Can we phase-out all of them?

How market interventions impact security of electricity supply in Germany

16th IAEE European Conference

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Authors: Lars Nolting and Aaron Praktiknjo

FCN | Future Energy Consumer Needs and Behavior
E.ON Energy Research Center
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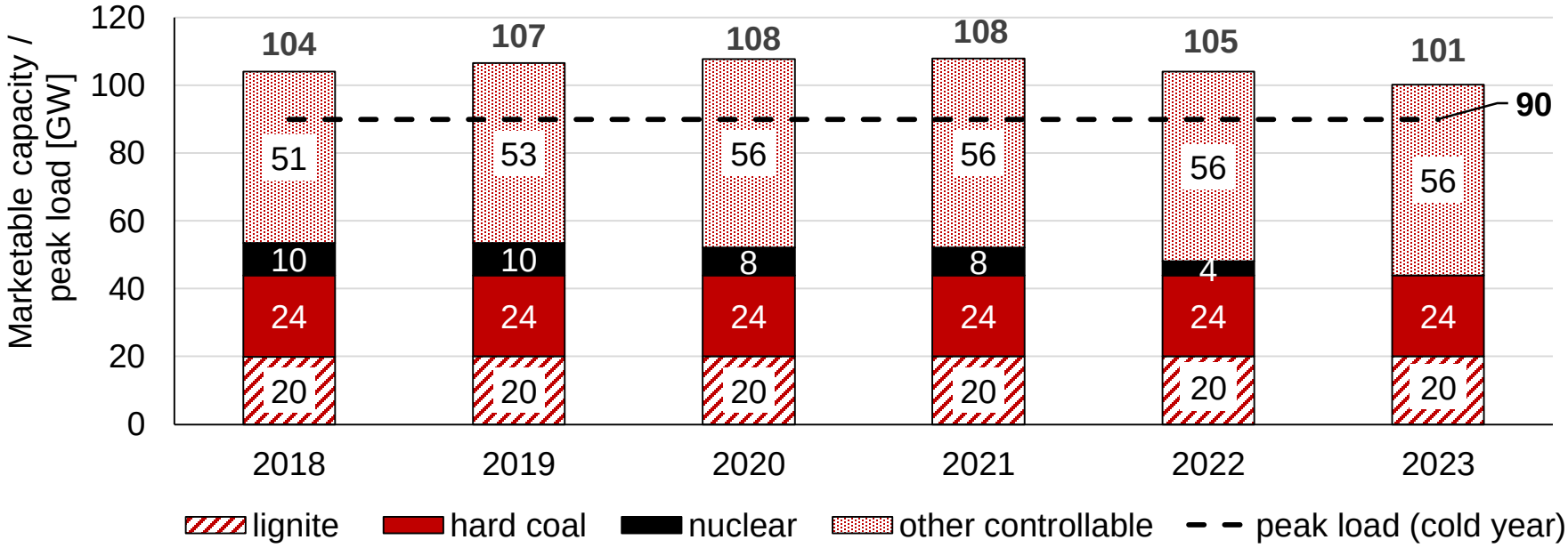
Current situation in Germany: reduction of controllable capacities and shift of burden to fluctuating renewables



1) **Phase-out** of **nuclear power** plants until 2023 is fixed

Sources of data: BNetzA, 2018a; Commission for growth, structural change and employment, 2019; German government, 2011; BNetzA, 2018b; entso-e 2018

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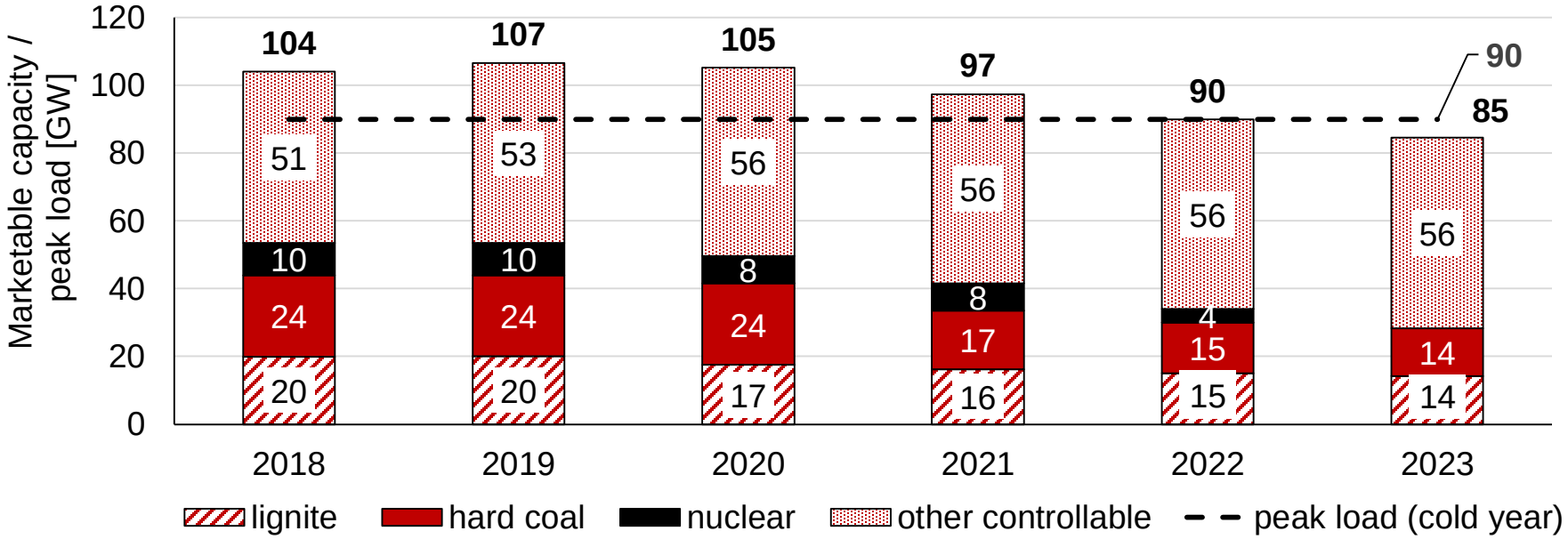
INTRODUCTION & MOTIVATION

Current situation in Germany: reduction of controllable capacities and shift of burden to fluctuating renewables



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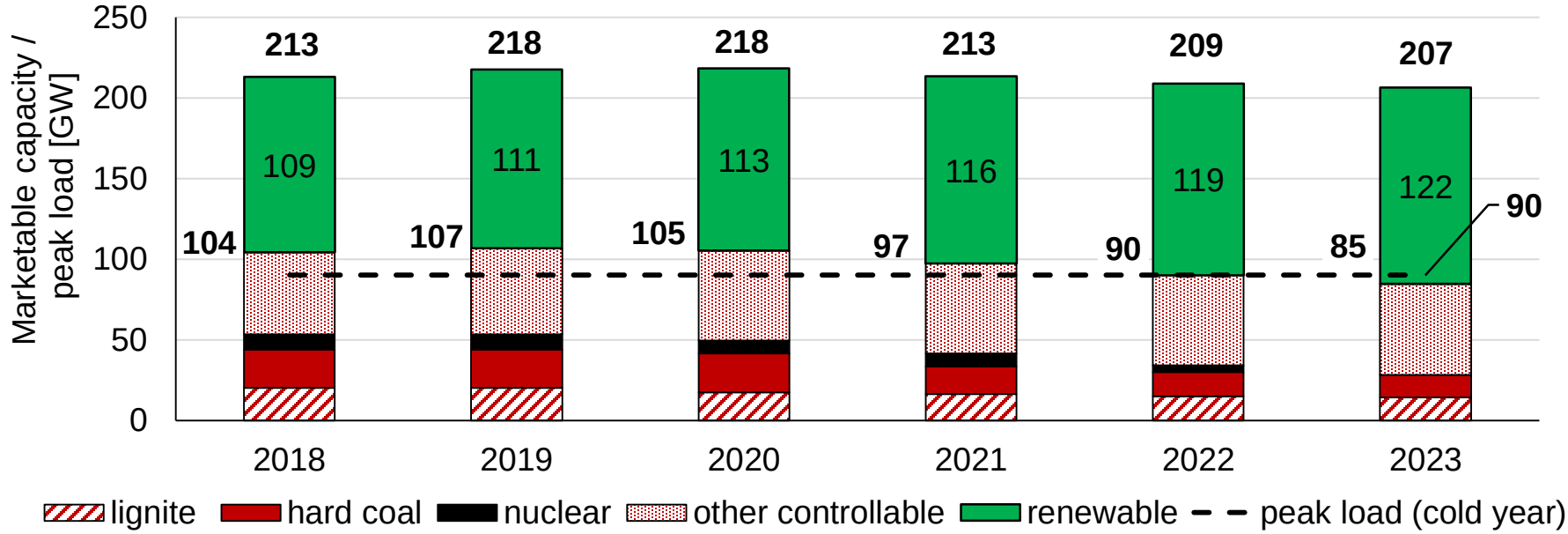

1) **Phase-out** of **nuclear power** plants until 2023 is fixed
2) **Mothballing** of **coal-fired power plants** until 2038 is suggested
3) **Increasing capacities** of **renewables**
4) **Non-availabilities** and **weather effects** need to be accounted for

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INTRODUCTION & MOTIVATION

Due to changes in the composition of power plant parks, scientific assessments of security of electricity supply gain further importance

- Burden shift towards renewables claims for **stochastic assessments** of **weather influences** and simulations in **hourly resolution**
- Thus, the **JERICHO module** to assess security of electricity supply is introduced and applied in the following
- Scientific key indicators such as ***Loss of Load Probability (LoLP)*** and ***Loss of Load Expectation (LoLE)*** are determined
- Definition of **nine scenarios** for the future security of electricity supply in Germany in the **scenario years 2020, 2022, and 2023**

Year	Additional phase-out of coal-fired power plants		
	0 GW	**5 GW**	**8 GW**
2020	2020	2020_-5GW	2020_-8GW
2022	2022	2022_-5GW	2022_-8GW
2023	2023	2023_-5GW	2023_-8GW

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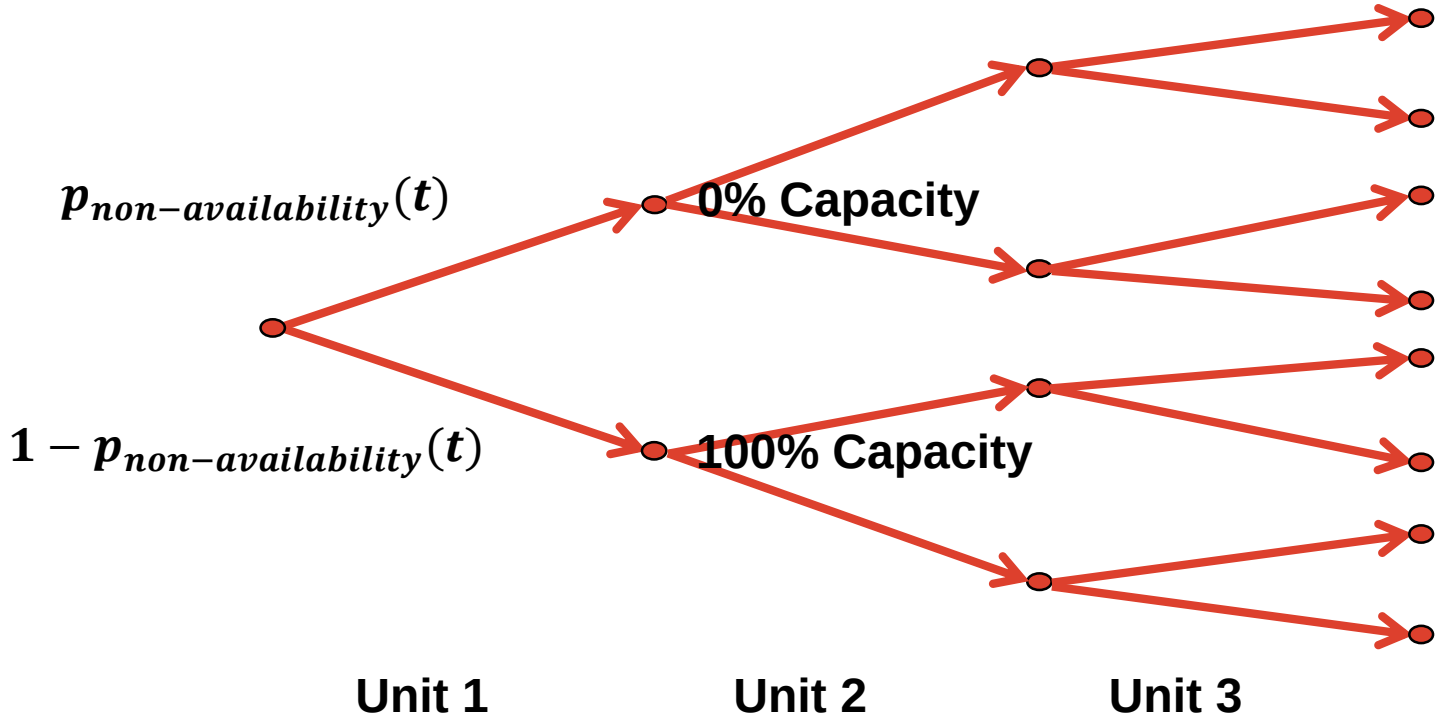
METHODOLOGY

Computationally intense calculation of all possible system states



- **Exponential** growth of possible states in number of block units n: 2^n
- **Recursive algorithm** according to Brückl 2006
- **Computation time of 8.5 h** using computing cluster of RWTH Aachen University

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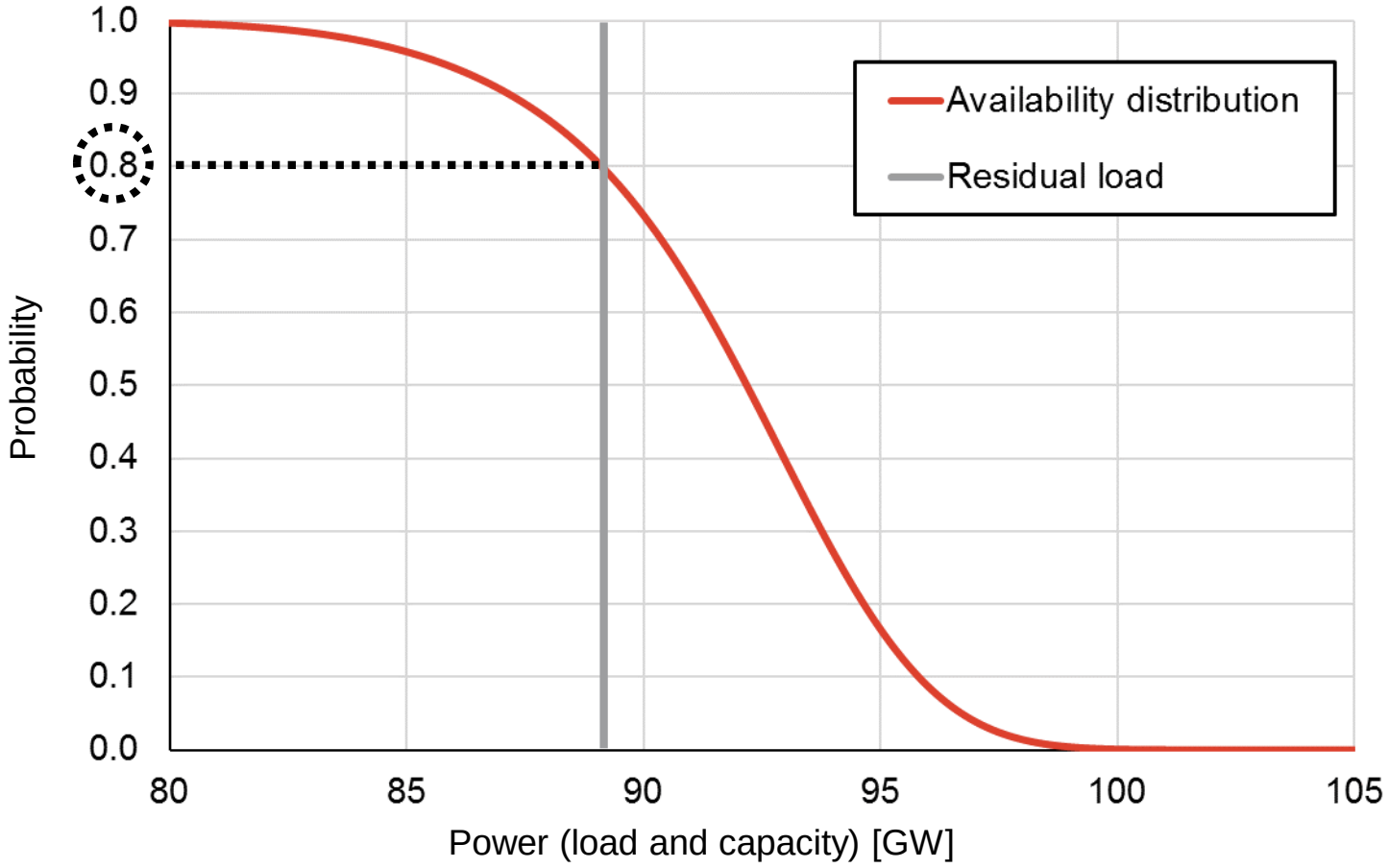
METHODOLOGY

JERICHO: Probabilistic simulation models in hourly resolution to assess security of supply



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METHODOLOGY

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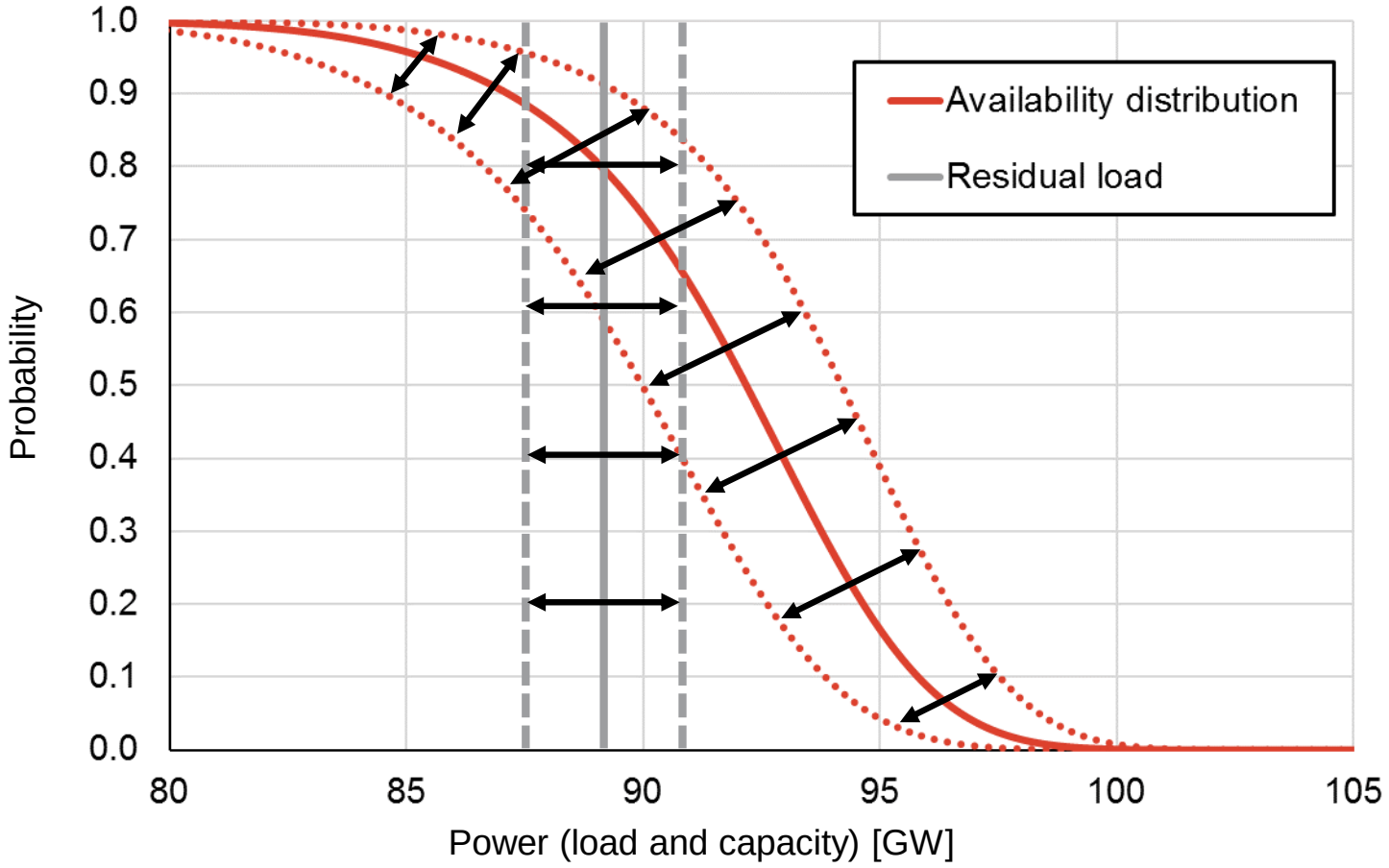

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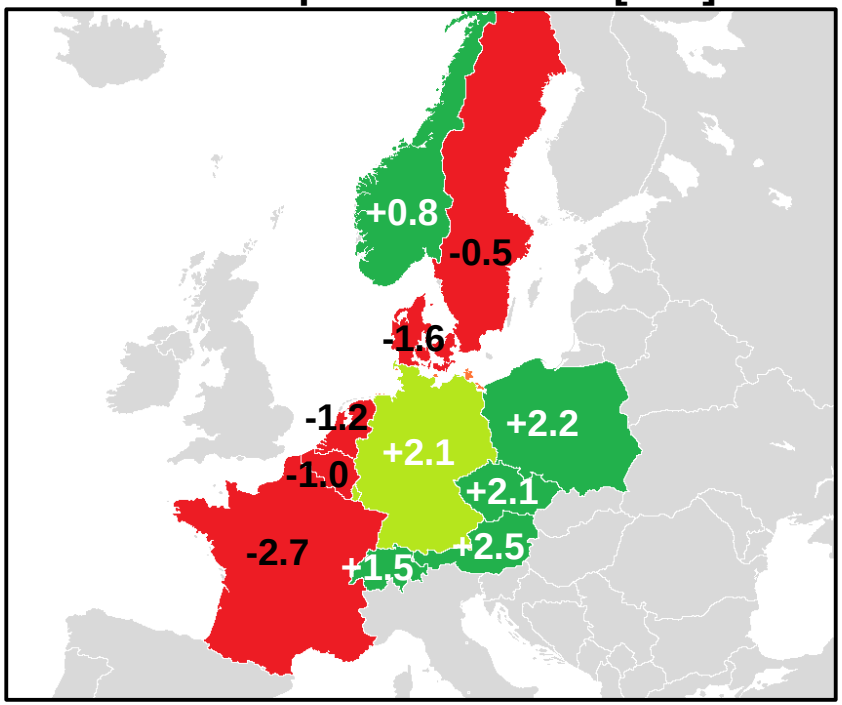
METHODOLOGY

Consideration of neighboring countries using hourly capacity balances

Capacity surpluses / needs during German peak load hour [GW]



- **Import potentials** are accounted for
- Usage of **bilateral Net Transfer Capacities (NTCs)**

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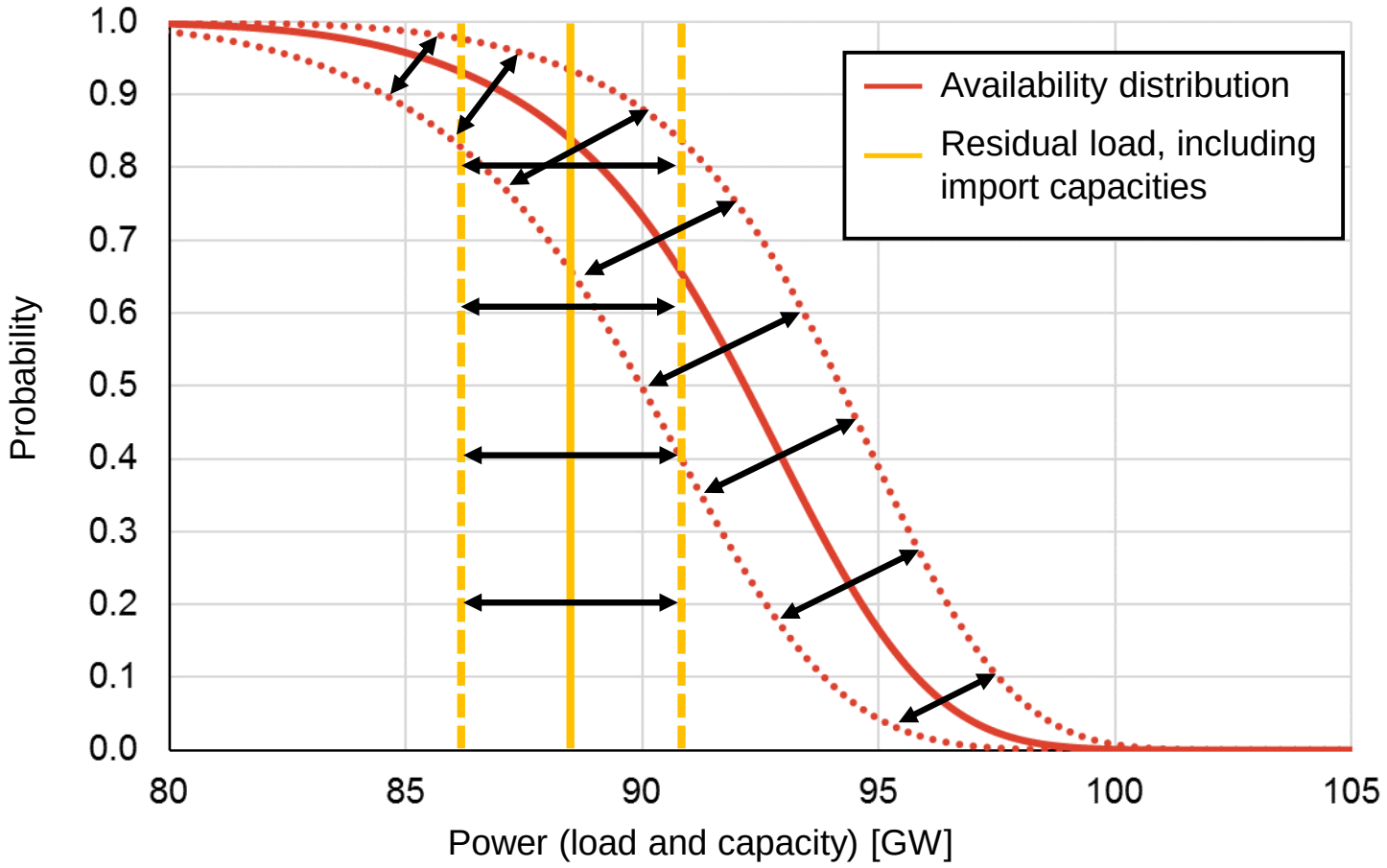
METHODOLOGY

JERICHO: Import potential is considered on the residual load side



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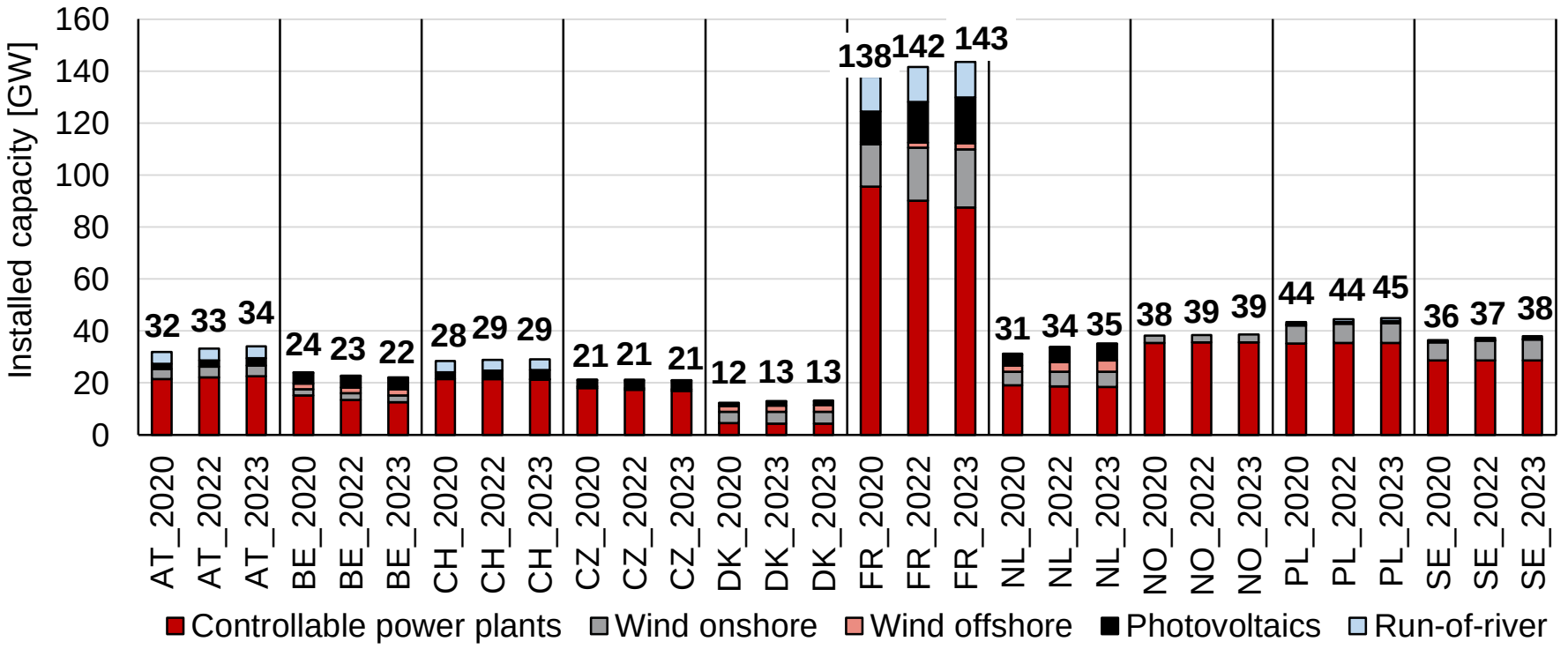
MODEL INPUT DATA (EXCERPT)

Installed capacities in neighboring countries



- Overall **increase** of **installed capacities**
- However **reductions** of **controllable capacities**

Sources of data: entso-e 2017; entso-e 2018a

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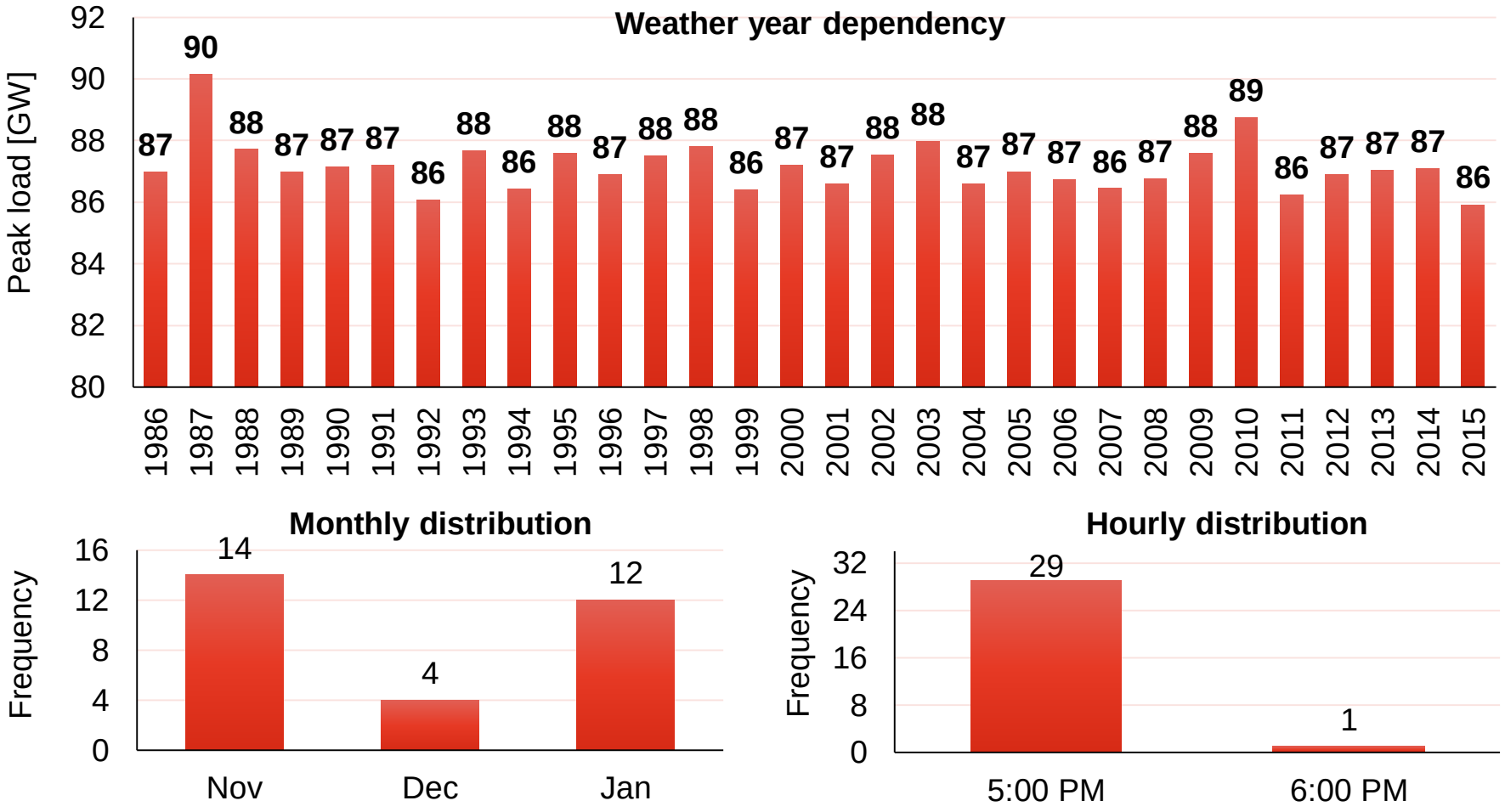
MODEL INPUT DATA (EXCERPT)

Electricity demand in Germany



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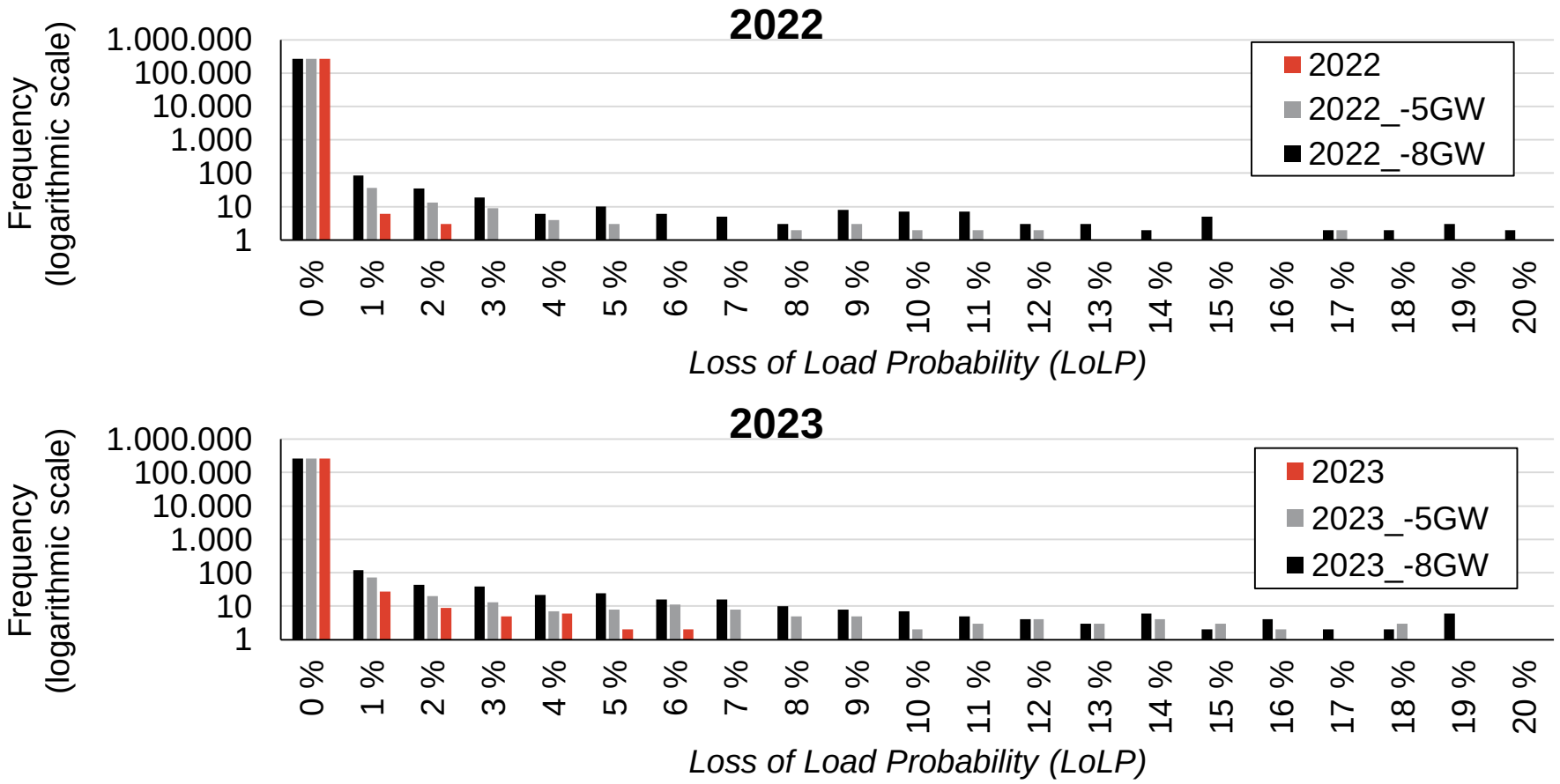
RESULTS

Hours with high *Loss of Load Probabilities (LoLPs)* occur in reduction scenarios



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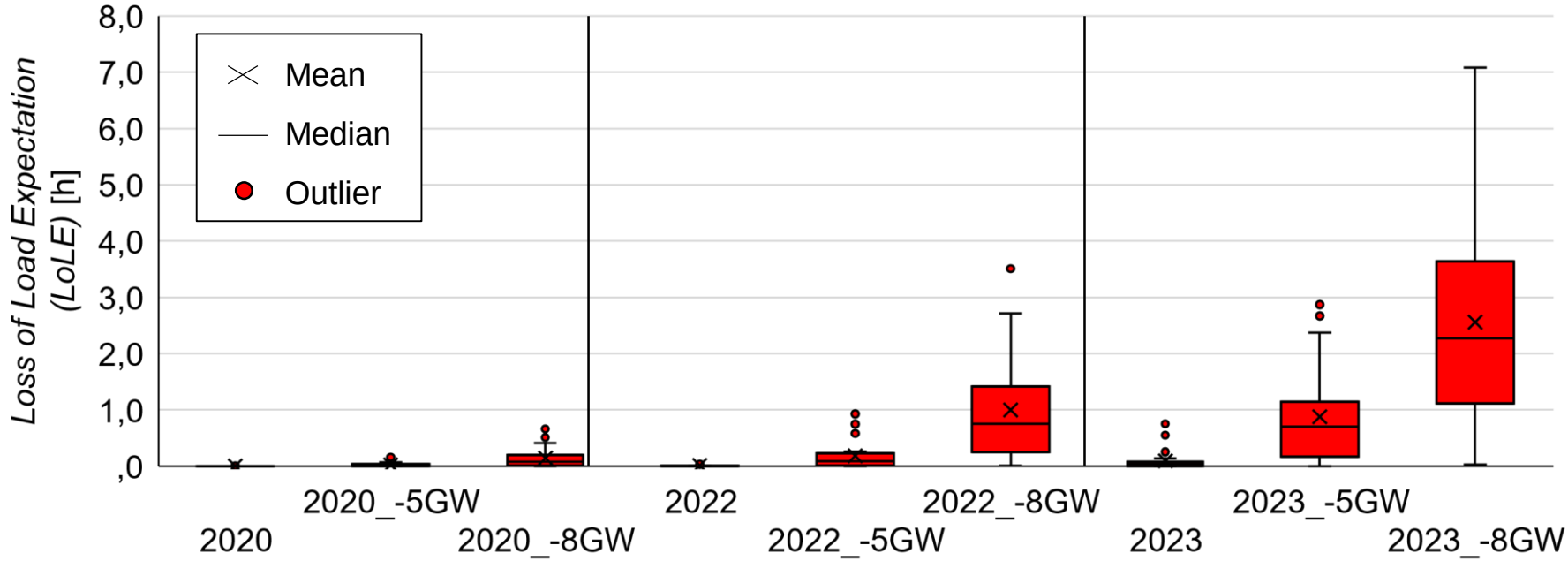
RESULTS

Quasi-absolute levels of security of supply are set at danger



- **2020: No substantial threat** to security of supply
- **2022:** Mean ***LoLE of* 1 h** for 8 GW reductions
- **2023:**
  - Mean ***LoLE* of ~1 h** for 5 GW reductions
  - Mean ***LoLE* of 2.6 h** for 8 GW reductions
- **Overall:** Increasing dependency on **weather effects**

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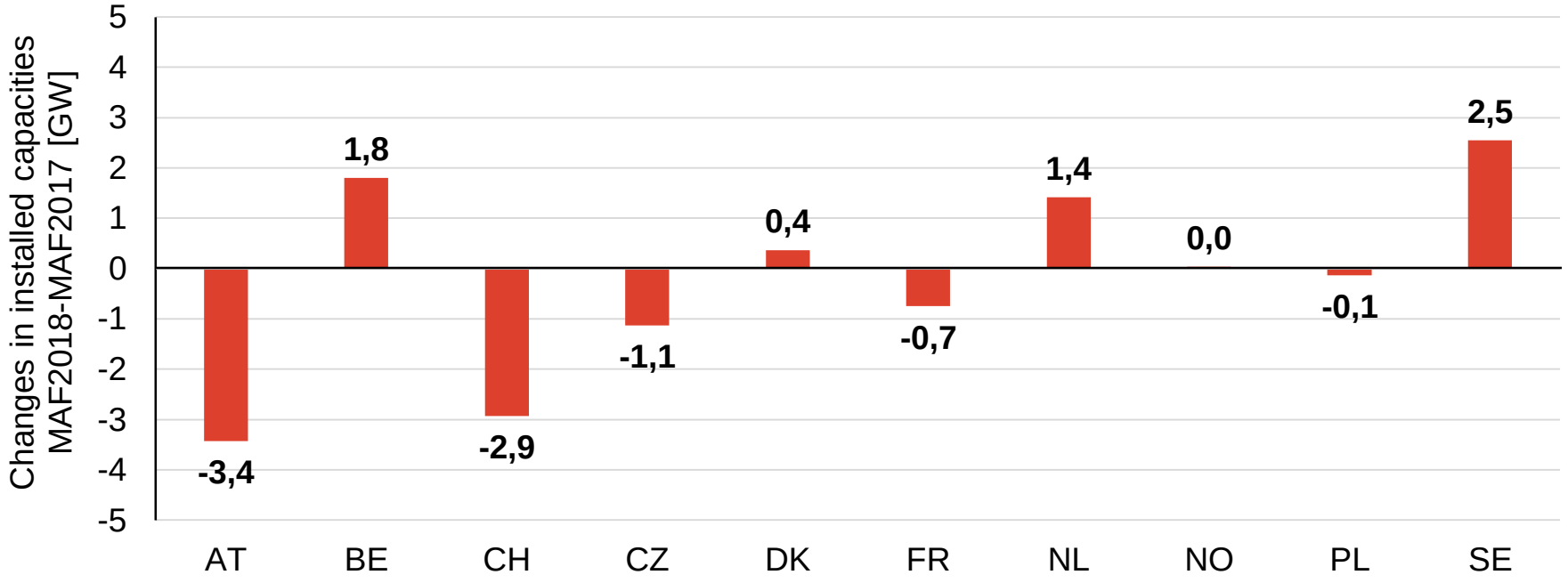
DISCUSSION: UNCERTAINTY OF INPUT DATA

Changes in installed capacities in neighboring countries for 2023



"In fact, the reason behind this difference is not an error but an update of data due to better information-availability compared to last year."
(e-mail communication with representative from entso-e 2018b)

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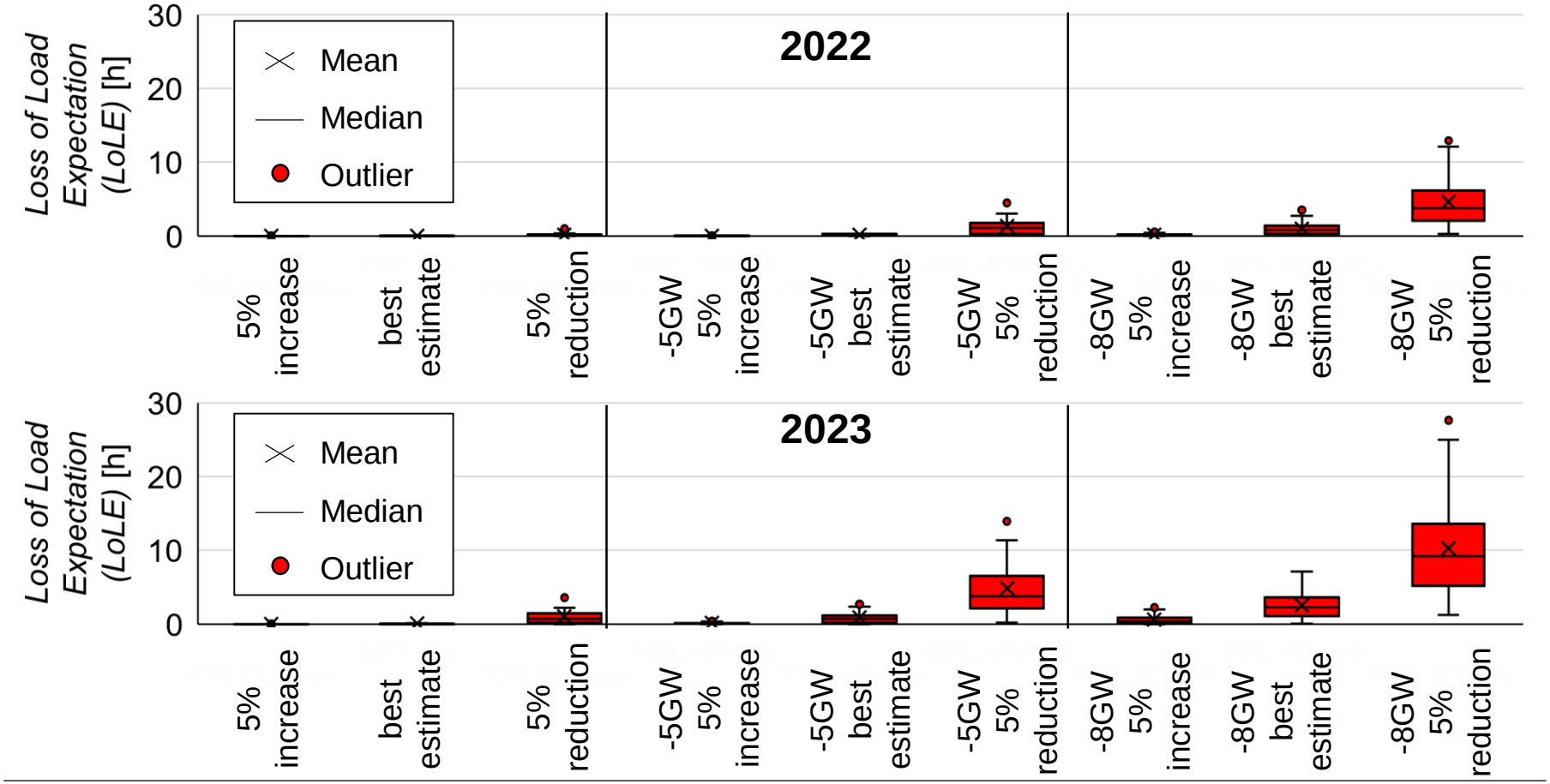
DISCUSSION: SENSITIVITY ANALYSES

High sensitivities towards changes in installed capacities of neighboring countries



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CONCLUSION & OUTLOOK

Market interventions have set the quasi-absolute levels of security of electricity supply in Germany at danger

- The system has reached a **tipping-point:**
  - Levels of security of supply increasingly depend on **weather influences**
  - **Imports from neighboring countries** significantly contribute to the security of supply in Germany
- Capacity planning activities need to **be coordinated on an European level**
- The **future electricity system** might be **economically more efficient** as quasi-absolute levels of security of electricity supply **come with high costs**
- It is ***a priori*** difficult **to predict all consequences of market interventions** in complex energy systems
- Model results should not be used as basis for **planned-economy approaches**

The following **hypotheses** can be concluded for further scientific assessment:

1. **Market-based mechanisms** should be used **to handle complexity**
2. **Unforeseeable** interventions **hinder investments** in needed capacities
3. **Long-sighted** definition of **reliable political frameworks** is necessary

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Thank you for your attention!

Do you have any questions or comments?

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