Modelling tools for assessing the transition to low-temperature district heating

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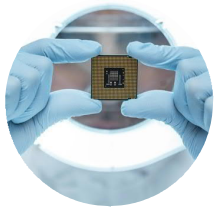
VTT – *beyond the obvious*

VTT is a visionary research, development and innovation partner for companies and the society.

We bring together people, business, science and technology to solve the biggest challenges of our time. This is how we create sustainable growth, jobs and wellbeing and bring exponential hope.

Carbon neutral solutions



Digital technologies

Sustainable products and materials

244 M€

turnover and other operating income

2,129

employees

45%

of the net turnover from abroad

32.5%

a doctorate or a licentiate's degree

Established in

1942

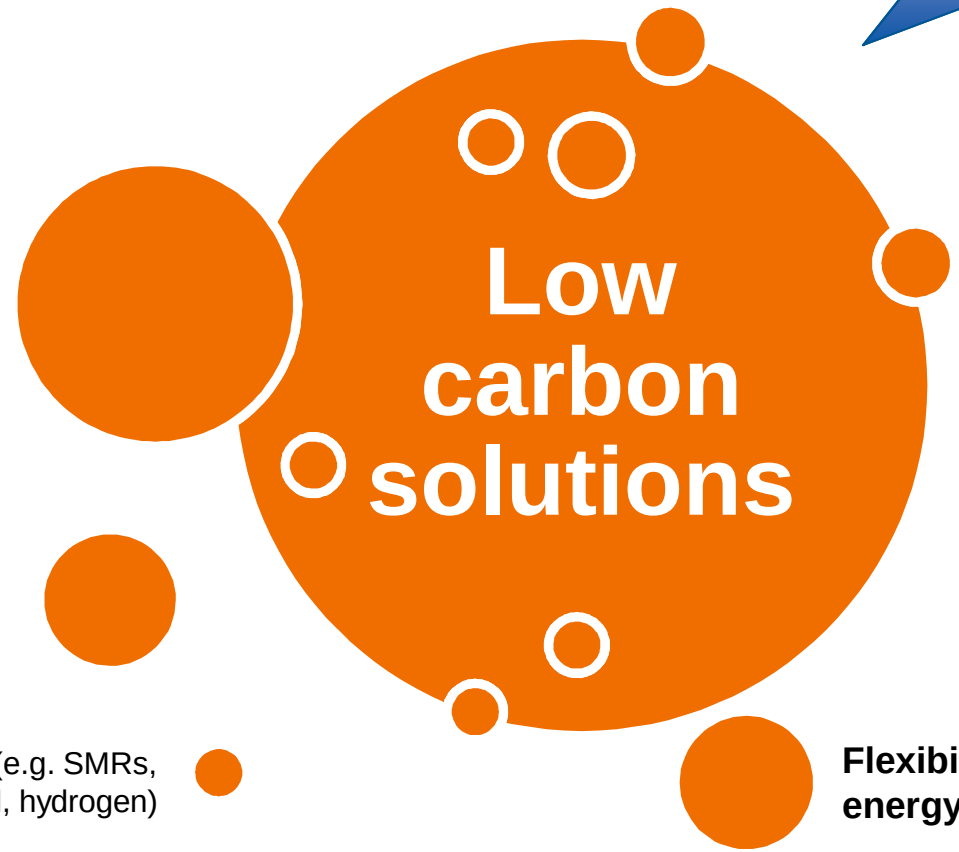
Owned by Ministry of Economic Affairs and Employment

Presentation contents

- Trends in developing district heating
- Specific challenges related to the development
- Assessing transition to low-temperature distribution
- On-going work within IEA Annex XIII programme: Case Lapua (Finland)
- Next steps, current activities in Finland
- Summary

Trends in developing DH

Word ”District heating” in renewable energy directives: RED (2009) → RED2 (2018): 9 matches → 47 matches



Low distribution temperatures

Neutral temperature distribution; combined heating and cooling network

Excess heat utilisation

More distributed heat supply

Flexibility and energy storage

New technologies (e.g. SMRs, advanced geothermal, hydrogen)

Combined heating and cooling

Electrification and sector-coupling

Specific challenges related to the development

Low-temperature distribution has defining impact on most of not all of the listed items.

- Large-scale implementation of the low-carbon solutions
- Business (models) for flexibility and sector-coupling
- Anticipating the technical and regulatory development of the new technologies
- Implementing low-temperature distribution for existing systems
- Managing a more distributed/complex system
- Mapping and harnessing local excess and natural heat sources

→ **All these require deep insight into DH technologies/systems, involved stakeholders and the business <u>as well as modelling tools</u>**

Assessing transition to low-temperature distribution

- Buildings and their heating systems
- Network design and operation; capacities, temperature levels
- Impacts on existing and new heat supply
- Stakeholders and their assets; targets and decision-making
- Long-term planning; system evolving within an energy system in transition
- Economics and market; benefits and costs of the transition, market and/or mechanisms to align interests of different stakeholders

Technical solutions
Economics
Decision-making
Policy/regulation

Bottlenecks not always self-evident

OPTiTRANS objectives and scope

An IEA DHC Annex XIII project

The principal objective is to address the practical barriers for developing DH into a low-temperature and a low-carbon system.

IVL uses an urban strategic investment optimization model (TIMES) to analyse the optimal long-term (by 2050) transition pathway toward low-temperature and low-carbon DH systems.

VTT combines a distribution network simulation with a city-level optimisation model.

DTU focuses on new strategies based on data-driven analysis using the capabilities of existing wireless digital devices. The cost-effectiveness of the proposed solutions and an assessment of the impact of the 'Motivation tariffs' will also be presented.

VITO focuses on fault detection and new control solutions for DH substations to ensure the lowest temperature operation under all circumstances.

https://www.iea-dhc.org/the-research/annexes

IEA Annex XIII OPTiTRANS:

Case Lapua (Finland)

Heat supply

- CHP unit with a flue gas condenser (4 MW_e, 18 + 2 MW_{th})
- A biomass boiler run by a 3rd party (1.5 MW)
- Sawmill, burning residues (6 MW)
- 7 heat-only boilers as backup/peak (7 MW peat, 28.5 MW oil)

Distribution network

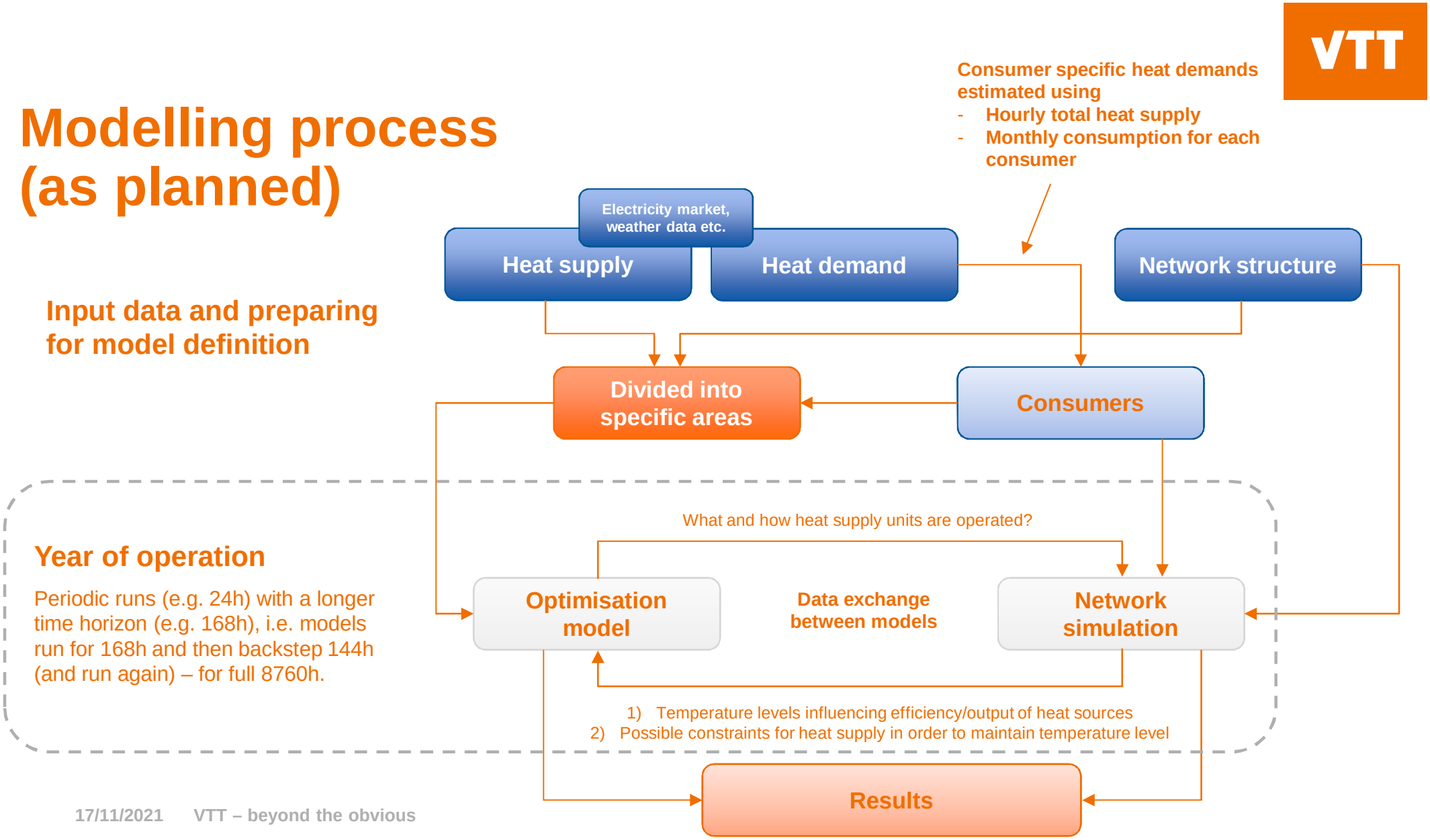
- 71.6 km, supply temperatures 70-113 °C, yearly heat losses 15.8%

Demand

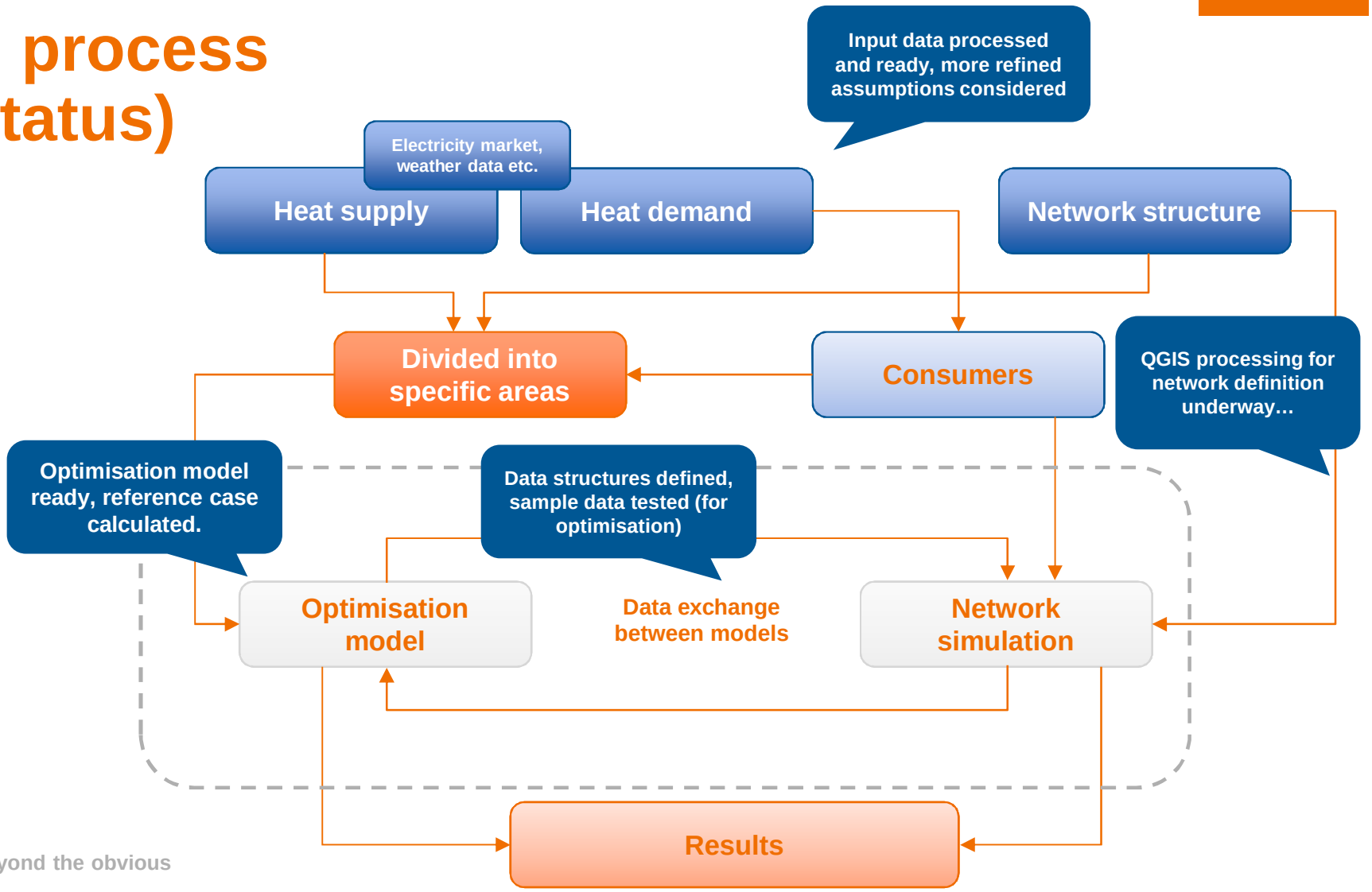
- 70 GWh, 700+ customer connections

Source: https://lapuanenergia.fi/

Modelling process (as planned)

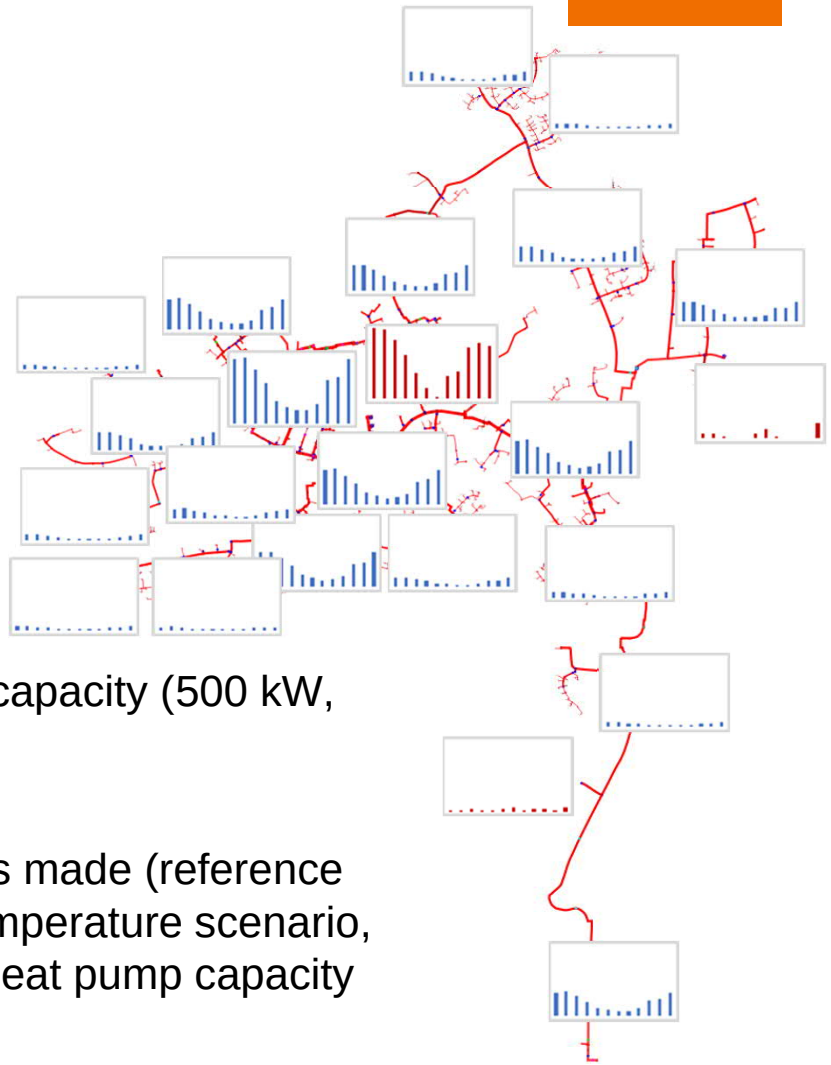


Modelling process (current status)



IEA Annex XIII OPTiTRANS:

Case Lapua (Finland)

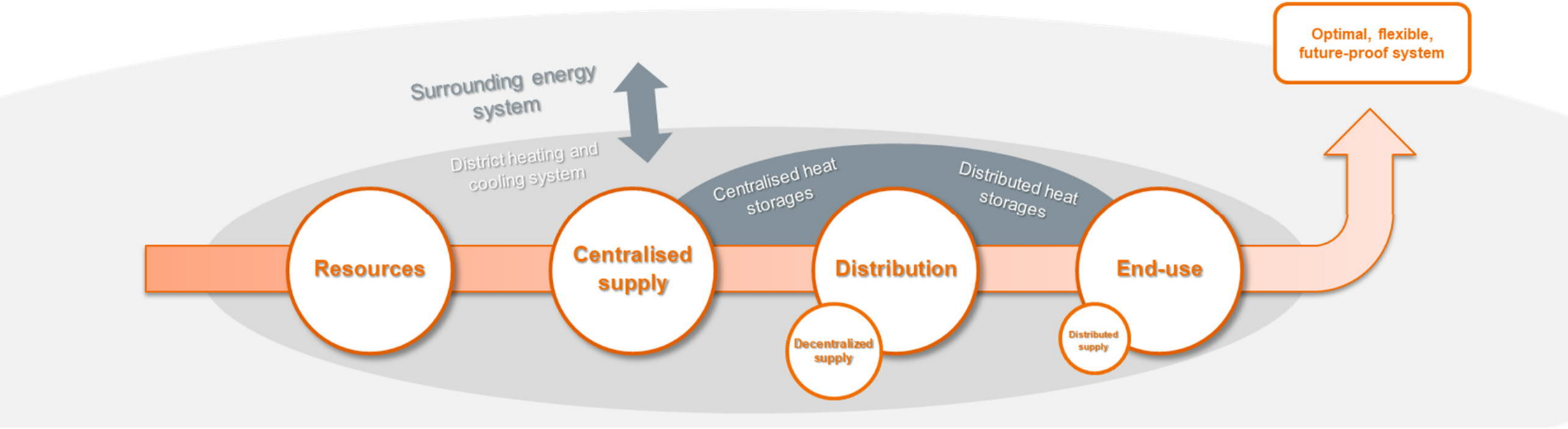


- Network divided into 21 areas; each with their own demand, losses and supply balance
- Connections between areas constrained according to pipe heat transport capacity
- **Reference case**; existing heat supply as such
  → CHP dominates
- **New renewable/excess heat supply**; additional heat pump capacity (500 kW, COP=3) for areas with low heat demand densities
  → very little impact on current heat supply
- **Next steps;** Network model completed, first combination runs made (reference scenario; updated COPs and efficiencies), then low return temperature scenario, low-temperature scenario, refining the assumptions for new heat pump capacity

Next steps, current activities

Continuation of the IEA activities and implementation of VTT's research plans

- Joint project with the Finnish DH industry prepared; focusing on the whole DHC value chain
- Topics included; changing operational environment, summarising and analysing company-specific low-carbon roadmaps, developing modelling tools and practices, multi-stakeholders decision-making
- The most important element; involving the industry in defining the research needs



Summary

- **Emission reductions remain the primary driver** for development of DHC, but integration of the H&C sector with the surrounding energy system getting more and more important
- **Low-temperature distribution** appears to be a key element in future systems; although the whole value chain needs to evolve
- VTT is working on **combining system optimisation with distribution network simulation** → a tool for assessing the low-temperature transition
  - A realistic large-scale case system enables meaningful results
- **Joint project in Finland planned**; getting the DH industry involved in system-wide development of DHC and the needed tools/practices.

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