Scenarios for climate-neutral district heating

DEMO DISTRICT

City of Leipzig

PARTNERS INVOLVED

UNIVERSITÄT LEIPZIG

Leipziger Stadtwerke

COMPLETION DATE

May/2023

KEY NUMBERS

4 generation scenarios with LCOH spread: 74-139 EUR/MWh

30 fuel price sensitivities with LCOH spread: 74-256 EUR/MWh

CO_2 REDUCTION POTENTIAL

High

CONTACT PERSON AND LINKS

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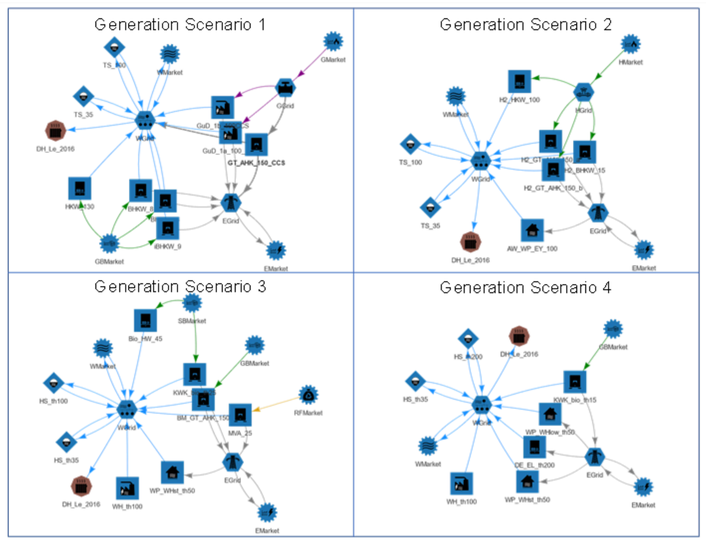
Uni website

Publication

Short description

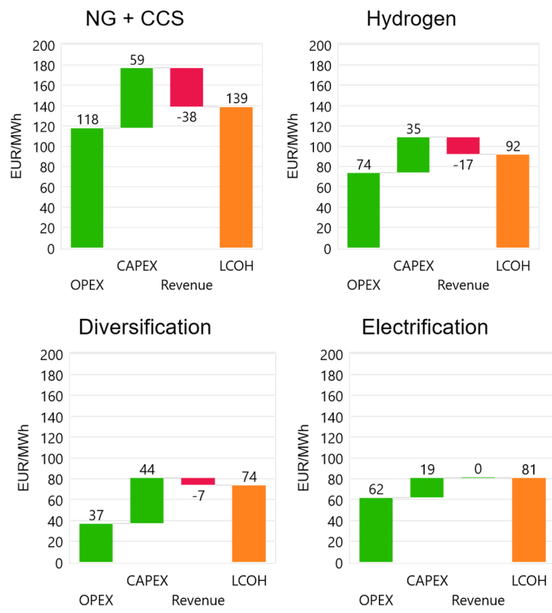
- The city of Leipzig plans to be fully decarbonised by the year 2040
- However, the heating in building sector still makes up a large part of city-wide emissions
- Expanding and decarbonising the existing district heating system is a sensible approach to support the decarbonisation efforts of the city of Leipzig
- Four generation scenarios are proposed based on different development assumptions and respective energy carriers; they vary strongly and can be considered as extreme scenarios:
  - (1) Natural gas with carbon capture and storage
  - (2) Hydrogen
  - (3) Diversified mix of biomass, waste heat and solar
  - (4) Electricity
- Analysis of the future district heating demand for Leipzig with the support of LSW
- The scenarios' robustness towards commodity prices is investigated using a sensitivity analysis, 30 sensitivities are investigated in total
- The energy system model IRPopt was used to optimizs the hourly economic dispatch of the heat generation plants of the respective generation scenario
- Based on this, Levelised Costs of Heating (LCOH) are determined and evaluated



Design of the generation scenarios in IRPopt

Key results during the project lifecycle

- Calculation of the district heating demand of the city of Leipzig in 2040
- Design of four distinct generation scenarios
- Gathering of relevant techno-economic data for all generation scenarios to be implemented in the energy system model IRPopt with the support of LSW
- Implementation of the designed generation scenarios in IRPopt
- Design of a calculation tool for the variable and annualised investment cost, revenue and the resulting LCOH for all considered generation technologies of each generation scenario
- Sensitivity analysis of relevant commodity prices to evaluate the robustness of the various generation scenarios
- Establishment of regular meetings with LSW to inquire additional techno-economic parameters and to reflect and discuss results
- Calculation of the resulting LCOH for all generation scenarios and commodity price sensitivities
- Evaluation of the results :
- in collaborative meetings with LSW
- in the form of a scientific publication
- indication regarding future pricing can be extracted to a certain degree from the LCOH



LCOH of the generation scenarios

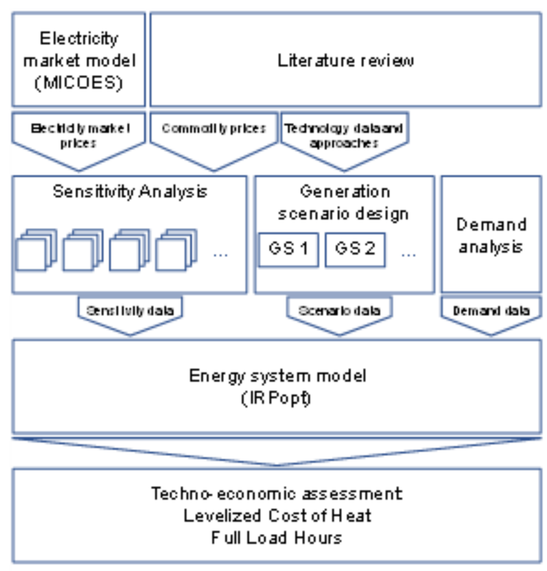
Insights and learnings

- A relevant and valid source of techno-economic data is essential when working with any energy system model
- The design and consideration of extremely distinct generation scenarios is interesting, however, it only gives a very broad indication of realistic future system cost; the consideration of more realistic scenarios may be a valued addition to the considered cases
- The current uncertain geopolitical situation further complicates the prognosis of realistic future LCOH connected to the scenarios. The critical reflection of techno-economic assumptions and commodity price sensitivity analysis are sensible approaches to tackle these problems
- In generation scenarios with higher diversification in regard to the fuel sources, fluctuations in fuel prices have a less significant effect on the LCOH
- Conversely, the focus on singular fuel sources (scenarios with natural gas and hydrogen) has major effects on the LCOH in the event of variation in the respective fuel prices
- Integration of CHP plants in the generation scenario and corresponding sale of co-generated electricity at wholesale prices can counteract the negative effects of rising electricity prices; this is the case in the scenarios considering natural gas and hydrogen

Challenges

- The current uncertain geopolitical situation complicates the prognosis of realistic future LCOH connected to the scenarios
- Uncertainty and data inaccessibility regarding the considered generation technologies (mostly for novel technologies like hydrogen powered CHP-plants, carbon capture plants, etc.)
- Uncertainty regarding the development of the regulatory framework over the coming decades: which technologies will be penalised, which will be subsidised

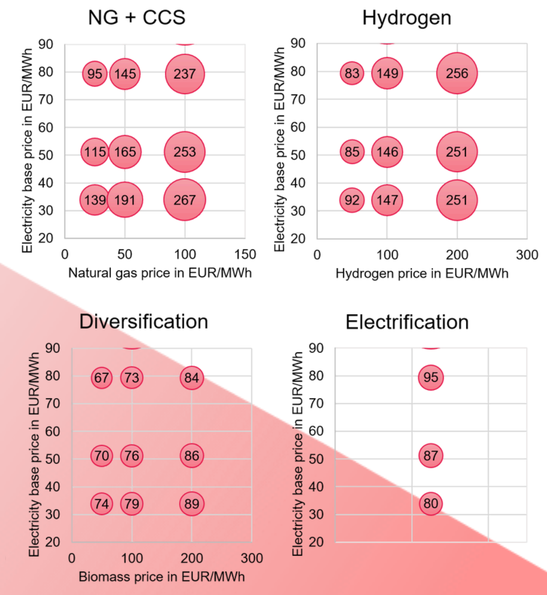
Methodological approach



Plans for replication

- Publication as a scientific paper → Dissemination into the scientific community, potential for replication
- Application of the methodology in future projects with the aim of decarbonisation of district heating grids in the new regulatory frame of Germany ("Gesetz Wärmeplanung"); the chosen methodology was evaluated and will be partially expanded upon in the following project(s)
- integration of the gained knowledge into university teaching

Considering sensitivities



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