Study: Towards Finnish SMR pilots

Ville Tulkki, Mona Arnold, Olli Soppela, Jaakko Leppänen VTT
Juhani Hyvärinen LUT

Background

- City of Lappeenranta and Lappeenranta Energia initiated a project to review options to enhance adoption of nuclear district heating in Finland
  - Recognised need for various options for low carbon heat production with nuclear energy as one of the options
- VTT and LUT University performing research, 12 participating organisations
- VTT and LUT have had projects on nuclear district heating reactor desings
  - Intent to review how municipal actors' needs can be taken into account early in the development, and how the Finnish technology work could be efficiently accelerated towards demonstration

Project consortium

- City of Lappeenranta and 11 energy companies
  - Companies responsible for more than half of Finland's district heat supply

Overview of the study

Study in three parts

- Survey of the present situation
- Technology status, financing of investments
- Pathways to future

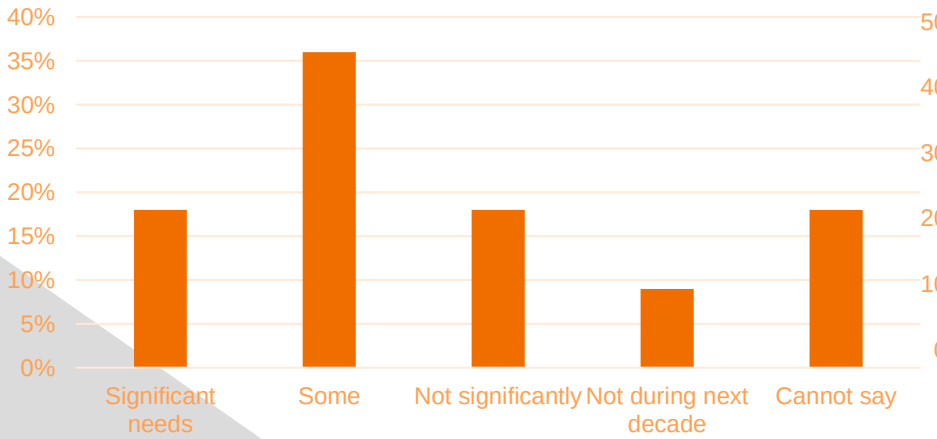
Survey overview

- The questionnaire contained three parts:
  - Current and future need for renewable and low-carbon energy
  - Technology maturity and investment criteria
  - Location of a possible pilot-plant

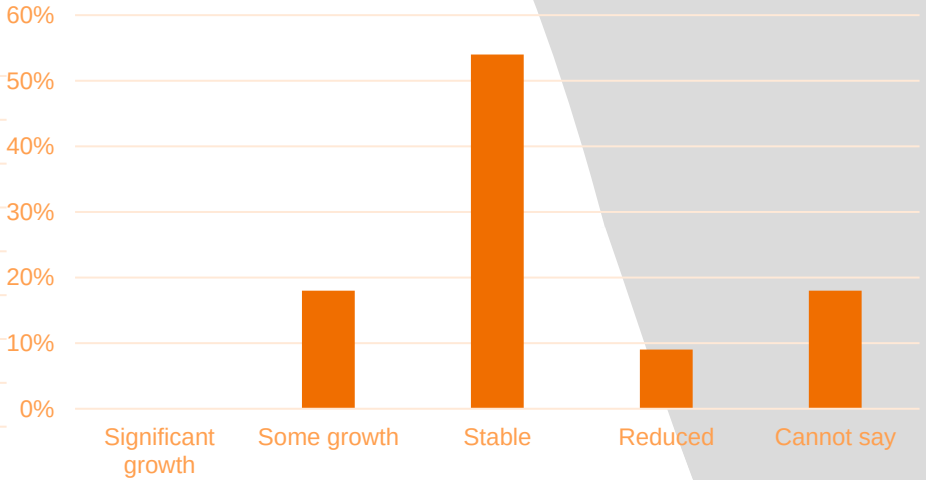
  + other critical factors and stakeholder needs
- Follow-up interview of circa half of the respondants:
  - aim to find out the boundary conditions for participating in a pilot plant
    - Possible performance requirements (e.g. heat output, network requirements)
    - Possible schedule boundary conditions
    - Possible plant locations
  - Role and business model
  - Critical stakeholders

Current and future need for renewable and low-carbon energy

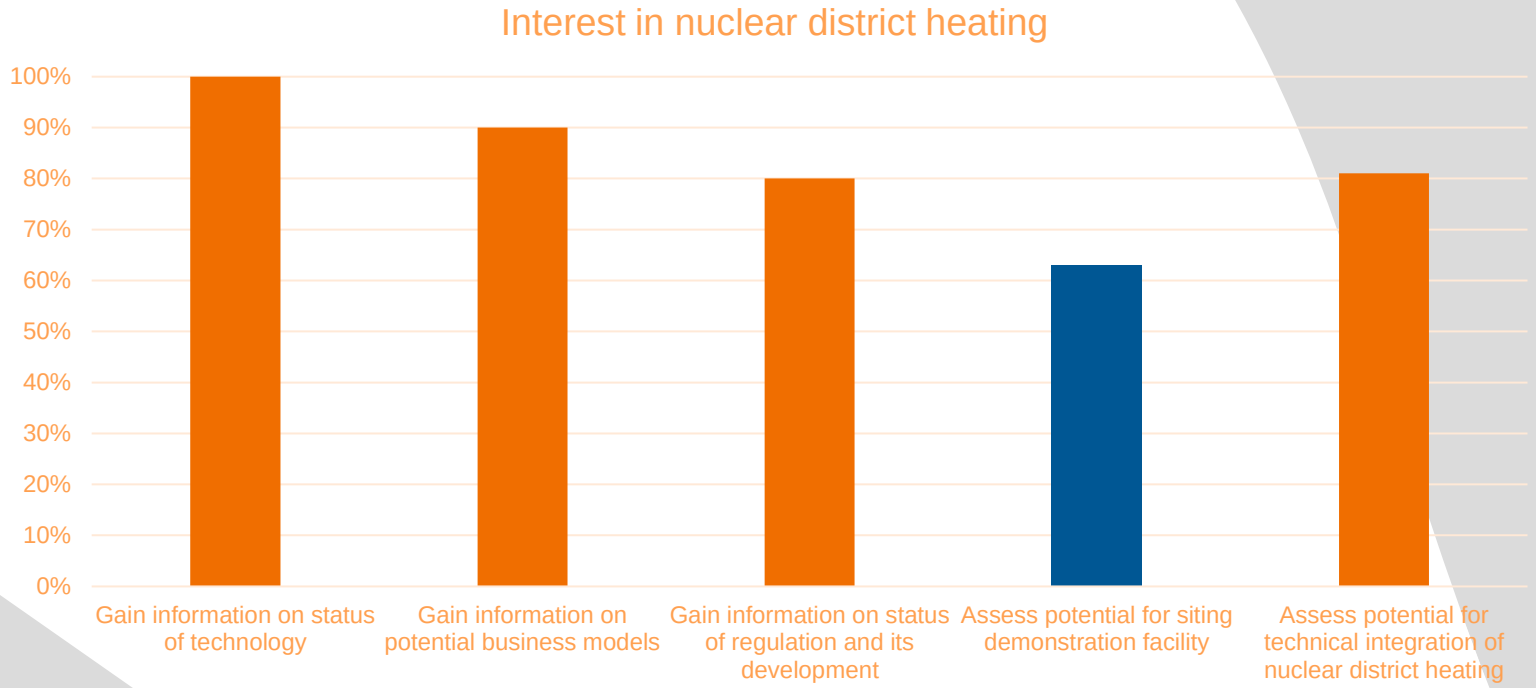
More than half see need for near term investment



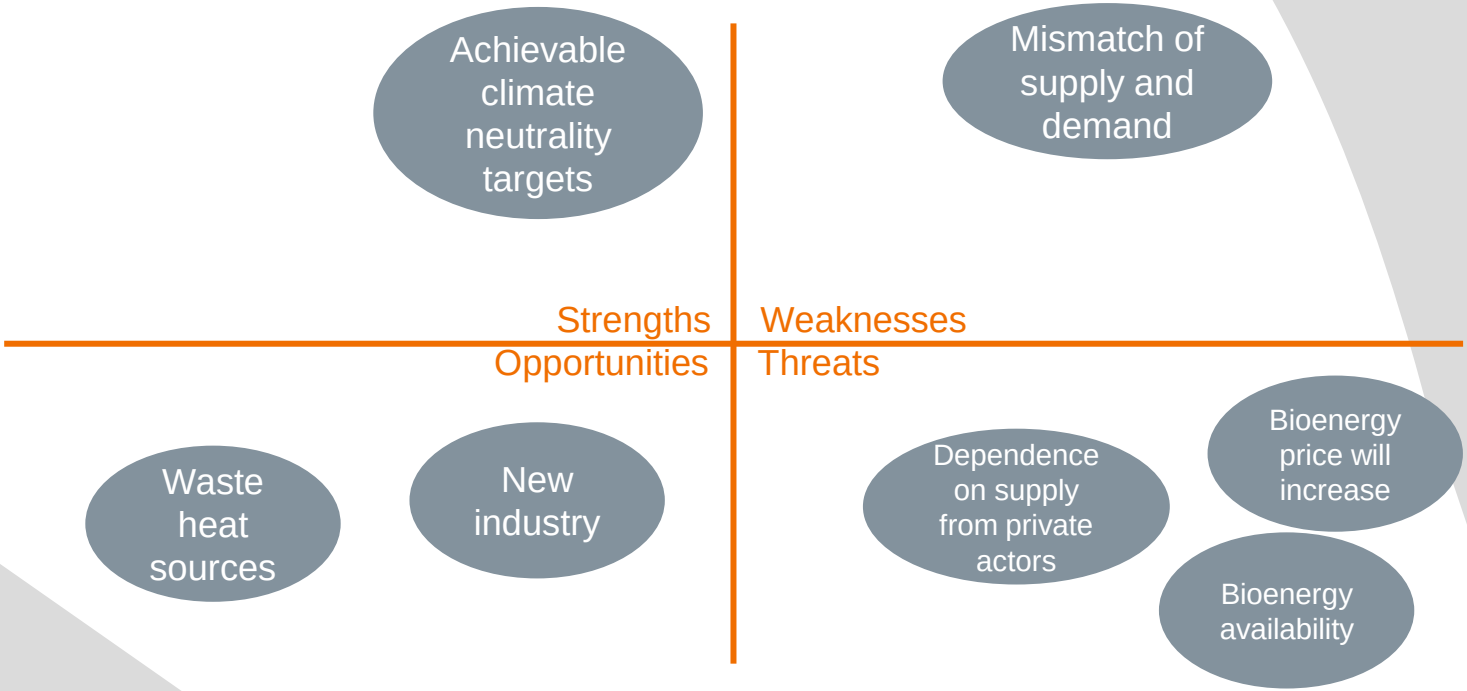
Future district heating consumption



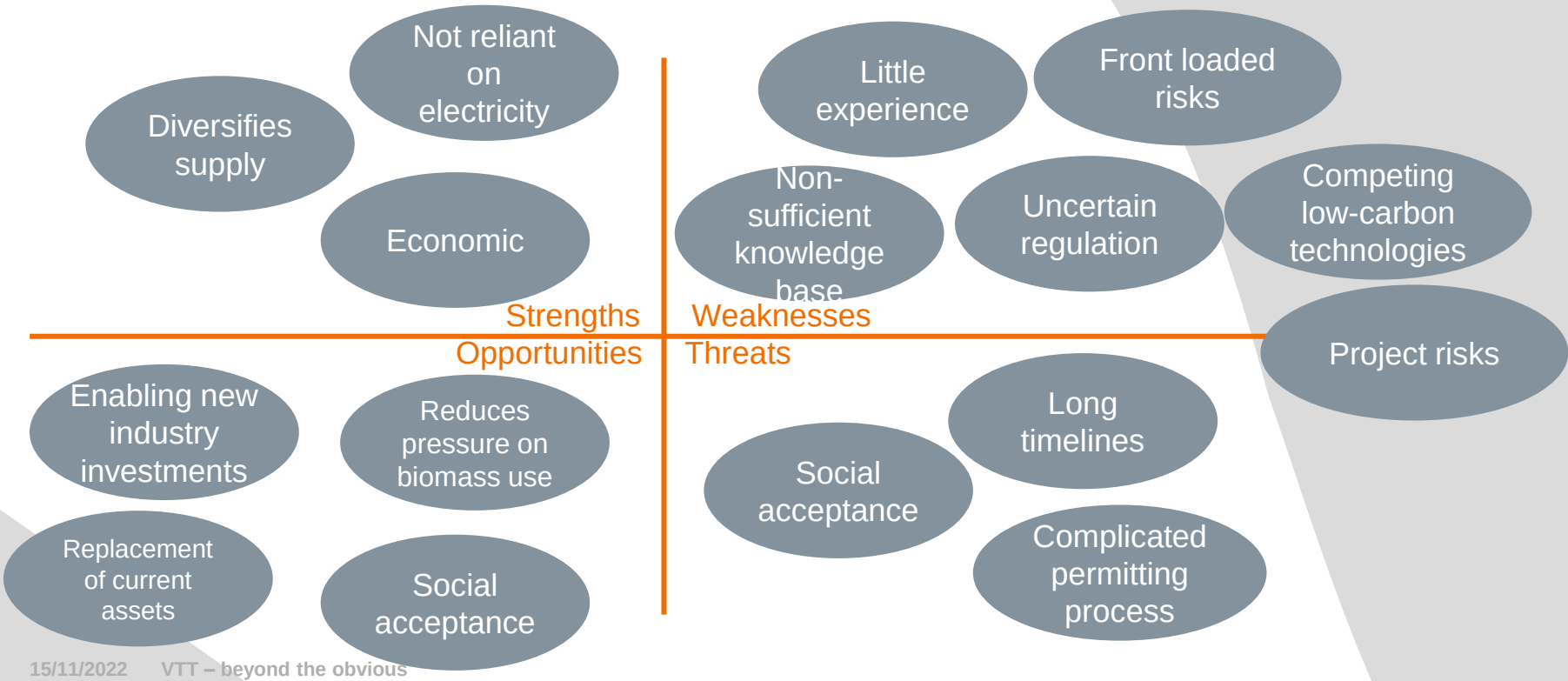
Interest and role in participating in a collaborative SMR pilot



Commentary on current situation



Perception of nuclear district heating



Outcome of the survey

- Potential supply need varies
  - 50 to several hundreds MWs of heat
  - Low summer demand requires flexible low power operation
  - Combined heat and power production vs heat only depends on economics
- Timeline of needs varies
  - Recent investments don’t need replacement soon
  - Economy & acceptability may justify technology swifts before the end of the technical lifetime of current assets
  - Several cities foresee investment needs in the 2030s
- Security of supply emphasized
  - Technology
  - Operational
  - Organizational – operations may be outsourced but this must not hinder supply

Interviews:

- Appraised benefits of new non carbon technologies:
  - Diversification of supply options
  - Easing pressure on biomass use for all
- First mover risks are seen as high
  - Regulatory risks
  - Implementation risks
  - Public acceptance
- How to mitigate / share risks
- Collaborative approach beneficial

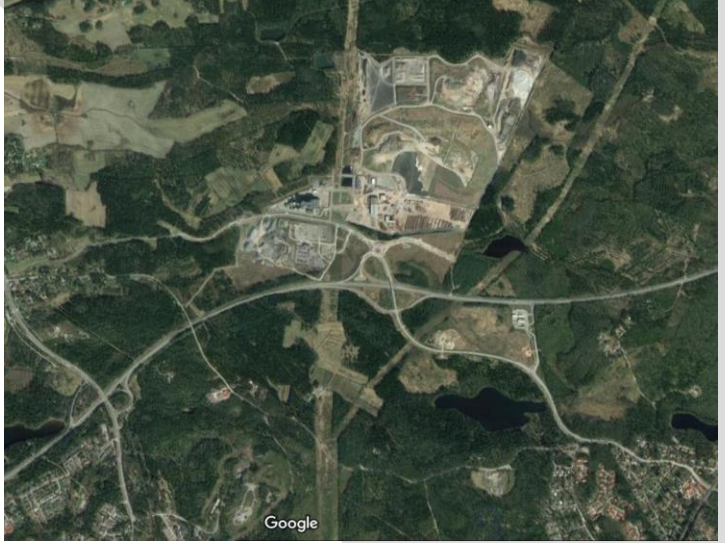
Shared benefits

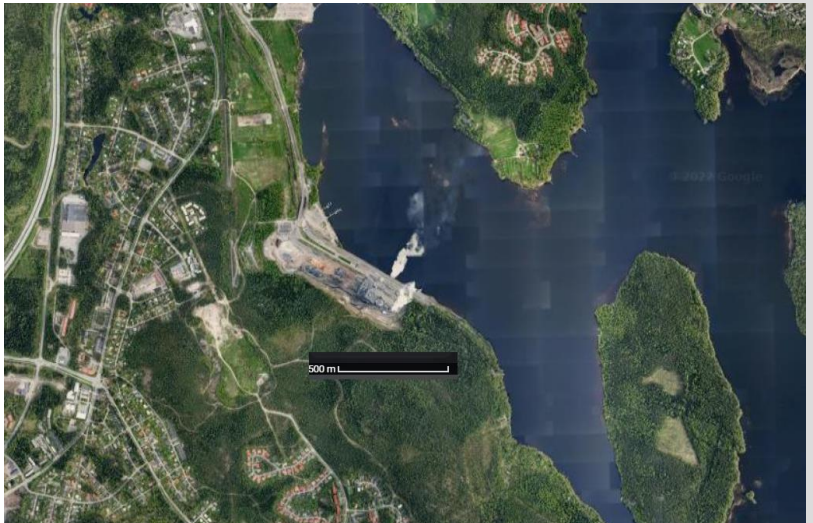
Individual risks

Sites for the district heating plants

- District heating plant must not endanger the activity near it; it must not be endangered by the activity
  - Safety and security a precondition for activity
- Brownfield sites would benefit from existing infrastructure
  - Industrial site, closeness of connections
  - Other options exist if these not possible
- But location raises questions
  - Closeness of main roads, other industry, residences
  - Regulations made for large electricity producing nuclear power plants would not allow siting in those locations
  - Some examples shown for illustration in next slide

Illustrative sites with existing infrastructure





Technology status

- IAEA ARIS data base describes more than 70 different ”SMR” designs, of various technologies and maturities
- Near-term deployable are mainly Light-Water Reactor designs (LWRs), similar to but smaller than presently operating large reactors
  - Unit sizes in generic LWRs: 60 to 470 MWe: NuScale, BWRX-300, Rolls Royce SMR
  - Cogeneration available as an add-on feature
  - Commercial demonstration about to begin in North America and UK
- Niche also for district heating designs
- Costs uncertain, depend on country-specific conditions

Financing

- **Mid-size municipal energy companies** can afford an one-time investment in the 100..300 M€ range
  - Payback time usually 10-15 years; investment lifetime at least 2x
  - Typical funding sources: balance sheet and bank loans
  - Financial feasibility depends very much on perceived project risk and how risks can be mitigated
- Risk and benefits of large investments have to be shared
  - With industrial partners operating in the area, or
  - Other comparable utility companies
  - Mankala ownership model much used in practice
- Might, in theory, afford an SMR project to the tune of 100 MWe
  - Optimisation of electricity and heat cogeneration needed
  - Different support for technology development or import

Pathways towards the pilot

- Technology-wise two main pathways
  - For development of district heating reactor a demonstration facility to build confidence, with larger production in mid-2030s
    - Incorporating Finnish technology development an opportunity
  - Buying an international reactor if applicable offer available

- Other issues are on critical pathway
  - Site and land use planning for the first reactors
    - Difficulty for environmental impact assessment if not enough information to be had
  - Requirements for siting especially if near existing infrastructure

Conclusion

- Interest for nuclear district heating exists
  - Diversification of energy sources for district heating
  - Shared benefits for technology demonstration, reducing pressure for sustainable biomass use
- Investments into new capacity from
  - Replacement of old assets
  - Economic reasons
- Need for investment in 2030s are seen
  - Nuclear district heating first movers have project risks
  - Technology development support, risk-sharing, political acceptance needed