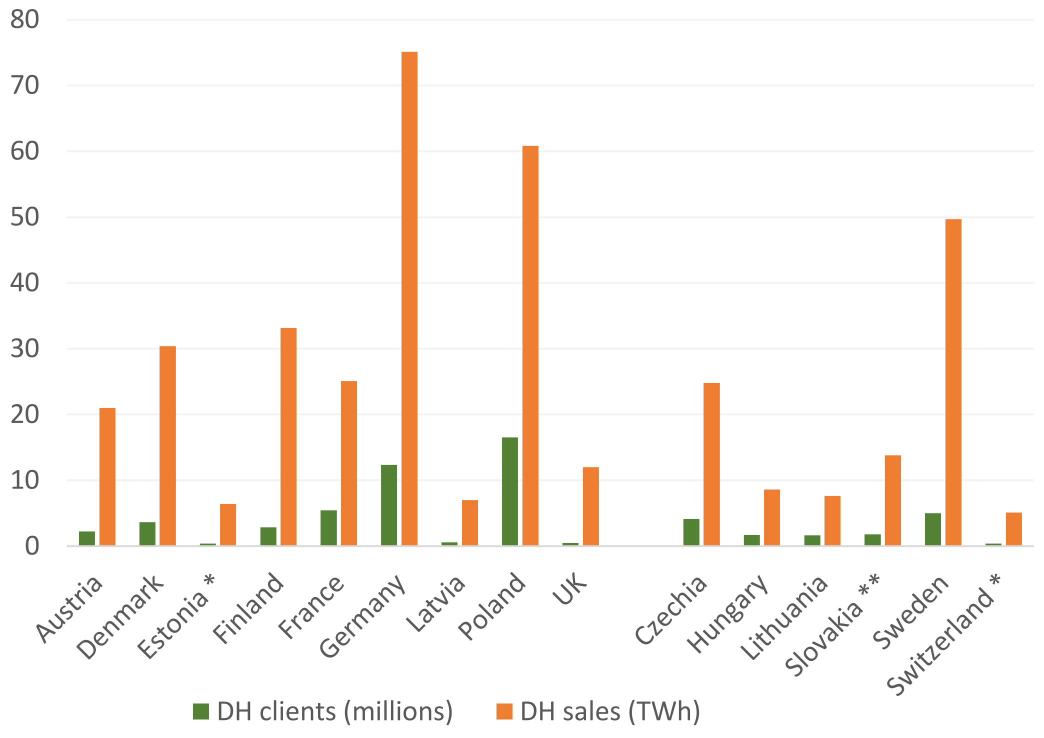
Modelling investments to district heat SMRs

Tomi J. Lindroos,
Tomi.J.Lindroos@vtt.fi

24/11/2021 VTT – beyond the obvious

European district heating (DH) overview

- District heating in Europe has
  - Largest market shares in Nordic and Baltic countries,
  - Largest volumes in Germany, Poland, and Sweden
  - Fastest growth in relatively new DH countries
  - Largest share of coal as DH fuel in Poland, Czechia, Germany, Finland (2017 data)

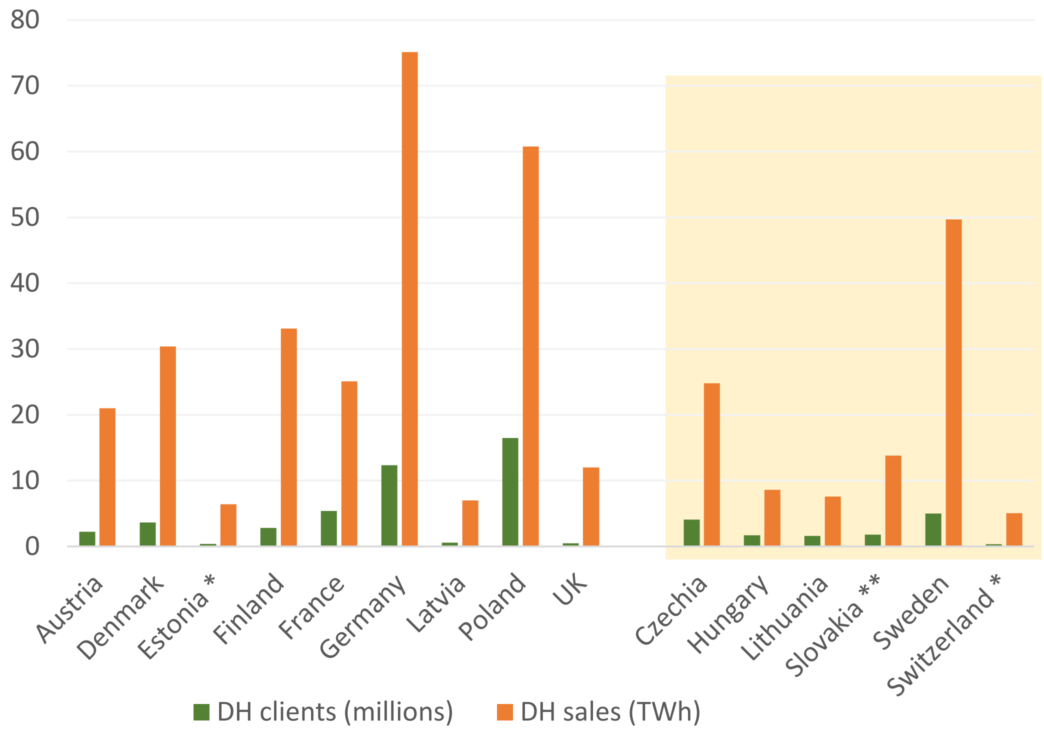


Data from 2017, except * from 2015 and ** from 2013

European district heating (DH) overview

- Existing nuclear DH in
  - Czechia (~0.5% of supply?)
  - Hungary (~2% of supply)
  - Slovakia (~0.5% of supply)
  - Switzerland (~7% of supply)

- Previously nuclear DH in
  - Sweden in 60's and 70's
  - Lithuania before Ignalina was closed in 2009

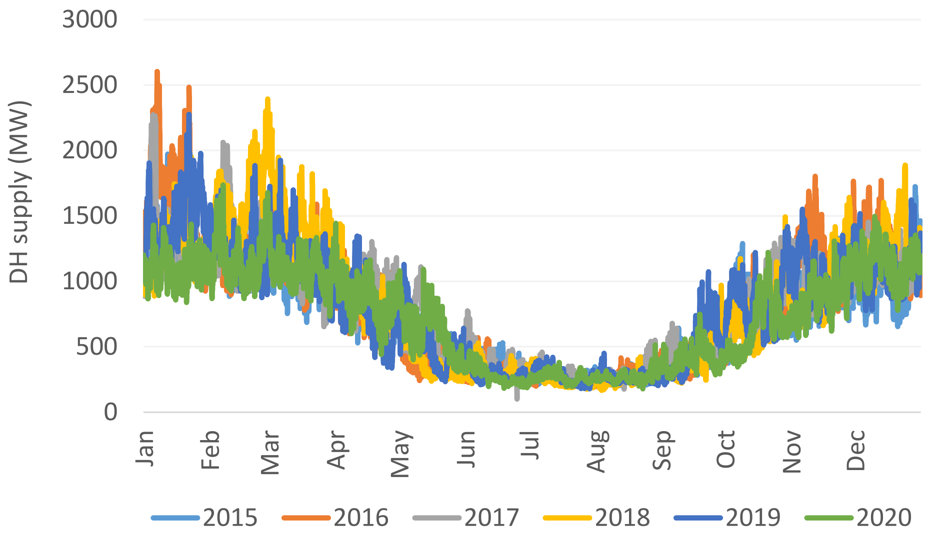


Data from 2017, except * from 2015 and ** from 2013

Requirements in DH grid

- Units in DH grid should follow varying
  - DH power,
  - Supply temperature (depending on country, typically below 100°C but up to 115°C during cold weeks in the Northern countries),
  - Produced typically close to consumption

- Combined heat and power units need to operate also on electricity markets



Data from Helen open data:
https://www.helen.fi/en/company/responsibility/current-topics/open-data

Estimating the potential market of SMRs

1) Theoretical potential
   - Forgetting all other units
   - Presented as function of unit size and required Full Load Hours (FLHs)
   - Requires grid-by-grid analysis

Number of large enough Finnish DH grids (capital region as one grid) assuming certain unit size and required operation time

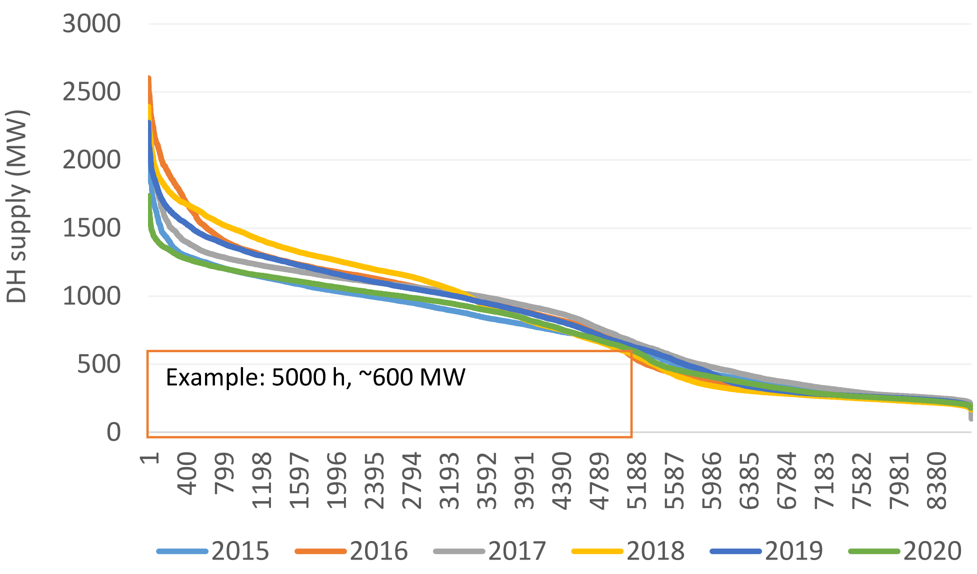
1)

	4000 h	5000 h	6000 h	7000 h	8000 h
400 MW_DH	4	3	1	1	1
200 MW_DH	7	7	4	1	1
100 MW_DH	19	14	9	6	3
50 MW_DH	26	23	19	12	7
25 MW_DH	47	41	31	23	15

Note: not the number of units, but number of grids/cities

Baseload vs. peak load

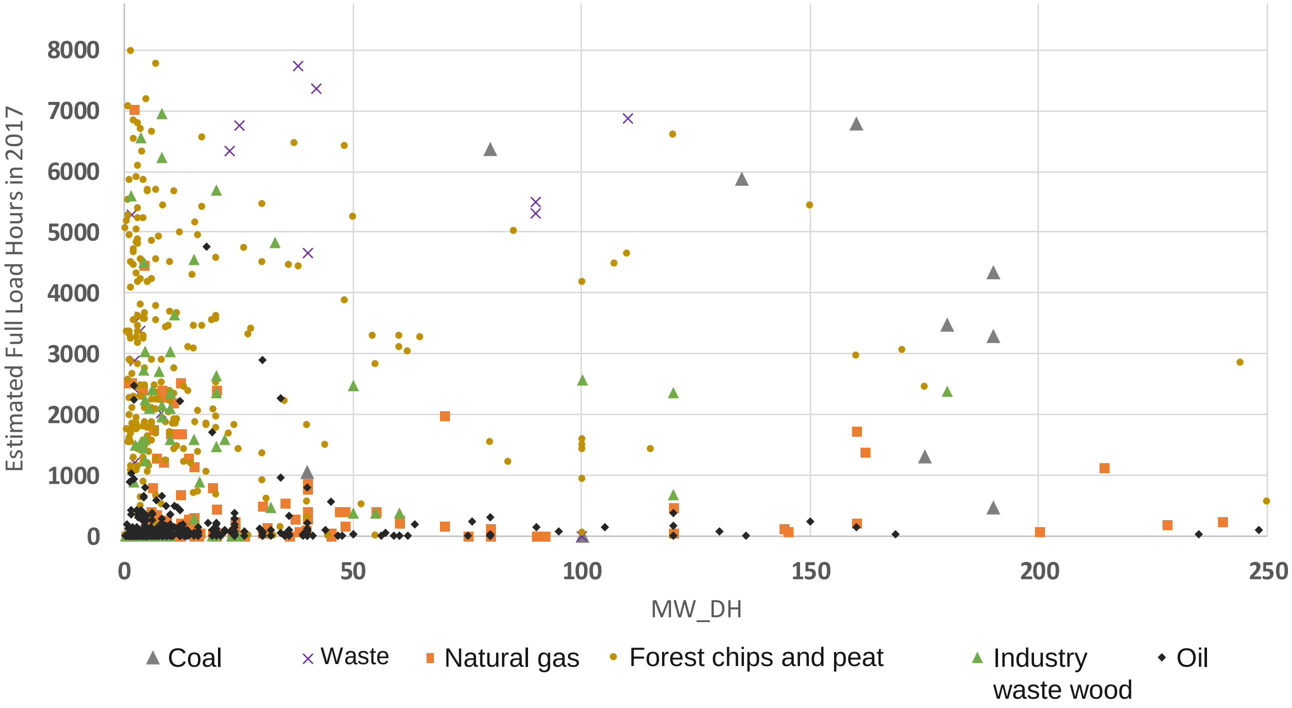
- Increasing unit size and increasing requirement for operation hours both quickly reduce the number of suitable DH grids.
- The larger the units are compared to the grid, the more they have to follow the load.
- Only few base load units can fit in to system



Data from Helen open data:
https://www.helen.fi/en/company/responsibility/current-topics/open-data

Existing units

- Different fuels for different regions and uses
- Data from 2017, recent price increases and new investments have changed the figure



Estimating the potential market of SMRs

1) Theoretical potential
- Forgetting all other units
- Presented as function of unit size and required Full Load Hours (FLHs)
- Requires grid-by-grid analysis

2) Practical upper potential
- Reducing the amount of heat from waste incineration and warm excess heats (industry, waste water treatment, etc)

3) The remaining heat with biomass, ambient heat sources, or heat SMRs?
- Detailed grid level modelling required

Number of large enough Finnish DH grids (capital region as one grid) assuming certain unit size and required operation time

1)

	4000 h	5000 h	6000 h	7000 h	8000 h
400 MW_DH	4	3	1	1	1
200 MW_DH	7	7	4	1	1
100 MW_DH	19	14	9	6	3
50 MW_DH	26	23	19	12	7
25 MW_DH	47	41	31	23	15

Note: not the number of units, but number of grids/cities

2)

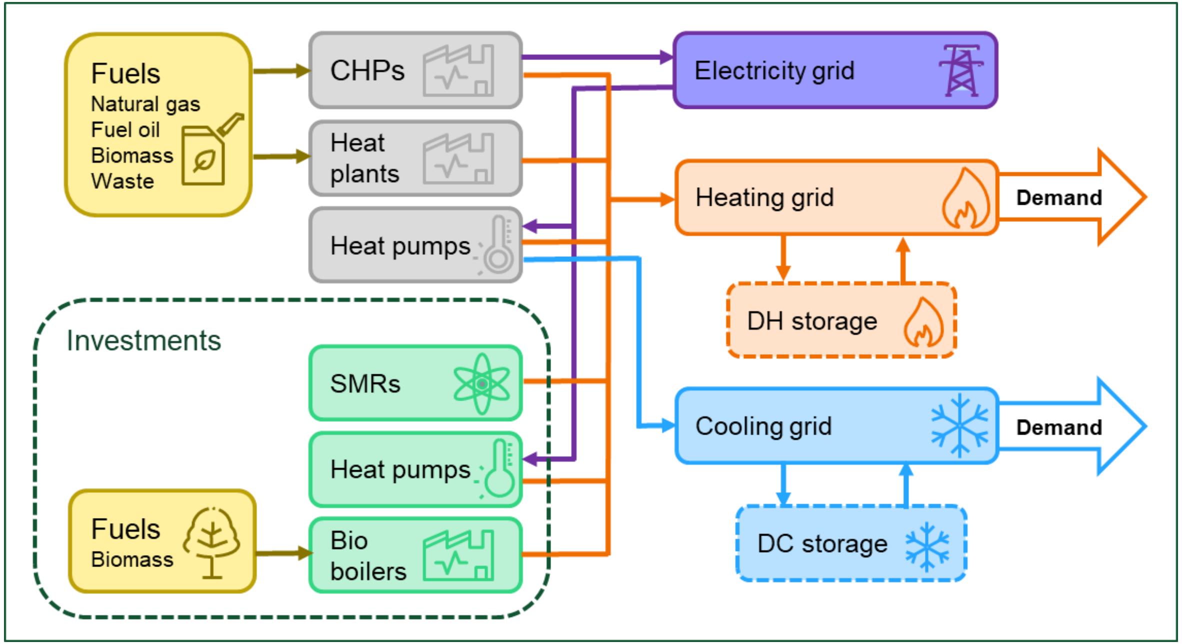
	4000 h	5000 h	6000 h	7000 h	8000 h
400 MW_DH	1	1	1	0	0
200 MW_DH	4	3	1	1	0
100 MW_DH	8	6	2	1	1
50 MW_DH	14	11	5	2	1
25 MW_DH	21	17	8	3	1

3)

?

Modelling energy systems

- Figure shows a simplified structure of the DH/DC energy system model
  - Analysis of the current systems
  - Estimating the development
  - Studying policies
  - Comparing investment options



Nuclear DH seems to be the cheapest option

- In our* and in many international studies, the nuclear DH seems to be the cheapest option to generate district heating

- Payback time and relative cost efficiency depends especially on
  - Studied system (e.g. costs of the other units)
  - Assumed development of the studied system
  - Amount of invested capacity (smaller unit costs, but less operation hours)
  - Assumed licensing and investment costs of SMR
  - At what year the heat SMR would be available
  - Assumed development of competing technologies

* Lindroos, T.J., Pursiheimo, E., Sahlberg, V., and Tulkki, V. 2019. A techno-economic assessment of NuScale and DHR-400 reactors in a district heating and cooling grid. Energy Sources, Part B: Economics, Planning and Policy. https://doi.org/10.1080/15567249.2019.1595223

* Pursiheimo, E., Lindroos, T.J., Sundell, D., Rämä, M., and Tulkki, V. Optimal Investment Analysis for Heat Pumps and Nuclear Heat in Decarbonised Helsinki Metropolitan District Heating System. In press.

Additional climate policies needed

- Objectives of the Paris Agreement require major and rapid actions on reducing greenhouse gas (GHG) emissions all over the world
  - EU increased it's GHG target to -55% by 2030
- Enhanced policy actions are necessary to
  - achieve these ambitious goals
  - realize the opportunities and avoid risks that economic sectors and societies will face
- Can SMRs help with solving these challenges before 2030 or before 2040?
- Can people accept SMRs close to cities?

Modelling investments to district heat SMRs

Tomi J. Lindroos,
Tomi.J.Lindroos@vtt.fi

24/11/2021 VTT – beyond the obvious