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Negative CO_2

Negative CO_2 Emissions with Chemical-Looping Combustion of Biomass

Nordicenergy.org/flagship/negative-co2/

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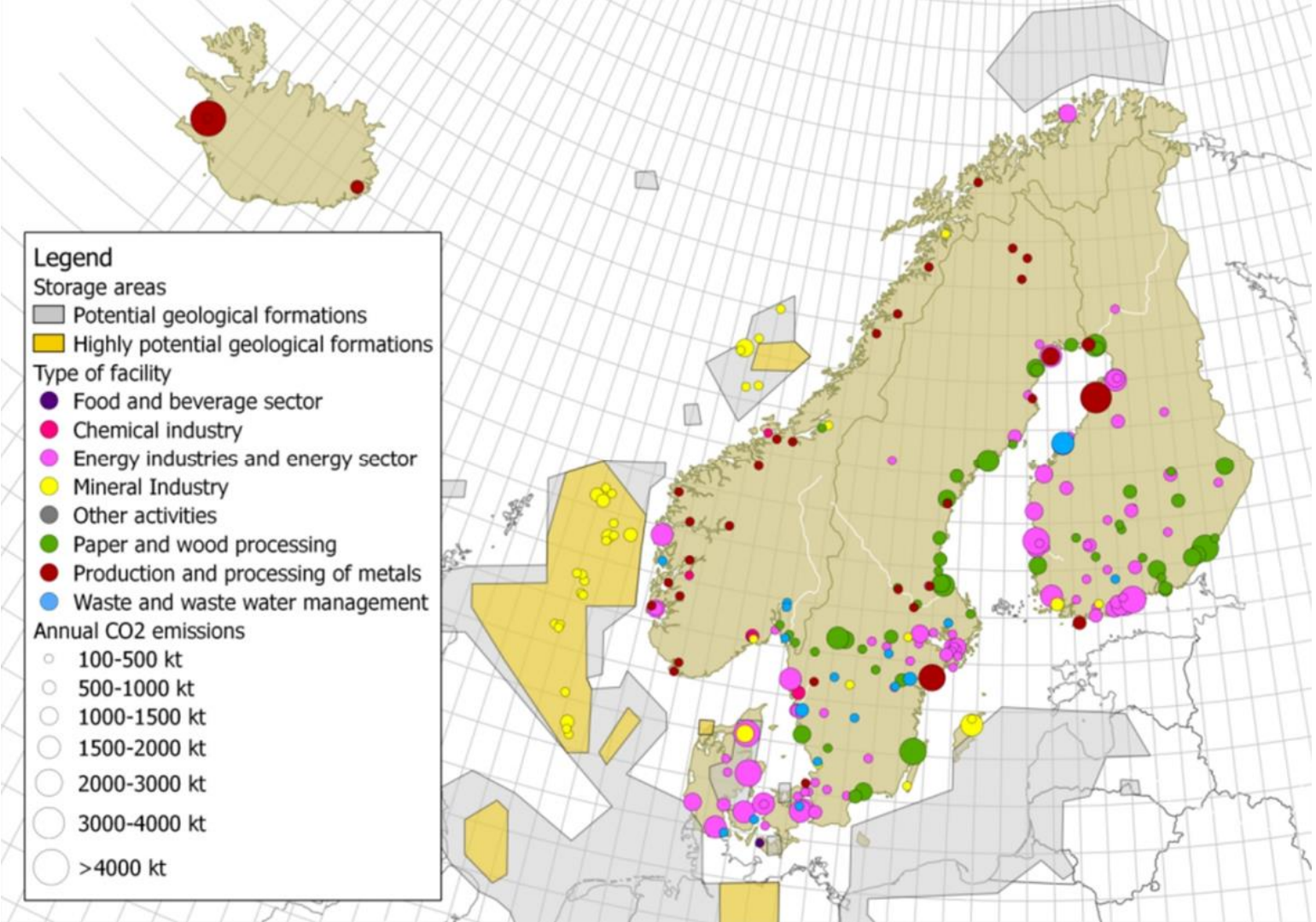


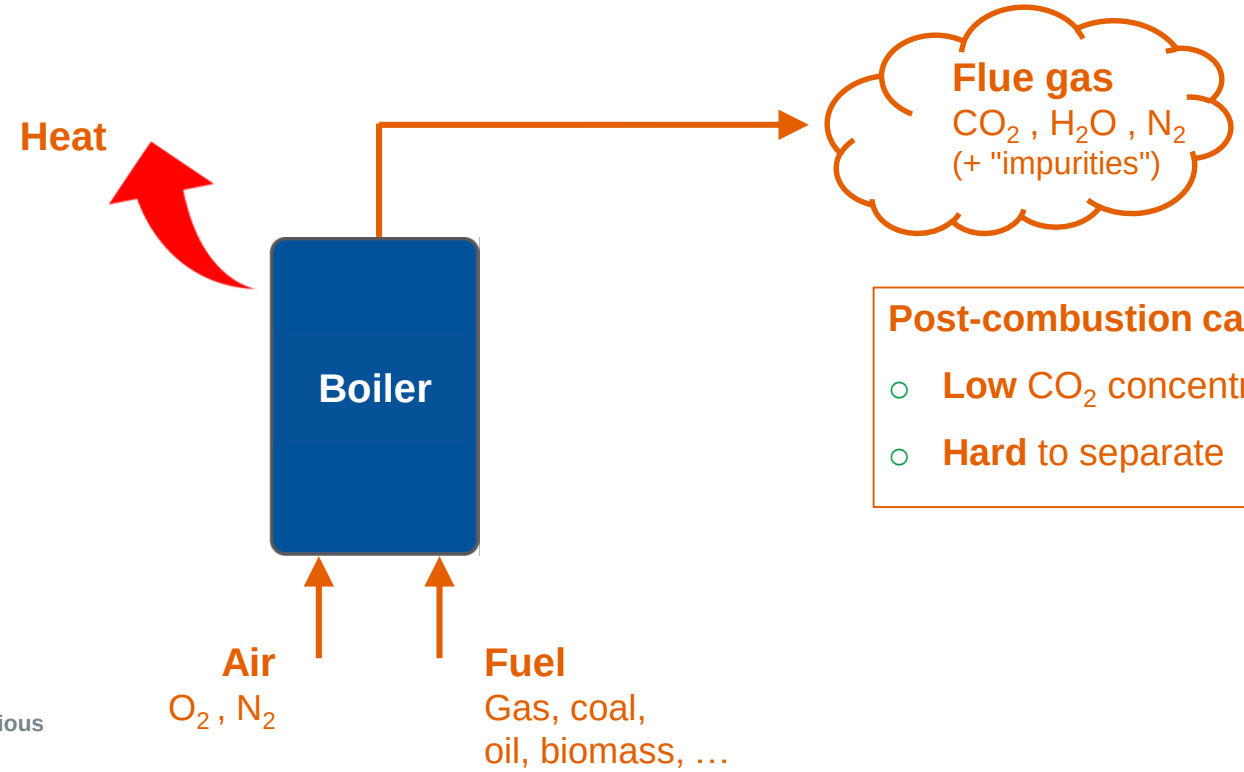
CO_2 point sources and storage areas

(in Nordic countries at 2010)

Negative CO_2 project

- Develops bio-CLC technology for cheaper bioenergy CCS
  - CLC = Chemical Looping Combustion

Combustion for heat and power

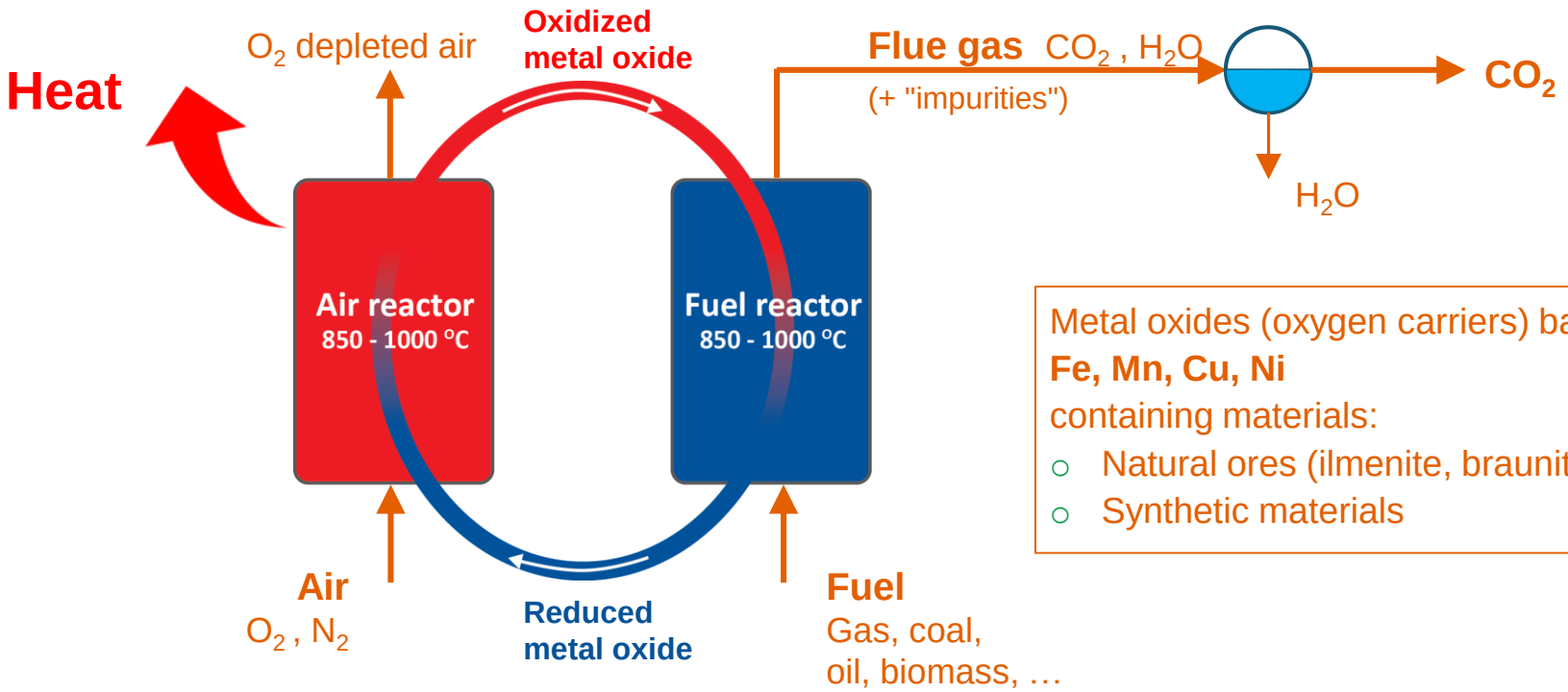


Post-combustion capture

- **Low** CO_2 concentration
- **Hard** to separate

Chemical Looping Combustion - CLC

See also https://www.nordicenergy.org/article/how-does-chemical-looping-combustion-work/



Metal oxides (oxygen carriers) based on **Fe, Mn, Cu, Ni** containing materials:

- Natural ores (ilmenite, braunite)
- Synthetic materials

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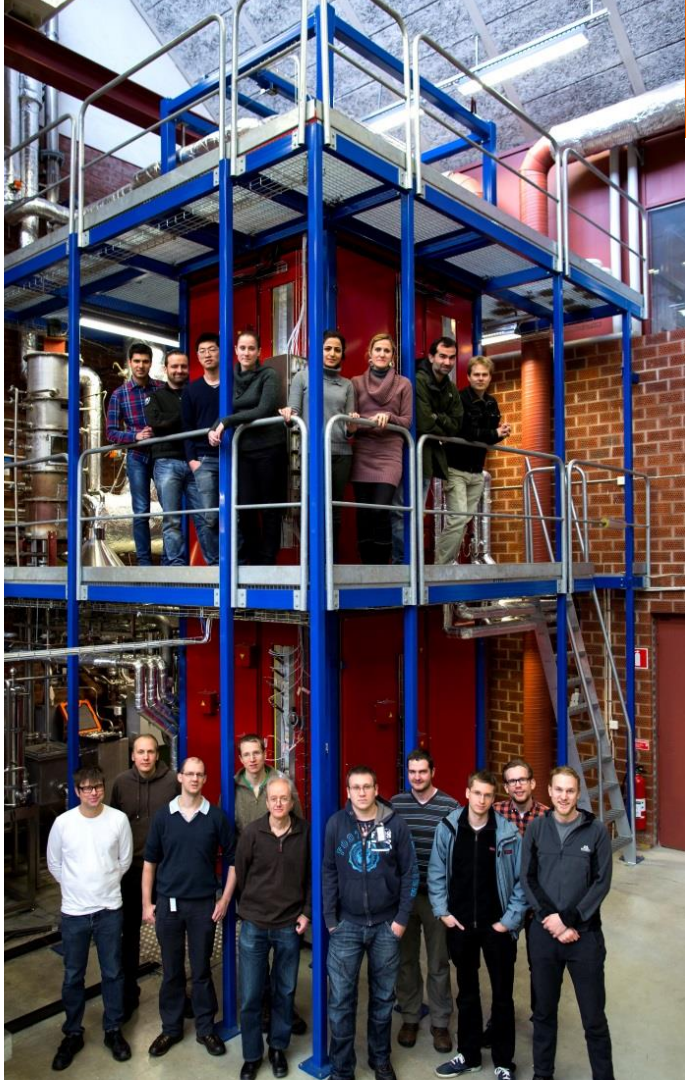
Negative CO_2 project

- Develops bio-CLC technology for cheaper bioenergy CCS
- Operates bio-CLC pilot units in Sweden, Finland, and Norway
- Is searching for medium-scale demonstration plant
- Models techno-economic studies of bio-CLC in energy systems

See also https://www.nordicenergy.org/flagship/negative-co2/



Yes, it works!

10 kW gas, 2003

10 kW solid, 2006

100 kW bio, 2011
Currently 3 pilot units

2.4 MW bio, 2015

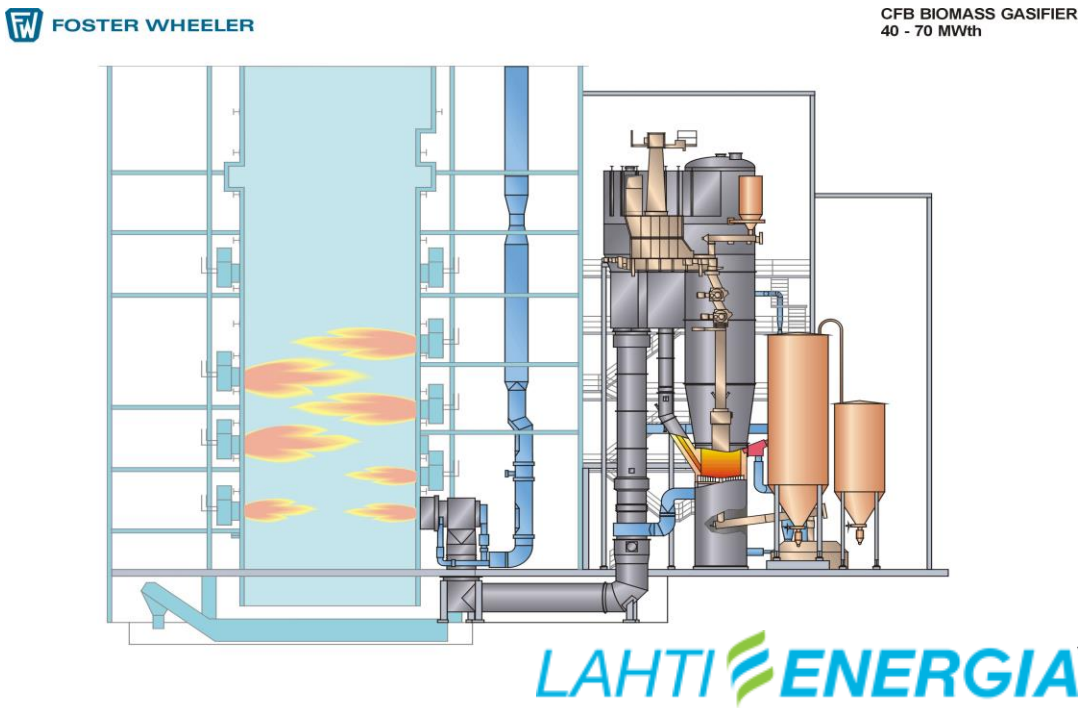
Ideal demonstration conditions?

- **Minimize the investment cost**
  - Use of existing fluidized bed units and other process components
- **Minimize the investment risk**
  - Multipurpose design. e.g. the bio-CLC unit can be utilized for energy production without CCS, if needed
- **Partial and/or stepwise demonstration**
  - The main target is to demonstrate the bio-CLC process,
  - other process parts, e.g. CO_2 capture and storage are similar to other CCS technologies
  - Capture and storage part can be installed later

→ **Funding possibilities and interested companies?**

Lahti Energia bio-CLC demonstration plan

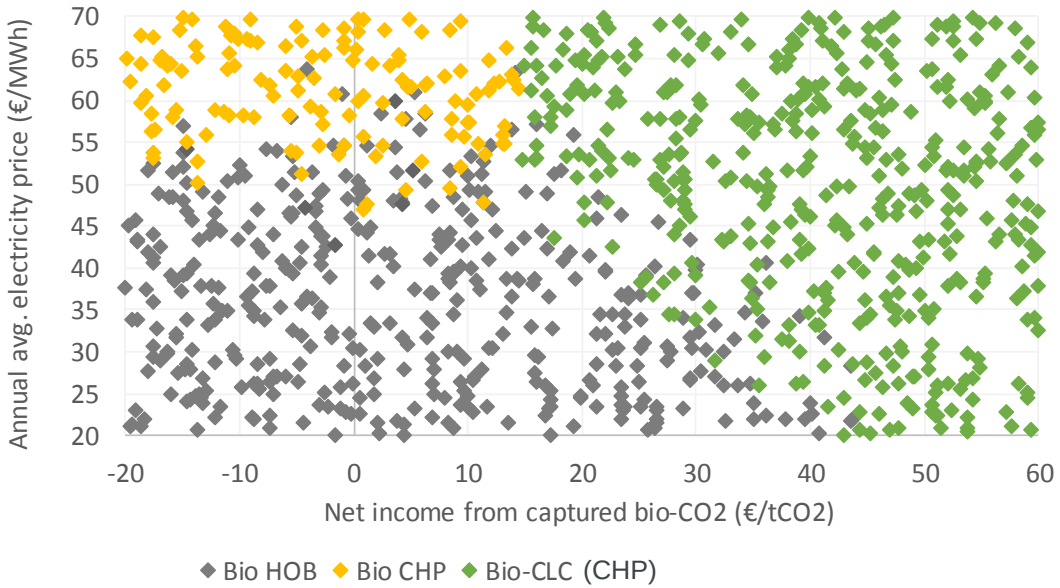
- In operation 1998-2019
- Nominal capacity 60 MW_{th}
- Fuels: previously SRF, demolition wood, wood waste (tested also tyres, dried sewage sludge, etc.); last years only clean wood
- CFB-gasifier planned to be bio-CLC fuel reactor
- Possibility to use also other existing infrastructure and fuel supply
- Heat generated to district heating



Techno-economic analysis

Biomass CHP, heat only, or bio-CLC?

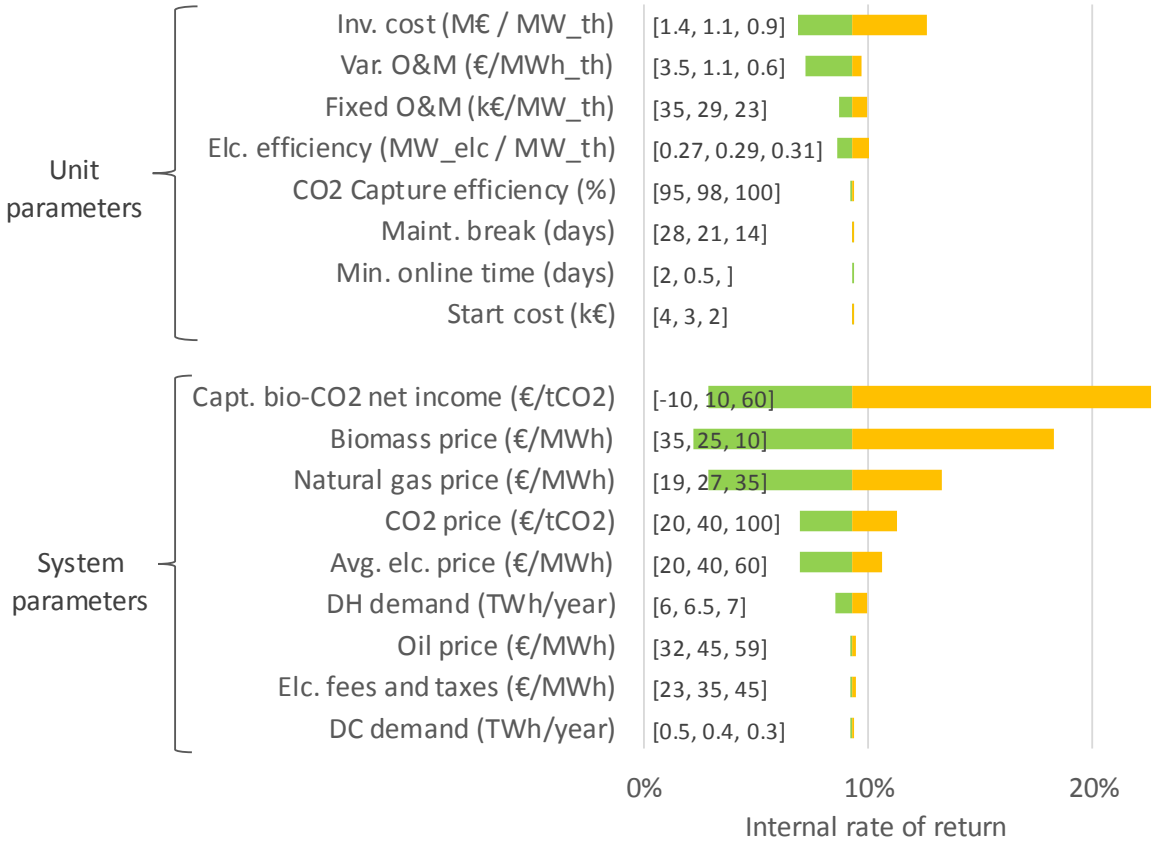
- Net-income from captured bio-CO_2 above 15€/tCO_2 could be enough for bio-CLC
- Electricity market price (current and expected) largely decides between CHP and heat only units
- Low electricity prices favor also large heat pumps



https://www.sciencedirect.com/science/article/pii/S2213138818306520

What are the largest uncertainties?

- Case study modelled for the capital region of Finland.
- Local conditions will differ from a city to another



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