Simulation of network hydraulics

Feeding renewable energy optimally into district heating networks

03ET1358A

03ET1358B

03ET1358C

Short Title: EnEff:Wärme: DELFIN - Prognose der Auswirkungen dezentraler Einbindung von Wärme aus erneuerbaren Energien und anderen Wärmeerzeugern in Fernwärmenetze

Running Time: 01/2016 bis 06/2019

Topics:
Decentralised energy generation, Heating & cooling networks, Energy storage, Operational management & energy management, Solar heat, Modelling & simulation

Innovation:
Model-based methods for predicting how the decentralised integration of solar thermal energy and other volatile heat generators can affect the operation of and components for existing district heating systems

Keywords: District heat
Quintessence

- Simulation tools coupled with a so-called functional mock-up interface (FMI) enable the effects of integrating decentralised, volatile energy sources into heating networks to be more accurately forecast.
- Simulations of exemplary district heating networks are being used to investigate the current situation as well as various scenarios for the integration of volatile heat generators to estimate their effect on the network operation.
- New software modules are developed to take into account decentralised heat generators for network planning and operation.

In this project, researchers want to find out how an increasing number of decentralised heat generators affect the network hydraulics and thermal cycling of existing district heating networks, and whether heat storage systems need to be retrofitted. Software modules are being developed on the basis of statistical and model-based methods. This will enable volatile heat sources to be taken more into consideration in network planning and operation.

Project context

The economic conditions for district heating have changed during the course of Germany’s Energiewende – its energy transition. Experts predict that district heating will play a particularly important role in securing heat supply in urban areas. There are an increasing number of ideas for integrating decentralised heat sources into district heating networks. However, there are still currently very few tools for planning and evaluating volatile, decentralised components in district heating, for example from solar thermal energy and heat from CHP and power-to-heat systems.

The precursor project entitled “Decentralised feed into local and district heating systems with special consideration for solar thermal energy” (DEZENTRAL) has been used to develop basic principles that will now be linked in-depth with practical issues. The main focus is on the effects of integrating solar thermal energy and other volatile heat generators on the operational management and components of existing district heating systems. Corresponding prediction methods are not yet fully developed.

Using time- and location-resolved simulations of typical district heating networks, the researchers are investigating the actual situation and scenarios with increased shares of volatile decentralised heat sources in the respective networks. This is being done in collaboration with district heating companies, scientists and commercial software providers.
Research focus

The main objective of the DELFIN project is to develop tools that can predict in suitable simulation environments how the thermo- hydraulic conditions in district heating networks change through incorporating volatile, decentralised heat generators and provide information on this. Here it is intended to realistically reflect both the effects on the existing generation units and components – for example circulation pumps, pressure maintenance, pipe systems – as well as the effects of different storage locations.
Central idea and approach

In order to achieve the research goal, volatile producers are being modelled and simulated as a first step. The resulting models and profiles will characterise the temporal variability of parameters that are important in practice. These include, for example, the mass flow and temperature of the heat fed into the district heating network. These new generation models and profiles will then be integrated into different simulation models for district heating networks. This will be used to assess the current and future impact of an increasingly decentralised heat production.

Based on actually existing district heating networks, the effect of increasingly decentralising heat generation will then be investigated for different climatic conditions. Through targeted simulation studies, this will allow to identify the (primary) energy efficiency effects and the technical boundary conditions and determine sensible storage integration solutions. The project is therefore also assessing the influence of decentralised heat generators on the system efficiency and also intends to provide information on how this influences the cost-effectiveness of the heating networks.
### Purpose and aims

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<thead>
<tr>
<th>Application area</th>
<th>Planning of district heating networks, expansion and operational management strategies</th>
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<tr>
<td>Outlook</td>
<td>Following the project, it will be potentially possible to test and refine the project results on the basis of practical cases.</td>
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<tr>
<td>Modelling &amp; simulation</td>
<td>Heating networks with an increasing number of volatile, decentralised heat generators will be simulated thermo-hydraulically in a place- and time- resolved manner.</td>
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<td>Economic efficiency analyses</td>
<td>Simulation results form a basis for balancing the changes in the energy demand (final and primary energy) and CO2 emissions as well as ongoing operational costs.</td>
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Examples of simulation results for a 2.2 MW secondary network
**Testing and application**

The simulation tools and models used for the actual situation have largely been tested in practice or tested with practical data. A supervising project committee representing energy supply companies is ensuring that the investigation of decentralised heat integration also integrates practical aspects into the project. The results of the research project can then be transferred and applied by heating network operators to their situation. Selected software components will be available free of charge.

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<tr>
<th>Application conditions, possibilities</th>
<th>The project findings will enable providers of district heating network simulation software to consider volatile heat generators or integration profiles in their simulations.</th>
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<td>Reference address / Download</td>
<td>The project findings will inform the district heating industry and government about the necessary boundary conditions and expected effects of a technically possible and ecologically sensible decentralised integration of volatile heat generators in heating networks.</td>
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<td>Contact for the project</td>
<td>The project is currently in progress. The findings are set to be published in 2019.</td>
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**Contacts for the project**

- **Project coordination**
  - AGFW | Der Energieeffizienzverband für Wärme, Kälte und KWK e. V.

- **Research**
  - TU Dresden, Professur für Gebäudeenergietechnik und Wärmeversorgung

- **Research**
  - Solites - Steinbeis Forschungsinstitut für solare und zukunftsfähige thermische Energiesysteme

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