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Optimizing thermal energy storage in 4GDH

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Novelties

- Framework for optimal TES integration
- Optimization model for DHC pipes
- Synthetic neighborhood heat loads
Context – EFRO-SALK GeoWatt Project
“Towards a Sustainable Energy Supply in Cities”

Research topics
- Optimal design
- Thermal network control
- Flexibility
- Geothermal energy
- Fault detection
- Building models

Common case
- City of Genk (B)

Illustration by Annelies Vandermeulen
Aim & Objectives

**FINAL:** Optimize storage size and location in 4DH

This presentation:
- Set up optimization framework
- Model selection
- Data collection
Framework

Data
Heat demand, weather...

Control problem
Linear optimization

TES Parameters

Objective
e.g. min Energy

Parameter variation algorithm
Framework

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Parameter variation algorithm
Aggregated heat demand

Average occupancy for $N_i$ SFH

Detached SFH

Semi-detached SFH

Terraced SFH

$\times N_D$

$\times N_{SD}$

$\times N_T$

Simultaneity

$\hat{Q}$
Case Genk
Framework

Control problem
Linear optimization

Objective
e.g. min Energy

Parameter variation algorithm

TES Parameters

Data
Heat demand, weather...
Control optimization

- Linear, fixed nominal temperature levels
- Predefined pipe diameters

**Novel:**

- Model of mass and heat flow in pipes (van der Heijde *et al.*, 2017)
- $\dot{Q}$ and $\dot{m}$ decoupled, except at demand

Pipe model

- Fixed supply and return $T$ to calculate heat losses
- Linear model
- Integers for flow direction

Network nodes

<table>
<thead>
<tr>
<th>Component</th>
<th>Temperatures</th>
<th>Mass flow rate</th>
<th>Heat flow rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Fixed</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Heat demand</td>
<td>Fixed</td>
<td>Preset</td>
<td>Preset</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>Fixed</td>
<td>Preset</td>
<td>Preset</td>
</tr>
<tr>
<td>Central heat production</td>
<td>Floating</td>
<td>Variable</td>
<td>Variable</td>
</tr>
</tbody>
</table>

Heat and mass flow balance in every node

But $\dot{Q} = \dot{m} \cdot c_p (T_H - T_L)$ only valid at fixed components

Source:
Preliminary results
Preliminary results
Conclusion

- Framework for optimal TES integration
- Optimization model for DHC pipes
- Synthetic neighborhood heat loads

Future work

- Storage optimization loop
- Implement representative weeks
- Evaluate different objective functions
References


Context – EFRO-SALK GeoWatt Project

Techno-economical boundary conditions
Heat production
Thermal network control and flexibility
Thermal storage

Building modelling
Building simulation
Parametrisation

Fault detection in substations
Optimal routing
Case Genk

Building Count Map

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