TECHNISCHE UNIVERSITÄT DRESDEN

**Fakultät für Wirtschaftswissenschaften**, Lehrstuhl für Energiewirtschaft, Prof. Dr. Möst

# Aggregation of Temporal Representation of High-Resolution, Fundamental Flow-based Market Coupling Input Data to Identify Typical Market Scenarios

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## A Systematic Evaluation and Selection of Relevant Cluster Algorithms

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27 April 2018 @ ENERDAY 2018

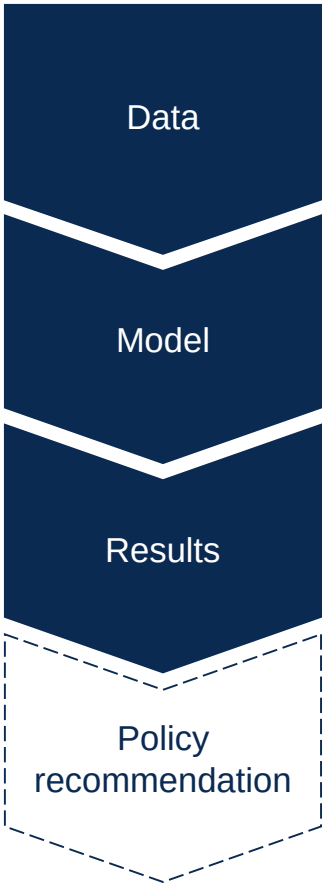
DRESDEN concept
Exzellenz aus Wissenschaft und Kultur

# Agenda

1. Setting the scene
2. Methodology
3. Main findings
4. Conclusion & Outlook

# Setting the scene

**(Abstract) process chain of transparent, model-based, quantitative studies**




- Selection of required parameters, e.g. fluctuating system elements
- Due to computational limits selection of representative data
  - key issue: adequate representation of spatial and temporal variability
- Data-driven, fundamental, cost-optimizing modeling of system variables
- Optimal investment in generation and transmission capacity
- Interpretation of results for derivation of policy recommendations

Focus of Master's thesis

**What if the recommendations are based on low-quality, imprecise model results?**

- Underrepresentation of variability → Overestimation of role of renewable energy
  → Underestimation of system integration cost

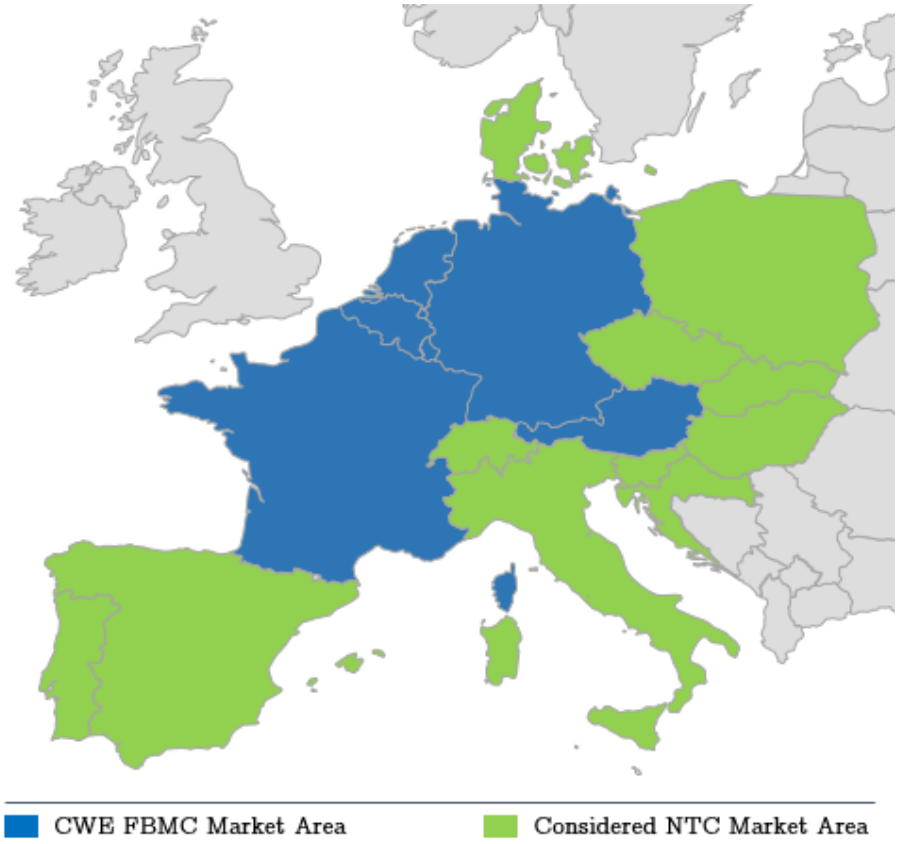
# Setting the scene

**Research objectives**

- Identification of a minimal, yet representative set of market situations in the CWE electricity markets in 2016
- Systematic evaluation of the impact of aggregation techniques on market situations and on model outcome

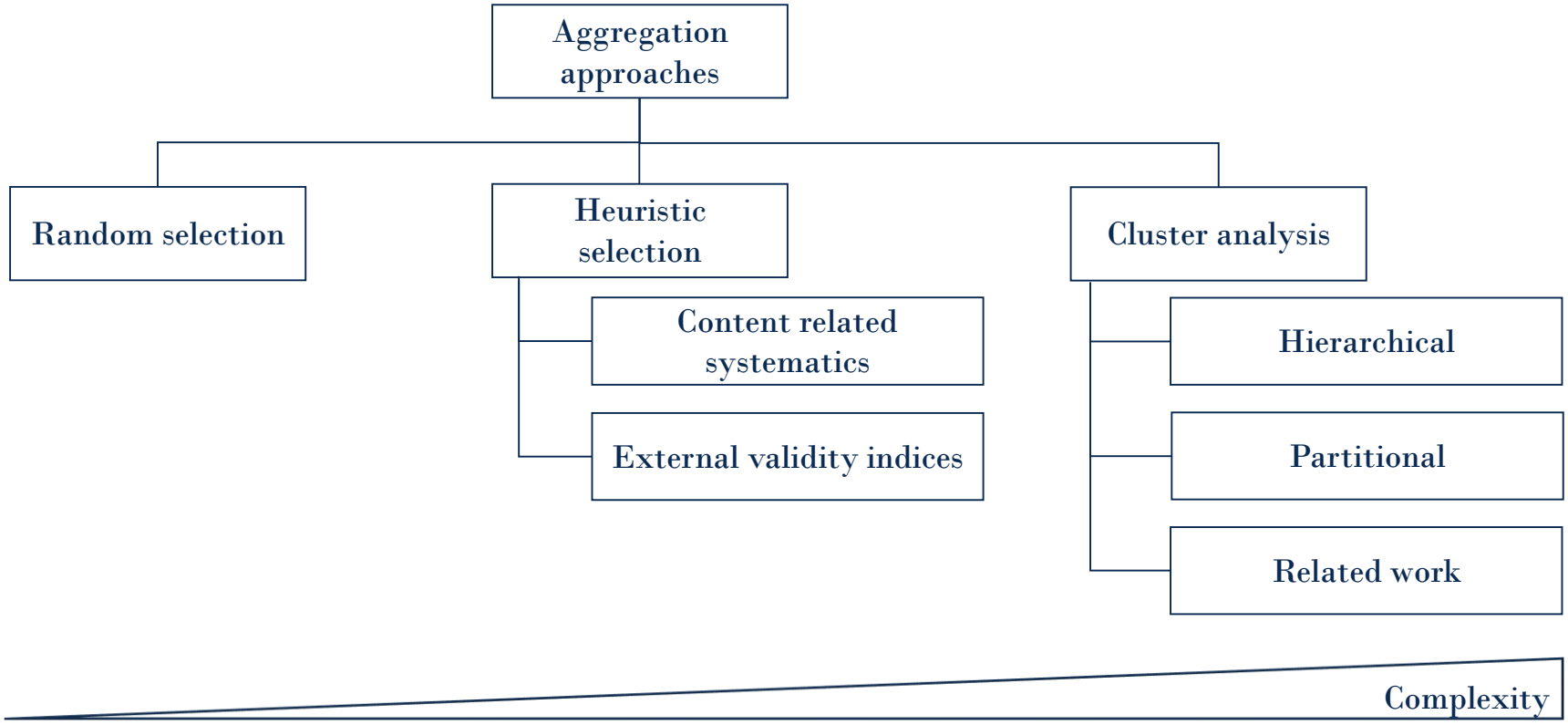
**Key problem: aggregating intra-annual time resolution of fundamental market data**

- Capturing temporal and spatial variability of load and variable renewable generation (VRES) patterns



# Setting the scene

## Relevant aggregation approaches

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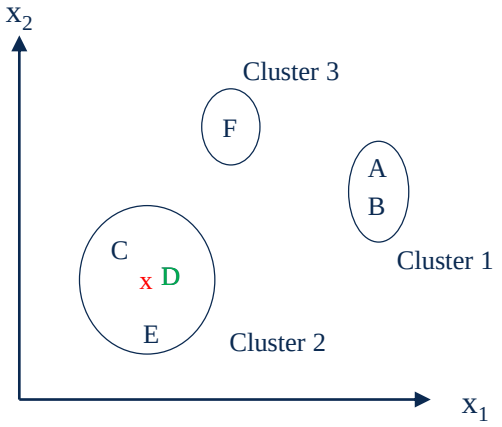
# Methodology I – Exemplary clustering

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## Iterative Procedure

- Six observations: {A, B, C, D, E, F}
- Logical final cluster partitioning
  - C1 = {A, B}
  - C2 = {C, D, E}
  - C3 = {F}

## Cluster representation

- Centroid: x
- Medoid: D

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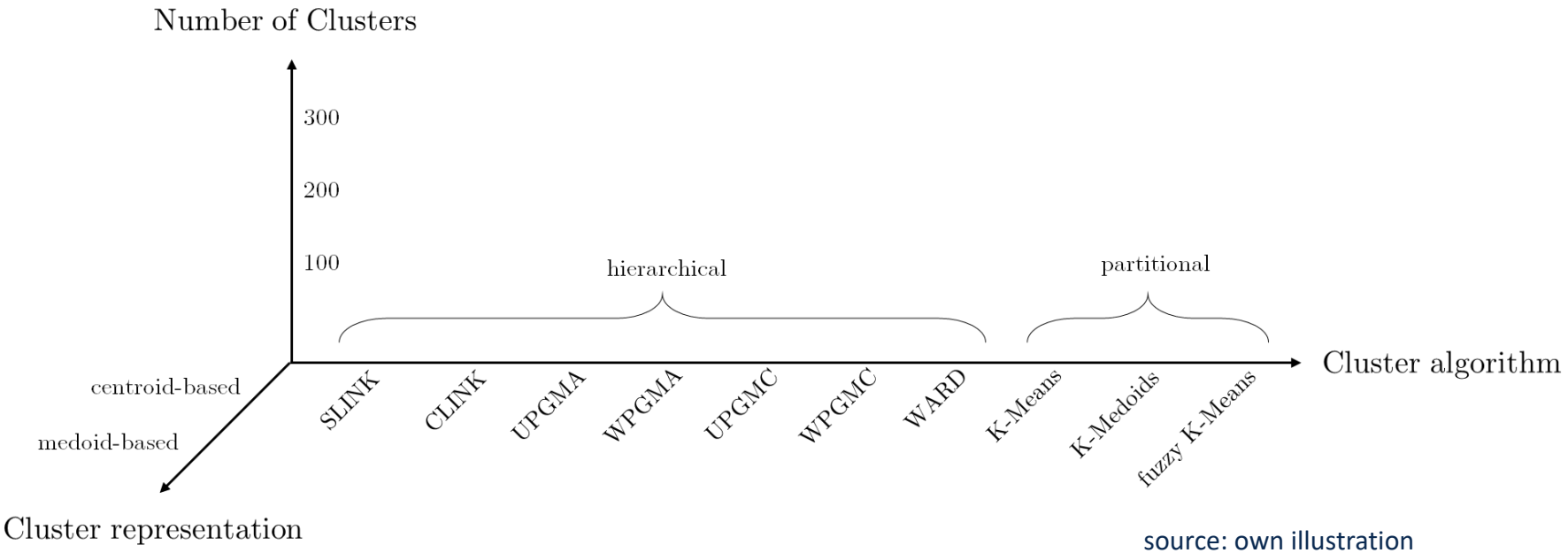
# Methodology II – Cluster dimensions

## 3-dimenionsal scenario space: 260 scenarios

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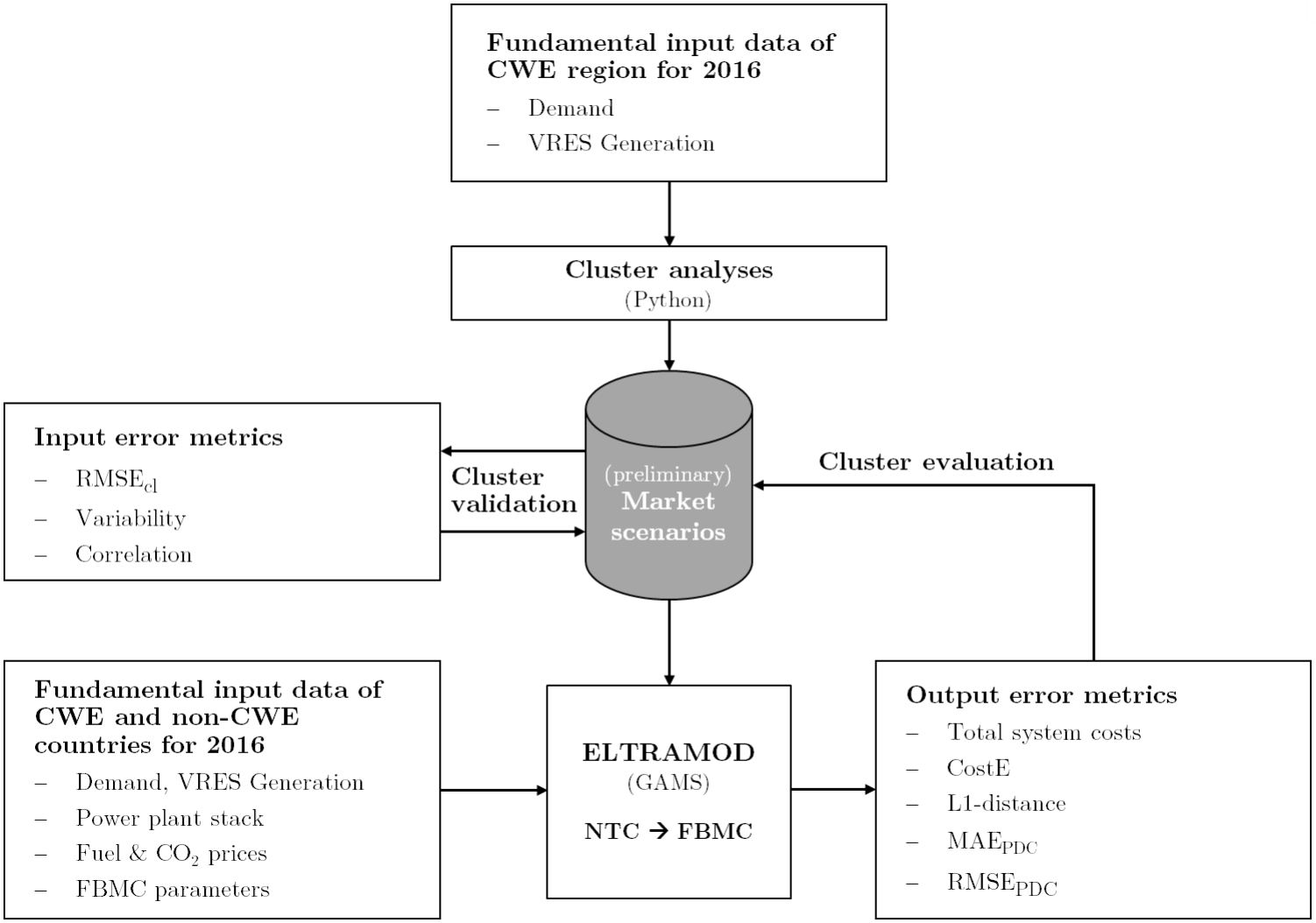
# Methodology III - Overview

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# Main findings

## Cluster dimensions

- Most efficient cluster algorithms achieve similar performance
  - WARD (hierarchical algorithm)
  - K-Means (partitional algorithm)
- Ambiguous results regarding cluster representation
  - Centroid-based representatives closer resemble original data
  - Medoid-based representatives capture greater deal of temporal and spatial variability
- Number of clusters
  - Research objective comprises adverse requirements → minimal in number vs. representativeness of set of scenarios
  - K = 15 based on K-Means
  - K = 20 based on WARD

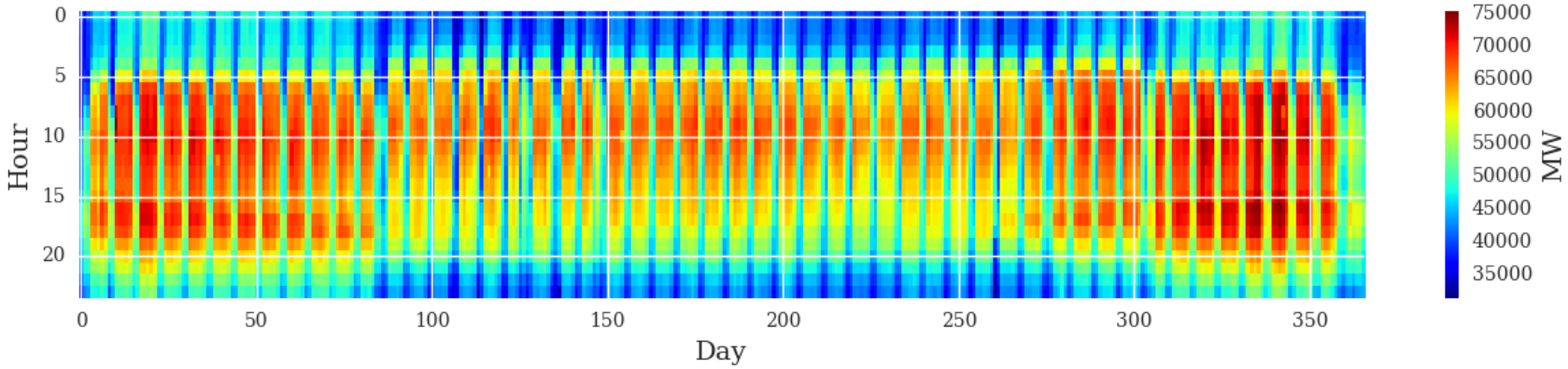
## → Facilitation of reduction to 4 salient cluster scenarios

- K = 15 based on K-Means
- K = 20 based in WARD

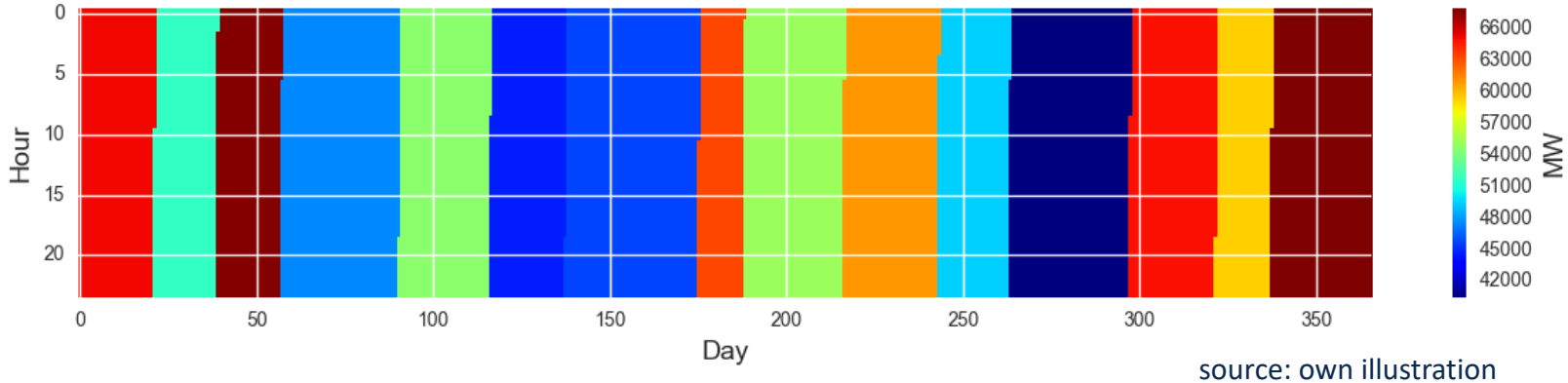
} for both centroid- and medoid-based representation

# Example of representative market situations

Original load time series in DE




Result: 15 clustered load situations in DE based on K-Means (medoids)

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# Conclusion & critical appraisal

## Conclusion

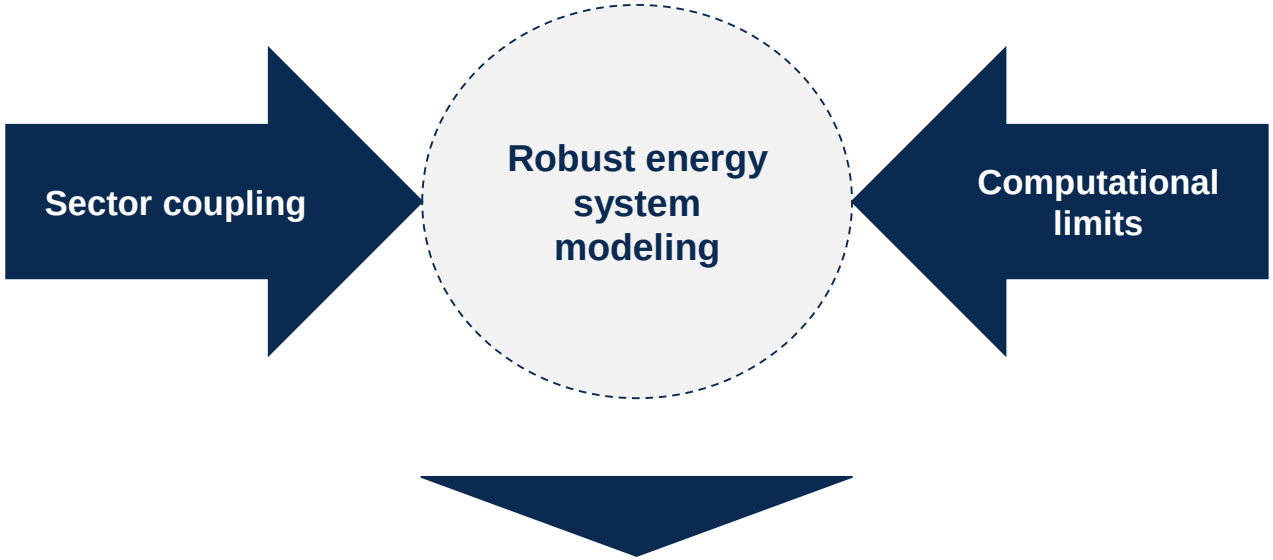
- Contribution in terms of comparison of large number of configurations of cluster analyses, thus empirically derived findings
- Provides holistic aggregation approach for deriving and selecting typical market situations in energy system modeling

## Shortcomings

- Disruption of diurnal structures are inherited to representative market scenarios
  - → Inadequate consideration of intertemporal constraints
- Order of representative hours remains unclear
- Output error metrics highly dependent on shortcomings of applied modeling framework
  - Methodological simplifications on technological resolution
  - Structural congestion and generation curtailment

# Outlook

- **Refinement, extension and elimination of shortcomings of developed approach**
  - Adequate aggregation unit (entire days comprising multiple hourly or multi-hourly time-slices)
  - Determination of order of representative market situations
  - Clustering of all time-dependent data




- **Reduction of temporal resolution of input data is inevitable in the context of sector coupling**
  - Key issue: consideration of variability of fluctuating system elements

  → underestimation of variability can lead to tremendous distortions of model results

# Relevant Literature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# Thank you for your attention!

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