

Coupling of Electricity and Gas Market Models

14th International Conference on the European Energy
Market – EEM 2017

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07.06.2017

Dresden

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Project Dynamis

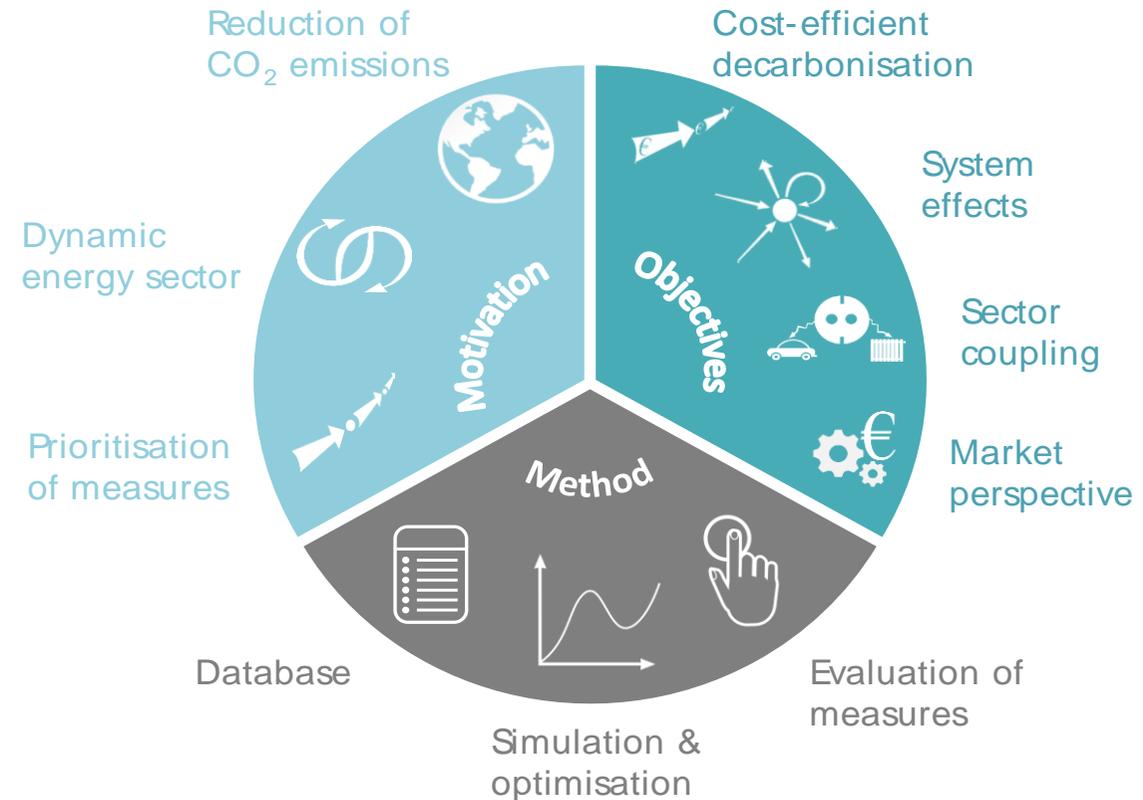
Energy Modelling in Project Dynamis

Short Description

Dynamic and intersectoral evaluation of measures for a cost-efficient decarbonisation of the energy system

Key Data

- Duration: 08/2016 to 07/2019
- Consortium: FfE e.V., FfE GmbH, TUM IfE
- 12 Project Partners: energy utilities, automotive manufacturers & industry
- Budget: 2,9 Mio. €



Gefördert durch:



aufgrund eines Beschlusses des Deutschen Bundestages

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Energy System Model ISAaR

Energy Modelling in Project Dynamis



Integrated simulation model for planning the operation and expansion of plants with regionalisation

- Linear Optimisation Model
- Optimisation of total costs of the system, emissions or network utilization
- 496 nodes in Germany/Austria & 1500 nodes in Europe
- Hourly resolution 8760h, rolling horizon (168h)
- PTDF-approach (DC-approximation of AC load-flow)



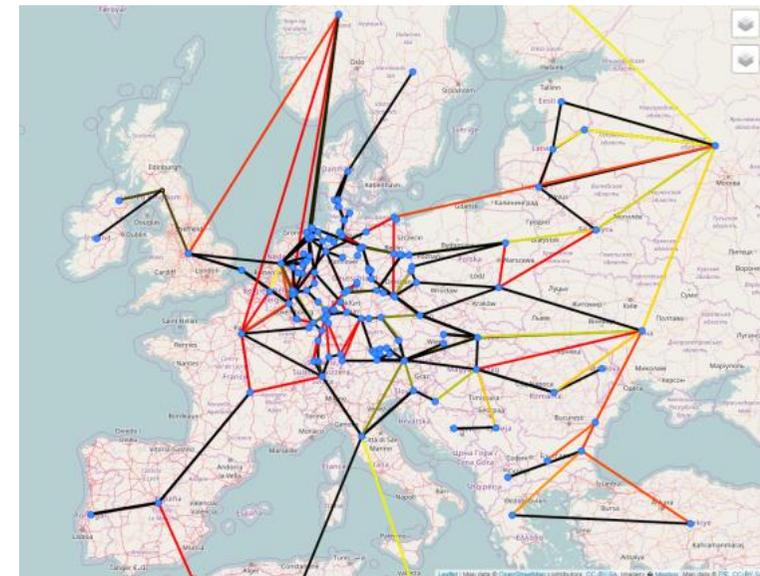
Gas Market Model MInGa

Energy Modelling in Project Dynamis

MInGa

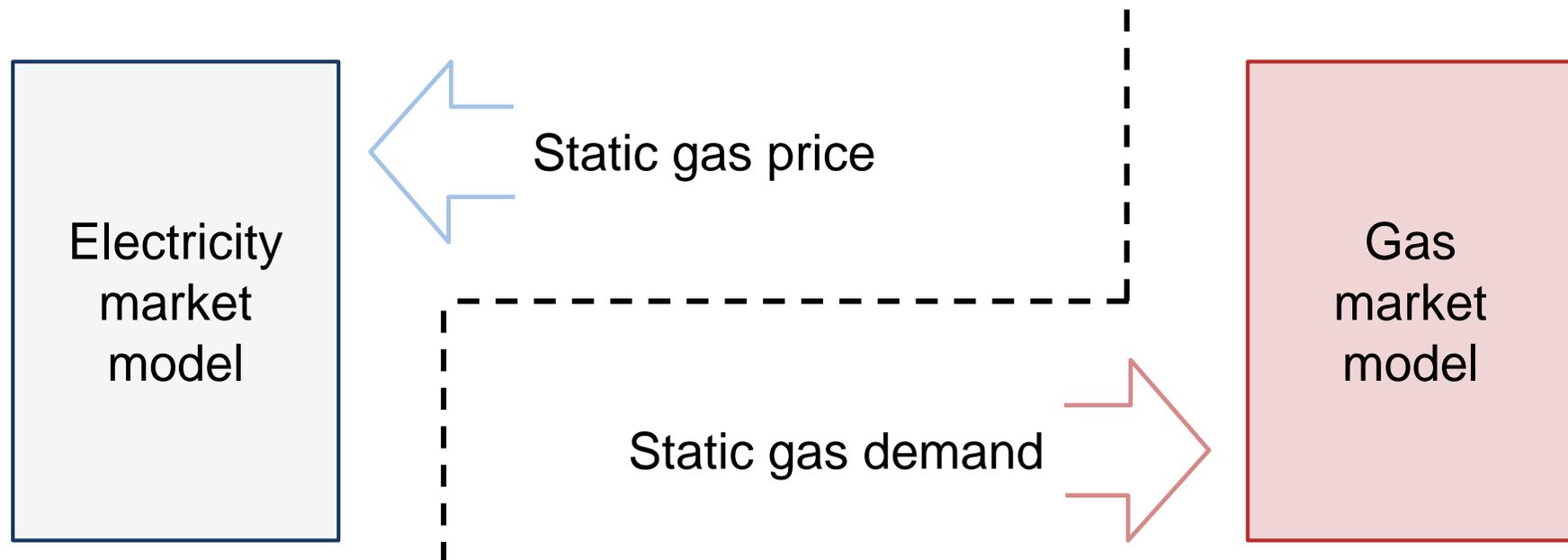
- Linear Optimisation Model
- Optimisation of total costs of the system
- 99 nodes in Germany & 154 nodes in Europe
- Daily resolution 365d
- Cost-optimal line-flow

Market and Infrastructure Model of Gas sector



Initial situation for electricity and gas market modelling

Coupling of Electricity and Gas Sector

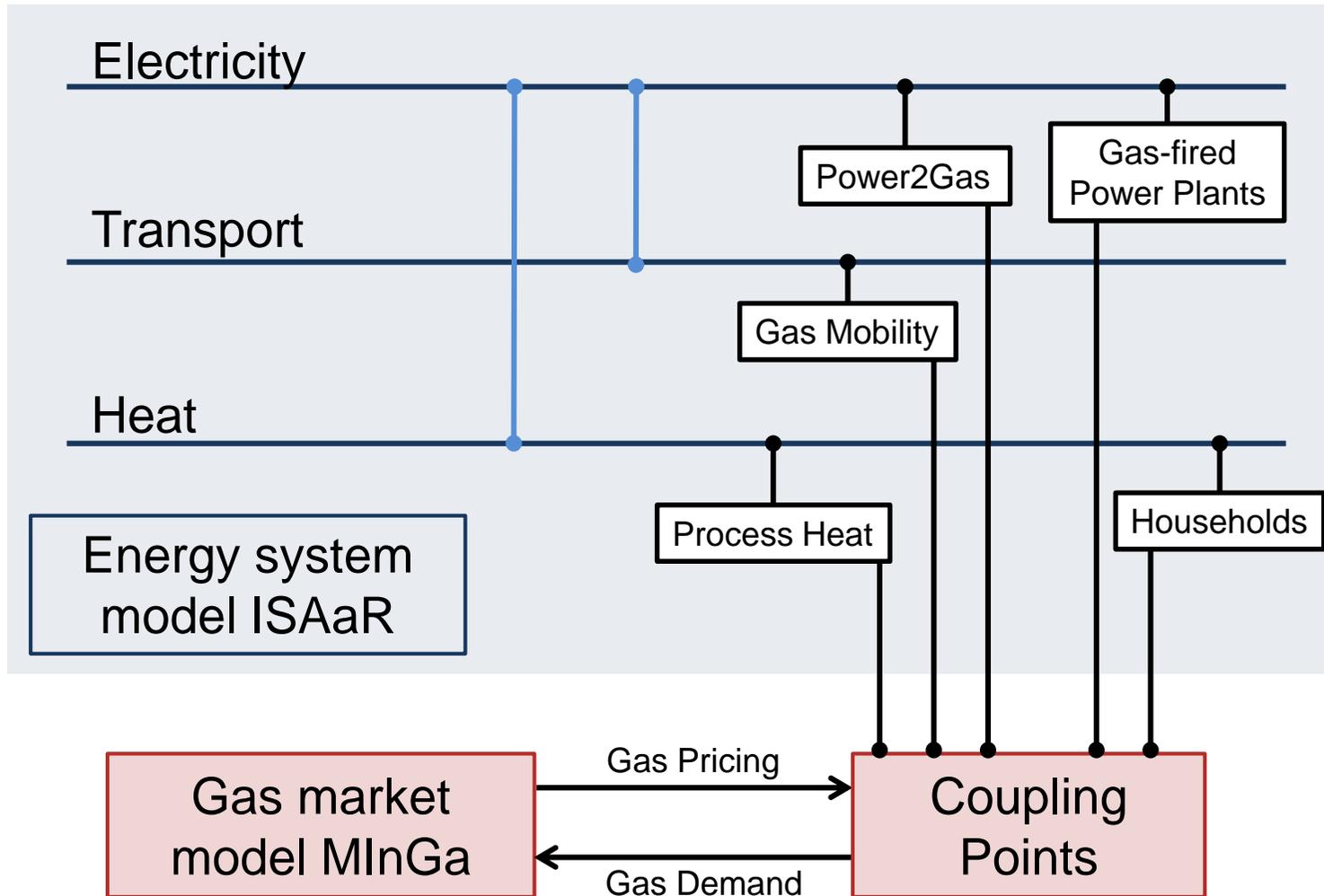


Scientific issue:

- Is a static gas price for electricity market models sufficient?
- Is a static gas demand for gas market models sufficient?
- How can the models be connected without increasing the complexity of the optimisation problem?

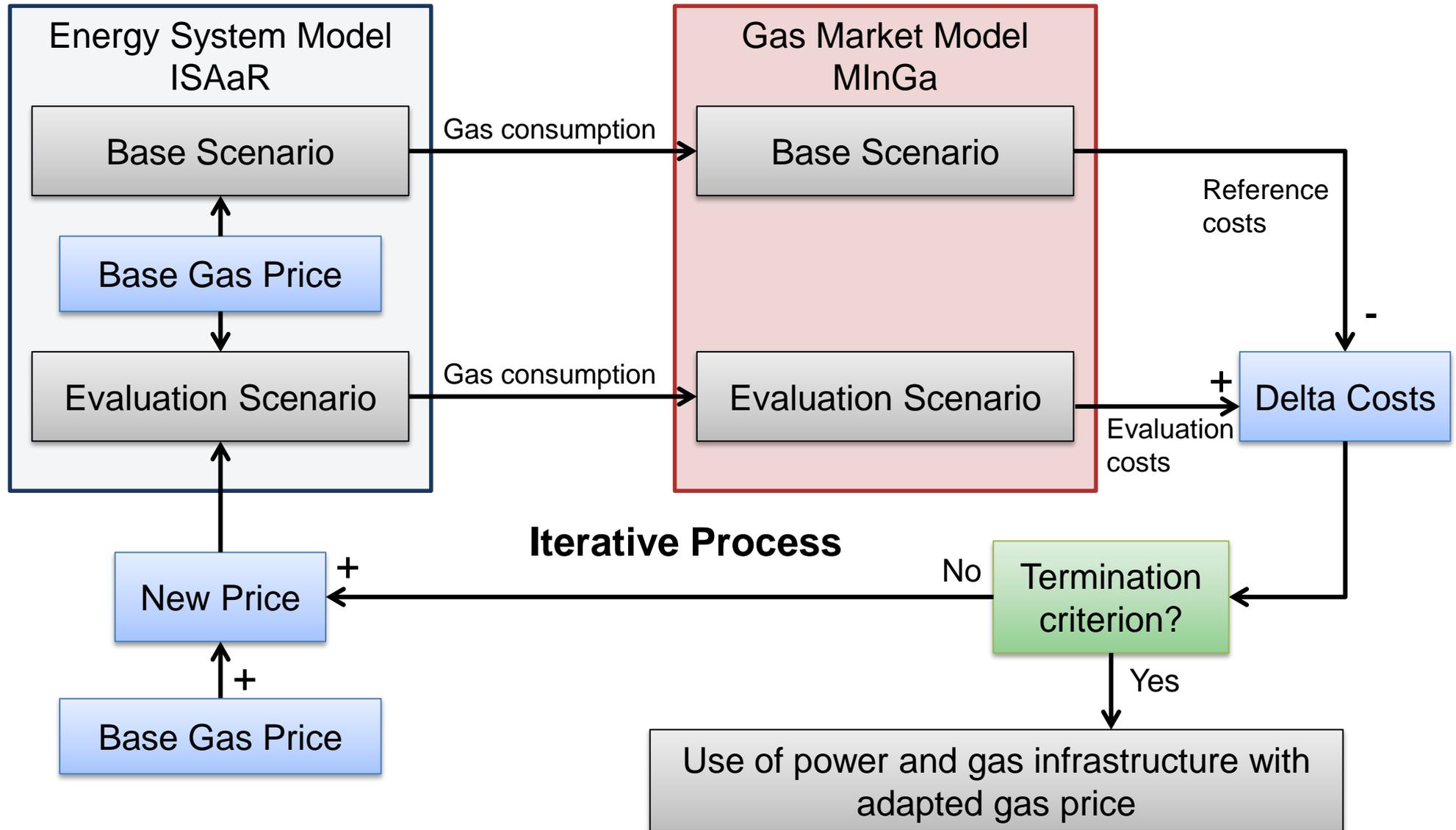
Sector coupling regarded in models

Coupling of Electricity and Gas Sector



Methodology

Methodology



Scenarios for Model Coupling

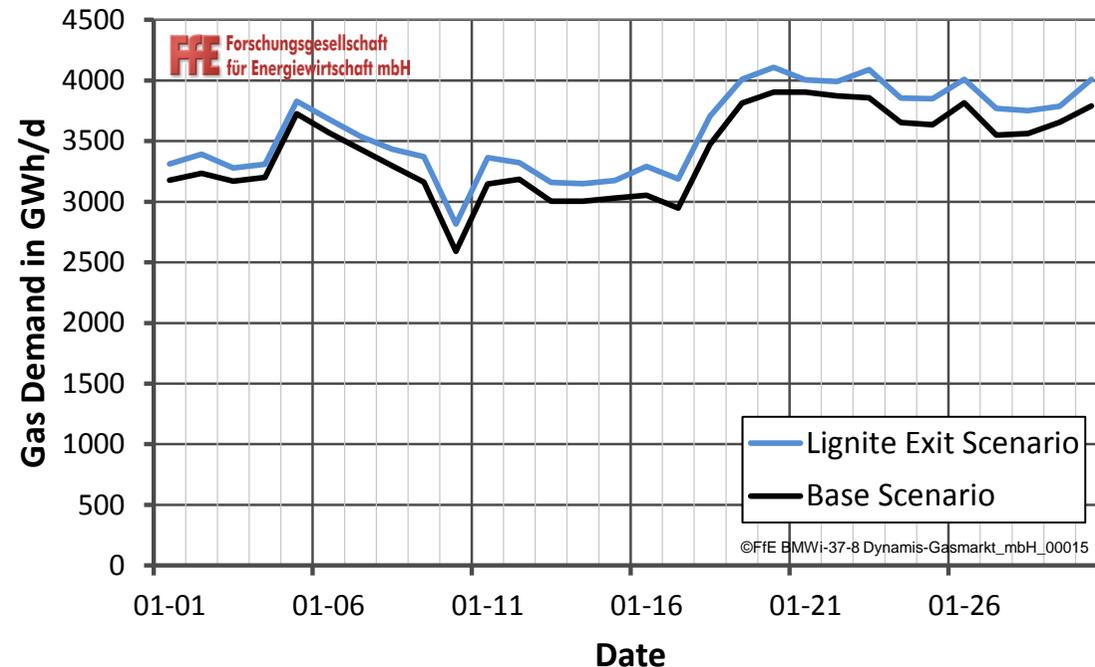
Exemplary Studies

- Parameters:
 - Retrospectively for the year 2015
 - Area under consideration: Europe
- Scenarios
 - Base scenario: Use of actual power plant availabilities
 - Evaluation Scenario: Lignite Exit
Decommissioning of all lignite power plants in Germany
- Termination criterion
 - Difference between two iterative prices is less than 1 %

Considered scenarios

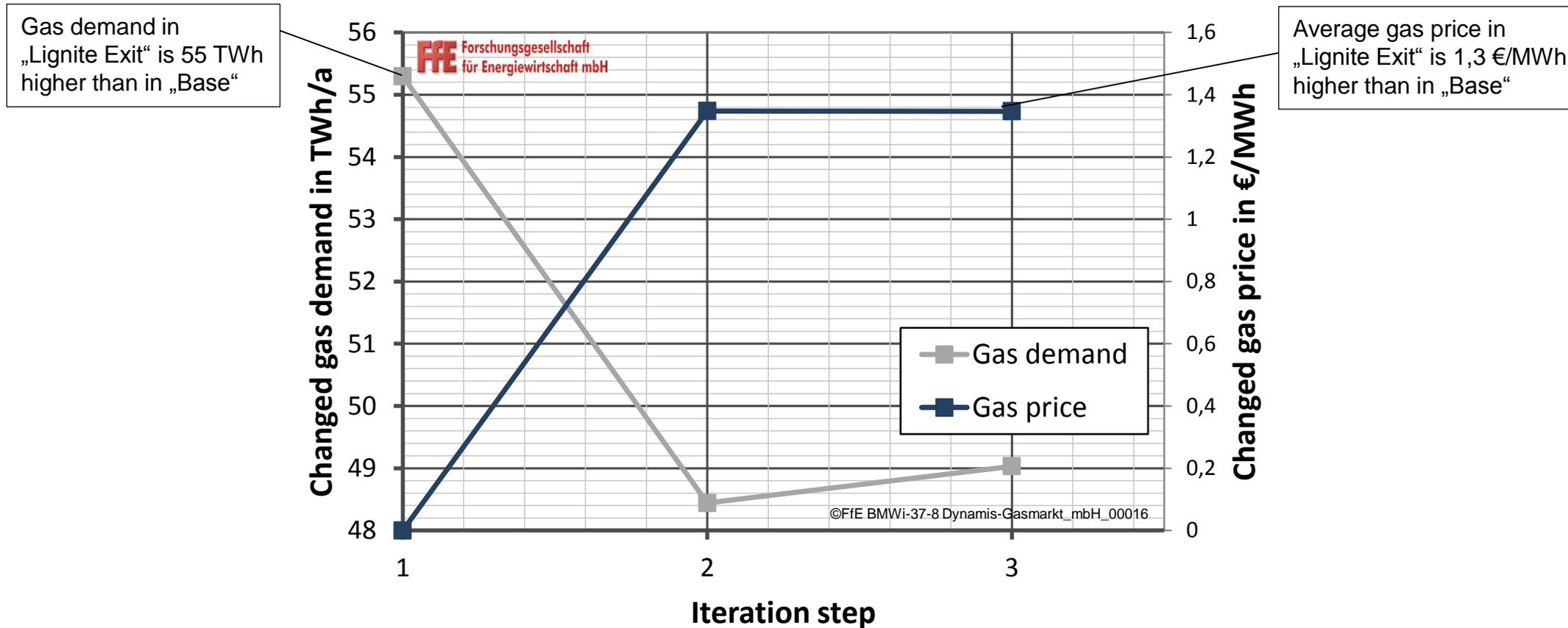
ISAaR: Simulation of Energy System

Adapted gas demand for Evaluation Scenario



Effects of Evaluation Scenario

Exemplary Studies



- Changed gas demand has effect on average gas price
- Termination criterion fulfilled quickly due to low merit order effects

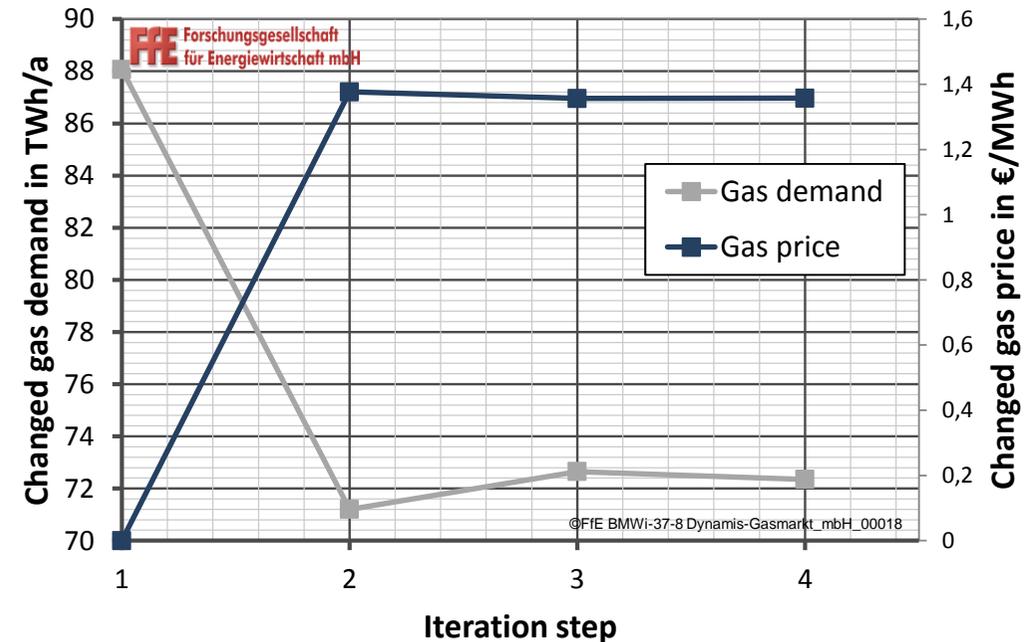
Effects of Evaluation Scenario with higher CO₂ certificate costs

Exemplary Studies

- Adjustment of CO₂ certificate costs for 2015
 - Actual average costs: 7.70 €/t CO₂
 - Adjusted average costs: 19.00 €/t CO₂
 - ➔ Gas power plants have similar marginal costs to hard coal power plants

- Bigger change in gas demand
- Slightly bigger change in gas price
- Fulfillment of termination criterion needs one additional iteration step

- ➔ Flexible gas demand has effect on gas price under the assumption that marginal costs of gas procurement have a correlation to the gas price
- ➔ If gas power plants compete with hard coal power plants, the gas price and demand fluctuations increase



Main Aspects

Conclusion

Initial situation:

- Electricity and Gas Market Models are often used separately
- Static gas price for electricity market models is sufficient?

Modelling:

- Coupling of gas market model and electricity market model via gas demand and gas price
- Iterative process for connection of the two models

Exemplary Studies and Outlook

- Flexible gas demand has an effect on gas price and should be considered
- Termination criterion fulfilled quickly due to low merit order effects
- Further investigations for realistic gas price modelling is necessary

Many thanks for your attention!

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