use of coal in full. Non-combustion based solutions are sought for Salmisaari.

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Helen’s energy services reach as many as 1.7 million Finns

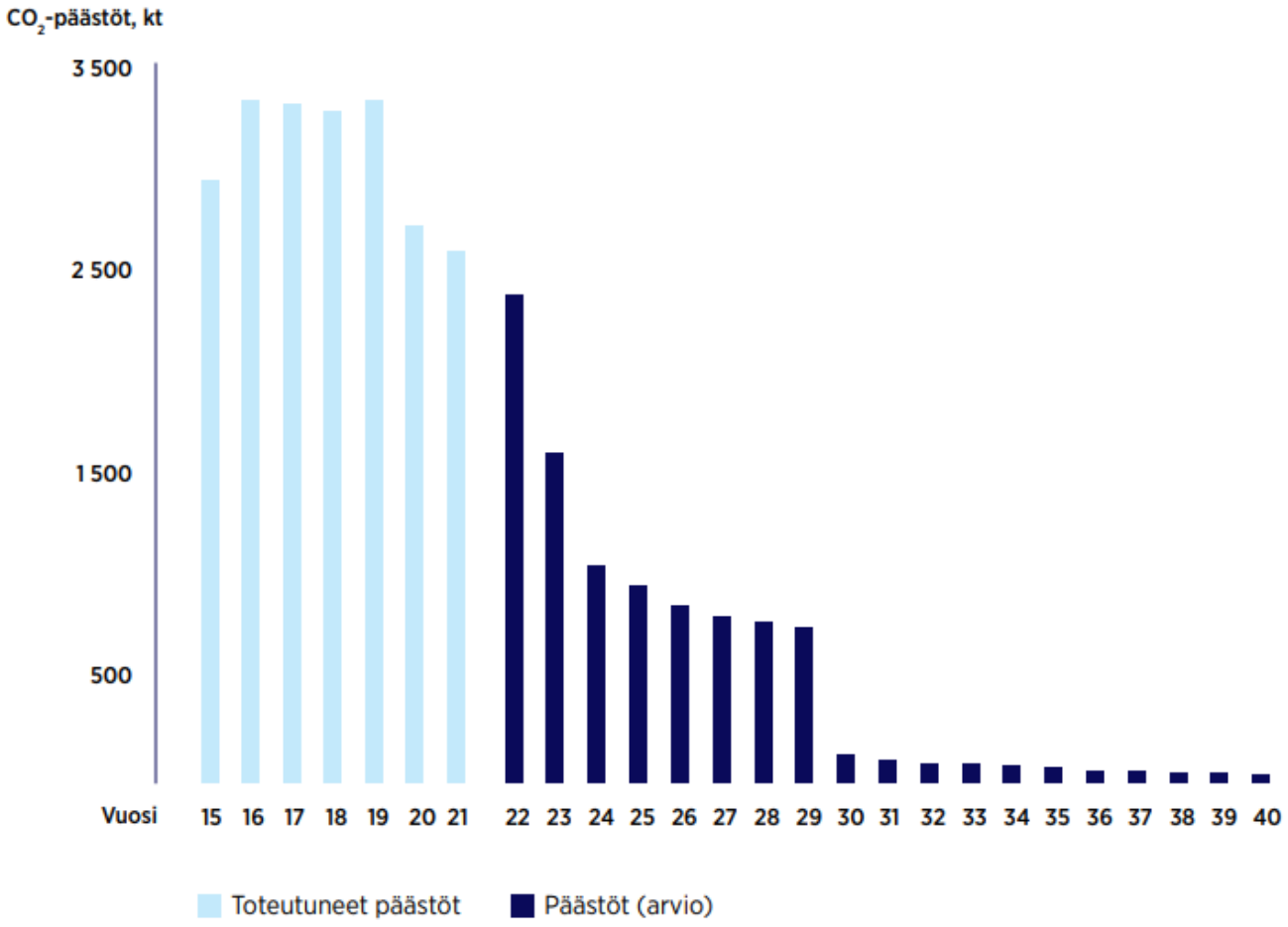
We produce increasingly smarter and cleaner energy solutions of the future with a bold and open-minded approach to provide an easy and carefree way of living.

HELEN

Heating, cooling and electricity form the basis of our operations.

We are building the new solutions upon this expertise.

Emissions from 2015 to 2040



- Largest emission reduction will occur after the shut down of coal fired power plants in Hanasaari and Salmisaari.
- Realized investments in renewable and zero-emission electricity and heat production have already turned Helen's emissions on a good downward trajectory.
- In 2021 the share of carbon-neutral production rose to 32%. Helen produces carbon-neutral energy from biomass, nuclear energy and renewable energy (wind, solar, etc.).
- In 2021 Helen invested to carbon-neutral production by a total of 184 million in euros.

Responsibility report 2021, https://www.helen.fi/globalassets/helen-oy/vastuullisuus/vastuullisuusraportit-pdf-2021/helen_oy_vastuullisuusraportti_2021.pdf

Existing thermal energy storages

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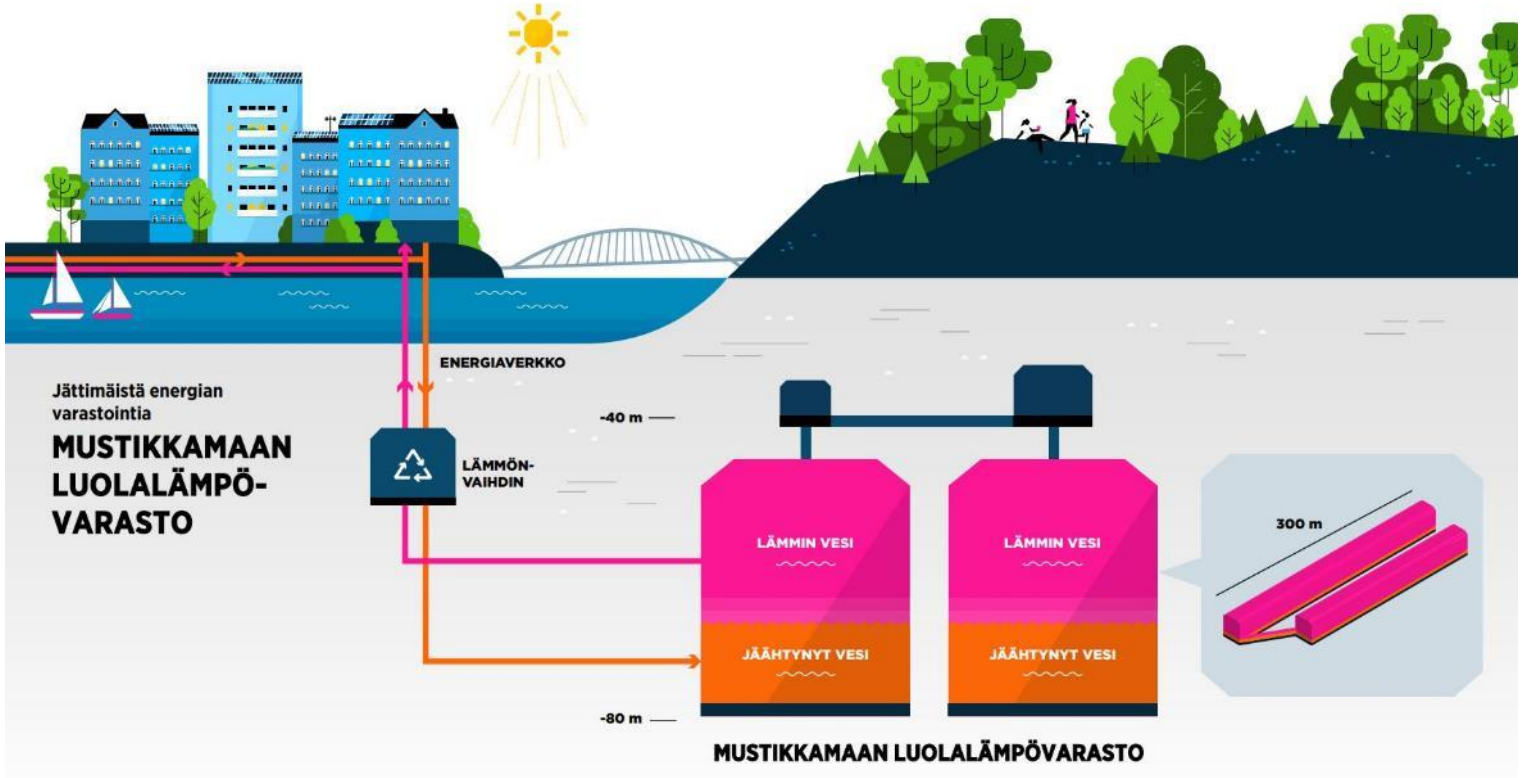
Mustikkamaa – Cave thermal energy storage

- Old oil caves used to store water at temperatures 40/90°C
- Heat exchangers 5 x 24MW
- 320 000 m3 the total volume, usable volume 260 000 m3 (80%)
- Energy content 11.6 GWh, (4 days) annual production 140 GWh
- 120 MW charging and discharging
- Production optimization, replacing peak production
- Better optimization of heat and electricity production separately

Currently in the deployment phase, already filled with water.

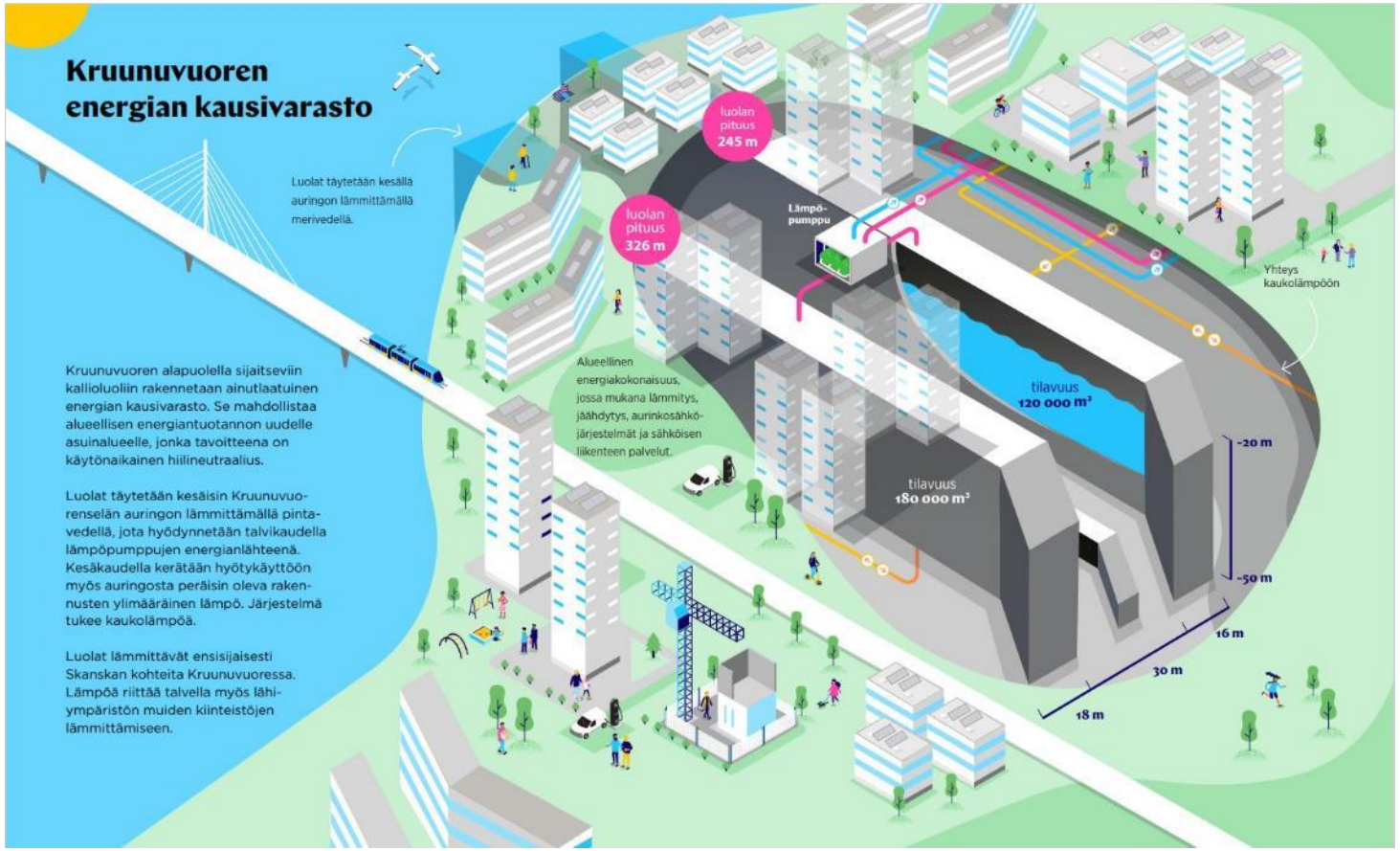
In use during 2022.



Mustikkamaa

Heat exchanger

Kruunuvuorenranta – Cave thermal energy storage



Used to store the heat from seawater

- 300,000 m3
- 2–24°C
- Annual production 6-7 GWh
- 3MW discharge power
- free source
- summer seawater as a source of heat pumps
- regional solution, 1/3 of the region's heat

Heat storages in Salmisaari and Vuosaari (surface)

Salmisaari (1987):

Two storages 18m width, 40m height

- total volume 20 000 m3
- storage capacity 1000MWh,
- heating temperature 90°C

Vuosaari (1998):

- 25 000m3,
- storage capacity 1250MWh,
- heating temperature 90 °C

120/200MW, max 10 hours charge/discharge

Vuosaari power plants and the storage.

Future thermal energy storages

https://energychallenge.hel.fi/

Helsinki Energy Challenge was launched in 2019.

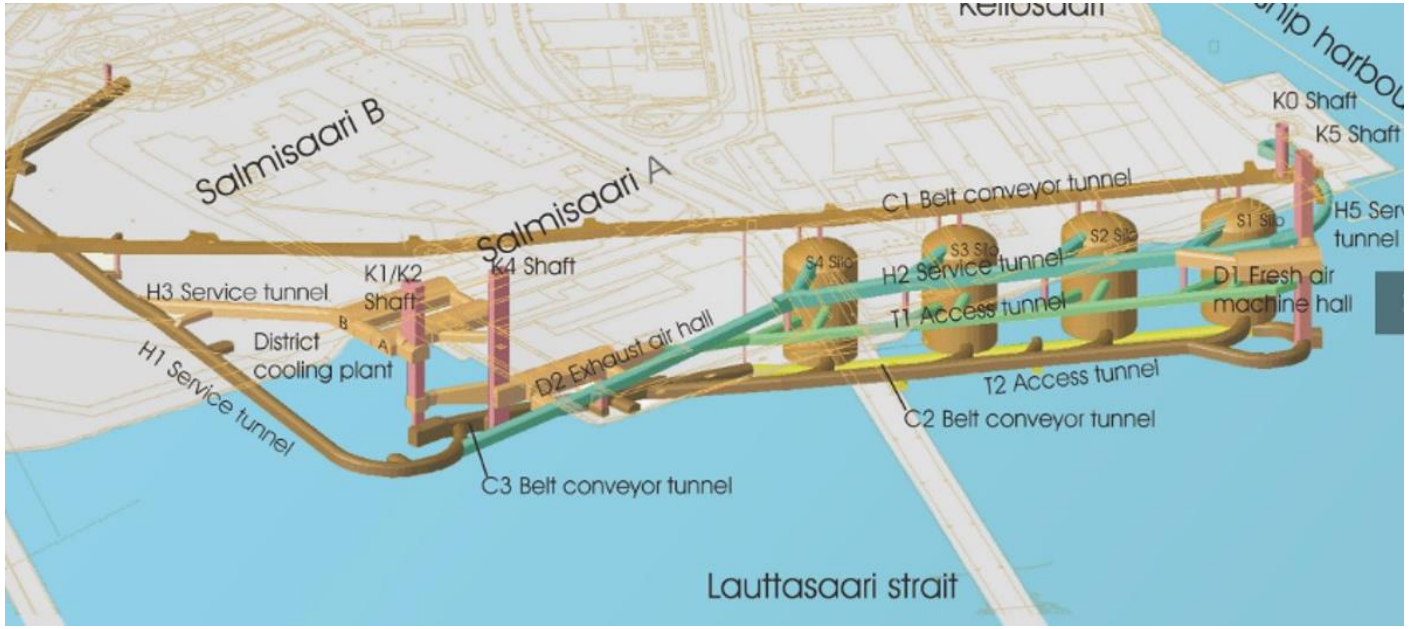
- Proposed solutions included various types of energy storages, from more mature to novel storage concepts.
- Different materials would enable the use of higher temperatures and properties, which would increase the storage capacity.
    - Salt, sand, rocks, etc.
- Thermochemical storages can provide solution in the future when the technology and costs are more mature.

<u>What substance and temperature?</u>

- Higher temperatures with water storages requires pressurized storage.
    - Site investigation crucial, urban areas can be challenging (buildings, soil properties).
- In Vantaa 140°C, 1 000 000m3 water storage enables a capacity of 90 GWh (8x Mustikkamaa).

Thermal energy storage concepts for Helen

Case: Salmisaari coal silos



Currently, a large-scale water storage requires a large volume.

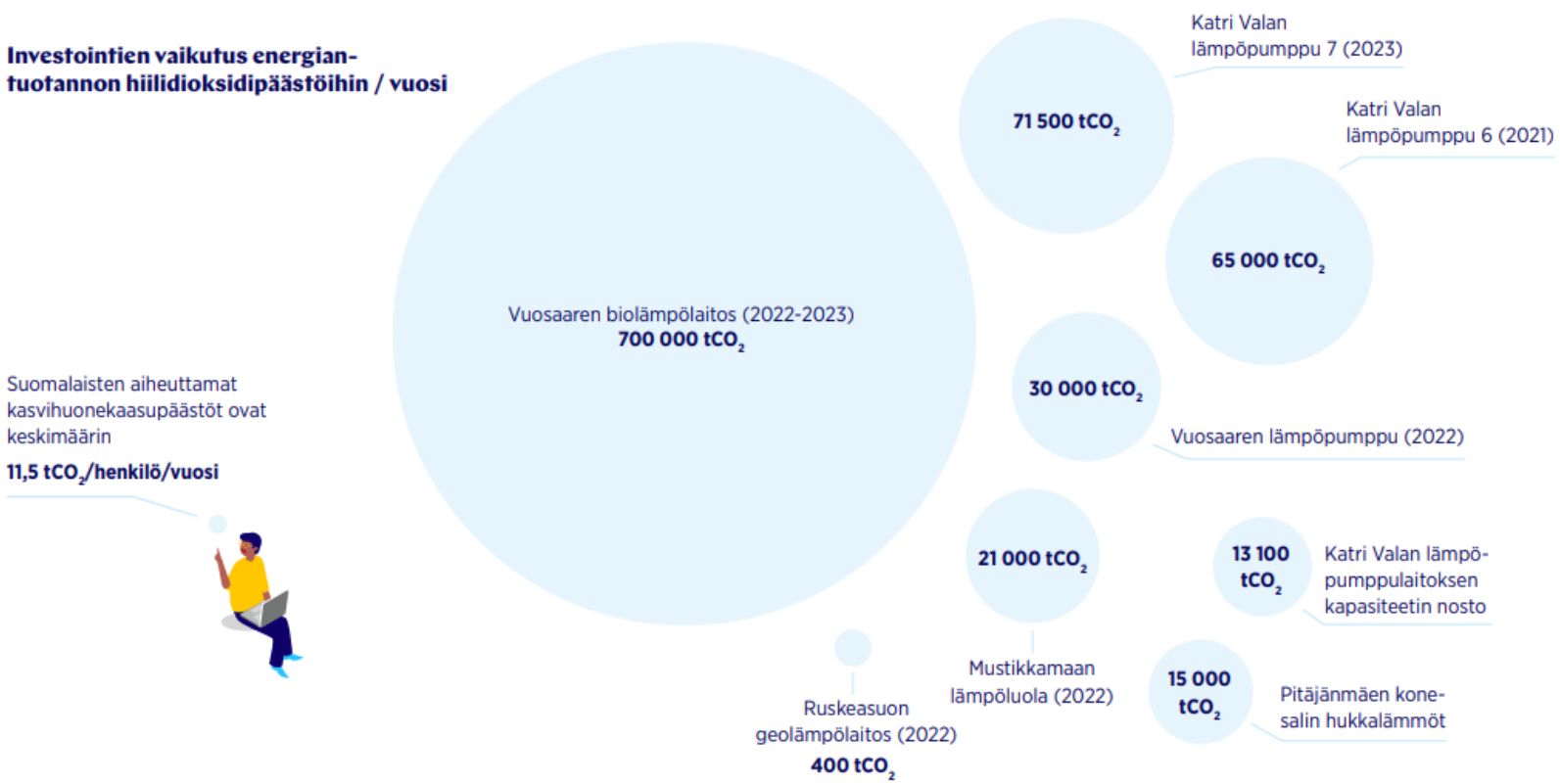
- Existing infrastructure and underground spaces are challenging in urban areas.
- Reducing coal, oil, and natural gas use will release storage spaces in the future.
- For example, in Salmisaari there are four silos for storing coal underground.
  - One silo 60m height, 33m width
    - 50 000 m3 / silo, 200 000 m3 the total volume.

Other projects

2020’s

Next steps in 2020’s

Emission reduction potentials



- Helen will move to decentralized energy system.
- Energy is produced from several carbon-neutral sources, as wind, solar, nuclear, ground, waste heat, bioenergy etc.
- Currently 20 projects under construction and more under development.

Responsibility report 2021, https://www.helen.fi/globalassets/helen-oy/vastuullisuus/vastuullisuusraportit-pdf-2021/helen_oy_vastuullisuusraportti_2021.pdf

Vuosaari C – bioenergy heating plant

https://www.helen.fi/helen-oy/energia/kehityshankkeet/biolampolaitokset/vuosaari

- The Vuosaari bioenergy heating plant is needed so that Helsinki's heat demand can be met even during the cold winter.
- The planned size of the Vuosaari bioheat plant is 260 MW. The main fuel is forest chips.
- The bioenergy plant accounts for approximately 15% of Helen's fuel consumption.
- The investment value of the project is approximately EUR 260 million.
- The use of a bioheat plant in the production of district heating is not expected to have an impact on the price of district heating.

In operation for winter season 2022-2023.

Vuosaari C – bioenergy heating plant

Heat pumps – Katri Vala

Katri Vala’s 7th heat pump is one of the largest in the world. Uses purified waste water.

- The length of the heat pump in Katri Vala is 22.5 meters, the height is 7 meters, and width is 11 meters.
- It has a district heating capacity of **32 MWs and district cooling 21.5 MWs**
- Investment value of EUR 30 million.
- Seventh heat pump is under construction and should be in production in 2023.
- The investment will increase the heat capacity of Katri Vala's heat pump plant to a total of **155 MWs** and the cooling capacity to a total of **103.5 MWs**.

Katri Vala’s 6th heat pump

Seawater heat pump in Vuosaari

- Helen is building a heat pump in connection with the Vuosaari power plants.
- The heat pump utilizes **both the heat energy bound to seawater during the summer and the wasted energy in the internal cooling water circuit** of the Vuosaari power plants for district heating.
- It is estimated that the heat pump can utilize an average of 20% of seawater heat and 80% of cooling water waste heat in its production from the power plant's internal process cycle.
- The district heating capacity of the heat pump is **13 MW,** and the district cooling capacity is **9.5 MW**.
- The heat pump reduces Helen's CO2 emissions by an estimated 30,000 tonnes per year.
- Construction started in 2020, and the new heat pump will be available for production in 2022.
- The value of the investment is about 15 million euros.

Vuosaari illustrative picture, helen.fi

Wind power

Low-carbon electricity is one of the key solutions to achieve carbon neutrality by 2030.

Lakiakangas 3 – 2022

- Lakiakangas 3 wind farm consists of 20 wind turbines with a total capacity of **86 MW**. The total investment of 100 million euros.
- From 2022, Helen will generate **350 GWh** of wind electricity per year, which corresponds to about 8% of the electricity consumed in Helsinki.
- An electricity storage with a capacity of 5 MW and an energy capacity of 10 MWh to be built in connection with the Lakiakangas 3 wind park.
    - Equivalent to appr. 200 electric car batteries.

Together with Fortum, Helen invested in wind power by building two wind farms in Ostrobothnia near Närpiö and Kristiina.

- Wind farms are in use at the latest in 2024. The project will triple Helen's wind power production.
- **Even 1 TWh per year**. The number corresponds to a quarter of Helsinki’s electricity consumption.

https://www.helen.fi/uutiset/2021/lakiakangas-3-viisinkertaistaa-helenin-tuulivoiman-tuotannon

https://www.helen.fi/en/news/2021/helenin-tuulivoimatuotanto-kolminkertaistuu-fortum-ja-helen-rakentavat-yhteisty%C3%B6ss%C3%A4-tuulivoimaa-pohjanmaalle

Customer case

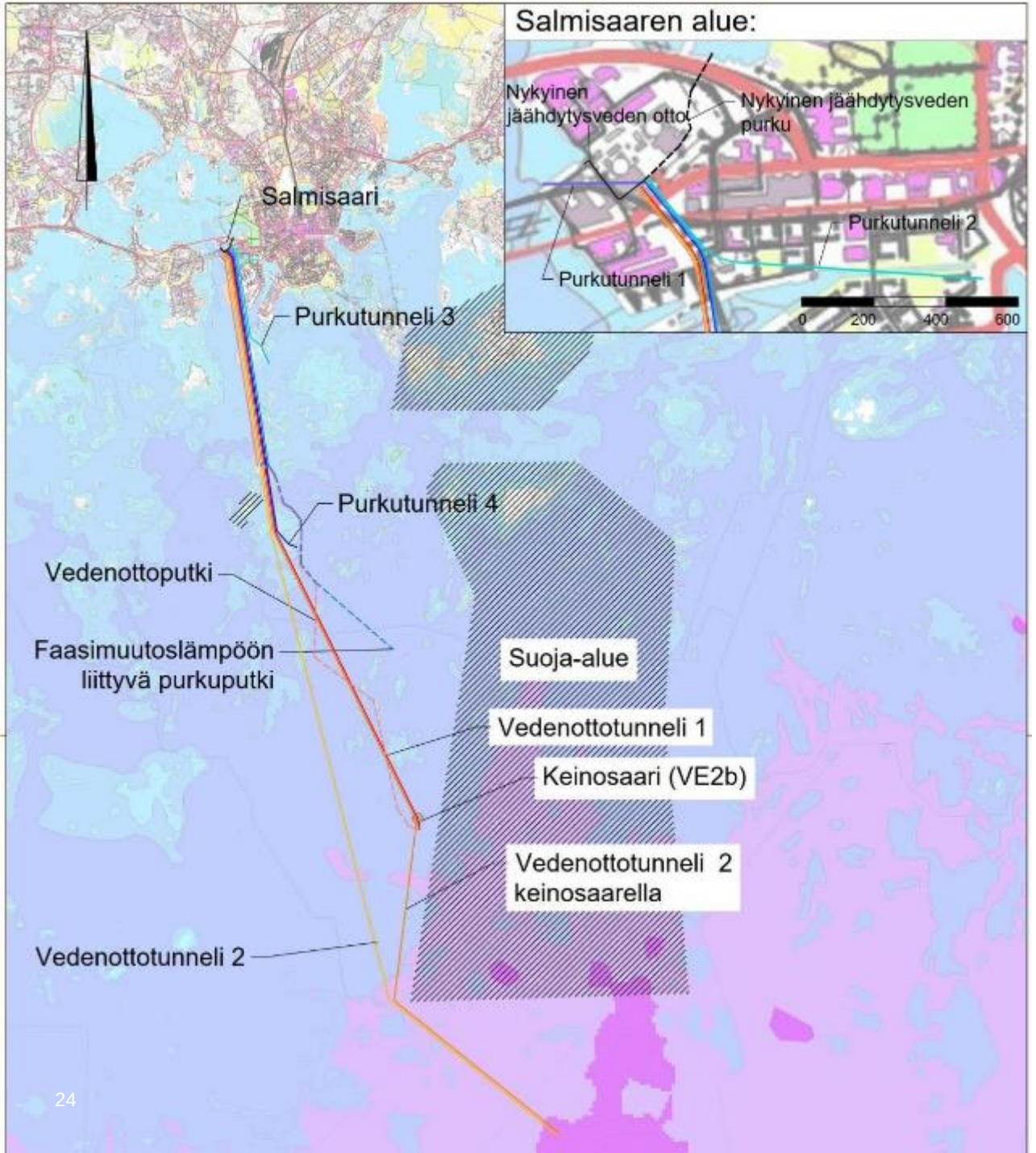
Helen and Paulig are harnessing excess heat produced at the coffee roastery for utilisation in a joint pilot

Located in Vuosaari.
Temperatures even 300 to 400°C.
Annual production 4 to 6 GWh.

Excess heat, which is produced during the coffee roasting process, can be utilised in the district heating network.

Heat can be recovered with a new kind of technical solution to such an extent that it corresponds to the annual heat demand of **1,000** one-bedroom apartments.

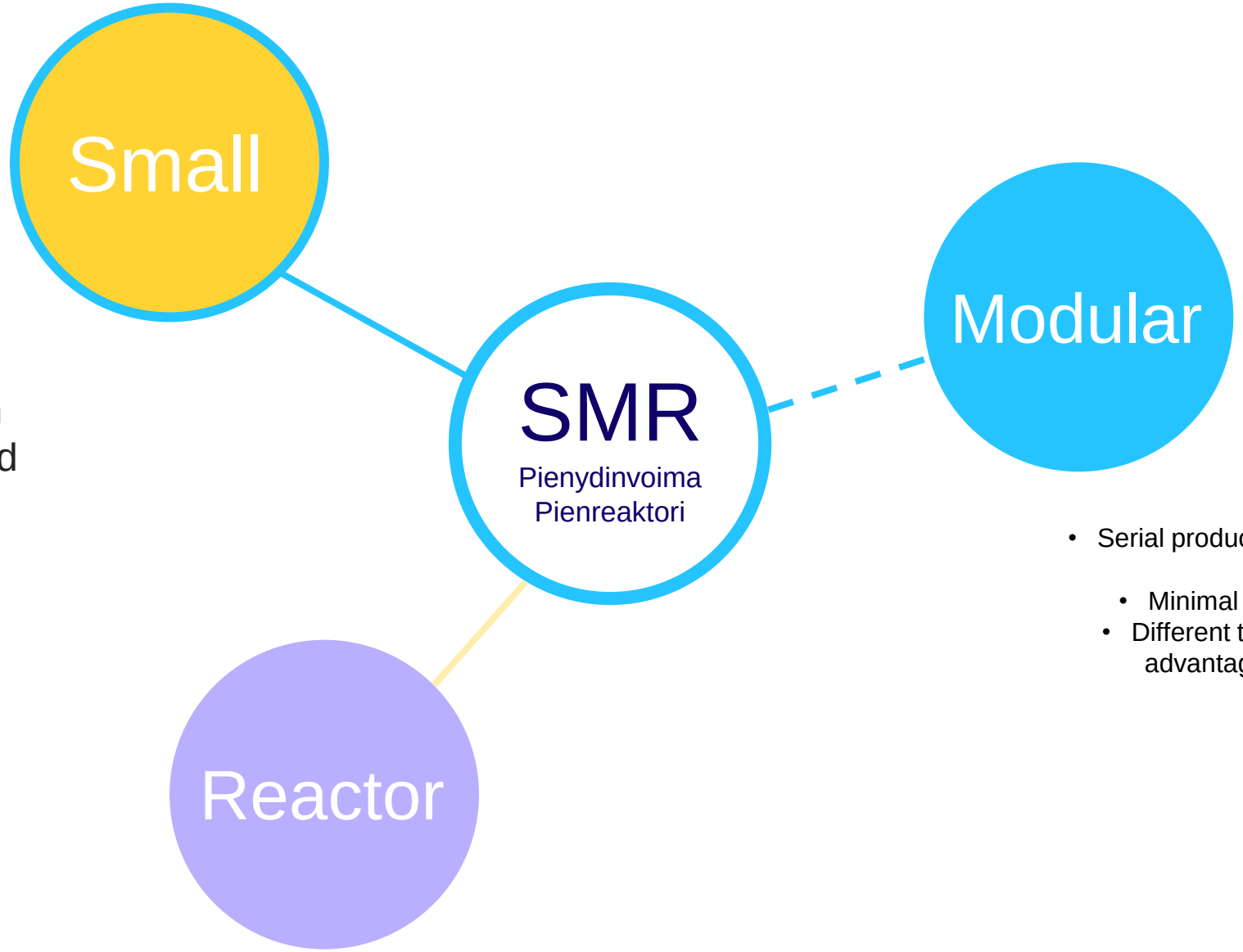
2030’s



Large-scale seawater heat pump

- Helen's seawater heat pump project proceeds to Alliance partner's tender for the development and implementation phases of the seawater system.
- The starting point for the design is **500 MW** district heating capacity.
- Heat pumps use both electricity and seawater heat to produce district heat
  - Appr. **40% electricity and 60% from seawater.**
- The seawater discharged has a temperature lowest around +2°C.
  - Water returned to the sea is appr. 0.5 °C.
- Finding enough warm water in winter requires water abstraction from the deep sea (**50-70 meters**). There are no suitable depressions near Salmisaari.
  - ➢ A tunnel up to **17-27 km long is needed to take in the water.**
- ➢ The required seawater flow for heat pumps is around **180,000 m3 / h.**
- Phase change option as more novel solution.
  - The surface water taken in the phase change is cooled that it becomes partly ice, and the heat pump mainly utilizes the heat released when the water freezes.
  - In this case, the amount of water supplied to the heat pump is remarkably reduced.

SMR – Small Modular Reactors



SMR is a general term
Lots of technologies and approaches

Modularity
- Serial production of components, modules and plants
- Minimal on-site construction work
- Different types of SMR facilities take advantage of this in different ways

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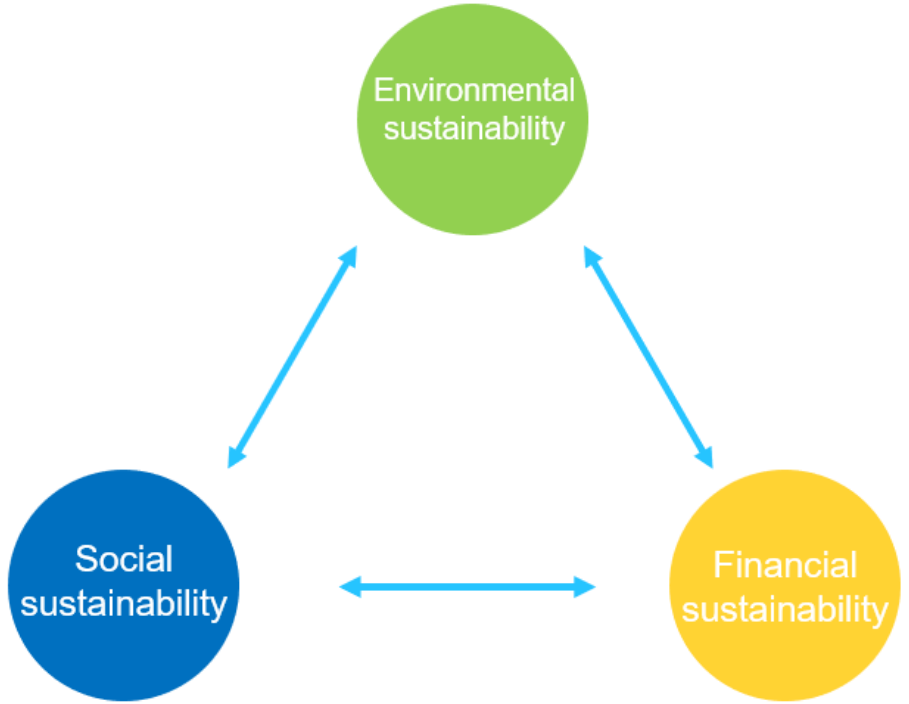
SMR study by Helen in 2021

Why SMR's:

- Climate and biodiversity
  - Reduces the need for energy from combustion on a large scale
- Cost-effectiveness
- SMR key to carbon negativity In the early 2030s,
  - Suitable for district heating production and cogeneration of electricity and heat.
  - SMR would enable Helsinki's carbon negativity. Nuclear heat can replace natural gas and combustion in general in the 2030s.
- SMR project from zoning of the are to energy production **~ ten years**.
- Finland and Helsinki potential places for SMR solutions
  - In Finland, long-term knowledge of nuclear energy
  - Pioneering and sector integration

- However, to reduce uncertainty: Legislation and the operating environment must be developed rapidly!



SMR sizes varies

The small-scale nuclear power plant area is responsible for a medium-large industrial plant

- Sizes of the reactors vary greatly.
- The International Atomic Energy Agency (IAEA) defines an SMR if **the electrical power from the reactor is 300 MW or less.**
- The smallest small reactors only ~ 1.5 MW electrical power
- On the other hand, some concepts are clearly larger than the IAEA definition (Rolls Royce: UK SMR, 470 MW electrical power)

Illustrative image GE Hitachi Nuclear Energyn BWRX-300

Source: https://www.world-nuclear-news.org/Articles/GEH,-BWXT-team-up-to-support-BWRX-300-deployment

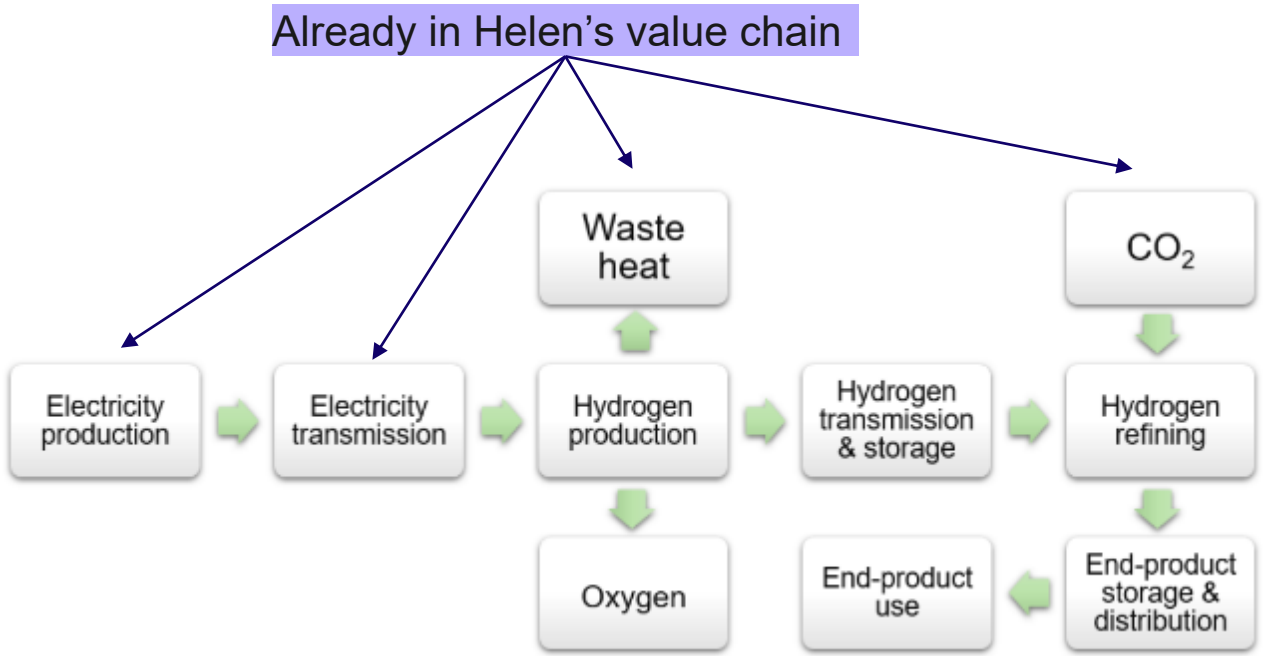
Hydrogen and PtX

Involved in several international research projects.

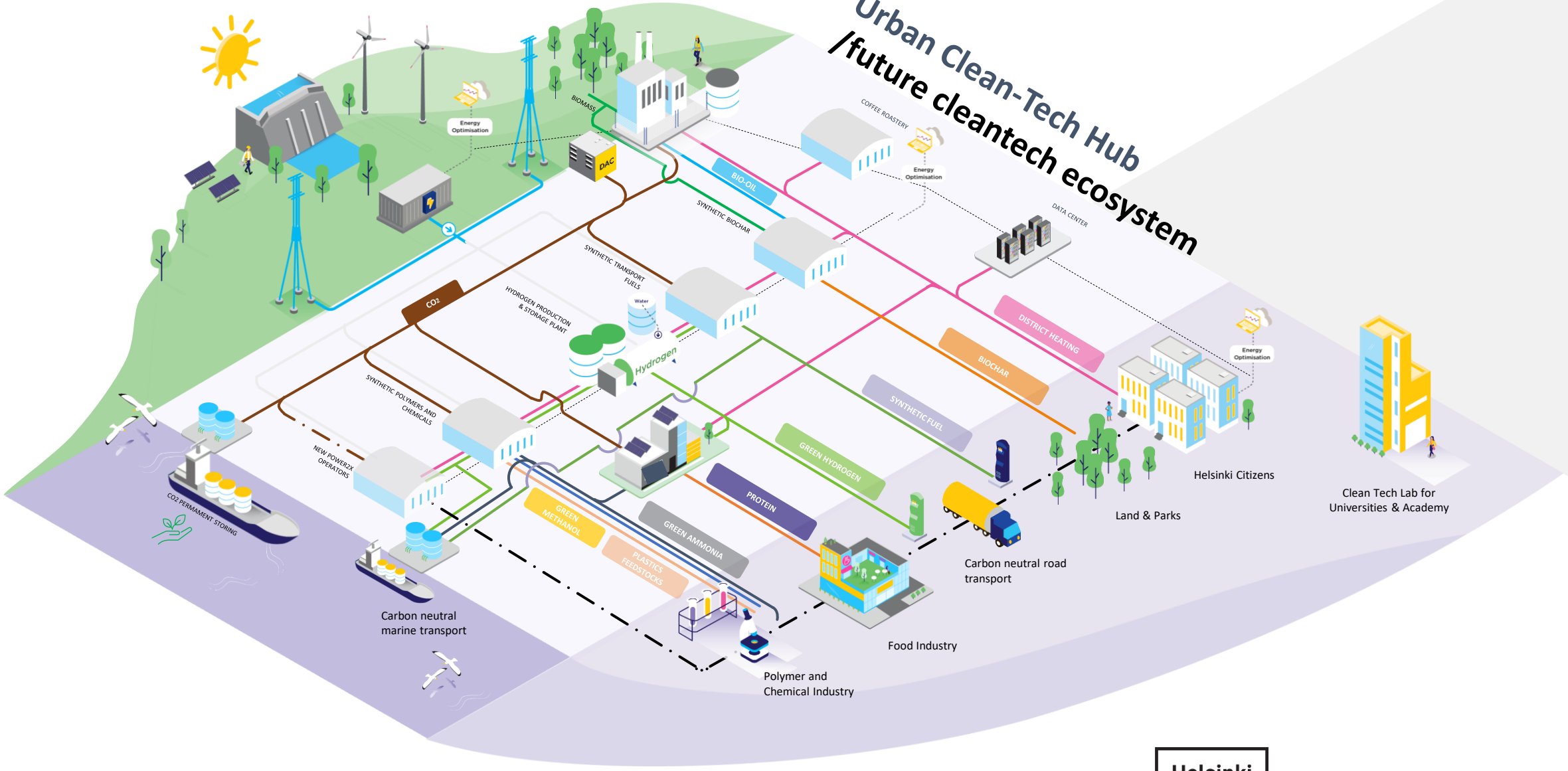
- **The MySMARTLife** project is part of the EU's Horizon 2020 program. Ways to tackle climate change are being tested in three in the pioneering city: Helsinki, Hamburg and Nantes.
- **The Sys Flex project** addresses energy breakthroughs, electrification of the energy sector, electricity networks and the efficient use of flexibilities.
- We are investigating the use of hydrogen as part of the synthesis gasification technology in the **FlexCHX-EU** project coordinated by VTT.
- We participate in Business Finland's **BECCU** and **eFuels** Co-innovation projects, which study the development of PtX technologies.

➢ The content of the related studies has been expanded with the examination of new business opportunities.

Our goal is to find the best ways to utilization of hydrogen technology in a carbon-neutral energy system and at the same time look for **new business models.**



Urban Clean-Tech Hub /future cleantech ecosystem



”Vuosaari HUB”

Helsinki

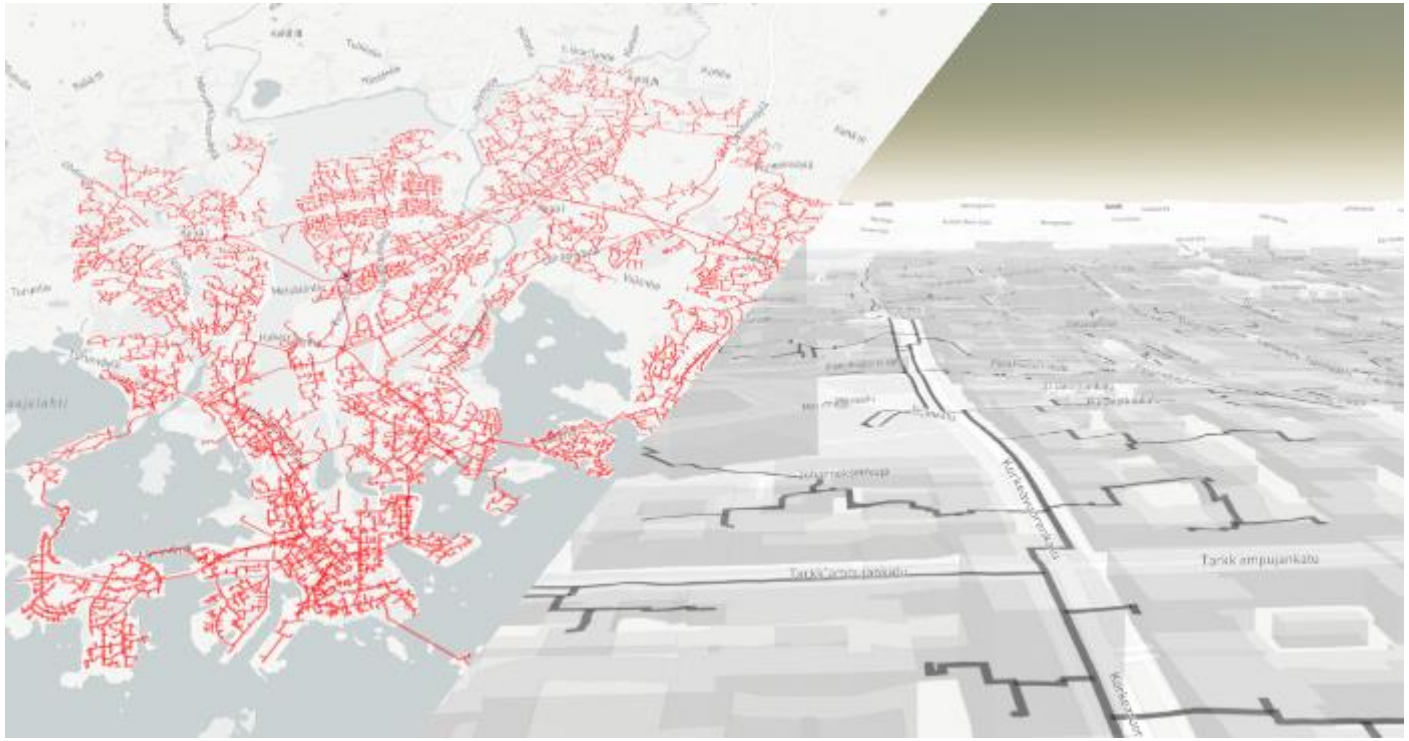
“Maailman toimivin kaupunki”

New investments & workplaces
Internationalization Opportunities
Efficient use of the land

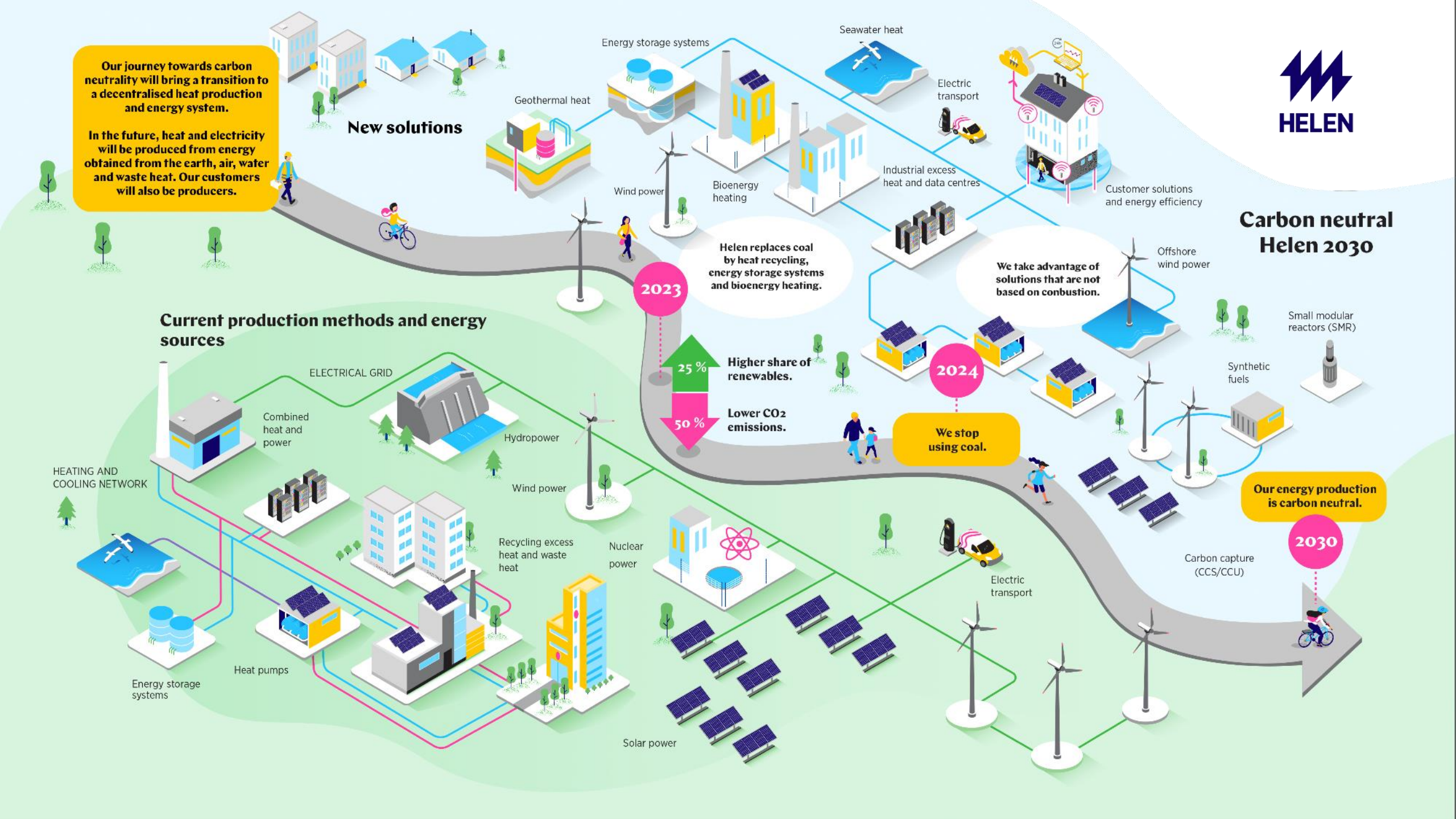
HELEN

Digital solutions and AI

- Helen accelerates the transition to carbon neutrality of various kinds **digital services, IoT solutions, energy data and through a digital user experience.**
- Helen builds future energy platform with **“digital twin” Gradyent.**
    - To **understand temperatures or pressure fluctuations** in the heating network.
    - Optimize the production of heat.
    - Ensure the transfer of heat to all customers even when the production of our large plants are shut down.
    - Data is collected from up to 13,000 measurement points.
    - Building a digital twin is the first step towards a system where AI can optimize production, distribution and consumption.
        - emissions can be minimized
        - waste heat can be utilized
        - heat pumps can be used as efficiently as *the price of electricity changes.*



https://www.helen.fi/en/news/2022/helen-builds-an-energy-platform-of-the-future-and-develops-a-digital-twin-of-the-district-heating-network-with-gradyent


Our journey towards carbon neutrality will bring a transition to a decentralised heat production and energy system.
In the future, heat and electricity will be produced from energy obtained from the earth, air, water and waste heat. Our customers will also be producers.
New solutions
Energy storage systems
Seawater heat
Geothermal heat
Electric transport
Wind power
Bioenergy heating
Industrial excess heat and data centres
Customer solutions and energy efficiency
HELEN
Carbon neutral Helen 2030
Helen replaces coal by heat recycling, energy storage systems and bioenergy heating.
We take advantage of solutions that are not based on conbustion.
Offshore wind power
2023
Current production methods and energy sources
ELECTRICAL GRID
Small modular reactors (SMR)
Synthetic fuels
25 %
Higher share of renewables.
50 %
Lower CO2 emissions.
2024
We stop using coal.
Combined heat and power
Hydropower
HEATING AND COOLING NETWORK
Wind power
Recycling excess heat and waste heat
Nuclear power
Our energy production is carbon neutral.
2030
Carbon capture (CCS/CCU)
Electric transport
Heat pumps
Energy storage systems
Solar power


Thank you!