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Matching renewable energy supply with building demand profiles and storage at the neighborhood scale

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Fifth generation district heating and cooling systems (5GDHC)

Multi-temperature system where demand and supply of heat and cold is matched in time and space using networks and storage technologies at appropriate time and geographical scales.

- Hot water generated close to demand, stored short-term
- Medium temperatures used for space heating within cluster, buffered for few days
- Low temperatures transported between clusters, seasonal storage
- Heat and cold exchange between connected buildings

Context

- Natural gas exit in the Netherlands
- Municipal heat visions and neighborhood approaches to be presented 2021

Goal

- Generate optimized sizing solutions for insulation, conversion technologies and storage for 5GDHC
- Developing a tool to assess the applicability of 5GDHC as an alternative to natural gas

Methods

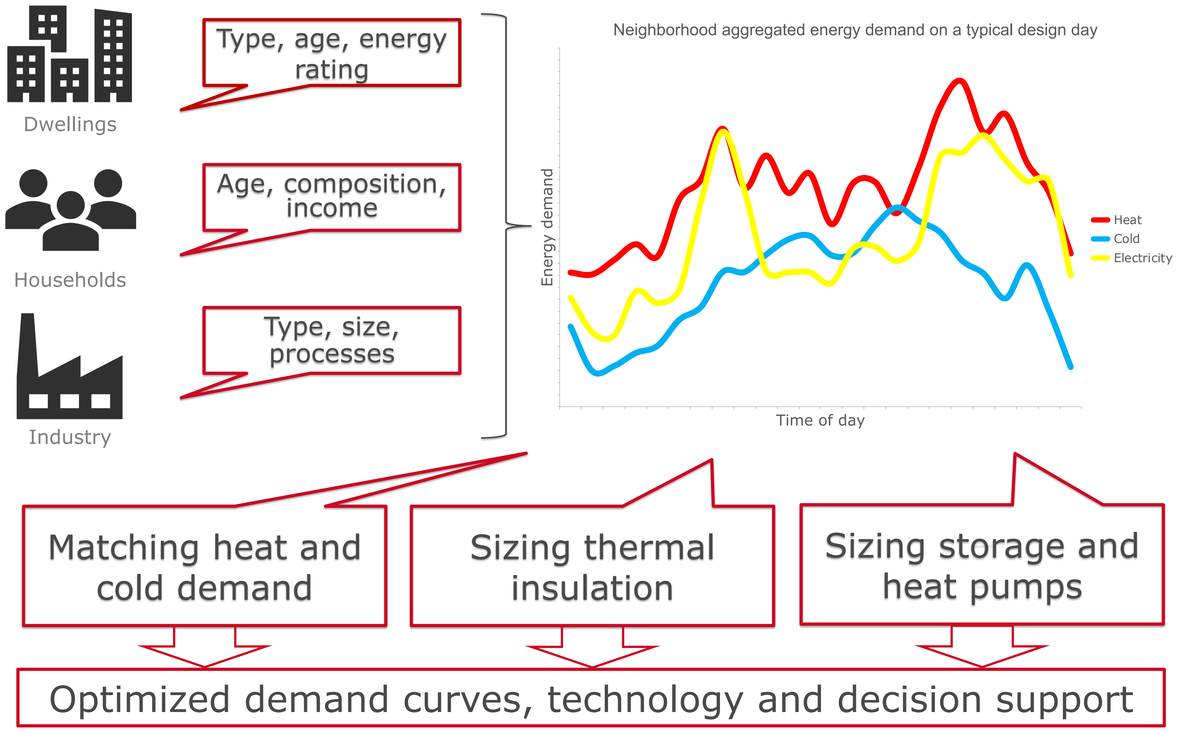
The tool is based on the energy hub concept, in which input energy flows are converted in an optimized way to meet demands.

- Neighborhood energy demand and characteristics converted into design day profiles
- Peak demand reduction from insulation measures and low-temperature
- Direct exchange of heat and cold between buildings within the cluster possible
- Optimal sizing of storage size, conversion techs, grid capacity

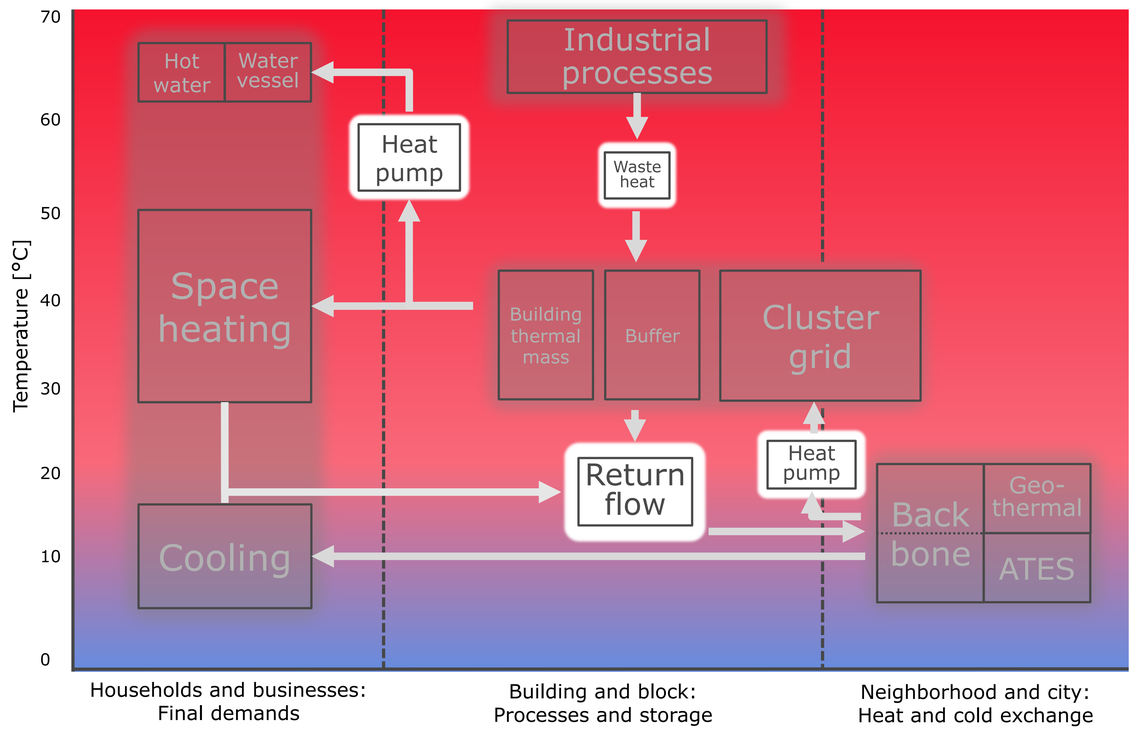
Case study

The case consists of a specific neighborhood, where 858 dwellings and some local businesses will be connected.

- South of Netherlands, developed by Mijnwater B.V.
- Mixed apartments/ground based and homeowners/tenants
- Mostly existing buildings with natural gas heating
- 100 % connection rate wanted, aim is to exit natural gas



Conceptual model
From generic neighborhood characteristics an energy hub demand profile is created. This is used to optimize for simultaneous demand of heat and cold, using thermal insulation to reduce total demand and peak demand, sizing storage to optimize for self-consumption of heat and cold in the neighborhood, sizing heat pumps to bridge between the different temperature demands at different times and in different places.



Flows, conversions and storage at different temperatures and spatial scales
The system allows for heat to be used at each temperature level and spatial scale level. Heat can be cascaded up using heat pumps and down using heat exchangers, depending on where and when the demand takes place.