Transformation Strategy for Chemnitz

towards a sustainable, affordable and resilient DH system

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GEF Ingenieur AG

Heat Roadmap Poland
Warsaw, 25.01.2018

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GEF Ingenieur AG

office in Leimen near Heidelberg

founded in 1984

office in Chemnitz

founded in 1990

Leading B2B Consultant for Planning District Heating in Germany

- more than 30 years experience with all aspects of planning district heating systems
- staff of 50 highly qualified specialists
- development of economic solutions with focus on the interest of our customers
- independent of construction and manufacturing companies

GEF Ingenieur AG: one-stop planning of DH/DC systems

range of services

- research and development
- strategic business development
- heat density mapping
- technical and economic feasibility studies
- planning services for all phases of the design process (basic, permit, detailed design)
- construction surveillance, quality control

service portfolio

- comprehensive grid development
- DH/DC generation and conversion plant
- DH/DC pipeline systems
- substations
- thermal storage
- hydraulic grid analysis
- pipe stress analysis (software sisKMR)

Transformation Strategy for Chemnitz DH system

The Point of Departure

- The City of Chemnitz
- The Energy Company: eins - energie in sachsen
- The DH System of Chemnitz
- The Task
- The Team

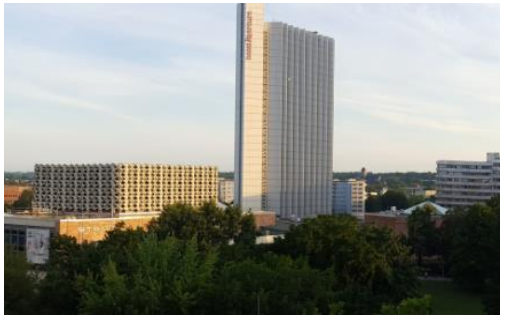
The Transformation Strategy

- The Project Phases
- Development of Heating Demand
- Generation Options
- Grid Development Options
- Proposed Joint Option

Summary

The City of Chemnitz

- 3rd largest city in Sachsen
- 243.000 inhabitants (1980: 315.000)
- envia, eins, VW, Siemens, Voith
- Technical University (> 10.000 students)
- City Council: majority for SPD / Left / Green coalition



Heating Market in Chemnitz

- market share of DH and gas > 90%
- gas and DH distribution grid often located in the same streets

Buildings in Chemnitz

- most inhabited buildings have been renovated to good energy-efficiency standards
- some vacancy, especially of old unrenovated buildings

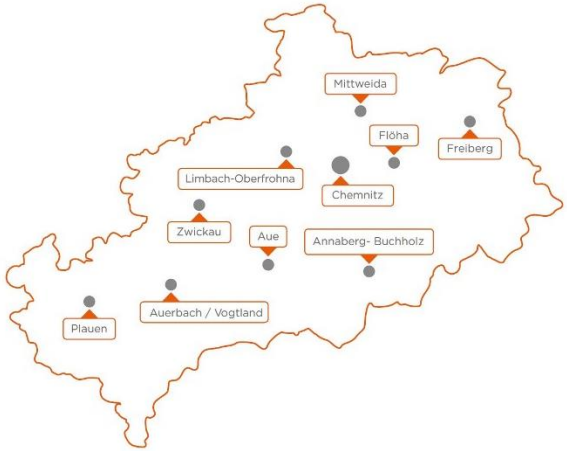
The Energy Company
eins energie in sachsen

Key Data eins energie in sachsen GmbH & Co. KG

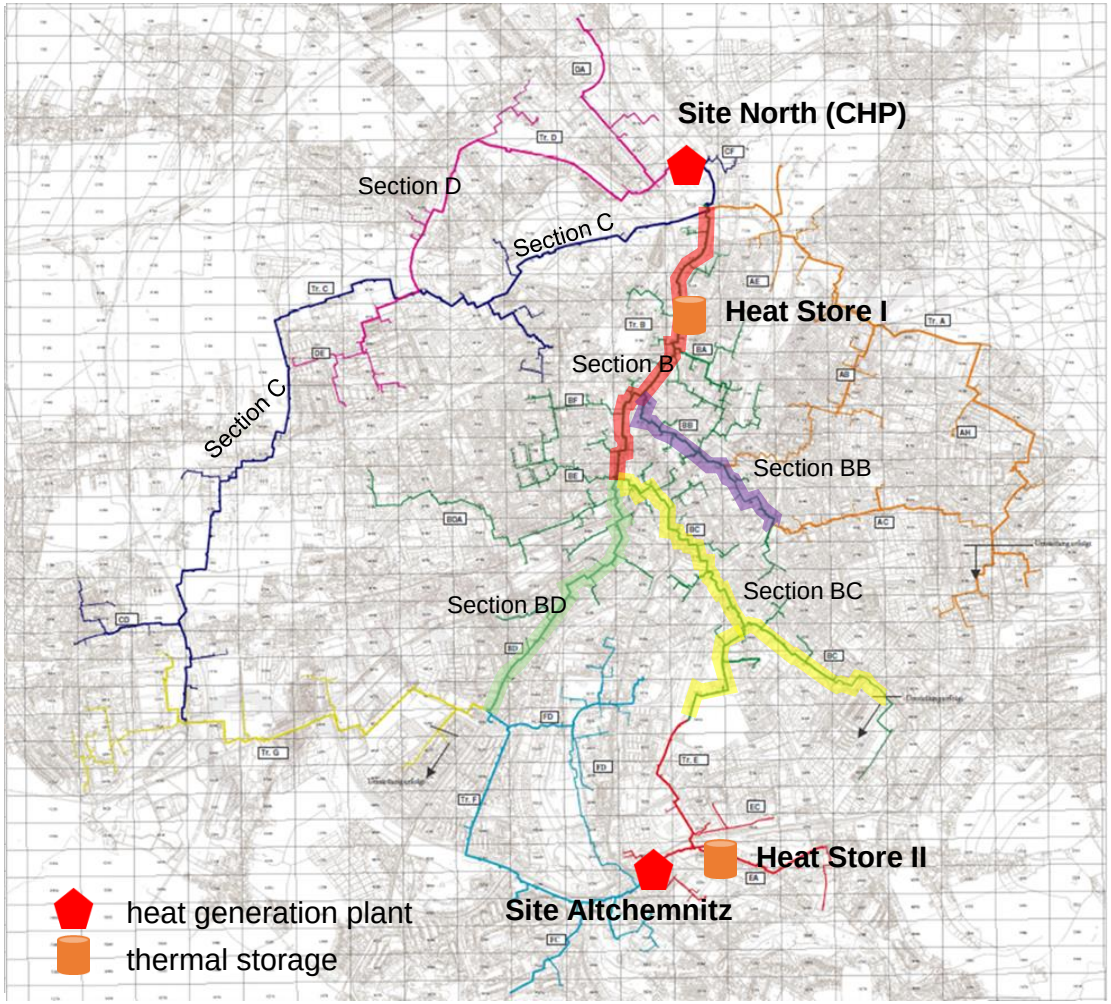
- regional utility in Sachsen, headquarters in Chemnitz
- 982 Mio. Euro turnover (2016)
- 400.000 customers, 650 employees
- shareholders:
  - 39,9 % Thüga
  - 25,5 % City of Chemnitz
  - 25,5 % ZV Gasversorgung Südsachsen
  - 9,1 % envia Mitteldeutsche Energie AG

Infrastructure

gas grid	7.300 km
electricity grid	3.000 km
water grid	1.500 km
fibre-optic network	1.000 km
district heating grid	300 km
district cooling grid	5 km



The DH System of Chemnitz



District Heating System

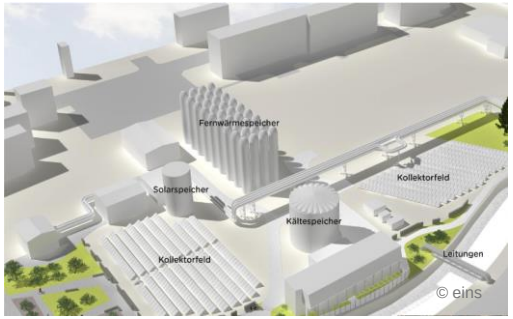
- primary system with high number of secondary systems, partially dating from the 1960s.
- supply temp. pri: 95 - 125 °C
  sec: 70 - 85 °C
  return temp.: 55 - 60 °C
- heat fed into DH grid (2014)
  885 GWh
  - 55 % from 1990
- DH pipe sizes too large for current heat load
- distribution heat loss: 20%

The District Heating System of Chemnitz

- **Site North (HKW Nord)**
  2 large lignite based CHP units (165 MW_{th}, 130 MW_{th})

- **Site Altchemnitz**
  2 gas boilers (2x 86 MW_{th})
  3 new gas boilers under construction (3x 33 MW_{th})

- **LowEx district heating** in the Brühl (inner city district)
  low grid temperatures 75/45 °C
  large solar thermal system (solar fraction ~10 % Brühl demand)
  integration of heat storage

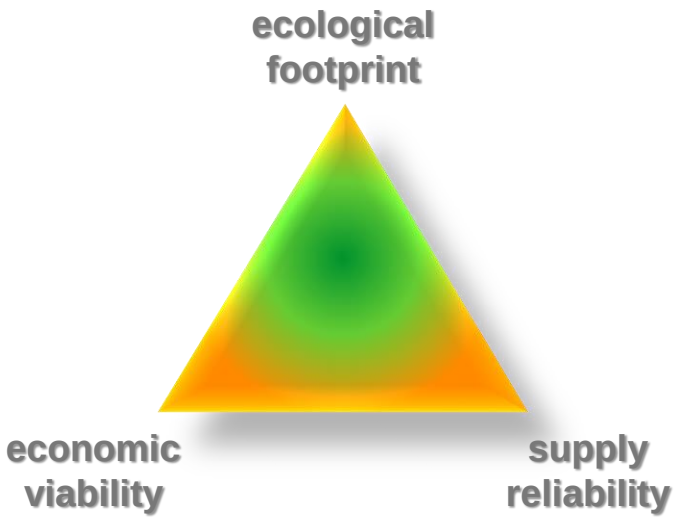


The Task: Transformation Strategy

Main Questions

- how to replace the lignite CHP units
- how to reduce the CO_2-emissions of the DH system and increase the share of renewables
- which strategy for DH grid development (repair, replace, dismantle, …
  which temperatures,
  which sites for future generation plant)

While maintaining/improving economic viability
reliability of supply
ecological footprint



Task

- design the future DH system (generation + distribution) that will be in operation after 2030
- devise a strategy to transform the current system into the future system
- Timeline of project: March 2016 to June 2017

The Team

eins energie in sachsen

Generation
Trading
Sales
New Business Fields

Communications
Controlling
Documentation

TU Chemnitz

inetz Ein Unternehmen von eins

DH/DC Grid
Gas Grid

GEF Ingenieur AG

Political Situation
Heat Densitiy Mapping
Analysis of Heating Market

Hydraulics of DH/Gas Grid
Technical / Economic Analysis of Grid Development

Transformation Strategy
Implementation Plan

Austrian Institute of Technology

Modelling of Electr. Market (TU Vienna)
Technical / Econonmic Analysis of future Generation Plant

Transformation Strategy
Implementation Plan

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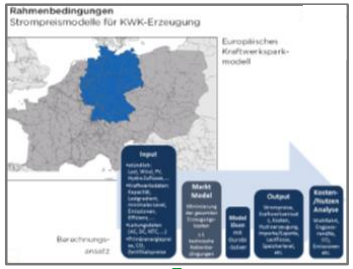
Summary

The Project Phases

Phase I

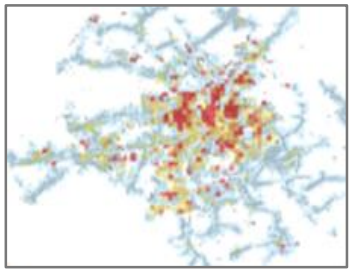
Defining Scenarios

commodity price scenarios, modelling electricity markets



political situation, regulation

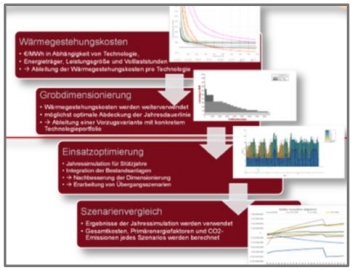
heating demand in Chemnitz



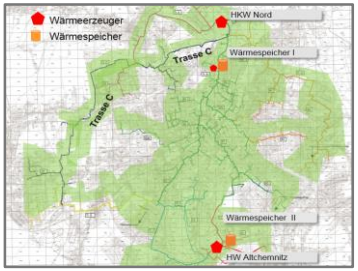
Phase II

Comparing Options

new generation



iterations



optimization of district heating grid

Phase III

Detailing the Transition Strategy

proposed joint option and implementation plan

COMMUNICATION

The Project Phases

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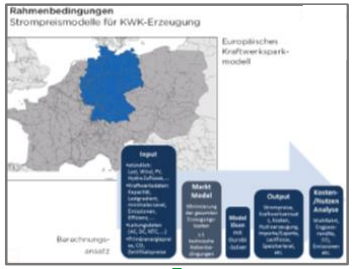

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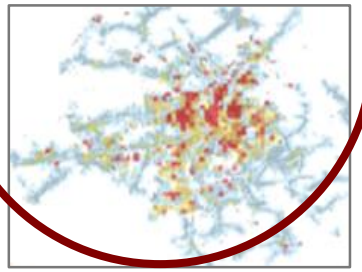

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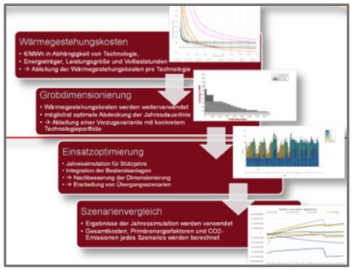

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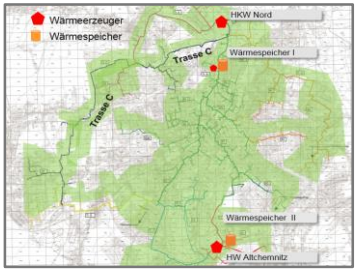

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COMMUNICATION

Development of Heating Demand

1. Step: Database of Buildings

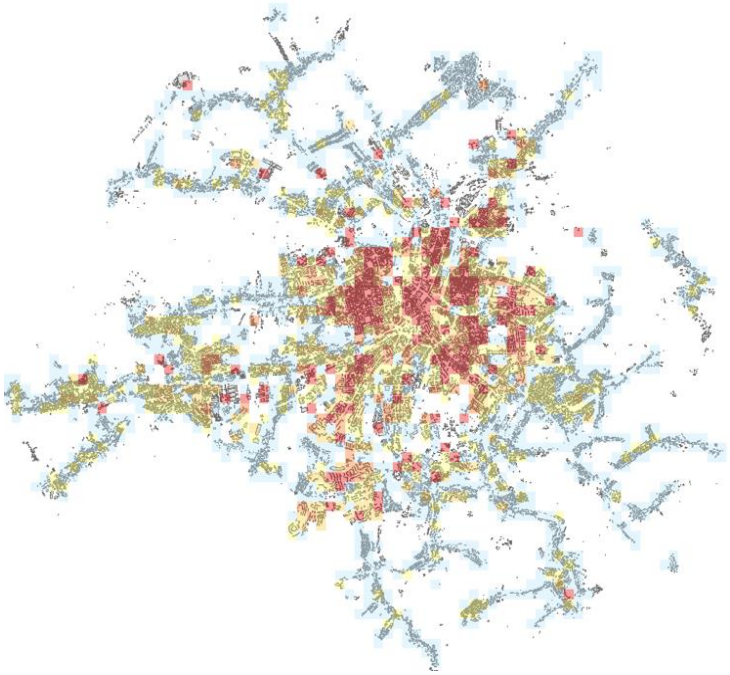
- database of buildings: location, size, type, use, heating demand, etc.
- input from the the city administration and large housing companies
  - no plans/expectations for intensive investment in further increase of energy-efficiency of existing buildings in the foreseeable future

2. Step: Defining Scenarios

- analysis of influencing factors
- definition of different scenarios for population development, levels of renovation, etc.

3. Step: Heat Density Mapping

- heat density mapping for currrent heating demand and scenario(s) for future demand
- analysis of longterm viability of DH using heat density maps (prepared with the tool ArcGIS)



Assumption for Phase II

Overall DH demand in Chemnitz will remain almost constant until 2040 (reduction < 10 %)

The Project Phases

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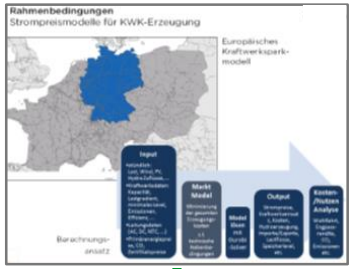
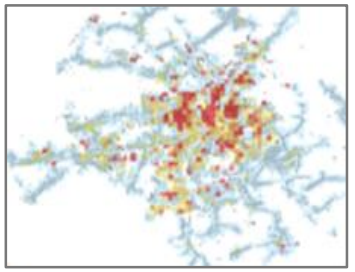
commodity price scenarios, modelling electricity markets

political situation, regulation

heating demand in Chemnitz





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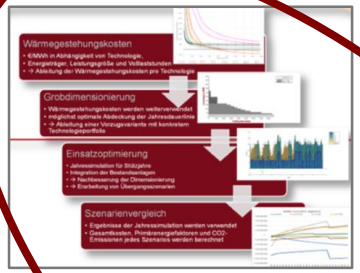
new generation



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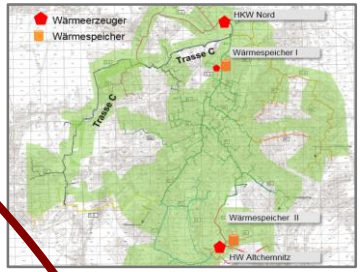


optimization of district heating grid

Phase III

Detailing the Transition Strategy

proposed joint option and implementation plan

COMMUNICATION

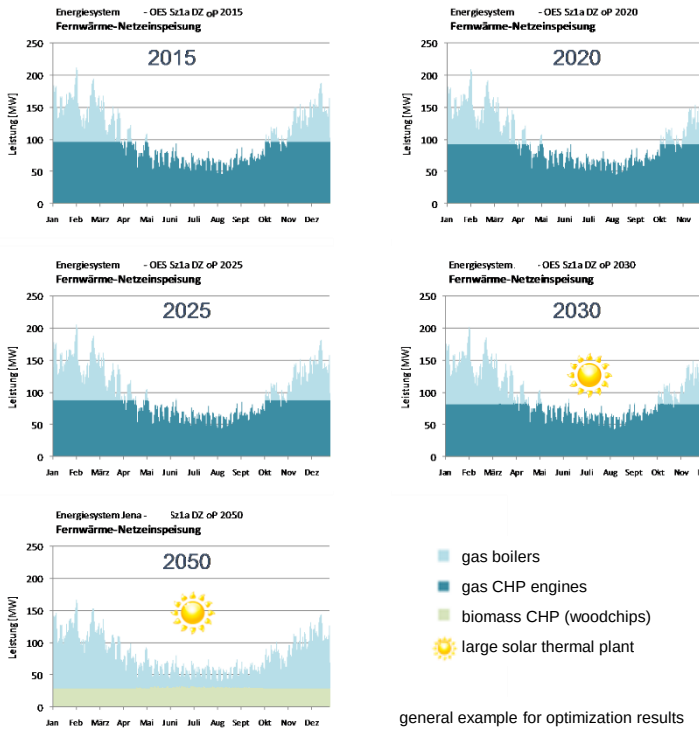
Comparing Generation Options

1. Step: Regional Potential of Renewables

- several options ruled out for lack of potential,
  other options included in the next stage (wood chips, waste incineration, solar thermal, etc.)

2. Step: Optimization

- optimization (Tool VarOpt) determines the cost optimal combination of type, size and operation for generation plant
- annuity method, heat demand(s) as hourly load curves for one year
- investment cost, operation cost, commodity prices, technical parameters included in the optimization model for the different types of generation plant
- aim: identify an option that is economically viable, has an acceptable ecological footprint, is resilient to varying scenarios (heat demand, prices), is technically possible to realise with the DH grid
- number of options reduced after rough optimization
- detailed optimization for 2-3 options using hourly price curves for electricity and including use of heat storage



general example for optimization results

3. Step: SWOT Analysis

4. Step: Selection of the Preferred Option for the Future Generation Portfolio

5. Step: Compatibility Check with Grid Option

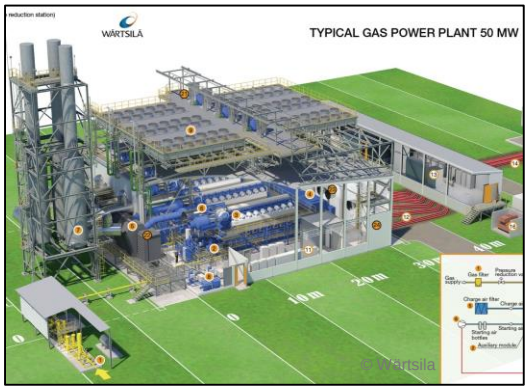
Proposed Option for Heat Generation

Renewable Baseload (e.g. CHP using wood chips)

Gas CHP Engines (units of 10 MW, total > 100 MW, possibly more units later)

Gas Boilers (60-80 MW)

waste incineration, bio-gas and solar thermal energy could be useful additions



Advantages

modular build + phased implementation → best ability to react on changing political and technological developments

- highly efficient technologies for the new generation plant
- renewable share of district heating is going to increase
- significant reduction of CO_2-emissions
- smaller generation units mean less capacity is needed to ensure security of supply (n-1)
- compatible with preferred grid option

High reliability of supply and reduction of CO_2-emissions at competitive prices in a long term

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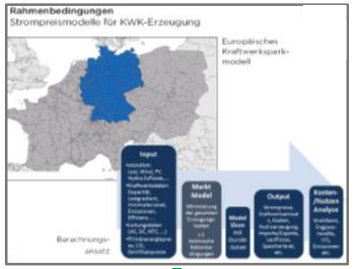

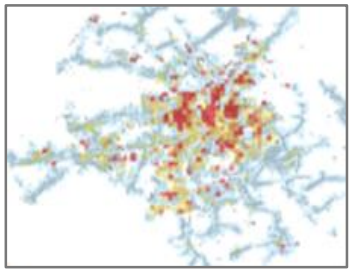

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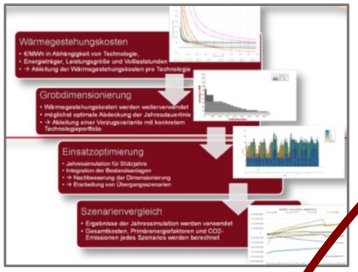

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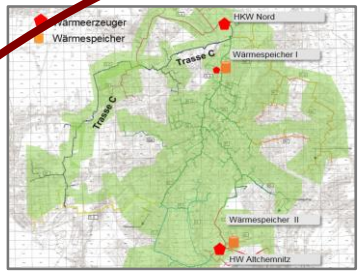

optimization of district heating grid

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COMMUNICATION

Comparing Grid Options

1. Step: Definition of future operation temperatures

- current primary grid: supply 95 – 125 °C
  future primary grid: supply 80 – 105 °C

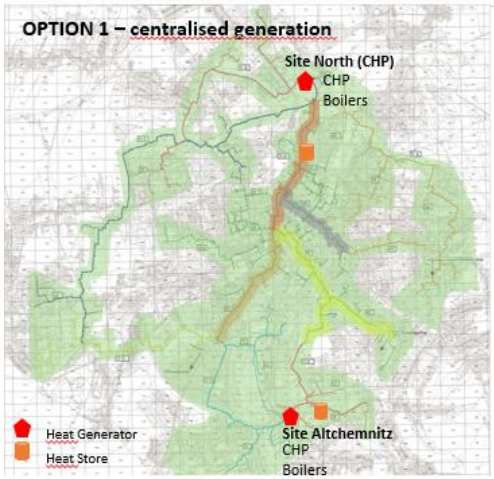
2. Step: Hydraulic Simulation

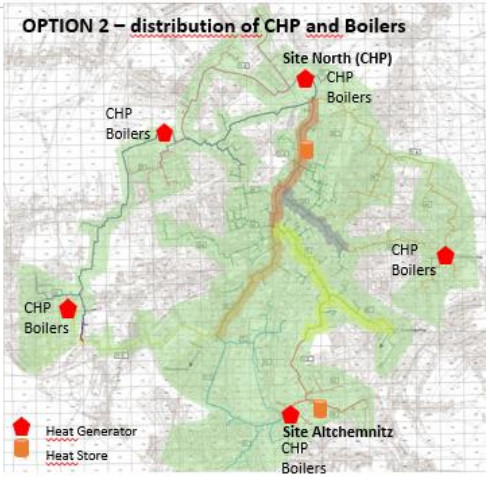
- simulation tool STANET
- four options
  simulation of future grids options
  assumption: pipelines will have been replaced by pipes with optimal size

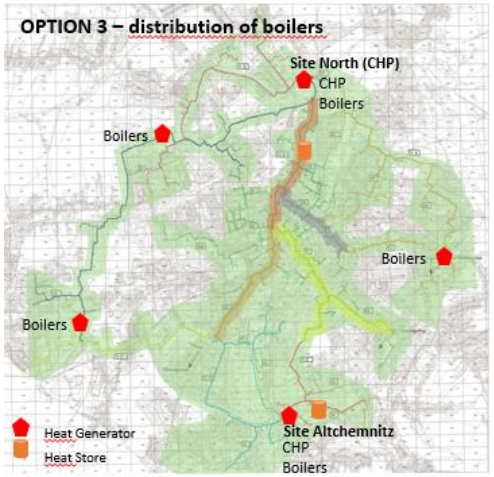
3. Step: Analysis

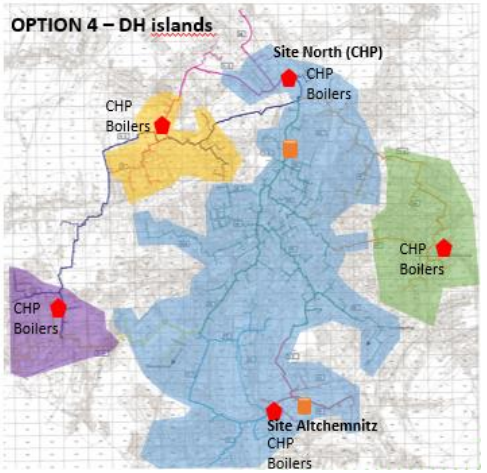
- comparison of grid options with regard to cost of grid replacement, reliability of supply, operation cost, electricity consumption for pumping, cost of preparing additional generation sites, etc.

4. Step: Selection of the Preferred Grid Option









5. Step: Compatibility Check with Generation Option

Proposed Option for District Heating Grid

3 generation sites – all with CHP

Decommissioning of section C pipe

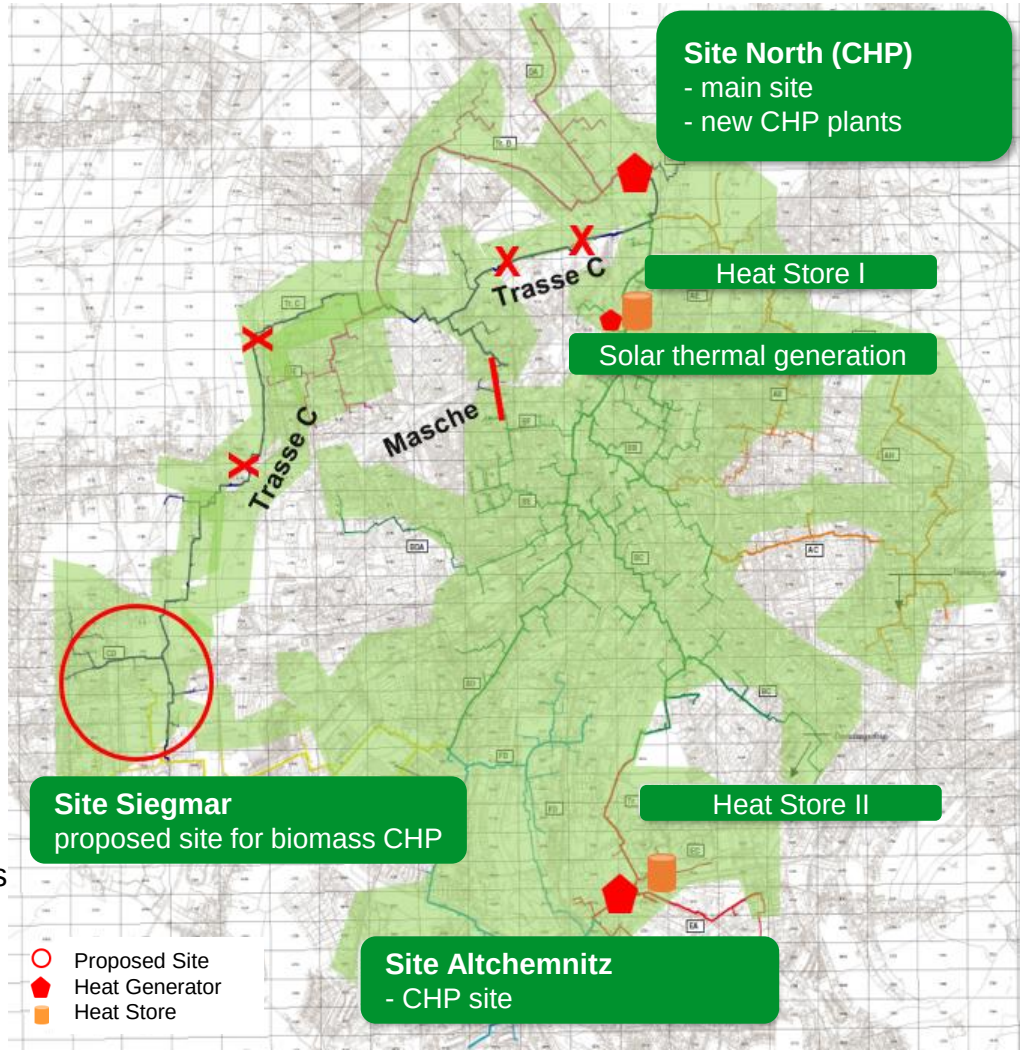
Closing a mesh to improve hydraulics and security of supply

Reduction of operation temperatures

Replacement of DH grid over the next decades with smaller pipe sizes

Advantages

- lower grid replacement costs and lower heat losses
- improved security of supply, flexibility
- better use of heat accumulators



Summary

- **Resilient solutions for the transformation of DH systems are very individual.**
  The Chemnitz strategy is not a blue print for the transformation of Polish or other German DH systems.
- **But the method of devising a transformation strategy by using an approach that looks at both, the generation and the grid structure, is tried and tested.**

- Energy policy is volatile in Germany, causing a difficult environment for long-term investment.
- Transforming the infrastructure (building stock, power grids, gas grids, DH grids) is cost-intensive and poses risks of stranded investment.
- District heating grids offer enormous possibilities regarding
  - primary energy efficiency, CO_2-reduction potential
  - integration of different types of heat generation and storage (improvement of sector coupling, integration of fluctuating renewable energy)
  - leverage to reach a high number of stakeholders efficiently