TECHNISCHE UNIVERSITÄT DRESDEN

DRESDEN concept

Faculty of Mechanical Science and Engineering Institute of Power Engineering Professorship of Building Energy Systems and Heat Supply

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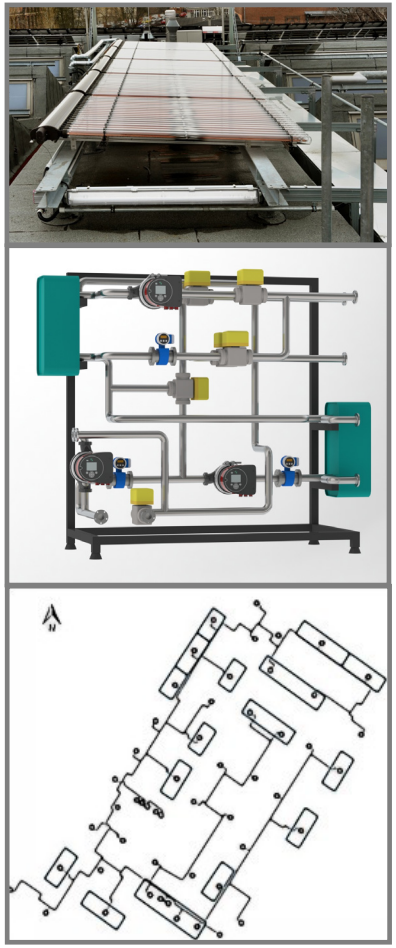
Integration of Solar Thermal Systems into District Heating



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Research project founded by the
Federal Ministry for Economic Affairs and Energy
following a resolution of the German Bundestag
FKZ: 03ET1039B

Federal Ministry of Economics and Energy

2nd SDH Conference · Hamburg · 2014-06-03

„Distributed Feed-in to Local and District Heating Networks with Particular Focus on Solar Thermal Heat“

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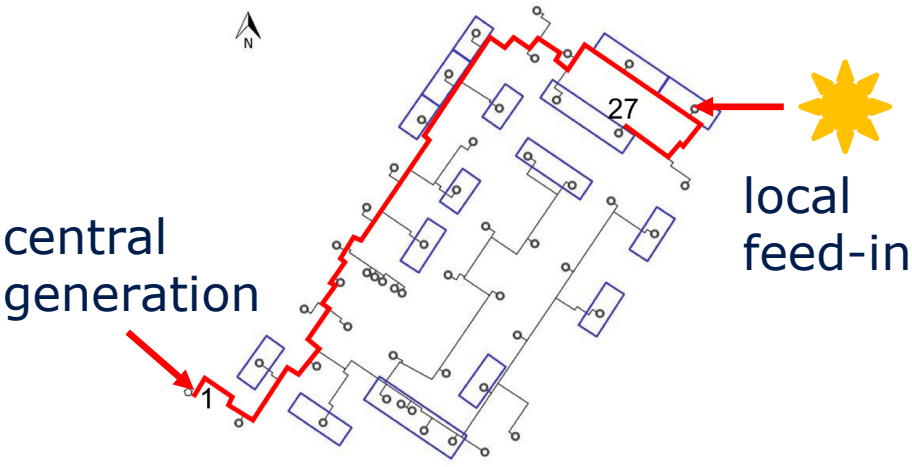
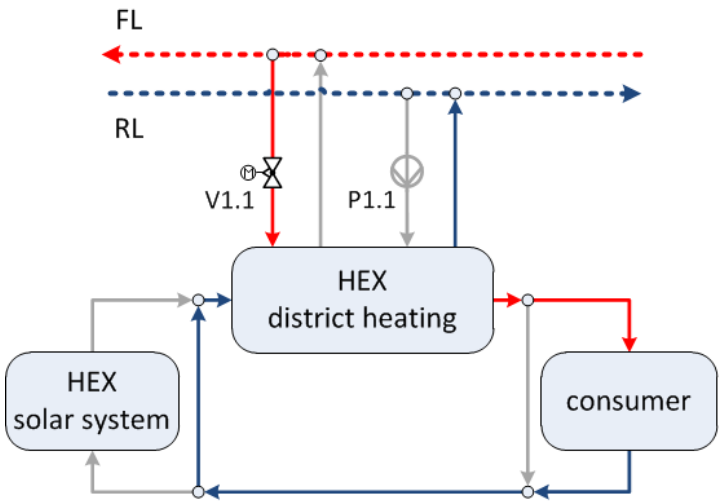
Main issues:

- Development of a combined supply and feed-in substation (HANEST), realization of a technical prototype
- Modelling of decentralized solar thermal feed-in to district heating networks using all-year net simulations with TRNSYS-TUD

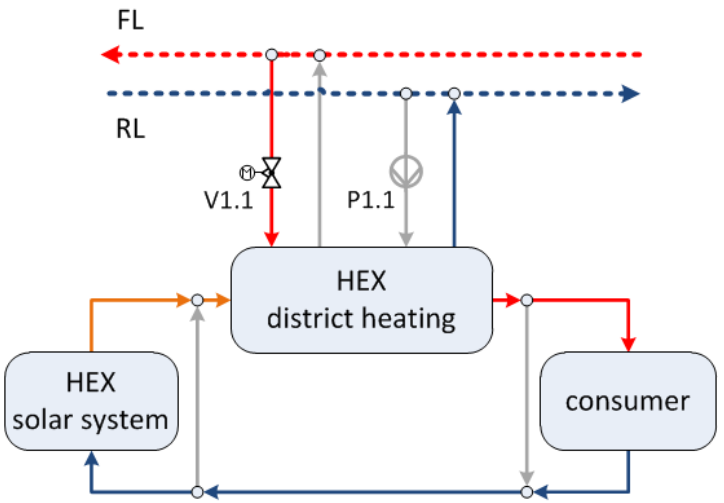


HANEST = combined supply and feed-in substation

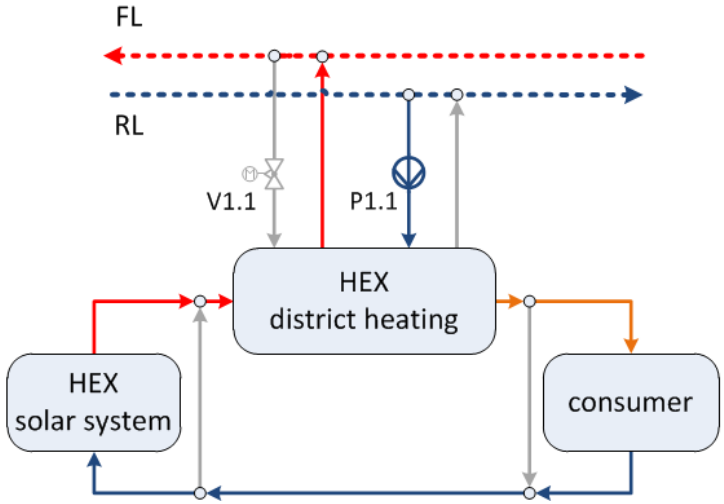
- Option for using renewable energy sources in areas with existing district heating networks via collection, transport and storage of solar thermal heat
- Use of solar thermal energy: At first covering local consumer demand, then feed-in of excess heat into the network
- **Why?** Higher energy efficiency due to lower temperature level when supplying the local consumer, reduction of component costs and space requirements



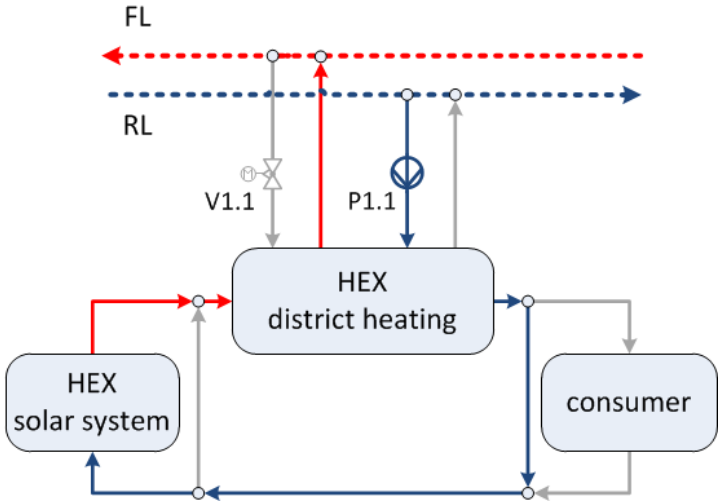
HAST – supply by district heating



HANEST-B supply by district heating and solar thermal



HANEST-E supply solar thermal and feed-in of excess heat



NEST – feed-in of solar heat

HANEST - technical prototype at the Centre of Energy Technology (CET)

Technical specifications:

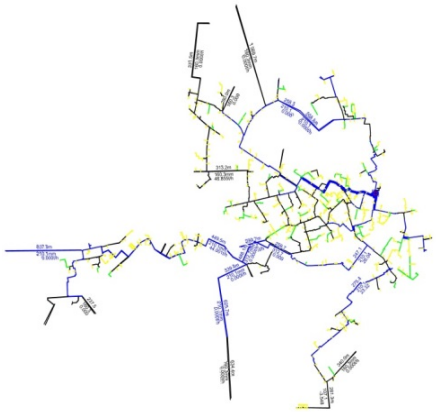
- Design load DH: 50 kW
- Solar thermal feed-in: 85 kW

Designed for:

- Multiple-family dwelling (6 .. 10 living units)
- Low-temperature surface heating
- Solar system with 80… 120 m²
- DHW in storage charging principle, with priority function

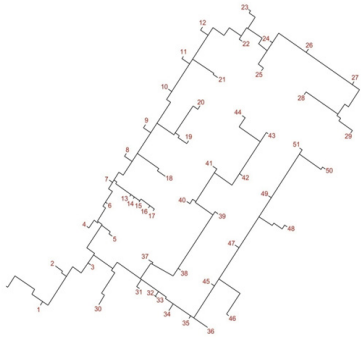
Upper fig.: solar thermal into secondary network, kW-scale
Lower fig.: CHP-heat in primary network, MW-scale

2nd gen. DH-net



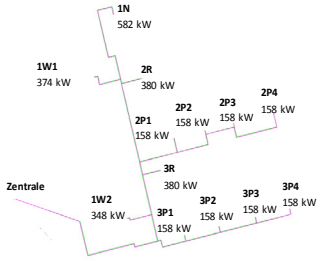
DHN city
747 consumers
60 MW, 71 km

3rd gen. DH-net



DHN settlement
51 consumers
2.2 MW, 2.6 km

4th gen. DH-net



LowEx DHN
13 consumers
3.3 MW, 0.62 km

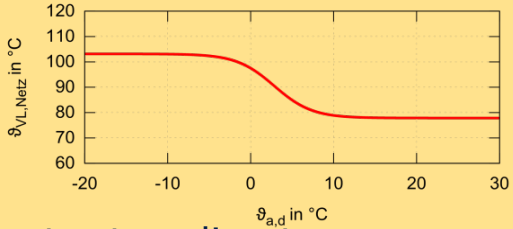
Aims of thermo-hydraulic all-year net simulations with **TRNSYS-TUD:**

- Identifying of thermal or hydraulic limits, design param. of feed-in pumps
- Comparing the amount of saved energy for several places of feed-in, adapted control concepts
- Alternating stress to the pipe system, caused by load alternation

Weather data set: TRY2010 (modified)

Net Temperatures (measurement data)

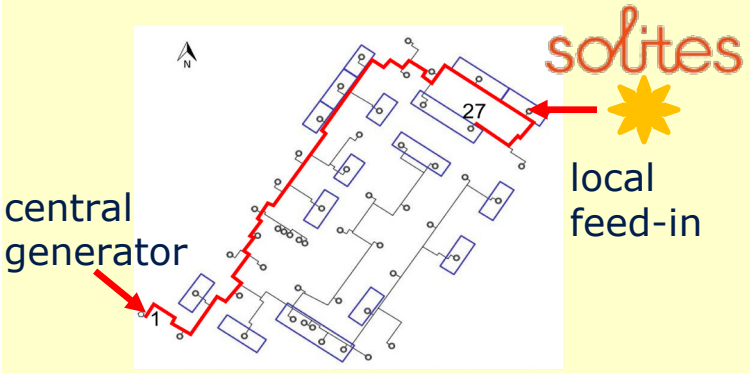
net flow line temp.: net operation curve



net return line temp.: consumer response

$$\vartheta_{RL}(\vartheta_{FL},\varphi) = \vartheta_{FL} - \Delta T_{RL,FL}(\vartheta_{FL},\varphi)$$

Distributed Solar Feed-in



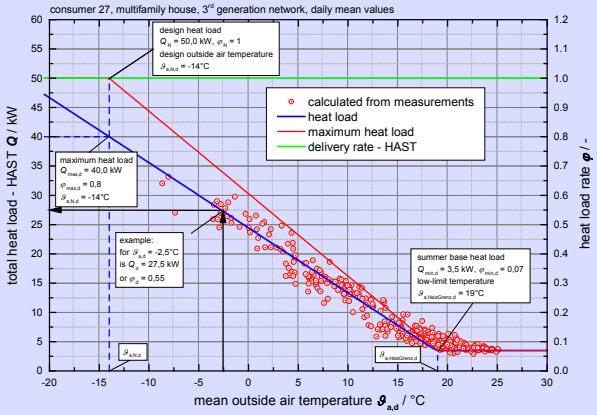
Consumer Load Profile, created via Typical Day Method (enhanced VDI 4655)

- Classified, normalized reference load profiles (RLP) on basis of measurements
- Transcription of the profiles to target weather data set by de-normalizing of a suitable RLP

$$\varphi(\tau) = F_{TT}(\tau) \cdot \varphi_d(\vartheta_{a,d})$$

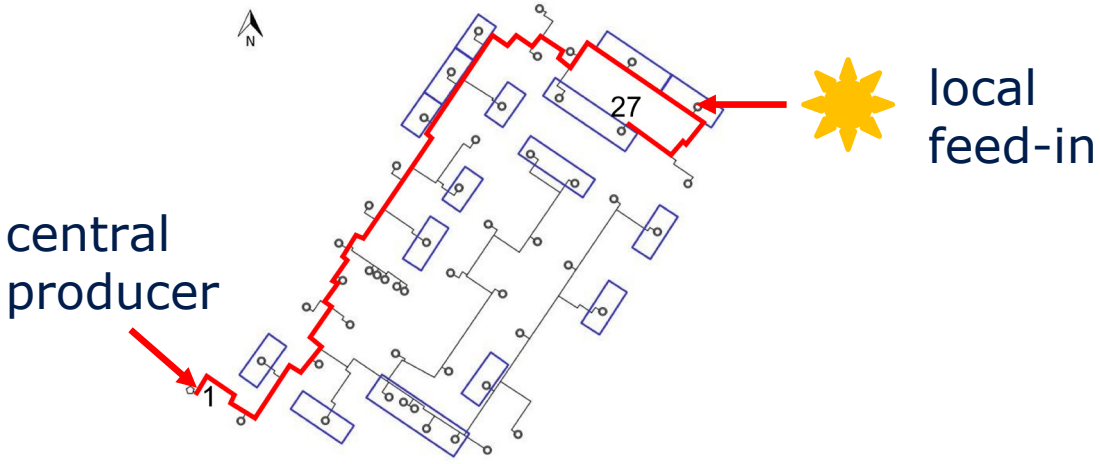
- Transcription to consumers of the same type, but variable design heat load

$$\dot{Q}(\tau) = \dot{Q}_N \cdot \varphi(\tau) \Rightarrow \text{individual load profiles}$$

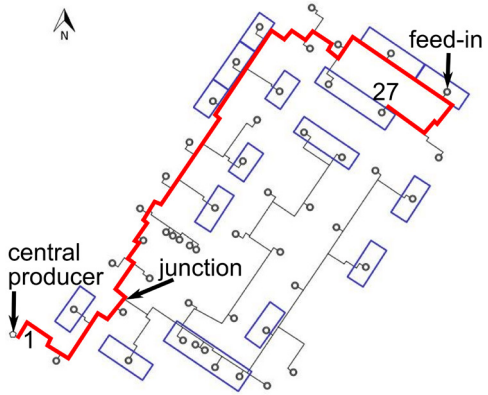


Basic Conditions Net Simulation

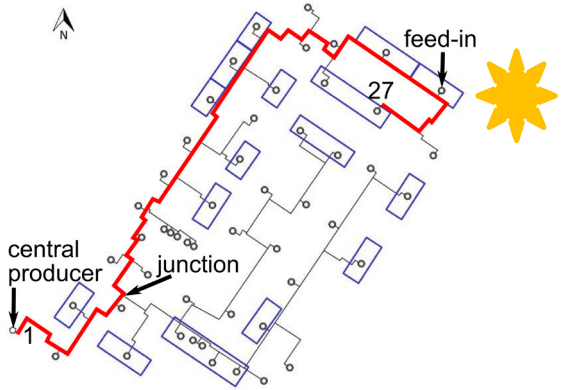
- Feed-in: separate substation, connected near end of branch, from return line to flow line
- High temperature flat plate collector
- Area: 100 m²
- Orientation: south west
- Inclination angle: 45°
- Heat consumer: individual heat load profiles
- Central pump: constant pressure difference control



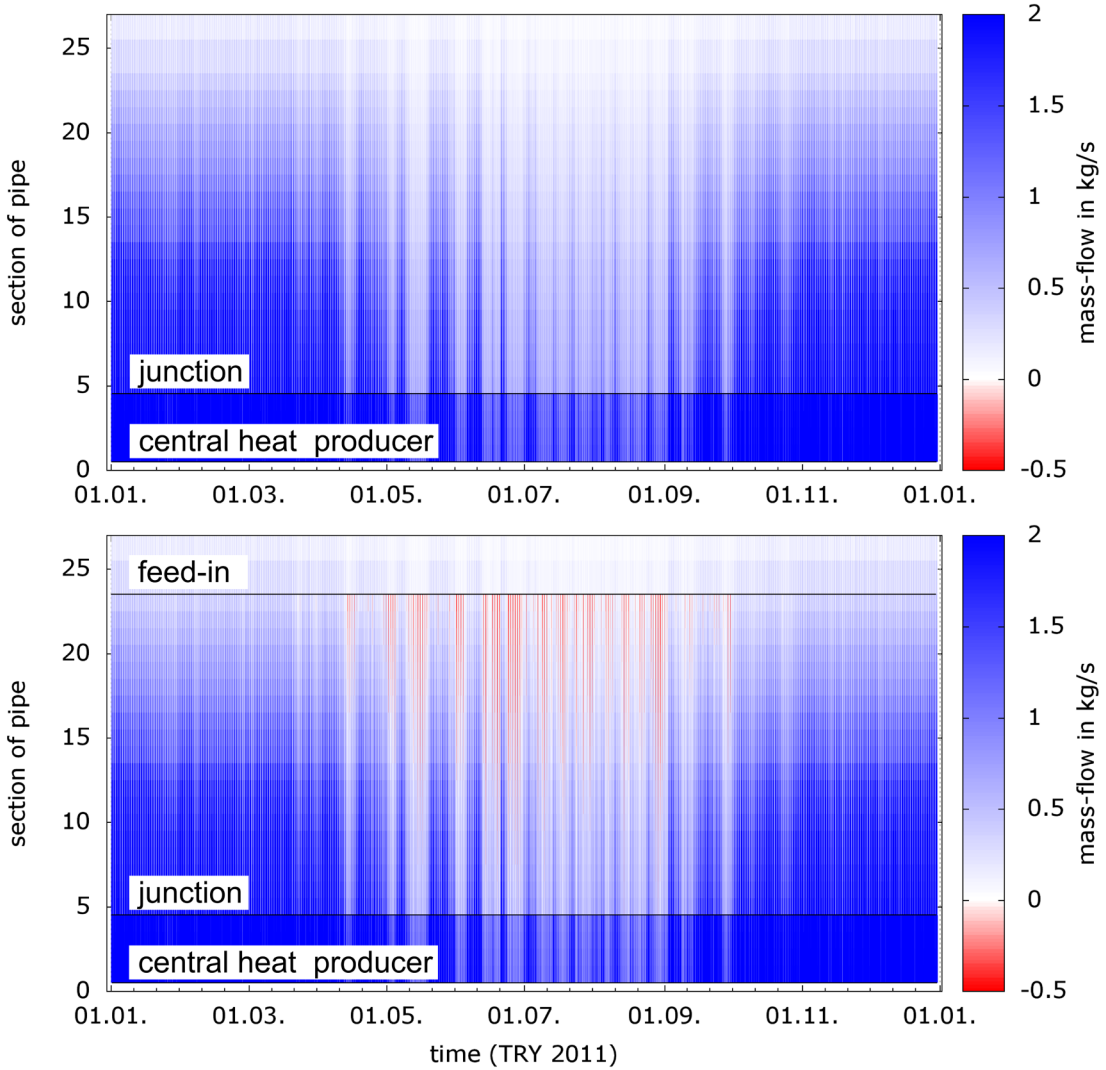
Mass-flow Distribution – Net Simulation



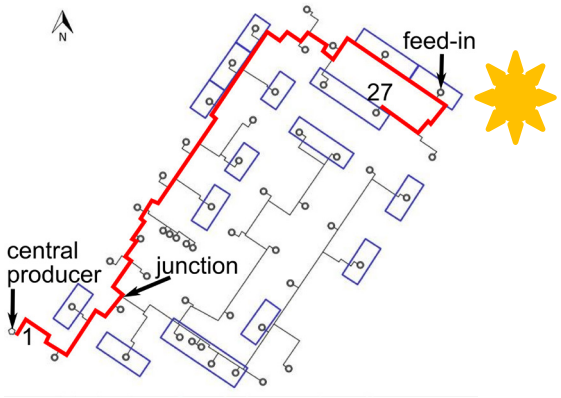
supply case

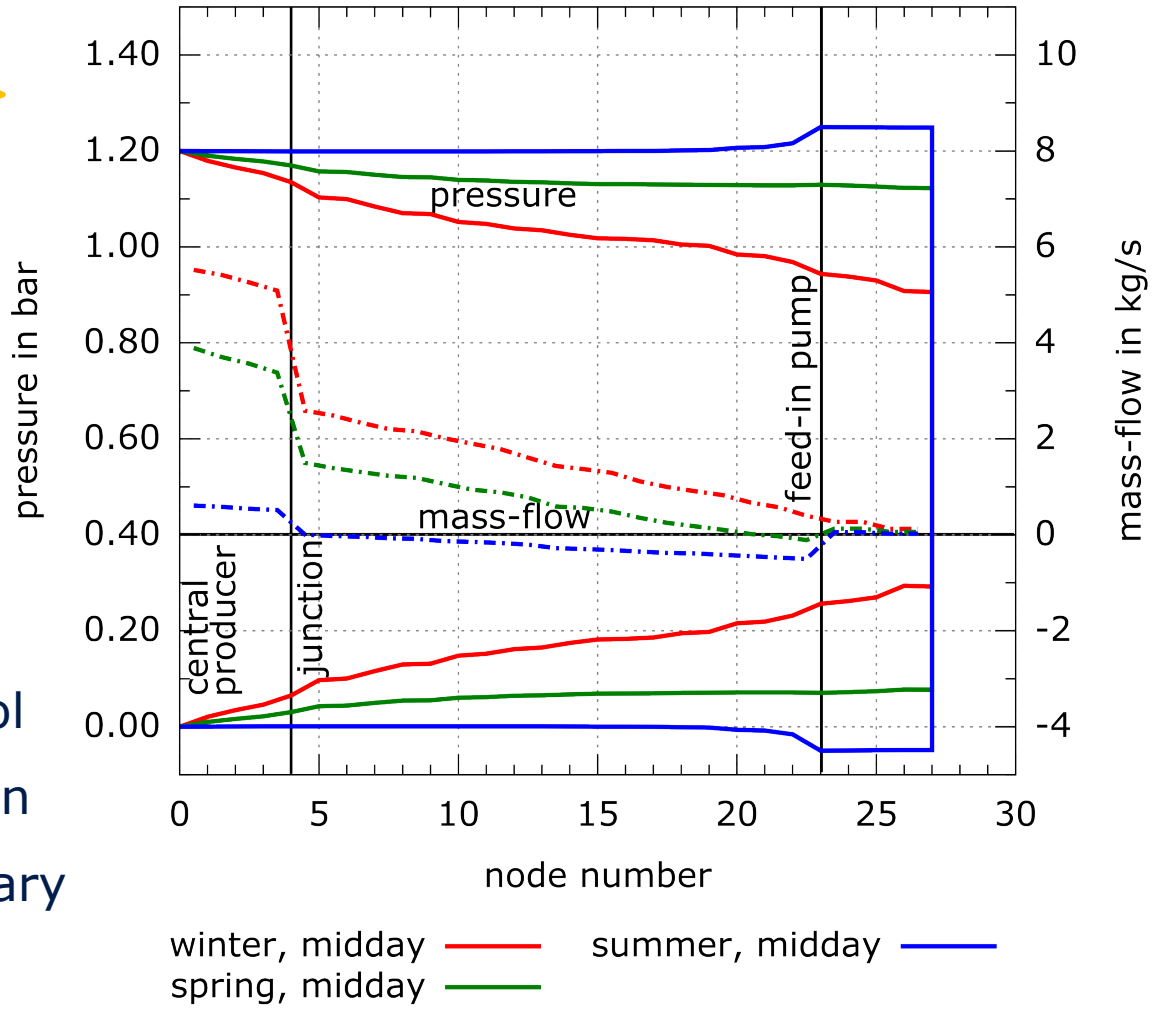


feed-in case



Pressure Distribution – Net Simulation





Adaption of the control concept is necessary in order to reduce auxiliary energy consumption!

- Technical Prototype of a combined supply and feed-in substation was developed and has been tested in the Centre of Energy Technology of the TU Dresden
- Operating experience is going to be used to improve field systems
- Thermal and hydraulic effects of distributed solar thermal feed-in can be simulated with TRNSYS-TUD
- Further DH-networks are going to be evaluated
- Hydraulic limits of feed-in pumps are to be considered
- Adapted control concepts for central circulation pump and feed-in pumps are to be developed