District Heating

TANDEM technical workshop - “Non-electric applications of SMRs, hybrid energy systems and their components”

Antti Rantakaulio, Fortum, 19 September 2024

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Introduction to District Heating

What is District Heating?

- District heating is an efficient and centralized method for providing heat to buildings in densely populated areas.
- Widely used in colder environments such as Northern Europe and Baltics.

How does District Heating work?

- Typically, in district heating systems, water in liquid phase is the carrier of thermal energy
- District heating is used to heat buildings and warm tap water. This means households, office buildings etc
- Transportation of heat through long distances is not economically feasible due to investment costs, pumping costs and heat losses → the power plants are located quite near (tens of kilometres) to the consumer.

Alternatives

- Non-centralized – each building has its own dedicated system
- Heat source: burning (gas, oil, biomass), electricity,

Characteristics of District Heating

- District heating system consists of following items:
  - Transfer pipe (hot and cold legs)
  - Power plants which produce heat and possibly also electricity as combined heat and power. Traditionally categorized into:
    - Heat only plants
      - Boilers (oil, natural gas, biomass)
      - Electrical (coils or heat pumps)
    - Power plants (coal, biomass, waste)
    - Gas turbines (oil, natural gas)
  - Buildings as the end users
  - Possible heat storages (typically water)

- Typical consumer needs:
  - Office buildings
    - Large 100-300 kW
    - Medium 40 -100 kW
  - Dwellings (apartment buildings, town houses)
    - small town house 10-20kW
    - apartment buildings 40 – 100 kW
  - Public buildings (schools, hospitals etc) 100 -300 kW
- Peak load of the consumption can reach 2GW for very limited time
  - In a city ~600 -700k habitans
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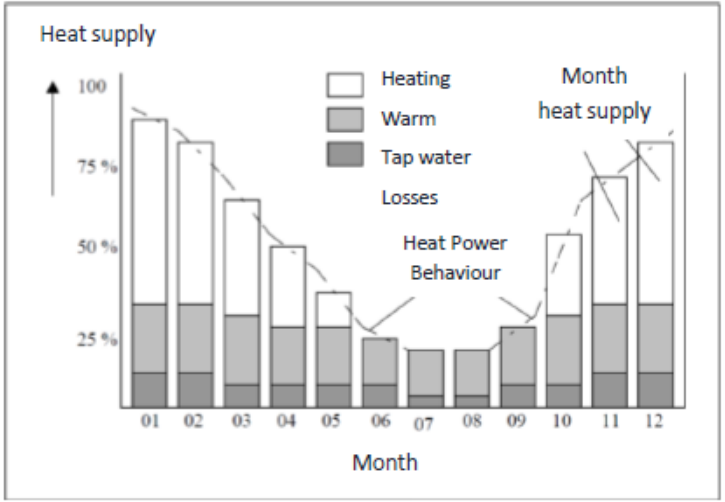
Characteristics of District Heating

- Temperature of the network depends on the outside temperature
  - Hot leg (inlet) temperature varies between 65 – 115 °C
  - Cold leg (outlet) temperature varies between 40 – 60 °C
  - Heating season vs summer season
- Recent trend has been towards lowering the inlet temperature
  - Allows for a wider range of production forms such as heat pumps
- Heat pumps offer new possibilities such as
  - Storing of heat when electricity price is low
  - Use of “waste heat” – e.g. data centers



Typical diagram of heat consumption for heating and warm tap water by month
during the year in Czech Republic (Karafiát, 2016).

Picture source: TANDEM project, WP1 – Task 1.2: D1.2 Description and techno-economic characterization of the hybrid system, 2023 – page 140

Ways to Utilize Nuclear Power for District Heating

Combined Heat and Power

- Combined heat and power (CHP) is a method of utilizing nuclear power for district heating where electricity and heat are both produced simultaneously.
- Configuration of a CHP plant differs from traditional nuclear power plant
  - Steam used to produce district heat is taken from the turbine circuit ->DH circuit separated from the turbine circuit
- Overall efficiency of the plant is increased
  - However, electricity power decreases
- CHP configurations can be based on existing PWR or BWR technologies

Heat Only Boilers

- Heat-only boilers are another method of utilizing nuclear power for district heating
- In this method, heat is generated by a nuclear reactor and used directly for district heating
  - DH circuit separated from the reactor circuit
  - -> no turbine-generator system
  - -> much simpler plant design
  - Smaller size -> located near cities
- So called HOBs are being developed (for example, LDR-50 by Steady Energy in Finland)

Current status - nuclear power and DH production

- In use in, for example, Russia, China, Switzerland
- Multiple studies ongoing in new countries such as Finland

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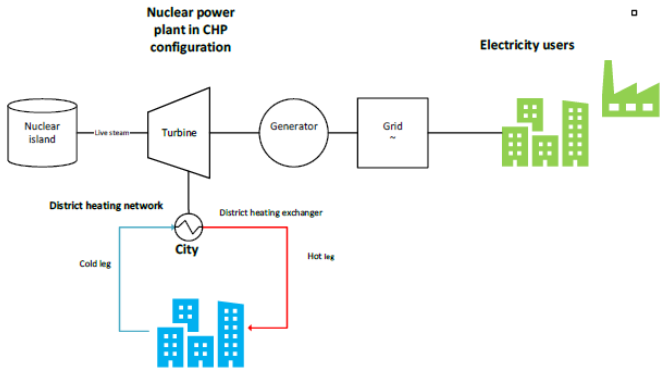
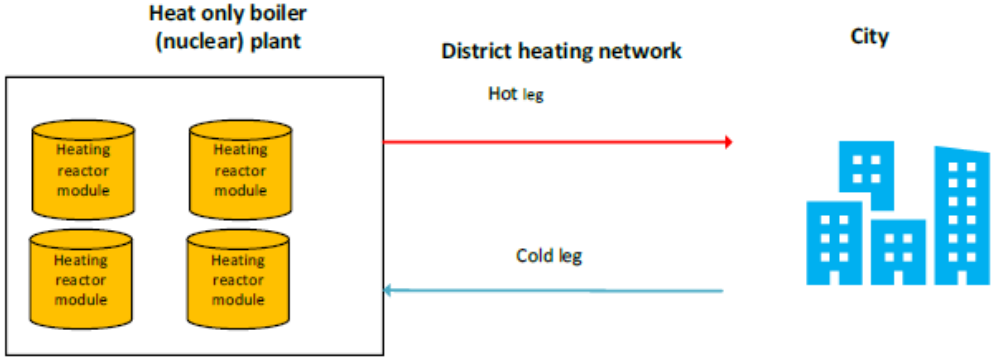
Ways to Utilize Nuclear Power for District Heating



Nuclear power plant in CHP configuration (created by FORTUM in the scope of the TANDEM project)



Heat only boiler model (created by FORTUM in the scope of the TANDEM project).

Picture source: TANDEM project, WP1 – Task 1.2: D1.2 Description and techno-economic characterization of the hybrid system, 2023 – pages 153 and 155

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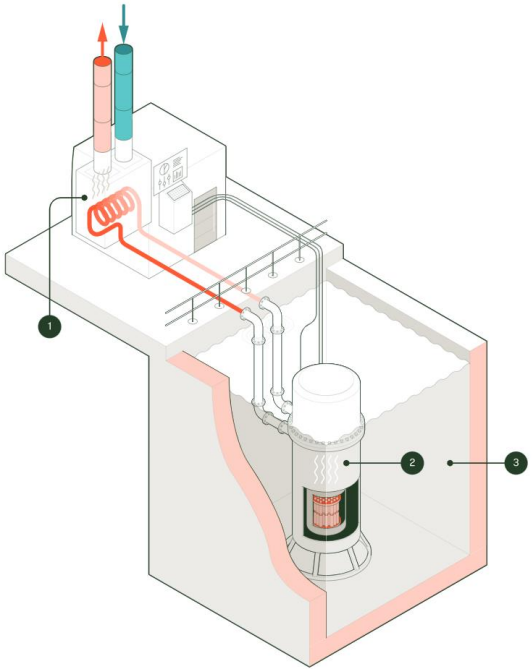
Low-temperature District heating Reactor (LDR-50)



Low-temperature District heating Reactor (LDR-50)

- Power level 50MWth per module
- Low pressure
- Multiple modules can be installed to same facility

1. Heat exchanger
2. Reactor module
3. Reactor pool

Picture source: Steady energy website https://www.steadyenergy.com/

Conclusion

Efficient and Cost-effective

- District heating is an efficient and cost-effective way to heat urban areas, reducing energy consumption and lowering costs.

Sustainable and Environmentally Friendly

- By utilizing nuclear power for district heating, we can produce heat in a way that is sustainable and environmentally friendly.

Viable Methods

- Both combined heat and power and heat only boilers are viable methods for utilizing nuclear power for district heating.
- Increases the overall efficiency of the plant (especially CHP configuration)
- HOBs are simplified and cost effective

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References

TANDEM project, WP1 – Task 1.2: D1.2 Description and techno-economic characterization of the hybrid system, 2023

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https://www.powermag.com/district-heating-supply-from-nuclear-power-plants/

Get in touch for more information:

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