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# Replacing coal with renewables in district heating, case Helsinki

EUFORES 19th Inter-Parliamentary Meeting on Renewable Energy and Energy Efficiency | 22.11.2019 | Parliament of Finland, Helsinki

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# Helsinki city

Climate target:
Carbon-neutral
Helsinki by 2035

630 000 citizens -
12% of 5,5 million
Finnish population

**#climatestrikeHelsinki**

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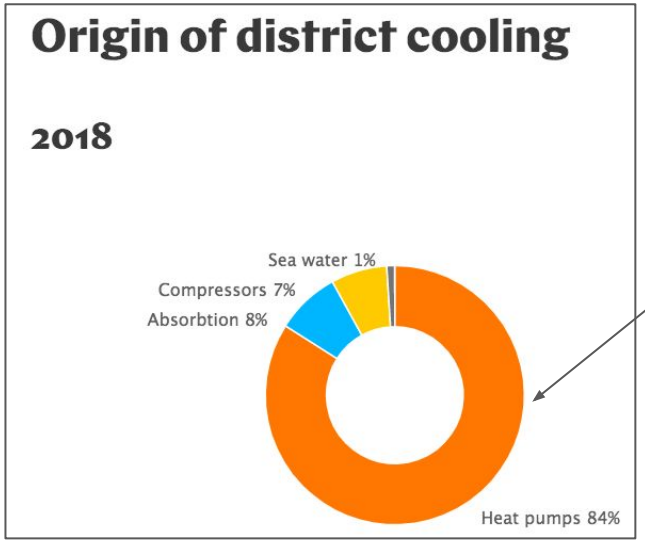
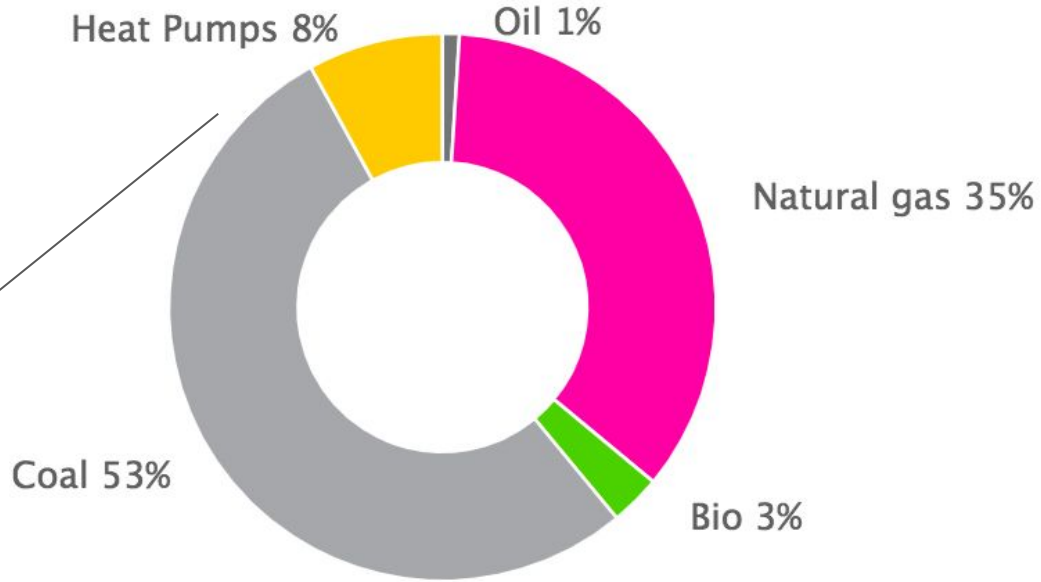
# Helsinki district heating energy sources

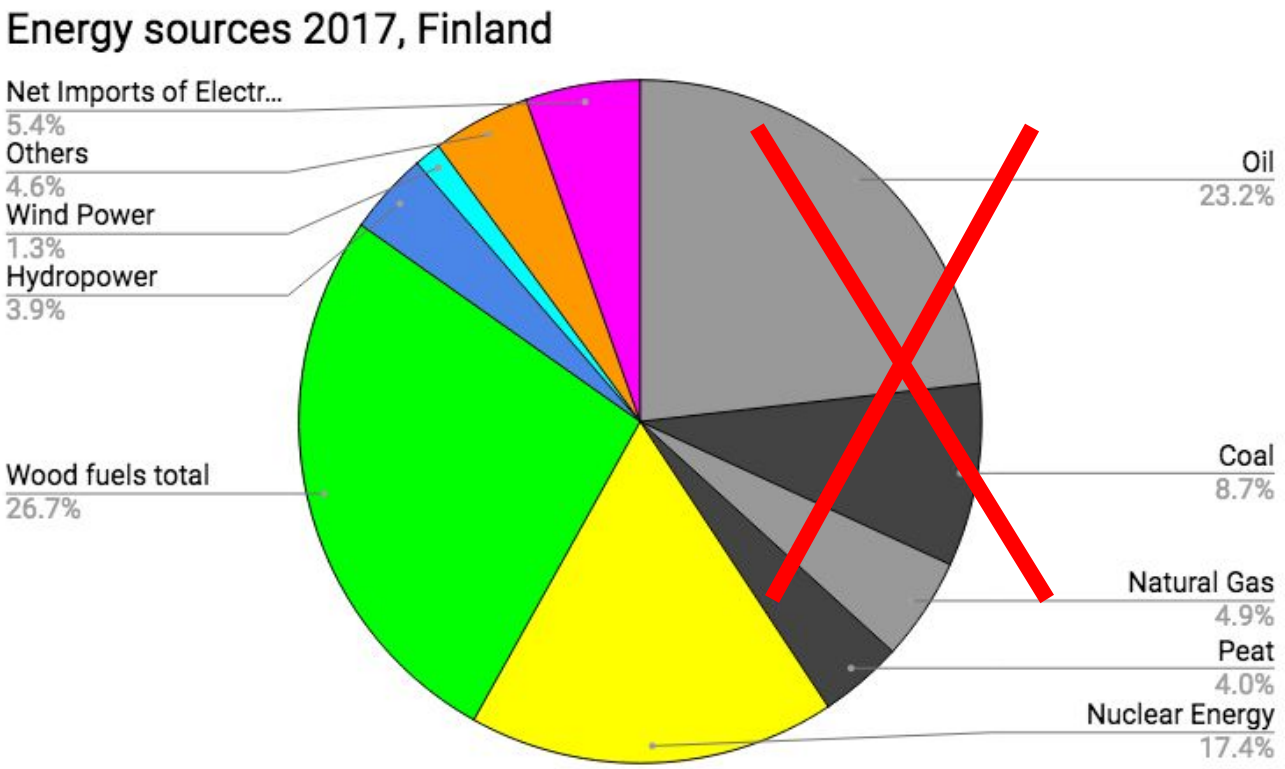



Source: Helen Ltd. Origin of district heating 2018.
https://www.helen.fi/en/company/energy/energy-production/origin-of-energy

Heating market shares in Helsinki: 90% of the district heating owned by Helen Ltd - 10% decentralized heating systems using electricity, oil, biomass, ambient & excess heat. **Significant energy efficiency potential exists in the old buildings!**

# All fossil fuels need to be phased out

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**Clean district heating - how can it work?**

Including fossil-fuel free scenario for Finland

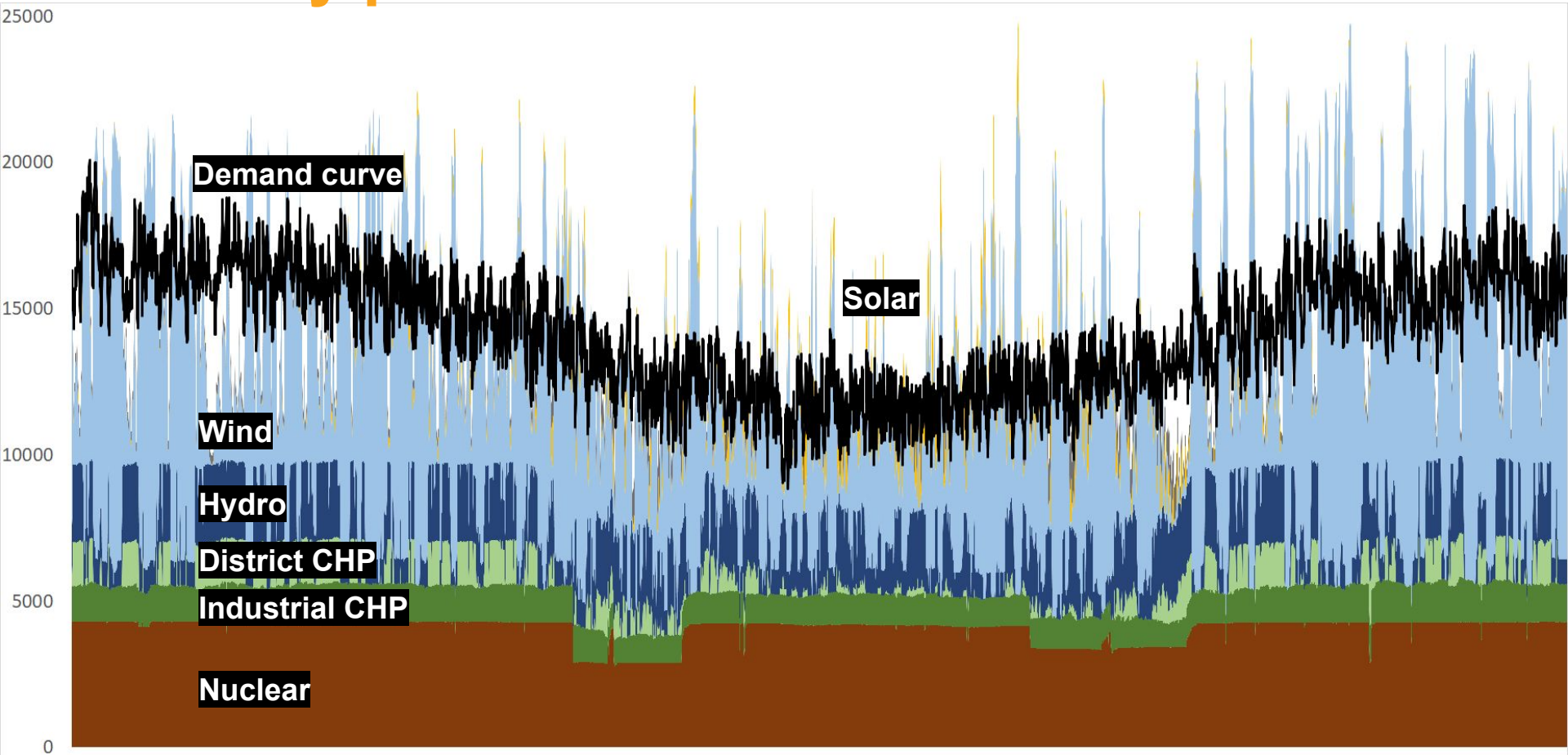
Available: https://aaltodoc.aalto.fi/handle/123456789/40756

www.smartenergytransition.fi

**Research consortium:**

A! SYKE HELSINGIN YLIOPISTO HELSINGFORS UNIVERSITET UNIVERSITY OF HELSINKI LUT Lappeenranta University of Technology US University of Sussex VATT VTT Motiva HEUREKA LAPPEENRANTA

# Electricity production in fossil-fuel free Finland




Electricity production and demand (one year, every hour) in fossil fuel-free scenario for Finland by simulation program EnergyPLAN.eu

# Flexibility solutions for the variable wind and solar energy

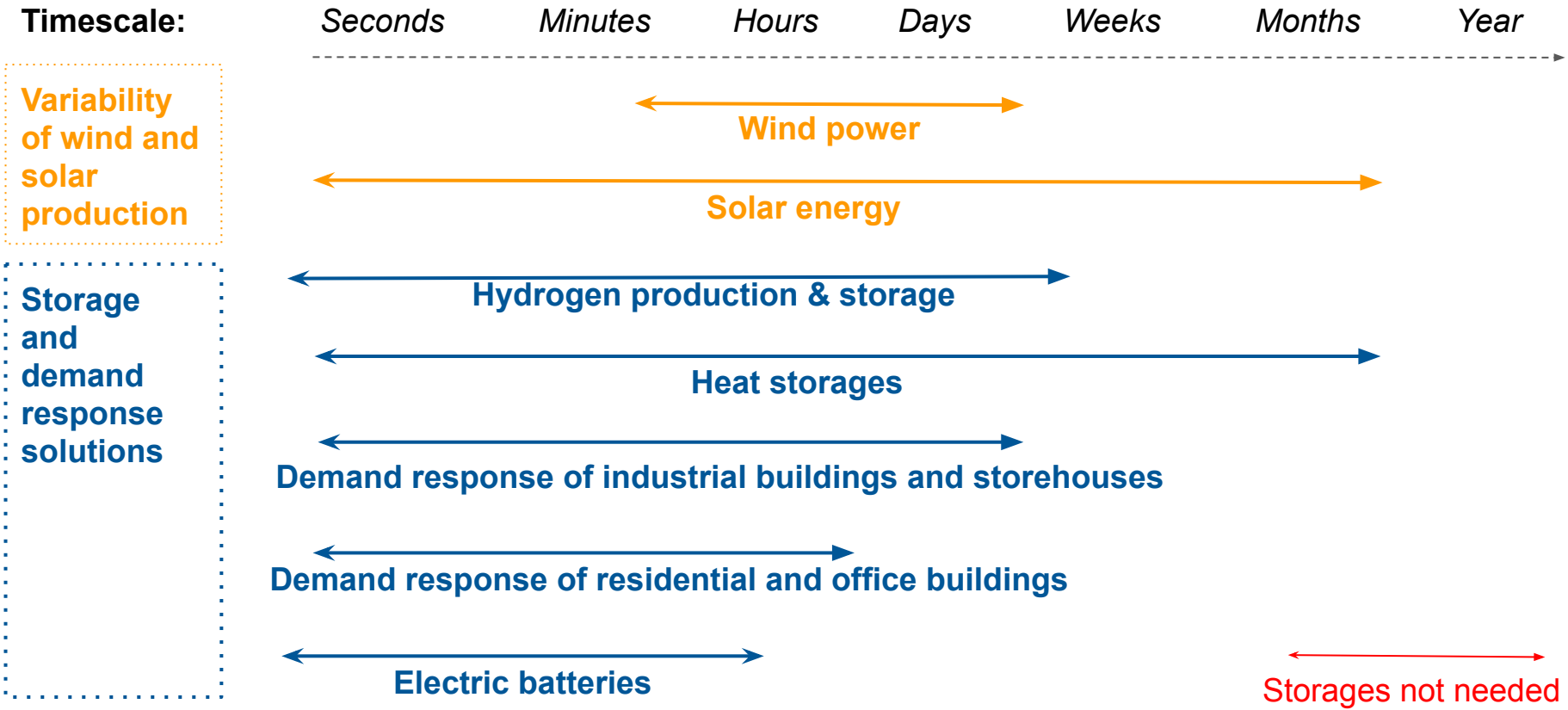



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Figure: Karoliina Auvinen and Samuli Rinne, Aalto University

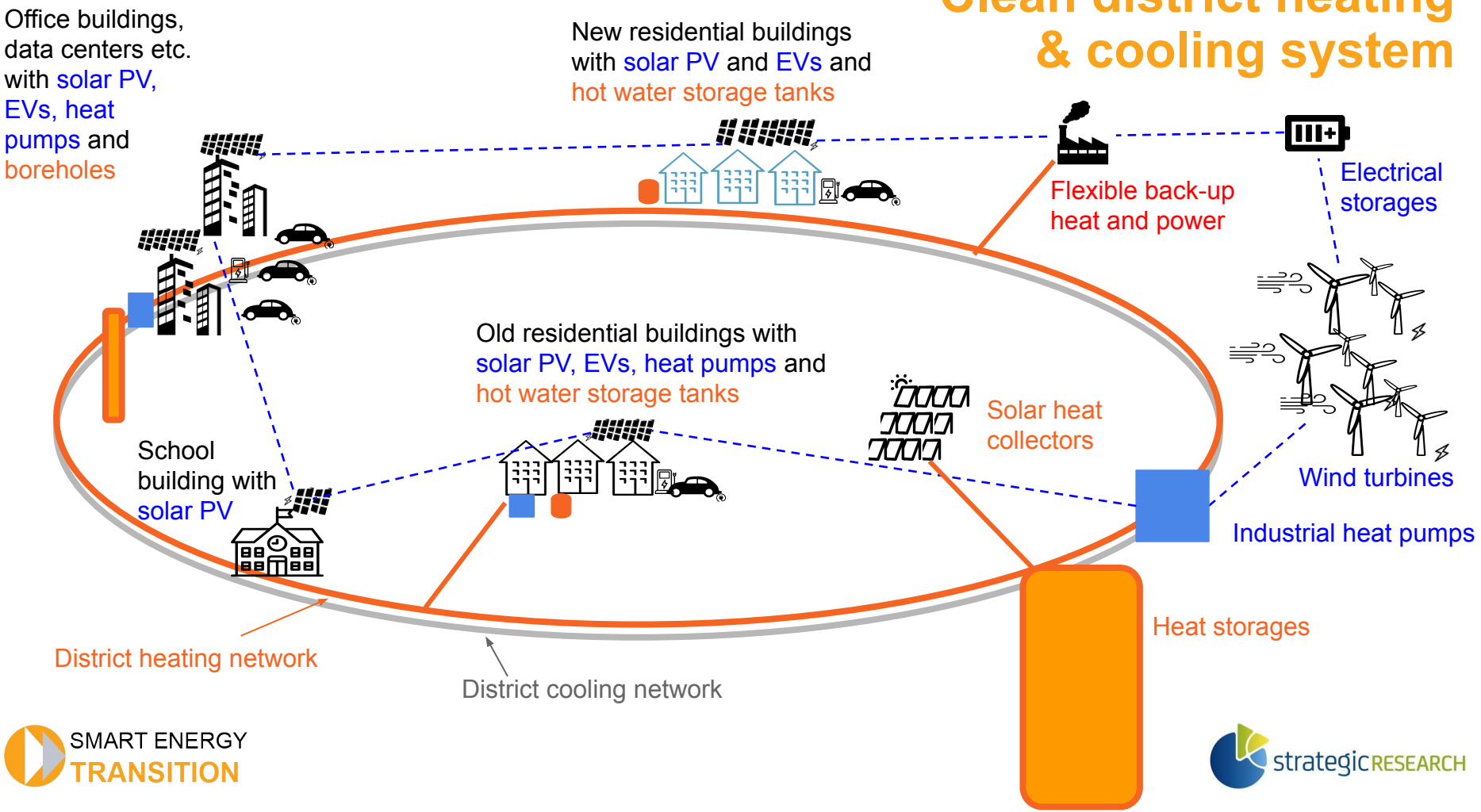
# Primary energy sources

| Primary energy sources | Primary energy consumption in Finland 2017* / 2018 | Primary energy consumption in fossil-fuel free scenario |
|---|---|---|
| **Wind power** | 6 TWh | **60 TWh** |
| | | + **40 TWh more if needed 16 TWh synthetic fuels are produced with wind power** (efficiency 40%) |
| **Solar energy** | 0,1 TWh* | **3 TWh** |
| **Nuclear fuels, uranium** | 66 TWh | **106 TWh** (36 TWh electricity) |
| **Biomass** | 104 TWh | **110 TWh** |
| **Ambient and excess heat (heat pumps)** | 6,4 TWh* | **38 TWh** |
| **Hydropower** | 13 TWh | **15 TWh** |
| **Export / import** | 20 TWh import | **5 TWh export** |
| **Fossil fuels** | Natural Gas 20 TWh, oil 85 TWh, coal 32 TWh and peat 17 TWh | **0 TWh** |

# Clean electrification is the way to reduce emissions in the heating, transport and industry sectors

www.smartenergytransition.fi

# Clean district heating & cooling system

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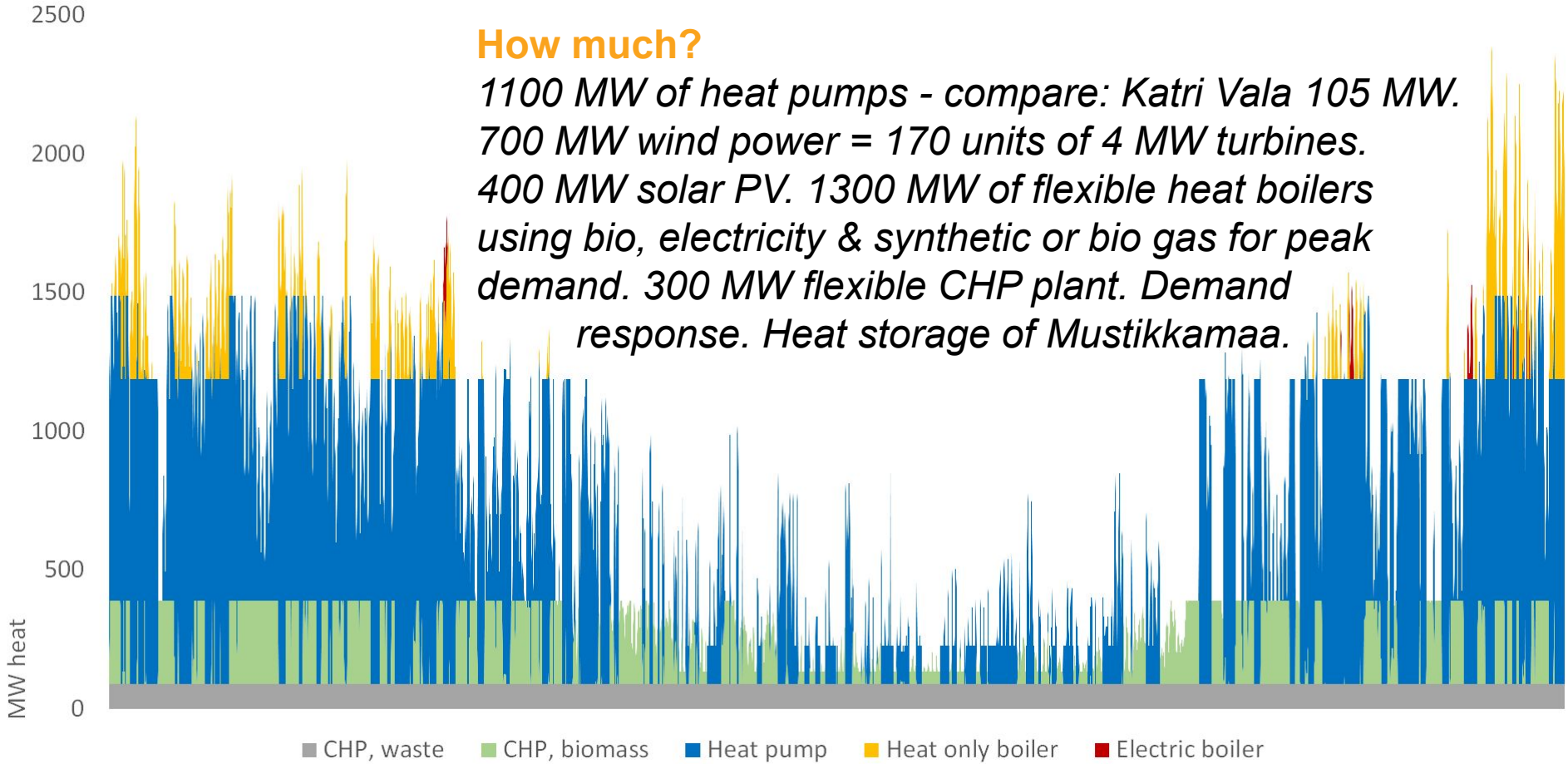
# Helsinki's fossil-fuel free district heating

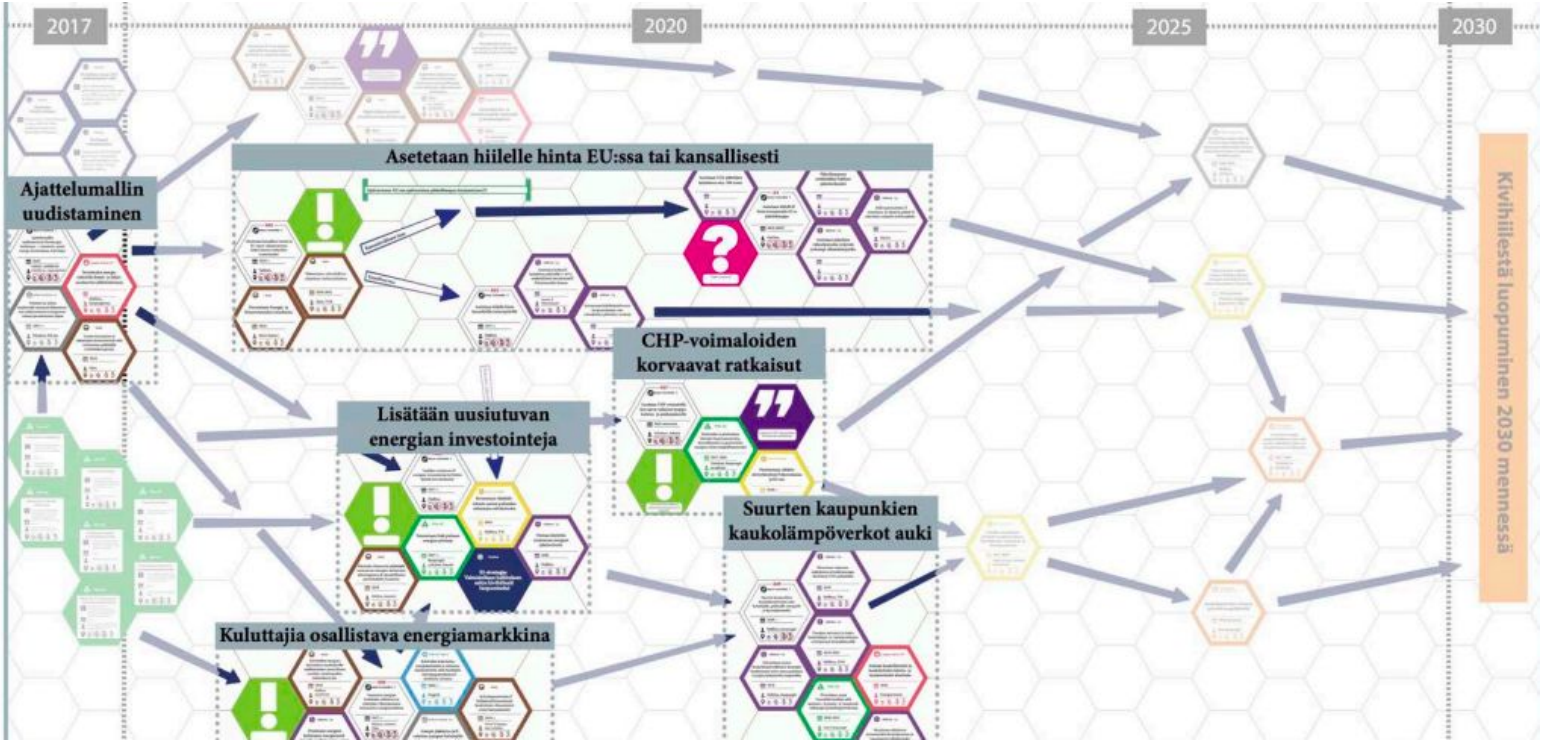
## How much?

*1100 MW of heat pumps - compare: Katri Vala 105 MW. 700 MW wind power = 170 units of 4 MW turbines. 400 MW solar PV. 1300 MW of flexible heat boilers using bio, electricity & synthetic or bio gas for peak demand. 300 MW flexible CHP plant. Demand response. Heat storage of Mustikkamaa.*




**The district heat production in Helsinki hour-by-hour *based on 100% fossil-free energy scenario for Finland. Figure: EnergyPLAN simulation tool.***

# Are district heating companies in transition towards smart and clean heating?

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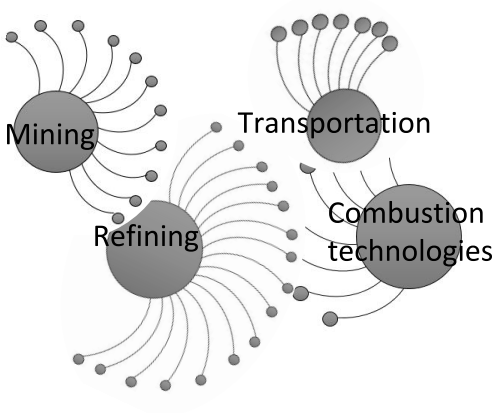
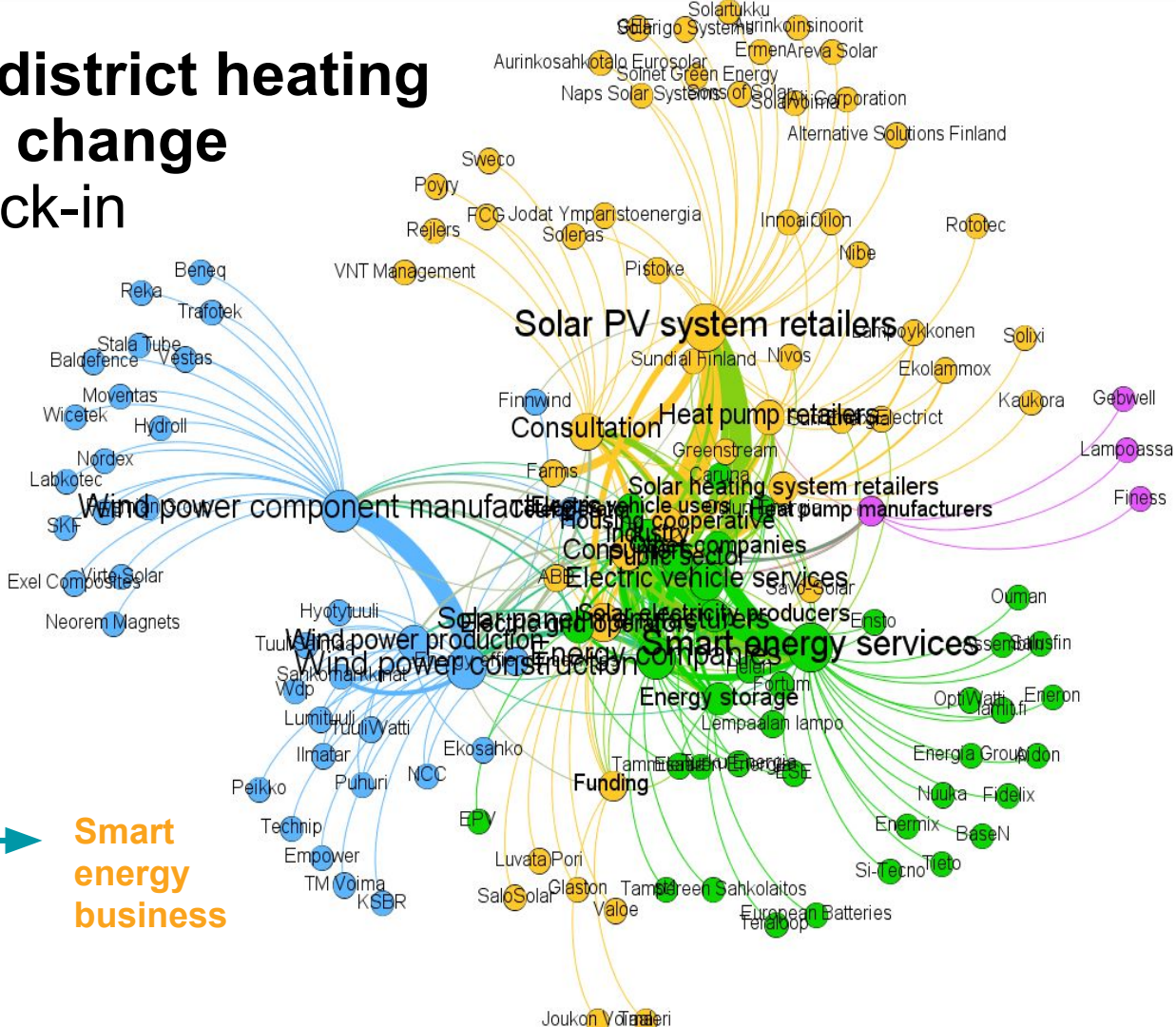
# Electrification of the district heating system is a systemic change

Barriers: technology lock-in and path dependency




**Fossil fueled industry** → **Smart energy business**

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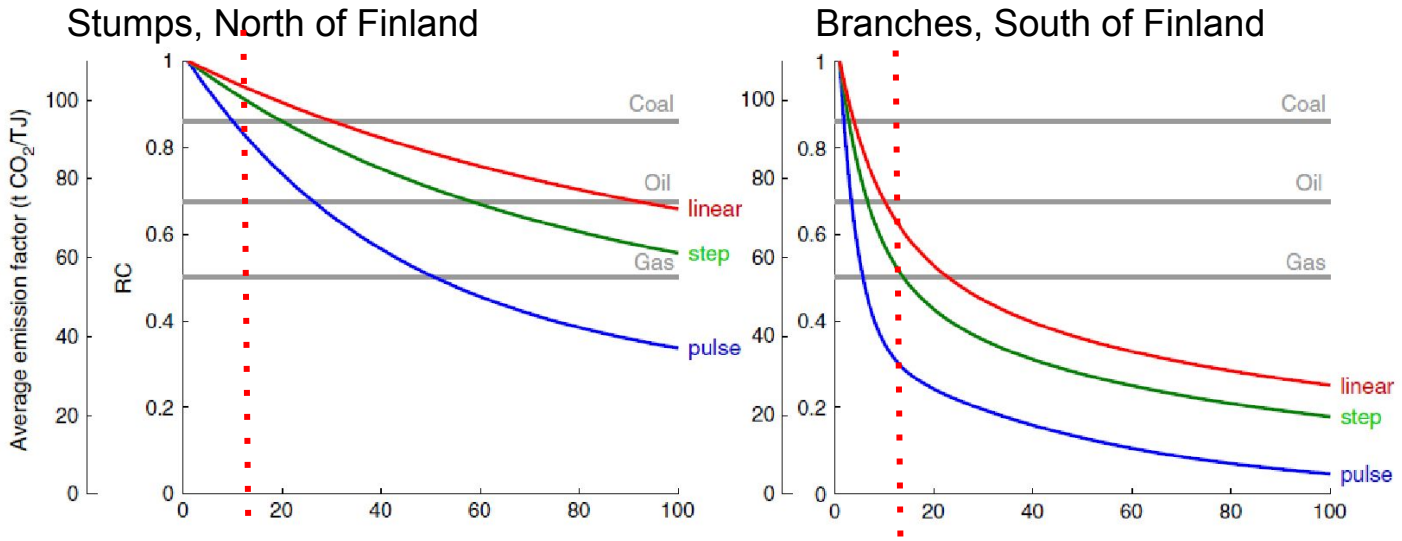
# Is biomass burning a climate solution?




Sources: Pingoud, K., Ekholm, T., Soimakallio, S. and Helin, T., 2016. Carbon balance indicator for forest bioenergy scenarios. Gcb Bioenergy, 8(1), pp.171-182.
Soimakallio, S., Saikku, L., Valsta, L. and Pingoud, K., 2016. Climate Change Mitigation Challenge for Wood Utilization - The Case of Finland. Environmental science & technology, 50(10), pp.5127-5134.
Helin, T., Salminen, H., Hynynen, J., Soimakallio, S., Huuskonen, S. and Pingoud, K., 2016. Global warming potentials of stemwood used for energy and materials in Southern Finland: differentiation of impacts based on type of harvest and product lifetime. Gcb Bioenergy, 8(2), pp.334-345.

# Challenges

- Finnish commodity taxation supports currently biomass and peat burning: electricity 22,5 eur/MWh, biomass 0 eur/MWh and peat 3 eur/MWh
  **-> government's promise: to lower electricity tax for DH heat pumps**
- ETS is not reflecting true costs of climate change
  - **EUA price to drive investments should be minimum 35 eur/tCO2**
  - **EUA price to meet Paris Accord should be 42-85 eur/tCO2**

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# Game Changers: tax and technology

Technology breakthrough of the industrial heat pumps

- efficiency-temperature ratio increasing
- can produce 120 Celsius degrees heat

Many pilots are running In Finland:

- 1-3 km deep boreholes for industrial ground source heating and cooling & heat storage
- 6-7 km deep boreholes for geothermal heat

**Comercial industrial heat pump plants using boreholes expected to be available in appr. 1-2 years**

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**Friday, September 27, 2019**

**Finland: Testing at 40 MWth Espoo Geothermal District Heating Project Scheduled to Begin at Year End**

Piloting world's first seasonal geothermal energy storage (Business Finland)

**Interview with Mikael Maksimow,** Chief Operative Officer - Quantitative Heat Oy

How to develop 2000 meters deep geothermal heat well and confirm its function? This is exactly what we at Quantitative Heat Oy are set to do in Smart Otaniemi programme. During the last years we have done a huge amount of research and simulations and developed a working hypothesis of how 2000 meters deep geothermal heat well would behave in real estate heating and cooling.

**St1 to launch the final phase of drilling the world's deepest geothermal heat wells in Otaniemi**

ST1_RELEASE 03.09.19

# Thank you!

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