Development of scenarios for a multi-model systems analysis of cellular energy systems

Energy Scenario Conference

Matthias Kühnbach (Fraunhofer ISI)

Felix Guthoff (IER – University of Stuttgart)

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SINTEG
SCHAUFENSTER INTELLIGENTE ENERGIE

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C sells

Agenda

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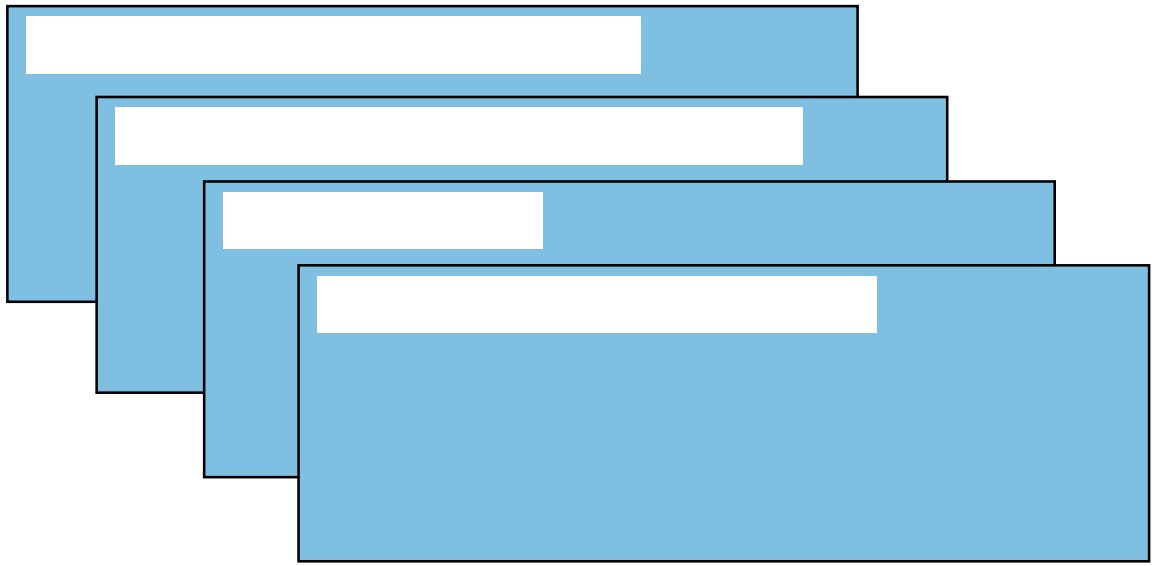
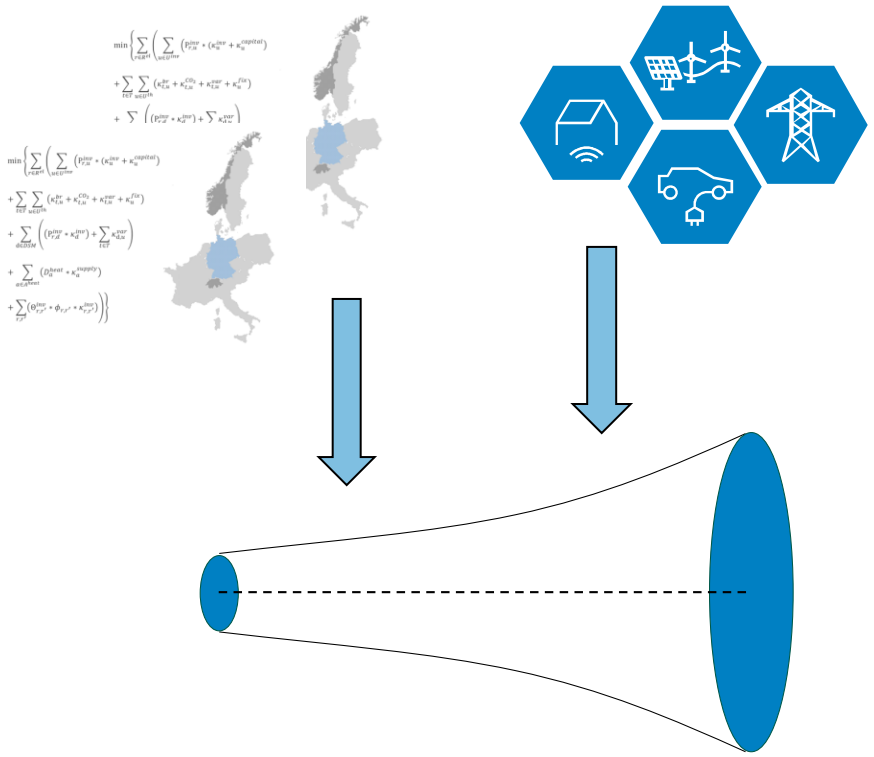
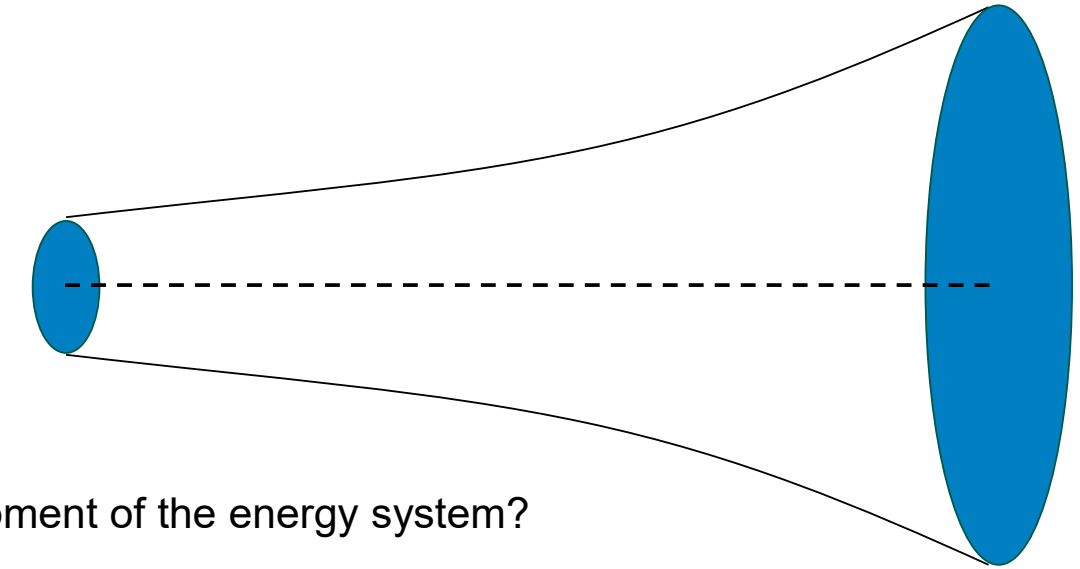




Motivation and Challenges

- The transformation of the energy system is ongoing:
  - Growth of RES
  - Decentralization
  - Sector coupling and electrification



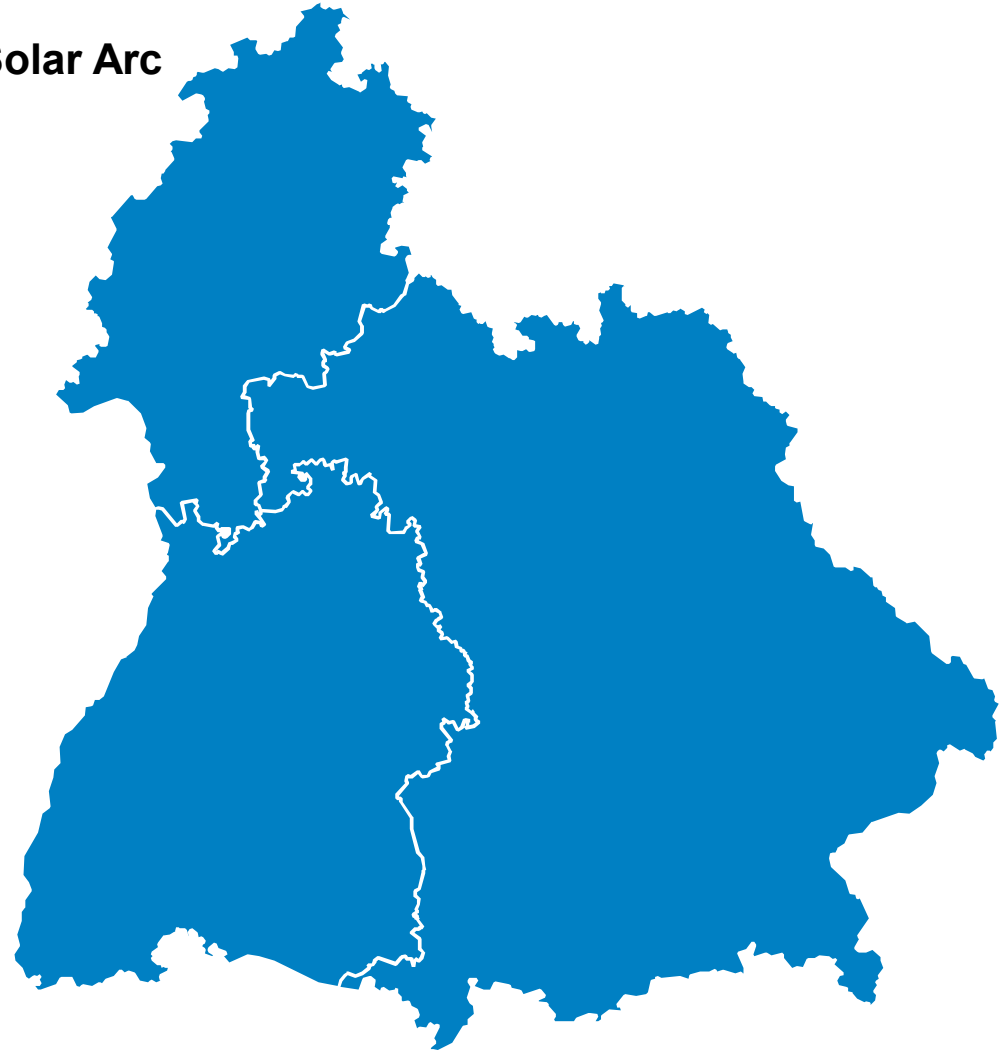
- How can we evaluate systemic transformations?
- How to analyse innovative concepts which affect the development of the energy system?
- How can we use and compare results from multiple models?

→ develop a scenario framework (consisting of two scenarios) which considers both innovative aspects and model-specific characteristics

Research Framework: **C/sells**

Energy System of the Future in the Southern German Solar Arc

- **Research project in the framework of SINTEG (funding: BMWi)**
- **Volume: 100 Mio. € (Total)**
- **Duration: 01/01/2017 – 31/12/2020**
- **Largest SINTEG showcase with a reach of approx. 30 Mio. citizens**
- **59 partners**
- **32 ‘demonstrators’, 9 cells aiming at active participation of citizens**



Decentralised and cellular energy systems

Decentralised energy systems

- Electricity supply close to demand [1]
- Small-scale generation, often based on renewable sources [2]
- Generation units connected to lower voltage levels of the grid [2, 3]

Cellular energy systems

- Balancing of generation and demand at the most local level before an interaction with a neighboring or superior cell [4, 5].
- Energy cells can range from single buildings or devices up to whole (grid) regions [4].

Objectives:

- Integrate RES
- Increase/maintain system security
- Decrease complexity

[1,5]

System Analysis in C/sells

- 6 research institutions, 5 energy system models
- General research questions addressed on the systemic level:

  What are the effects of elements of a cellular energy system on the energy system as a whole?

Methodology

(1) Identification of Areas of Influence

Narrowing the scenario‘s scope

- Identify and determine areas of influence
- Subdivide areas of influence into influence factors

- Potential impacts on the research questions
- Independent from modelling considerations

- How to consider cellular aspects in an energy scenario?

Development of technology	Generation technology
Infrastructure	Grid
Demand	Demand in sectors
	Flexibility options
Aspects of cellular systems	Definition of cell

(2) Selection of Descriptors

To describe the areas of influence more precisely, several descriptors are defined in each case

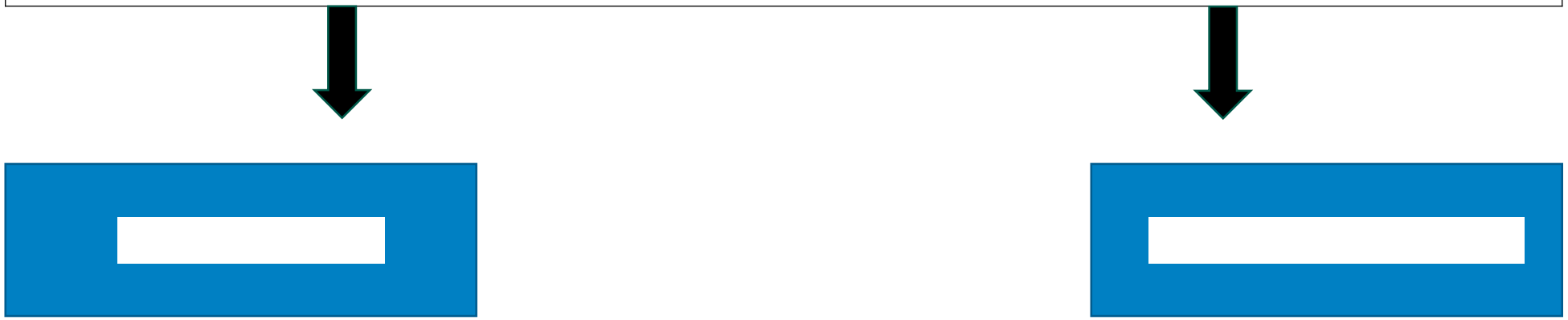
- Descriptors are a mean of explaining areas of influence
- Formulated in a neutral way
- Establish a common wording for scenarios

Development of technology	Generation technology	Generating capacities
Infrastructure	Grid	Development of NTCs
Demand	Demand in sectors	Degree of electrification
	Flexibility	Flexibility options
Aspects of cellular systems	Definition of cell	Degree of prosumer participation

Split of Paths

The descriptors are used to describe the scenario framework (1) and to identify the model requirements (2)

Development of technology	Generation technology	• Generating capacities • Drivers of RES-expansion • Assumptions reg. international projects	• Development of capacities / RES-feed-in • Development of costs of technologies
Infrastructure	Grid		• National system expansion • NTCs



(3A) Narrative Path: Qualitative Storylines

Two reference scenarios are designed in which the effects of new concepts are analysed

Superordinate framework conditions:
Climate goals, regulatory environment

Scenario „Reference A“ *Status quo, centralised tendencies*	**Scenario „Reference B“** *Distributed technologies, strong stakeholder participation*
• Large-scale technologies • Centrally organised structures • Supplemental small-scale and distributed generation	• Small-scale technologies • Prosumer-driven, decentralised decision making structures • Supplemental centrally driven expansion of infrastructure

(3B) Model-Specific Path

Model matrices are developed to compare the models' characteristics

- Externalise model characteristics and requirements
- Facilitate transparency
- Visualise models' system boundaries

Model A

Descriptor	Input	Parameter	Output

Properties
▪ Temporal Resolution ▪ Sector Integration ▪ Effects of regulatory frameworks

Model B

Descriptor	Input	Parameter	Output

Properties
▪ Temporal Resolution ▪ Sector Integration ▪ Effects of regulatory frameworks

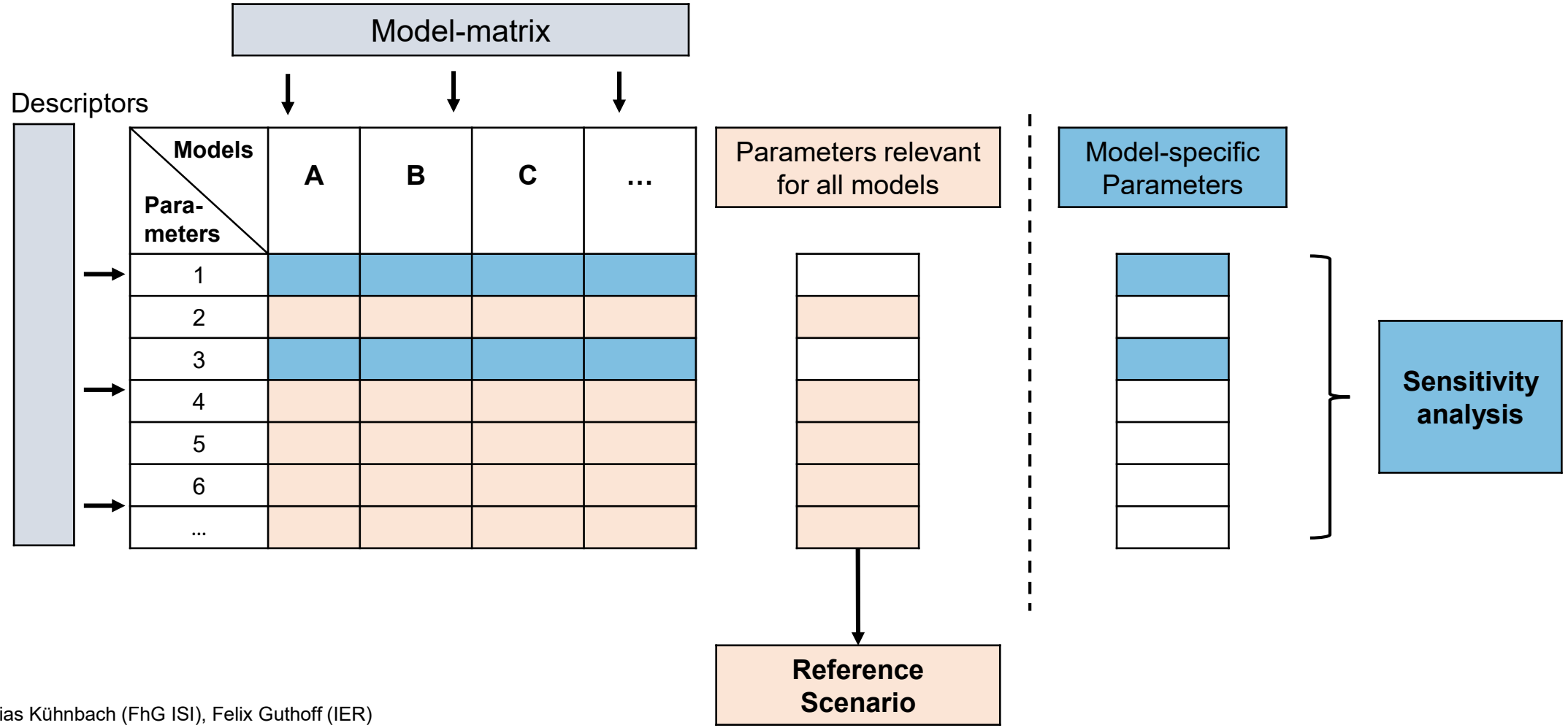
Model C

Descriptor	Input	Parameter	Output

Properties
▪ Temporal Resolution ▪ Sector Integration ▪ Effects of regulatory frameworks

(3B) Model-Specific Path

Objective: Obtain a condensed set of descriptors and parameters

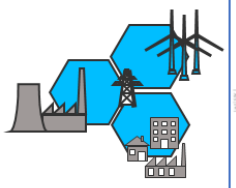


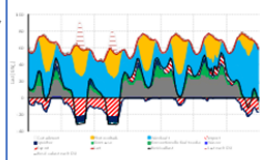
(3B) Model-Specific Path

The model matrix allows a comparability of the results and joint derivation of statements

Profiling of Different Models

Input	Model	Results
Investments Constraints Players Support Mechanisms	▪ Optimization ▪ Simulation	▪ Plant Park ▪ System Costs





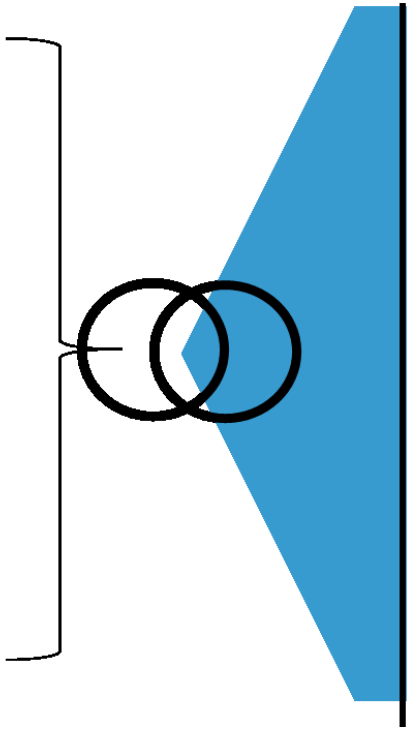
Properties

- Display of Balancing Power
- Cost impact on the Power Grid
- Sector Integration
- Effects of Regulatory Conditions

Model-Specific Analysis

1/4h-Resolution	Model 1
Agent-Based Model	Model 2
Integration Costs of Renewables	Model 3
E-Mobility	Model 4
Minimization of Generation Costs	Model 5

Common Statements on Research Questions



- Necessary degree of flexibility in cells?
- Effects of regulatory conditions on behaviour of players
- Effects of local supply on the total system costs

Conclusion and Outlook

- Straightforward method but time-consuming process (duration of process ~ 6 months)
- Method revealed heterogeneity of models but nevertheless facilitated comparability
- Complexity reduction (in order to make the scenario applicable for all models involved), however, approach can lead to oversimplification

Next Steps:

- Parametrisation and calculation of two reference scenarios: 2018
- Sensitivity analysis: 2019
- Test applicability for grid simulations within the project – is the methodology transferable to other research questions?

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Thank you for your attention

Matthias Kühnbach

Fraunhofer Institute for Systems and Innovation Research ISI

Breslauer Straße 48, 76139 Karlsruhe

+49 721 6809-147

matthias.kuehnbach@isi.fraunhofer.de

Felix Guthoff

Institute of Energy Economics and Rational Energy Use (IER), University of Stuttgart

Heßbrühlstraße 49a, 70565 Stuttgart

+49 711 685-87824

felix.guthoff@ier.uni-stuttgart.de