Cool Heat Grids
Lunch Lecture Urban Energy Platform & Thermo-X platform TU Delft

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Content

• Background: alternatives for natural gas
• Why ‘Cool heat grids’?
• Properties and possibilities
  – Sources
  – Temperature levels
  – Scales
• Example projects
Background: Alternatives needed for heating with natural gas

Alternative heating solutions for the built environment

Green gas or hydrogen
Heat grids
Electrical heating (including infrared)
Heat pumps
Electricity
Biomass
Alternative heating solutions for the built environment

**Individual**
- Infrared & electrical heaters
- Heat pumps

**Collective**
- Green gas
- Hydrogen
- Biomass
- Hot water
- Electricity

**Resources:**
- Solar
- Water
- Biomass
- Green gas
- Hydrogen

**For heat grid of 150 households..**
*(in Samso, Denmark)*

**Biomass**

Temperature levels (our definitions)

<table>
<thead>
<tr>
<th>&gt; 90°</th>
<th>&gt; 70°</th>
<th>45-70°</th>
<th>25-45°</th>
<th>10-25°</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traditional district heating</strong></td>
<td><strong>High Temperature (direct supply of hot water)</strong></td>
<td><strong>Medium Temperature (additional solution for hot water)</strong></td>
<td><strong>Low Temperature (direct space heating Booster HP for DHW)</strong></td>
<td><strong>Ultra low Temperature (heat pump for space heating and DHW)</strong></td>
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</tbody>
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Traditional district heating

> 70°
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45-70°
Medium Temperature (additional solution for hot water)

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Low Temperature (direct space heating Booster HP for DHW)

10-25°
Ultra low Temperature (heat pump for space heating and DHW)

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Temperature levels (our definitions)

<table>
<thead>
<tr>
<th>Table 1</th>
<th>1st Generation</th>
<th>2nd Generation</th>
<th>3rd Generation</th>
<th>4th Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Label</strong></td>
<td>District heating</td>
<td>District heating</td>
<td>District heating</td>
<td>District heating</td>
</tr>
<tr>
<td><strong>Main carrier</strong></td>
<td>District heating</td>
<td>District heating</td>
<td>District heating</td>
<td>District heating</td>
</tr>
<tr>
<td><strong>Pipes</strong></td>
<td>In situ insulated steel pipes</td>
<td>In situ insulated steel pipes</td>
<td>Pre-insulated steel pipes</td>
<td>Pre-insulated flexible (expanded) pipes</td>
</tr>
</tbody>
</table>

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[Lund et al., 2014, 4th Generation District Heating (4GDH): Integrating smart thermal grids into future sustainable energy systems]
Existing high temperature heat grid

Example from Smart Urban Isle Project

AIM:
Locally balanced neighbourhood energy systems
Case study Strandeiland

- 8000 new dwellings
- 150,000 m² non-residential buildings

Energy demand

- Hot water
- Space heating
- Cooling
- Building related electricity
- User related electricity
Energy potentials

1. **PV** (Photo Voltaic cells)
2. **PVT** (PV + thermal energy)
   - PVT with low temperature (ATES)
   - PVT with high temperature
3. **PT** (Solar Collectors; only heat)
4. **STW** = small wind turbine
5. **WT** = wind turbine (3 MW, not local)
6. Thermal energy from **waste water**
7. Thermal energy from **surface water**
8. **Energy from waste & biomass**

Energy demand and energy potentials Strandeiland
Potential energy concepts

1. High temperature

2. Ultra low temperature

3. Low/ Medium temperature

4. Individual heat pumps

Energy Performance Indicators

Energy assessment indicators:
- % ‘energy neutrality’ = locally generated renewable energy = B/A
- CO₂ emissions of the net energy import (C)
- Future-fitness of the net energy import (C)
KoWaNet project - Koele Open Warmtenetten

• Aim: To develop (ultra) low temperature smart thermal heat grids that connect sources and demands.

Important parameters of Cool Heat grids

• Temperature levels
• Monthly / daily, hourly profiles
• Spatial levels (building / urban block/ district)
Temperature levels

1. WKO net (regenerated)
   Principle: Heat delivered with a heat pump; passive heating not possible

<table>
<thead>
<tr>
<th>Heat demand</th>
<th>Cold sources</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV TW</td>
<td>K</td>
<td>Open WKO</td>
</tr>
<tr>
<td>13-24ºC</td>
<td>Passive verwarmen net mogelijk</td>
<td></td>
</tr>
<tr>
<td>WW</td>
<td>Warmte pump</td>
<td>Open WKO</td>
</tr>
<tr>
<td>8-12ºC</td>
<td>Bijvoorbeeld: Regeneratie koude in winter</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooling demand</th>
<th>Heat sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>K 12º 5º</td>
<td>PVT</td>
</tr>
<tr>
<td>Regeneratie warmte in zomer</td>
<td>Restwarmte</td>
</tr>
</tbody>
</table>

   TU Delft
3. LT warmtenet net (op basis van enkele warmtebronnen op ca 35 graden)

Principe: Ruimteverwarming kan direct; tapwater met BWP; koeling via HT koeling kan passief. 2 leidingen.

• Space heating and cooling:
  – Cooling demand = heat supply & Heat demand = cold supply
  – Profiles and temperatures depend on building functions

• Cooling processes & waste heat
  – Data centers, Supermarkets, ..
  – Waste heat from cogeneration / power production

• Solar thermal
  – Solar Collectors
  – PVT
  – Road collectors

• Greenhouses

• Water: Surface water, Waste water, Drinking water (TEO TEA TED)

• Unconventional sources (see Plan Heat Project www.planheat.eu)
  – Small industry, metro station, ..
Temperature & profile of thermal sources

Grey water and surface water
Strandeiland case

Temperature of thermal sources

Thermal output from solar PVT collectors

Ingoing collector temperature

Total yield in GJ/year per m²

Thermal output of PVT collectors (in MJ/m² per year), depending on ingoing collector temperature
(source: Triple Solar gelijkwaardigheids-verklaring)
Spatial levels

Spatial levels based on MIJNWA Water concept

Backbone for exchange between clusters and seasonal balance through the Minewater

City | Cluster | Urban Block | Building / street | Unit
---|---|---|---|---
75 | 70 | 65 | 60 | 55 | 50 | 45 | 40 | 35 | 30 | 25 | 20 | 15 | 10 | 5

Waste heat

HP Booster
### Design system based on:
- Location of the available sources
- Energy (efficiencies, distribution and storage losses)
- Costs
- Governance / ownership

### Work in progress:

**K*WaNet**
Total demand & potential supply (Haarlem case)
Decentralised supply of low temperature heat

- Local feed-in zonnewarmtenet
  - Isoleren tot minimaal ca. label C
  - Gemiddeld 8 PVT panelen per woning
  - Individuele warmtepompen
  - 'groepsgedeelde' WKO net met warmte uit PVT feed-in.
Low temperature demand?

Required heating power over the year (W)

- Original heat demand
- Heat demand after insulation measures

Cool heat grids enable exchange of energy and use of sustainable sources

Energy carriers:
- Green gas
- Hydrogen
- Biomass
- Hot water
- Electricity

Resources:
- Sun
- Leaf
- Earth
Thank you for your attention!