Future economic efficiency of gas distribution grids

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17.05.2018
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EFRE.NRW
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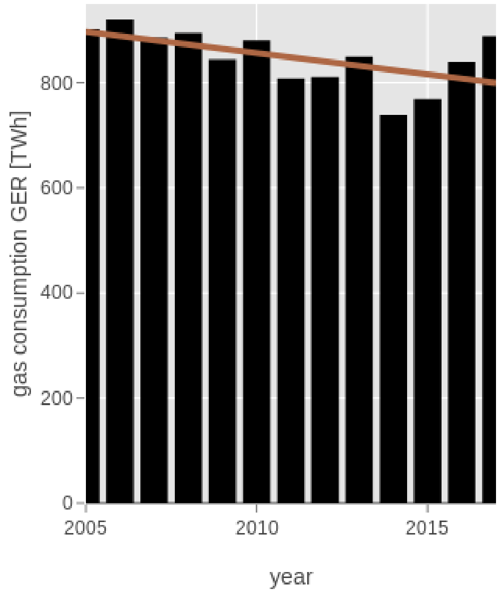
Europäischer Fonds für regionale Entwicklung

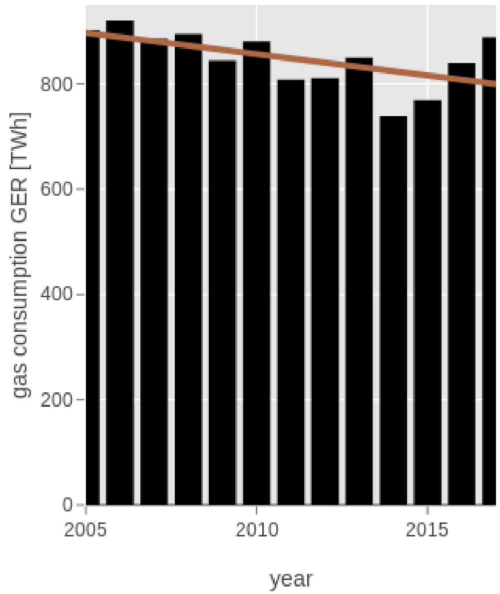
The case



Decreasing consumption

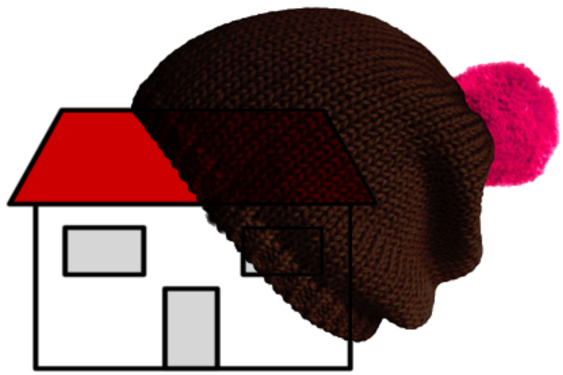
[1] BMWI: Energiedaten gesamt, 2016.

The case



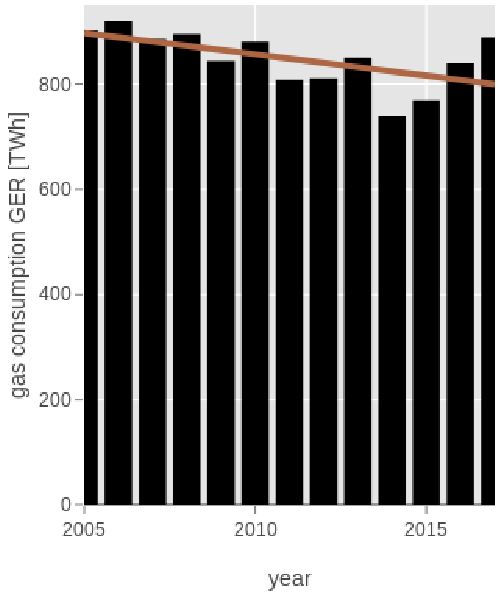
Decreasing consumption

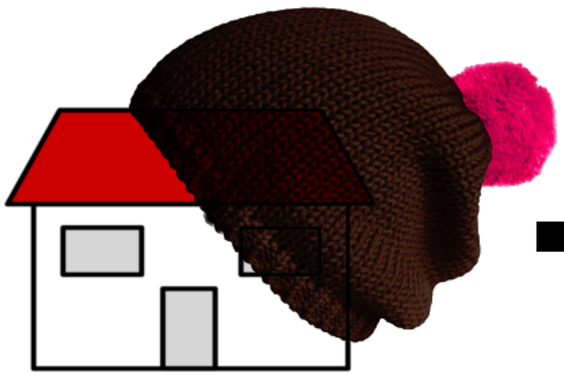
+

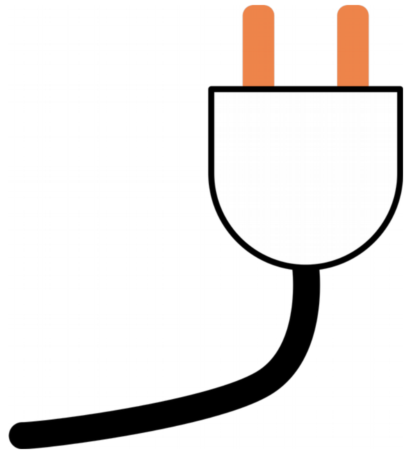


Renovation rates

The case







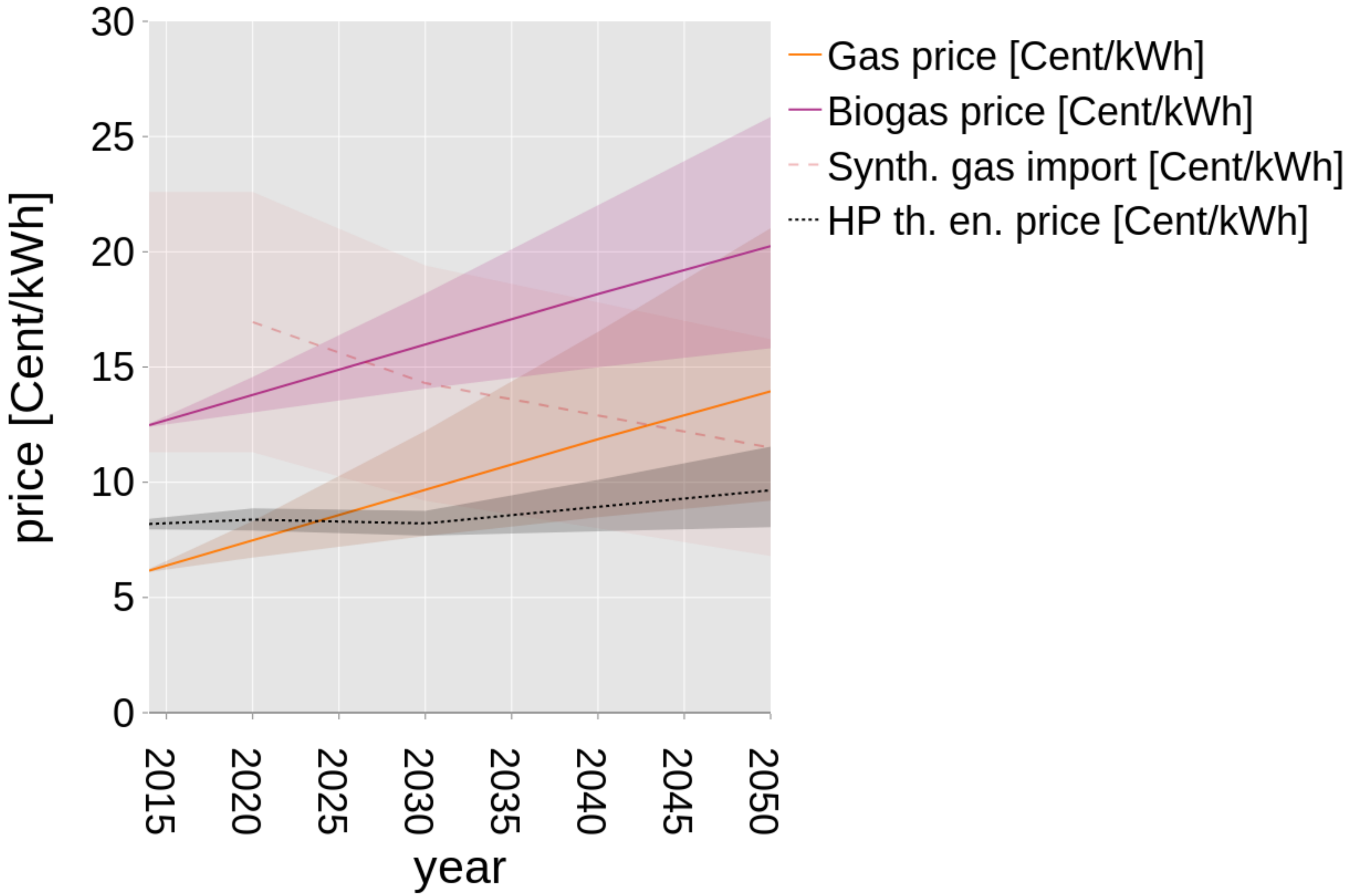
Decreasing consumption

Renovation rates

Electrification

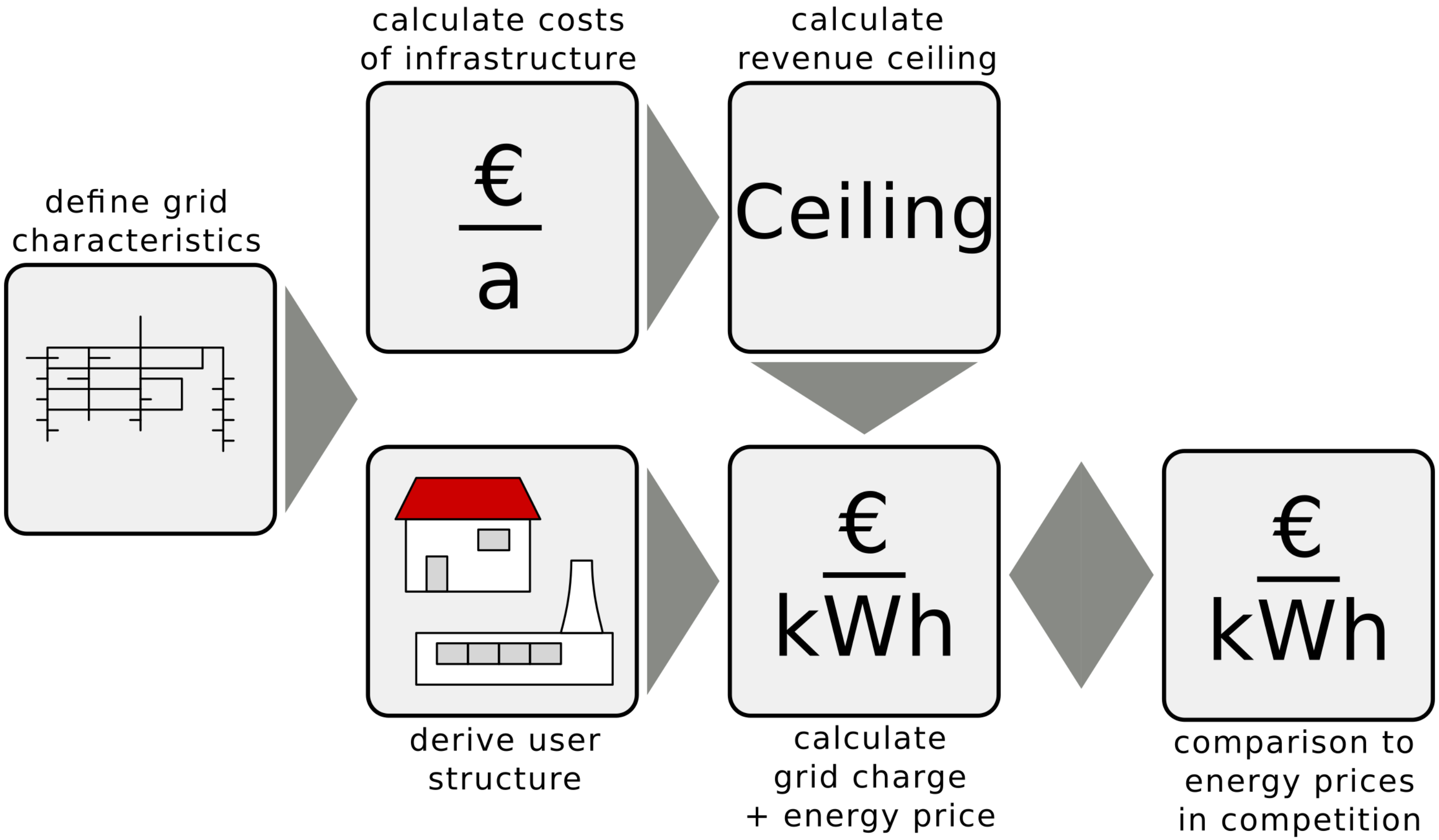
Will we need gas distribution grids in the future?

Future energy prices



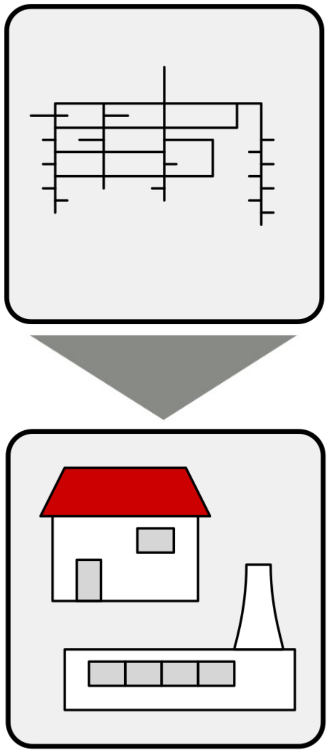
[2] V. Bürger, T. Hesse, D. Quack, A. Palzer, B. Köhler, S. Herkel, and P. Engelmann, Klimaneutraler Gebäudebestand 2050, 2016.
[3] Agora Verkehrswende, Agora Energiewende, Frontier Economics Ltd., Die zukünftigen Kosten strombasierter synthetischer Brennstoffe, 2018

Methodology

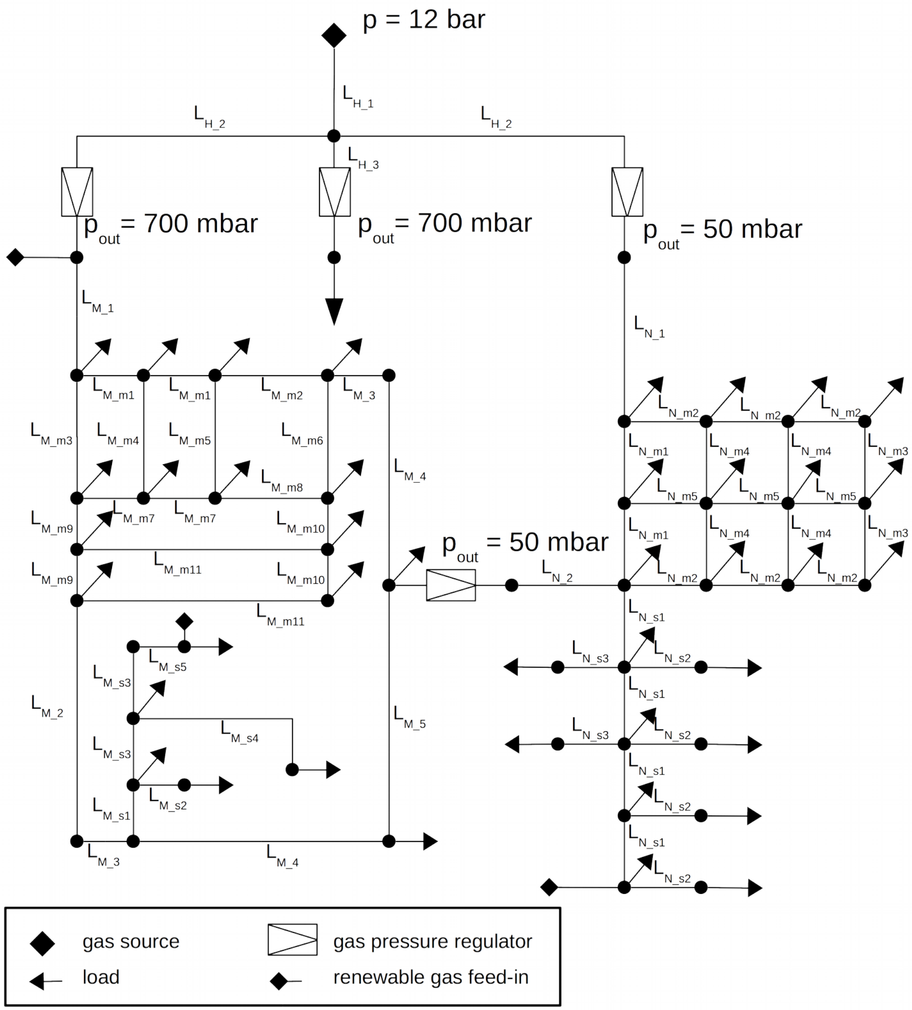


Grid structure: benchmark grid

define grid characteristics

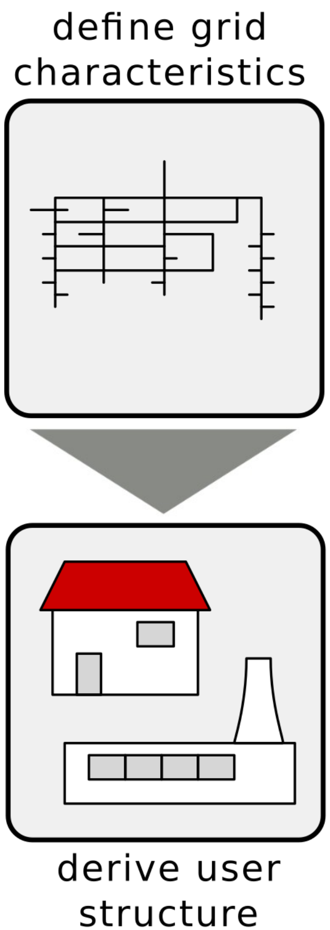


derive user structure



[4] C. Brosig, S. Fassbender, E. Waffenschmidt, S. Janocha, and B. Klaassen, "Benchmark gas distribution network for cross-sectoral applications," in 2017 International Energy and Sustainability Conference (IESC), Oct. 2017, pp. 1–5. DOI :10.1109/IESC.2017.8283183.

Grid structure: benchmark grid

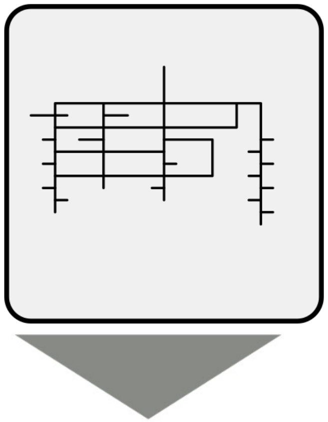


user	Connection rate	Consumption [kWh/year]
526 HH	0.7	4 799 487
339 SFH	0.7	8 277 024
164 RH	0.7	2 878 036
school	1	749 980
hospital	1	3 420 000
Sum		**20 124 547**

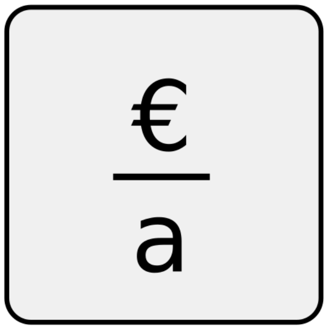
[4] C. Brosig, S. Fassbender, E. Waffenschmidt, S. Janocha, and B. Klaassen, “Benchmark gas distribution network for cross-sectoral applications,” in 2017 International Energy and Sustainability Conference (IESC), Oct. 2017, pp. 1–5. DOI :10.1109/IESC.2017.8283183.

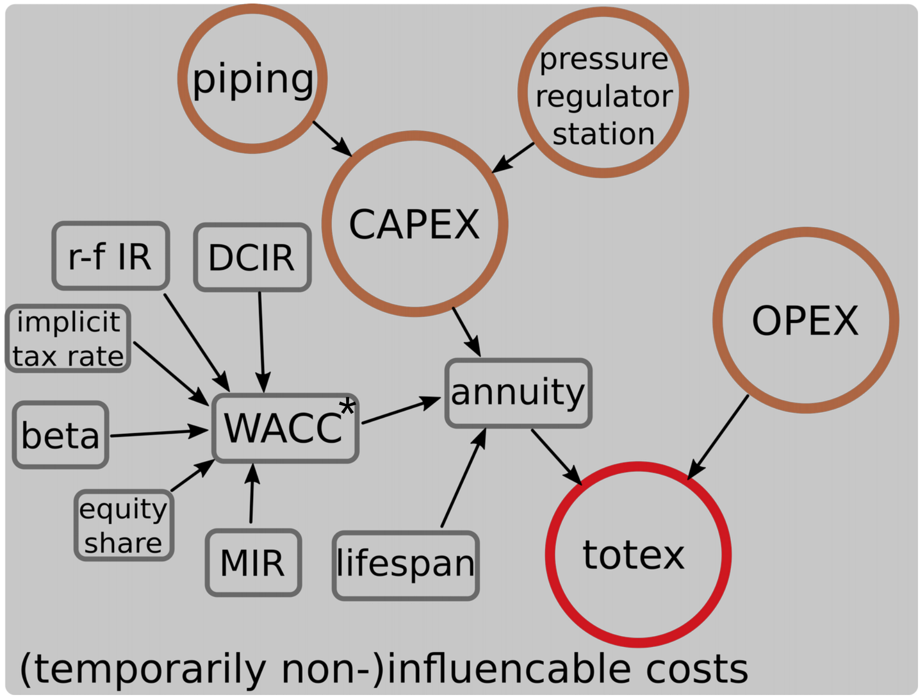
Yearly costs

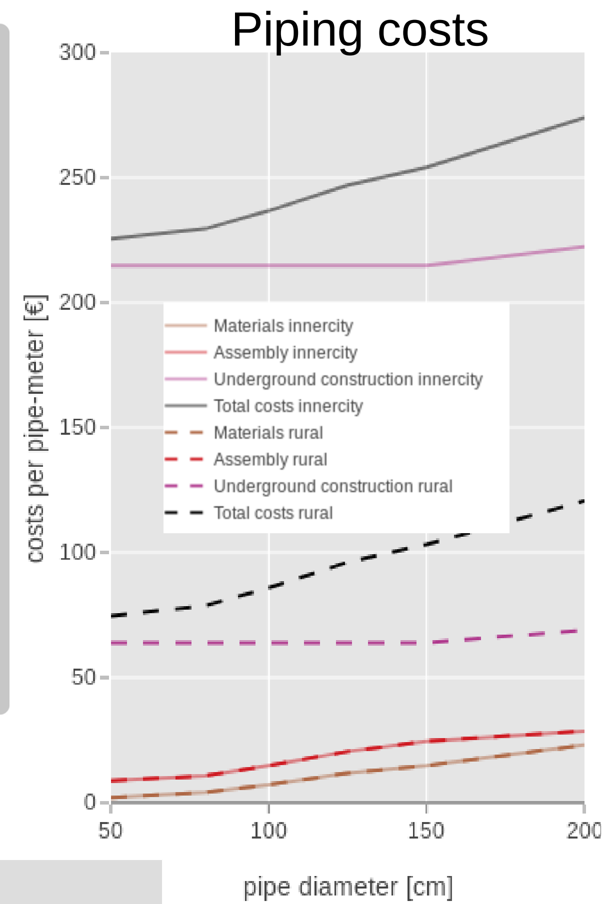
define grid characteristics



calculate costs of infrastructure







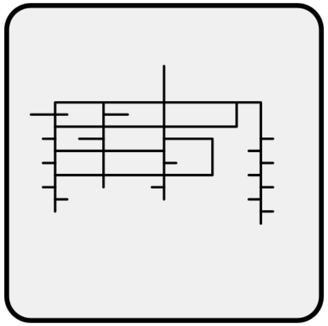
OPEX	5 €/m pipe
Pressure regulator stations	4 x 100 000 €

*weighted average cost of capital

[5] A. Scheunemann and M. Becker, Kennziffernkatalog: Investitionsvorbereitung in der Energiewirtschaft, 2004.

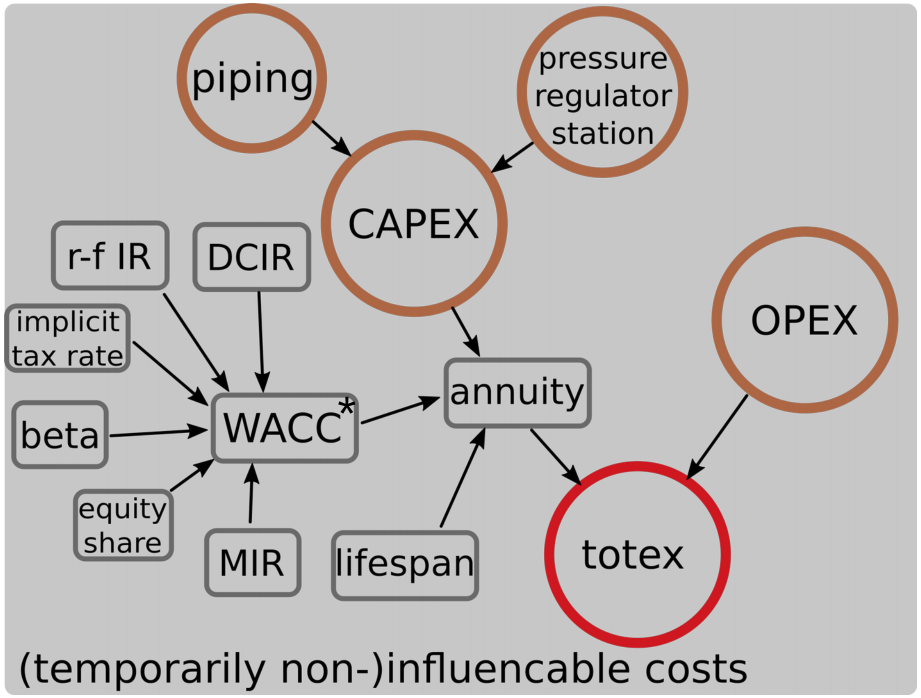
Yearly costs

define grid characteristics



calculate costs of infrastructure

€ / a



Assumptions

DCIR**	risk-free IR***	Implicit tax rate	Beta risk factor	Equ. share	Market IR**	lifespan
3.7 %	0.5 %	20.5 %	0.95	15 %	5.7 %	55 a

*weighted average cost of capital; **debt capital interest rate; ***interest rate

Revenue Ceiling

calculate costs of infrastructure

€ / a

calculate revenue ceiling

Ceiling

$$EO_t = KA_{dnb,t} + \left(KA_{vnb,t} + (1 - V_t) \cdot KA_{b,t} + \frac{B_0}{T}\right) \cdot \left(\frac{VPI_t}{VPI_0} - PF_t\right) + KKA_t + Q_t + (VK_t - VK_0) + S_t$$ [1]

non-influencable costs

temporarily non-influencable costs

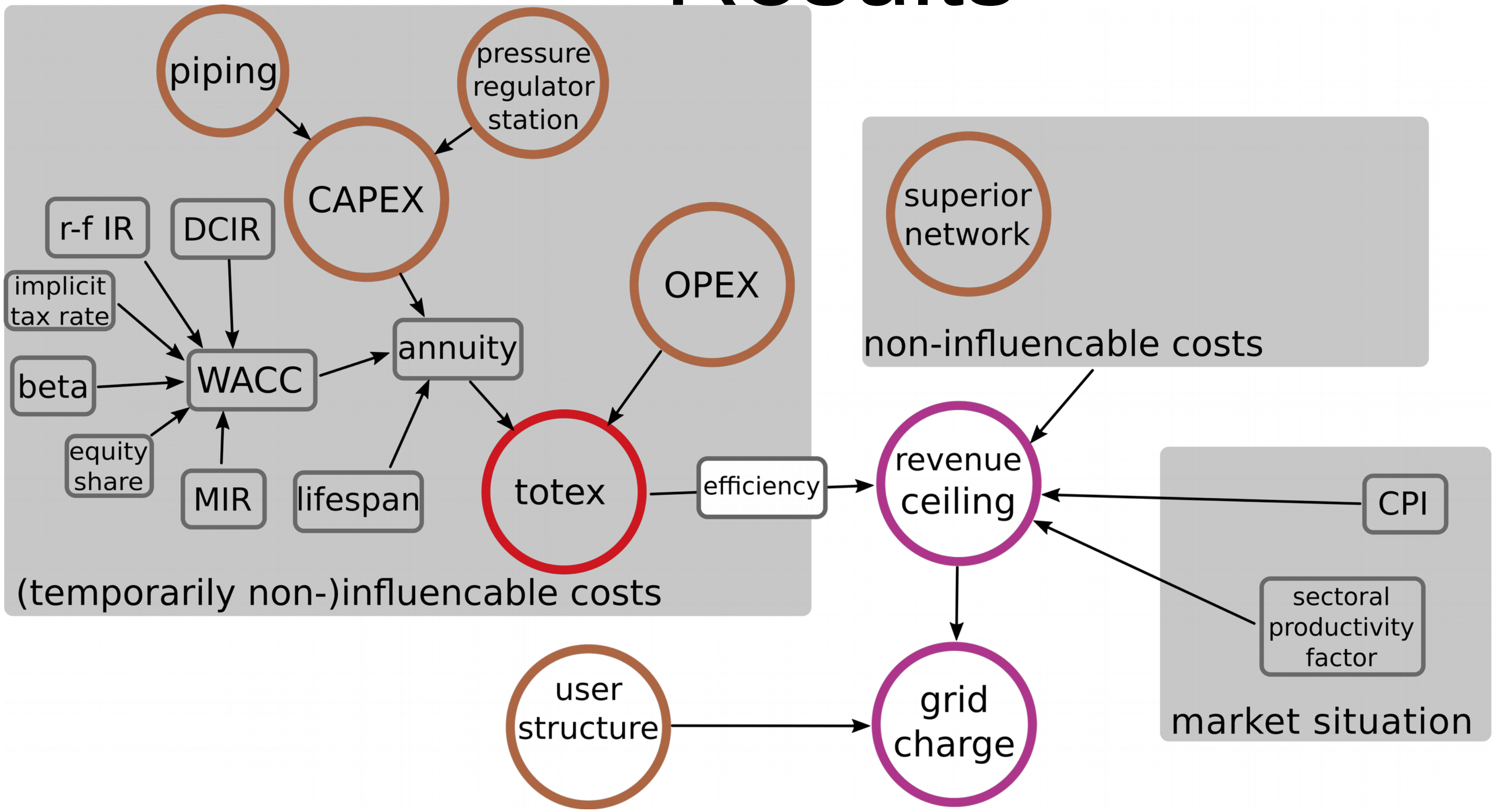
influencable costs

market situation

→ neglected factors

[6] Anreizregulierungsverordnung vom 29. Oktober 2007 (BGBl. I S. 2529), which last has been changed by Article 5 of the law from17. July 2017 (BGBl. I S. 2503)

Results

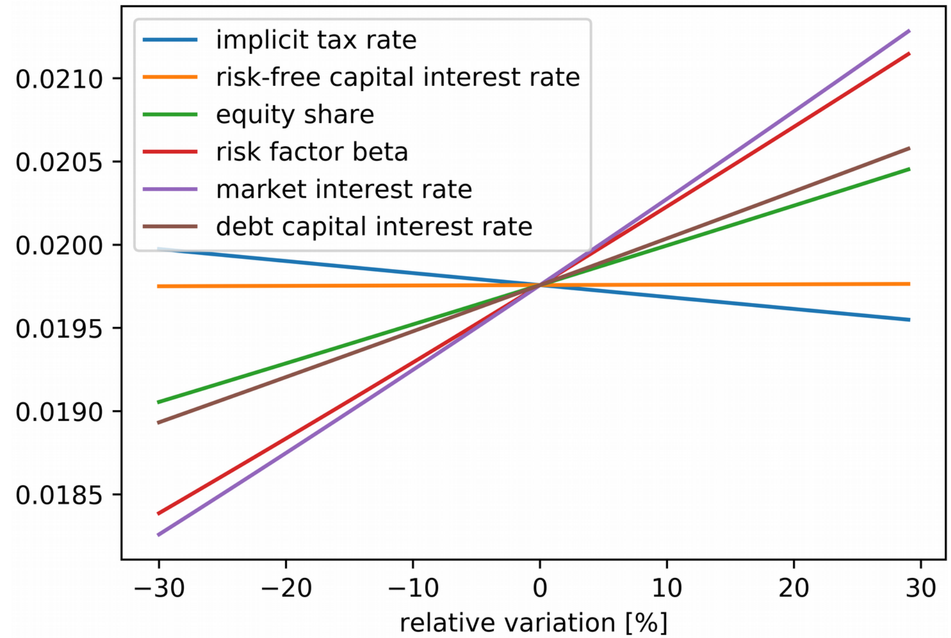


$$grid\ charge = \frac{revenue\ ceiling}{total\ gas\ demand}$$

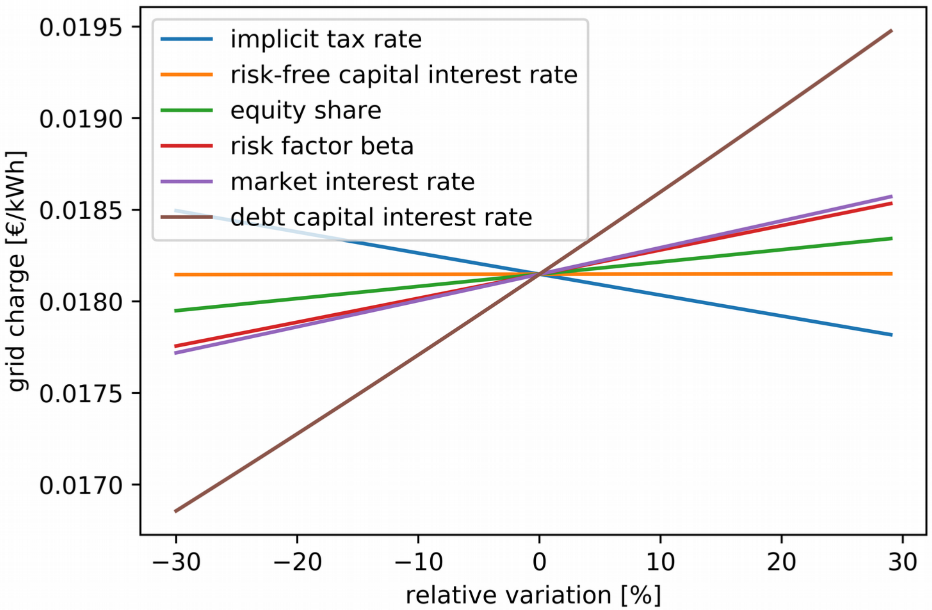
→ 1.85 Cent/kWh

Sensitivities

Equity share = 50 %



With given assumptions



Scenarios

Scenario I: Efficiency

- Efficiency measures without electrification
- Exchange of fuel oil based heating by gas based on 2016 [7]
- Reduction of space heating and warm water: 18 % - 54 % [8]

[7] BMWI, Energiedaten gesamt, 2018
[8] AEE, Metaanalyse Strom und Wärme, 2017

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Scenario II

- Electrification on basis of efficiency measures
- Heat pump installation in Germany from 14.56 to 244.56 TWh [8]

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Scenario III

- Renewable gas only

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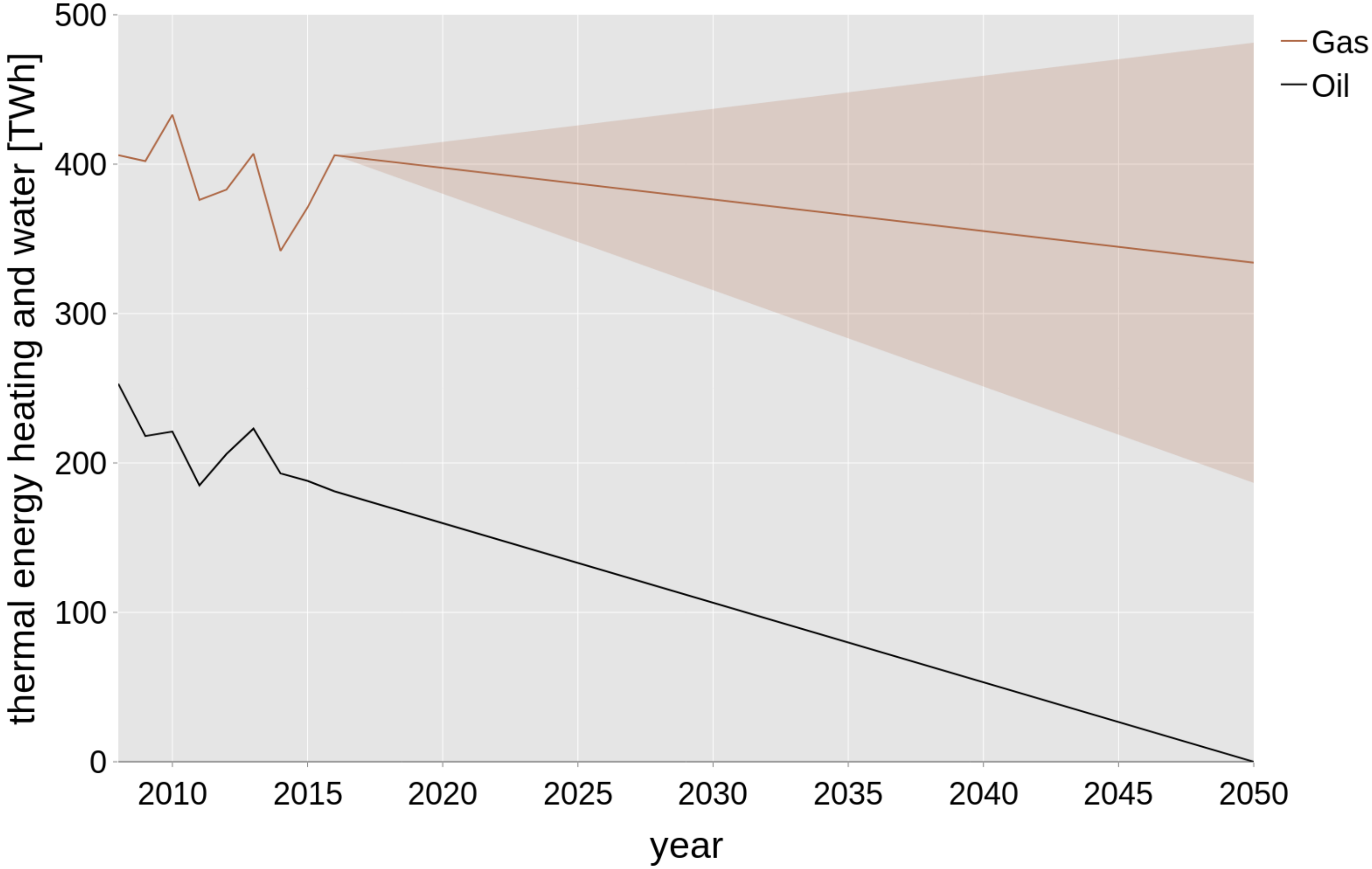
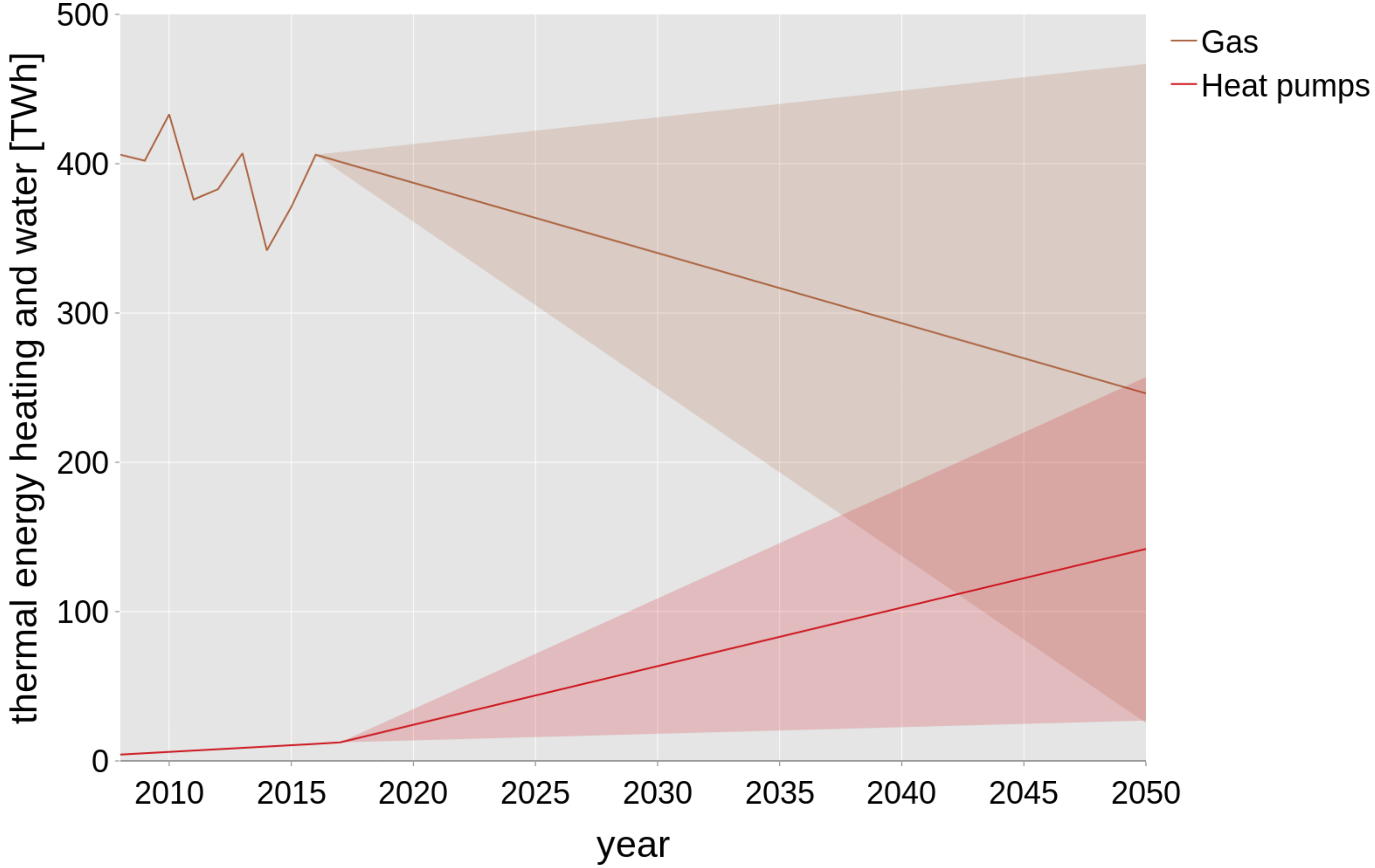


- Proportionally transferred to the benchmark grid
- Leads to a **grid charge** → 1.56 Cent/kWh – 4.03 Cent/kWh

[7] BMWI, Energiedaten gesamt, 2018
[8] AEE, Metaanalyse Strom und Wärme, 2017

Scenario II: Electrification



- Proportionally transferred to the benchmark grid
- Leads to a **grid charge** → 1.61 Cent/kWh – 29.58 Cent/kWh

Cologne Institute for Renewable Energy

[7] BMWI, Energiedaten gesamt, 2018
[8] AEE, Metaanalyse Strom und Wärme, 2017

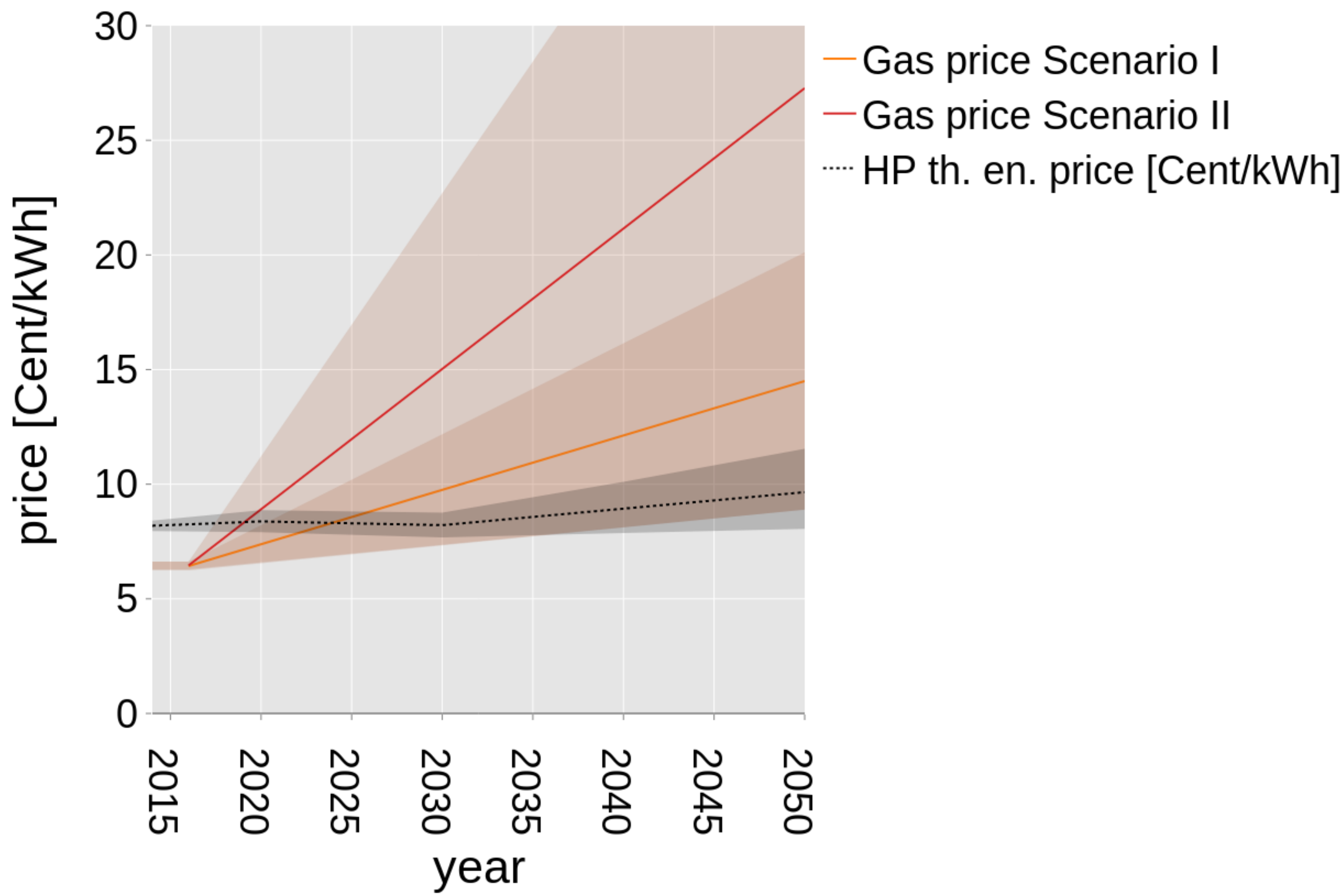
Scenario III: Renewable gas

- Connection of biogas or methanation = add. Costs
  → marginal in comparison to the total grid

- Supply with renewable gas only is feasible
  → imported!
  → but profitable?

- 100 % renewables: „cold dark lull“
  → CHPs instead of gas power plants to fill these weeks?
  → evaluation needed
  → political decision

Gas-price vs. Electricity-price



[3] Agora Verkehrswende, Agora Energiewende, Frontier Economics Ltd., Die zukünftigen Kosten strombasierter synthetischer Brennstoffe, 2018

Discussion

- Exchange of fuel oil with gas will need further investments to connect houses to the gas grid
  - Were not yet included!

- Grid charge is logarithmically distributed depending on the yearly gas demand
  - Leads to higher grid charges for households!

Conclusion

- Exchange of fuel oil with gas is able to buffer gas consumption losses, but...
    - Investment measures might not add up to the gain

- Heat-pumps will become less expansive than gas heating by 2020 to 2025

- Parts of the gas distribution grid should be shut down in future, to prevent grid charges from rising

- CHPs with <u>renewable gas</u> could have the potential to
    - save parts of the gas distribution grid
    - release stress from the electrical grid