COMPARISON OF DIFFERENT METHODS OF SPATIAL DISAGGREGATION OF ELECTRICITY GENERATION AND CONSUMPTION TIME SERIES

MODEX-Net

Join work with Thomas Dengiz, Wided Medjroubi, Chinonso Unaichi, Andreas Bruckmeier, and Rafael Finck

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aufgrund eines Beschlusses des Deutschen Bundestages

Outline

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2. Introduction to disaggregation
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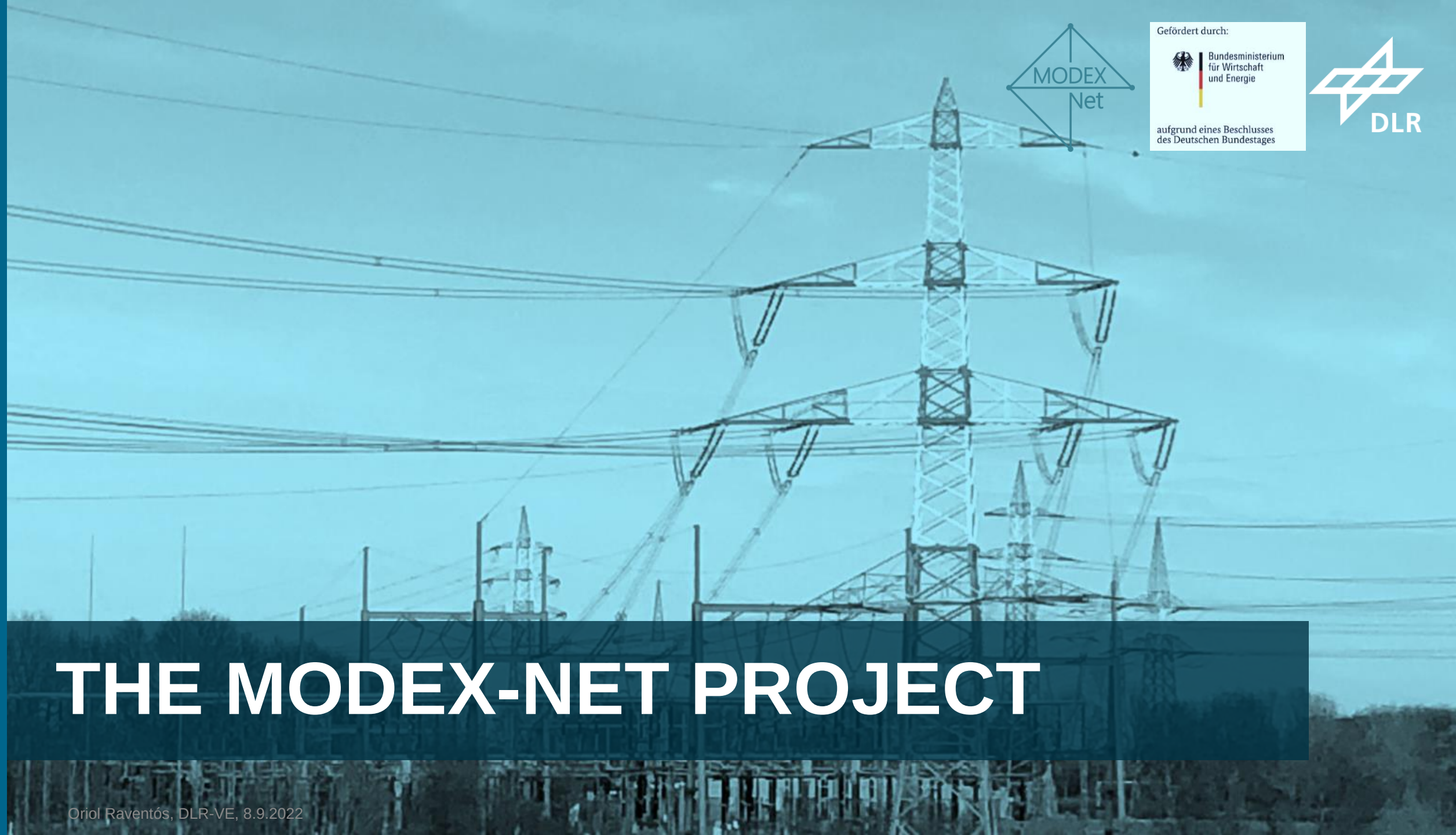

THE MODEX-NET PROJECT

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Oriol Raventós, DLR-VE, 8.9.2022

The MODEX-Net Project

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Project Aim:

Develop methods to compare transmission grid models

Output highlights:

- Comparison of models main features and harmonization proposal
- Comparison of disaggregation methods for RES and demand
- Comparison of market optimization: Price of electricity, energy mix and import/export
- Comparison of grid optimization: Redispatch, curtailment and line loading

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Partners and Models

PERSEUS/Tango

ELMOD

eGo/eTraGo

MILES

MarS/ZKNOT

EuroPower

ISAaR

PowerFlex-Grid-EU

INTRODUCTION TO DISAGGREGATION

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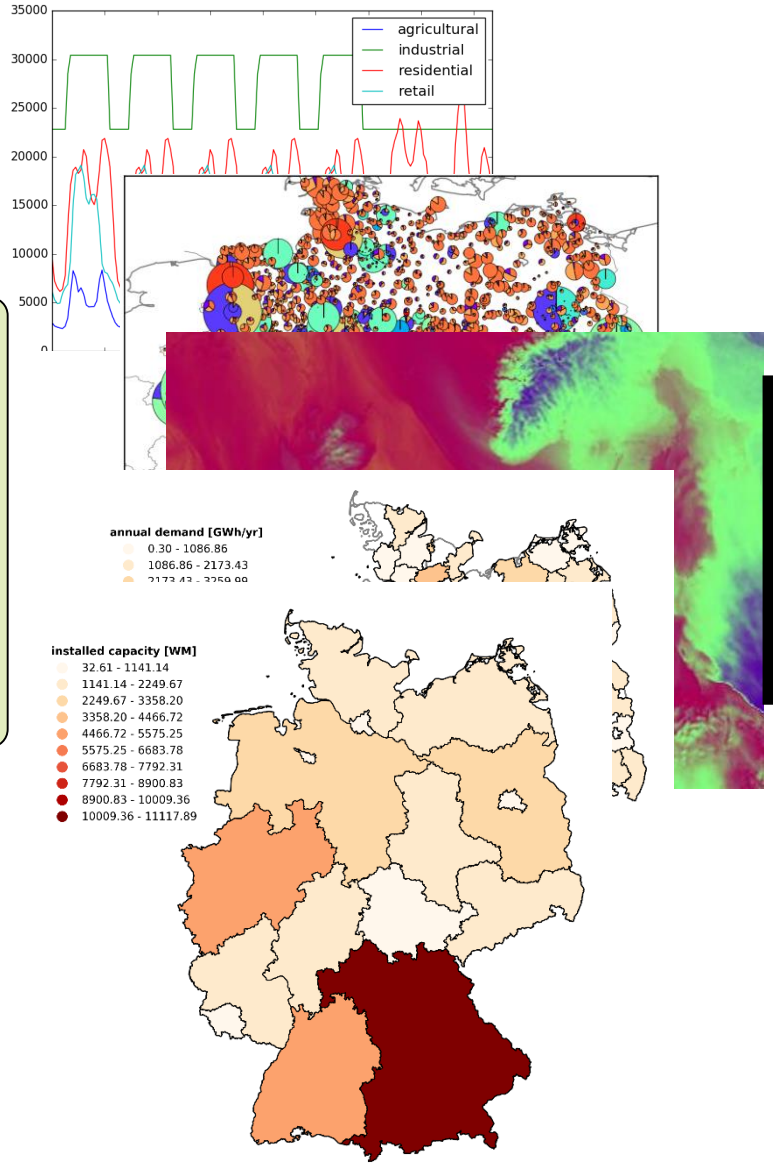
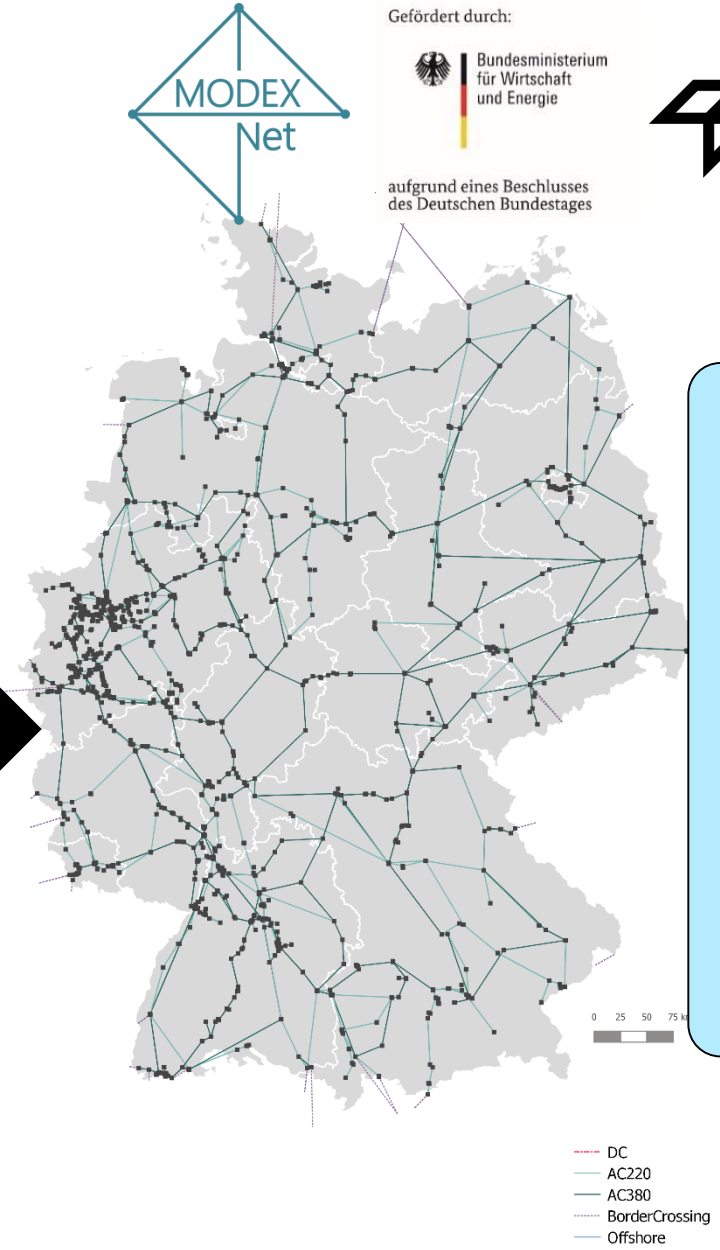
Introduction

Input data



Disaggregation workflow



Model of the extra high voltage grid

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Introduction

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Input data

Installed capacities

—

Annual demand

Hourly profiles

Disaggregation workflow

PV

Wind onshore

Wind offshore

Load

Model of the extra high voltage grid

German grid for a 2016 scenario

METHODOLOGY

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Methodology
Comparison of disaggregation workflows

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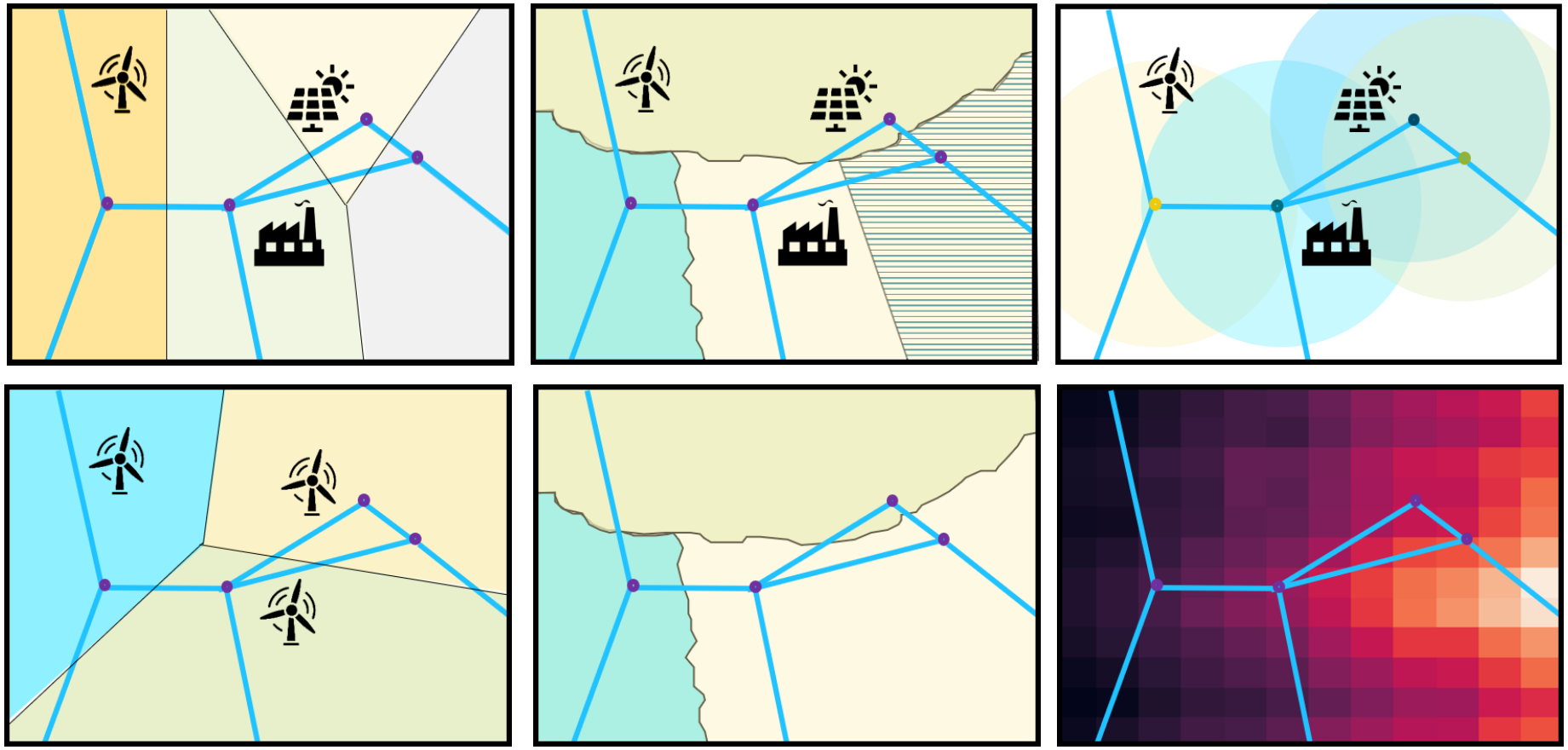
I. Allocate data inside a node region into its node

II. Distribute data region values into its nodes

III. Overlap of data and node regions



It could be a **post-processing**, e.g. harmonize national values

Methodology
Comparison of disaggregation workflows

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- PV installed capacity

Bottom-up / Top-Down

As LAU or NUTS level

	BU/ TD	Input resolution & source	Node allocation
ELMOD			Generator belonging to a node region
eTraGo			Generator belonging to a node region
Europower			Overlap of generation regions and node regions
ISAaR			Generator belonging to a node region
MarS/ZKNOT			Generator belonging to a node region
MILES			Generator belonging to a LAU region (& distributed to nodes in the allocation region)
PERSEUS			Generator belonging to a node region
PowerFlex			Overlap of LAU generation region and node regions

Methodology
Comparison of disaggregation outputs

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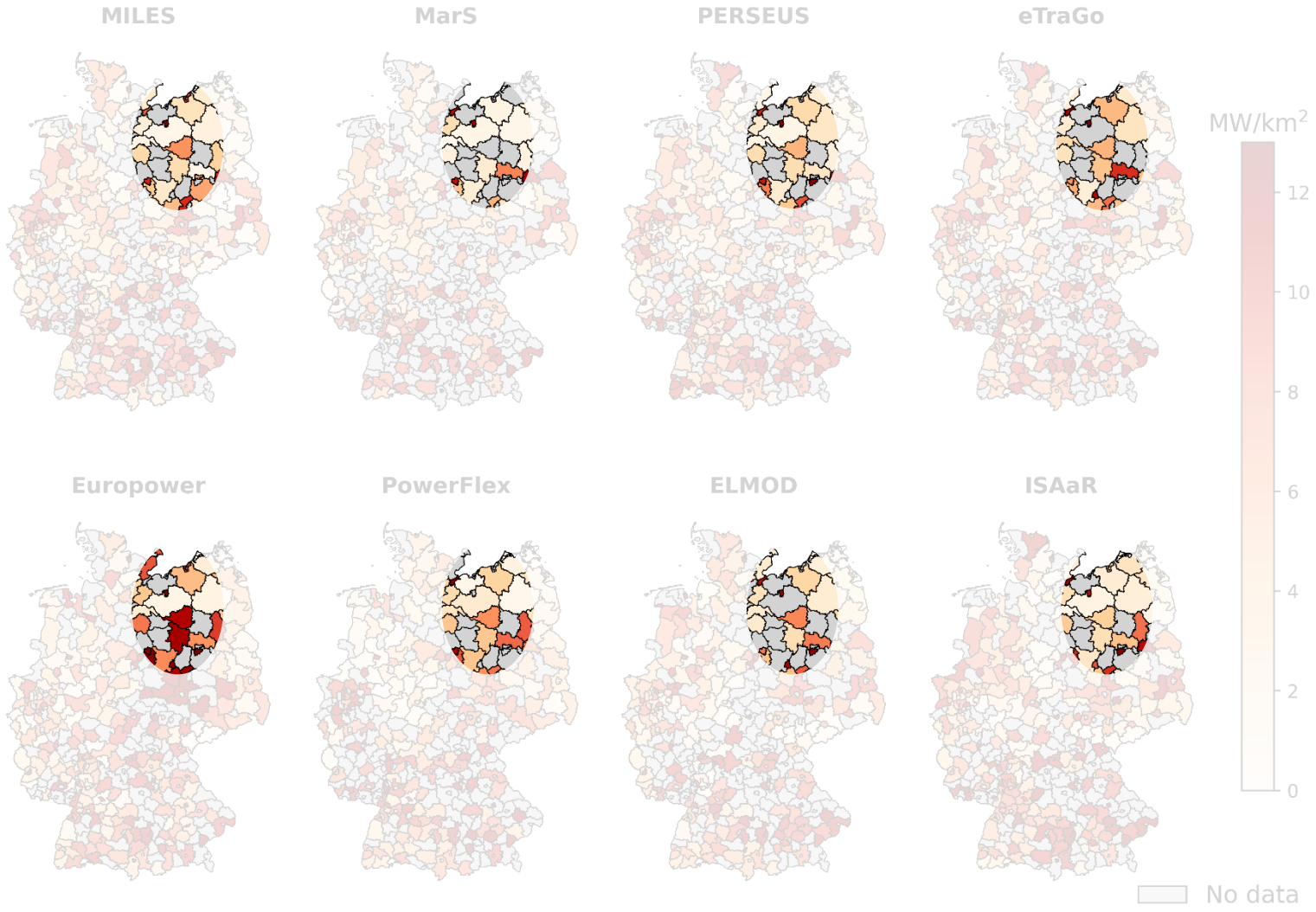
Warning: Just data in ehv-nodes aggregated to NUTS 3 regions



Methodology
Comparison of disaggregation outputs

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- **Installed capacity and annual demand comparison**: RMSE across all NUTS 3 regions (using 0 if no installed capacity)

$$RMSE(x,y) = \sqrt{\frac{\sum_{n=1}^{N}(x_n - y_n)^2}{N}}$$

where $\{x_n\}_{1\leq n\leq N}$ and $\{y_n\}_{1\leq n\leq N}$ are installed capacities

- **Profile comparison:** Mean value of the Pearson correlation of the profiles accross all NUTS 3 with installed capacity.

$$Pearson(X,Y) = \frac{cov(X,Y)}{\sigma_X \sigma_Y}$$

where $\{X_n^t\}_{1\leq n\prime\leq N}^{1\leq t\leq 8760}$ and $\{Y_n^t\}_{1\leq n\prime\leq N}^{1\leq t\leq 8760}$ are the absolute profiles


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Net
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RESULTS

Results
Comparison of disaggregation workflows

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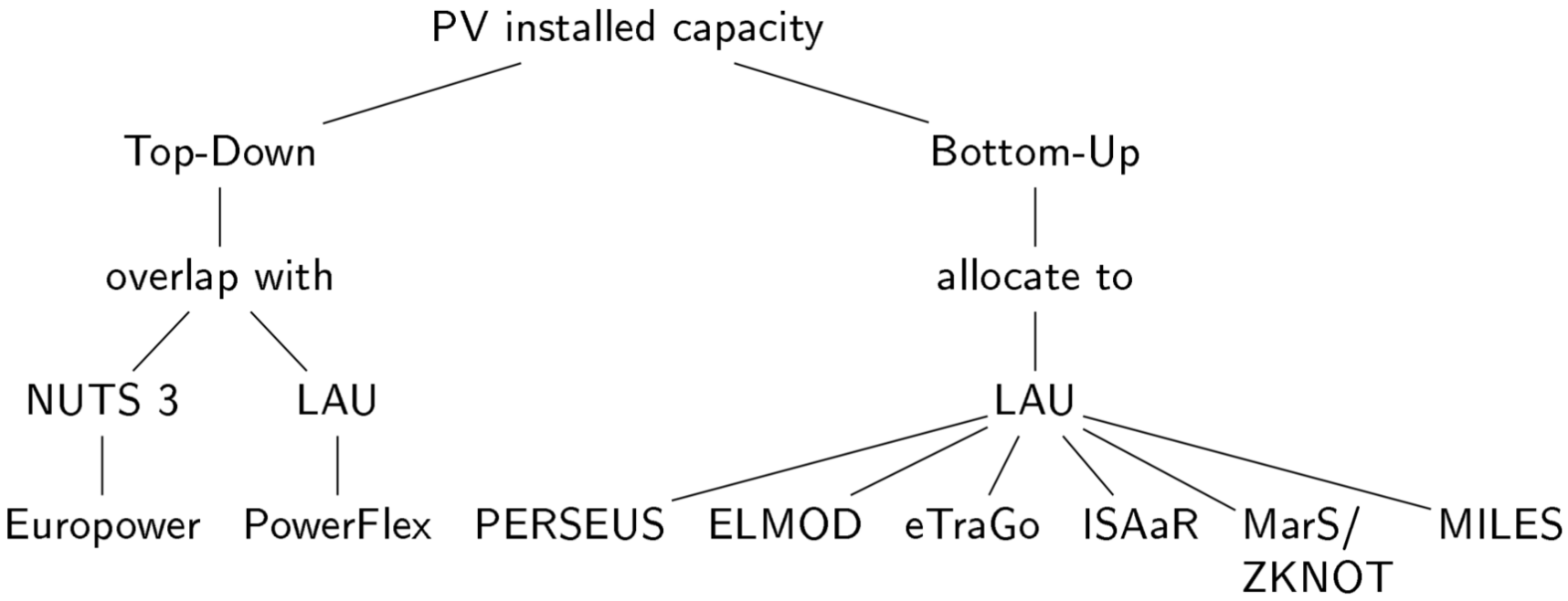
- PV installed capacity



Results
Comparison of disaggregation workflows

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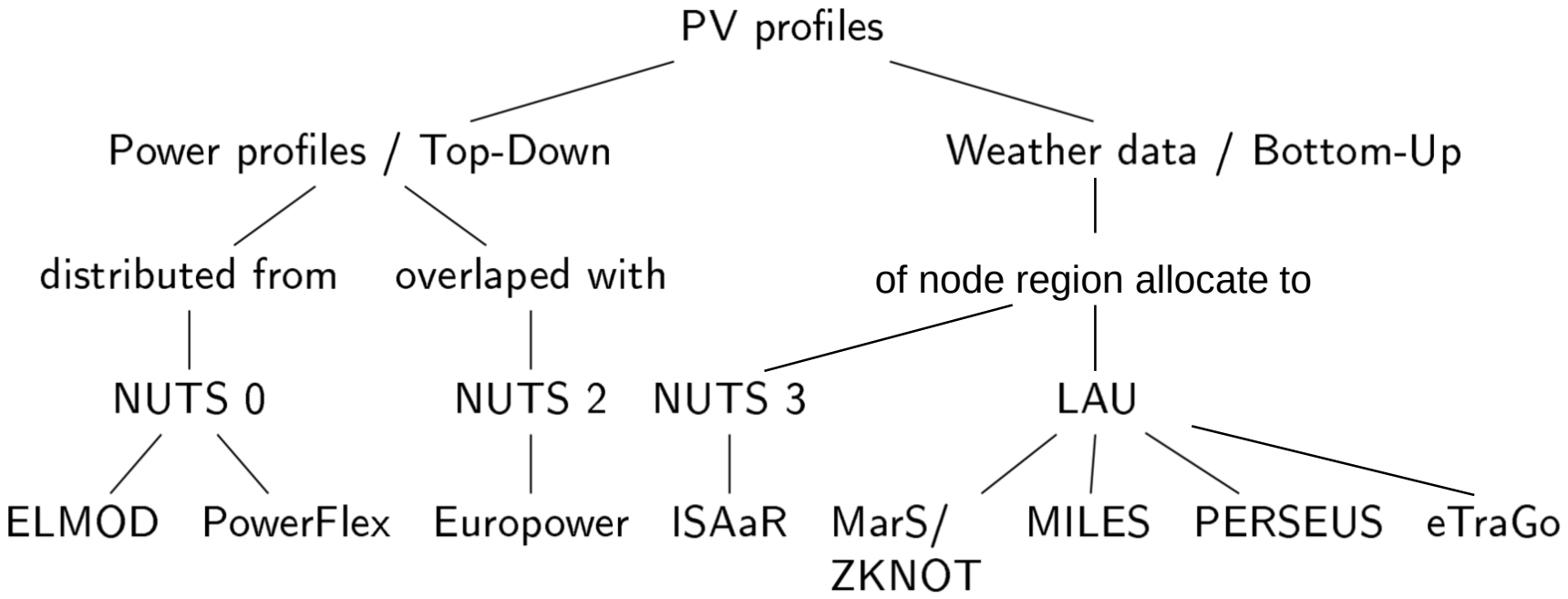
- PV profiles



Results
Comparison of disaggregation output

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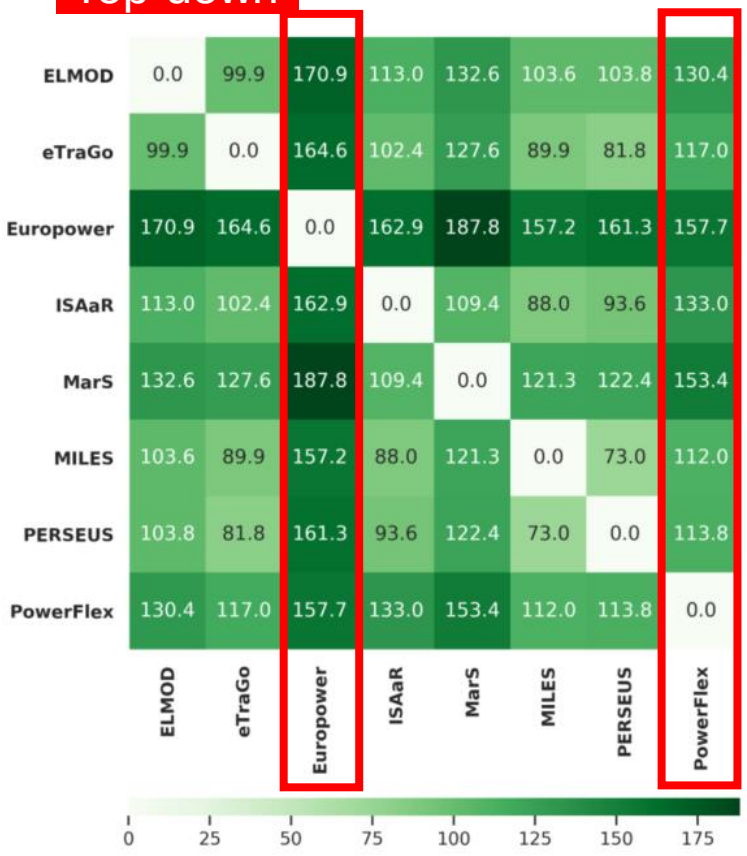
RMSE of PV installed capacities:

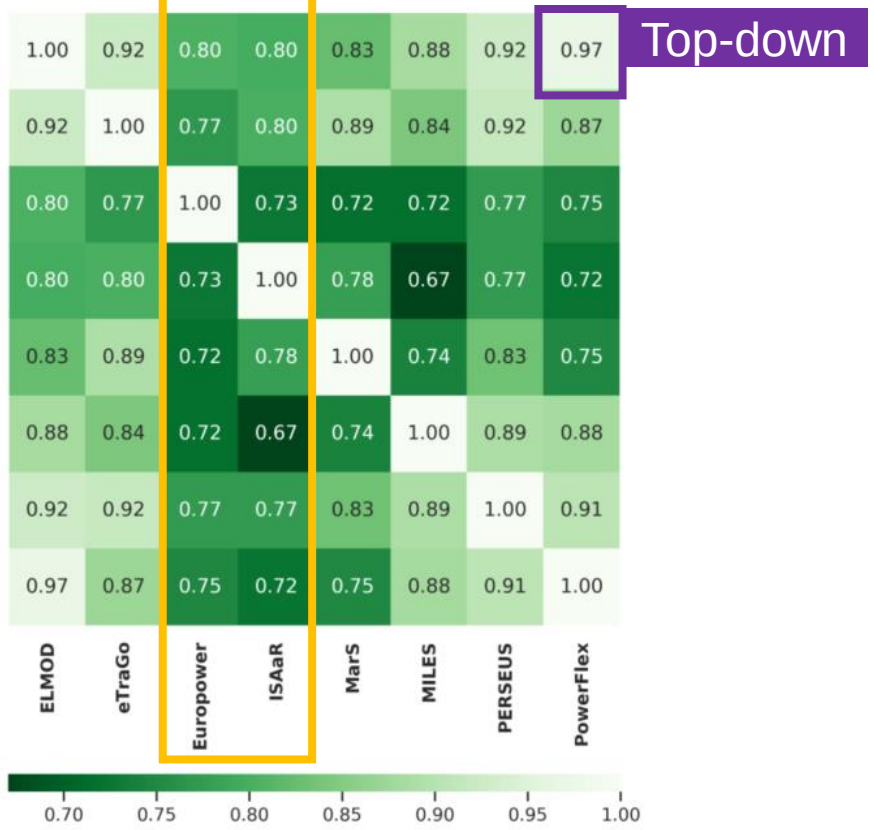
Top-down



Mean value of Pearson correlations of PV availability profiles:

Different weather year

Top-down



Results
Comparison of disaggregation workflows

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- **Wind onshore** and **PV**:
  - Installed capacity using a bottom-up allocation from LAU regions
  - Profiles from weather data using high spatial resolution

- **Wind offshore**:
  - Installed capacities mostly allocated to the grid connection points
  - Profiles either use offshore region potentials or one location

- **Demand**:
  - Mostly done by a top-down distribution from national sectoral load profiles (e.g. agricultural, residential, retail, industry) and
  - Annual demand factor using bottom-up allocation based on administrative regional parameters (e.g. GDP, population, temperature, land use...)

Results
Comparison of disaggregation output

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- In all cases the Top-down/Bottom-up approach is the main factor that influences the output
- **Wind onshore** disaggregation differences are of a higher magnitude than **PV**.
- **Wind offshore** disaggregation is strongly influenced by onshore connection (either Baltic Sea or North Sea)
- **Demand** disaggregation depends highly on the source, sectors and date of the data. Nevertheless, the profiles look very similar, since they are mostly based on national profiles.

CONCLUSIONS

Conclusions

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- A high resolution is necessary to be able to compare disaggregation workflows (NUTS 3 is adequate for transmission grid models)
- The resolution of the input data and the use of Top-down/Bottom-up workflows are the two main influence factors in the disaggregation process.
- PV produces a closer disaggregation output regardless of the workflow.
- The disaggregation outputs of demand profiles are significantly close, regardless of the workflows (probably because most models use standard load profiles).

Sources

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- Project website (harmonization data and final report):

https://www.energiesystem-forschung.de/forschen/projekte/modex-net

- Publications in a RSER Special Issue:
  - Comparison of different methods of spatial disaggregation of electricity generation and consumption time series https://www.sciencedirect.com/science/article/pii/S1364032122001101
  - Development of an open framework for a qualitative and quantitative comparison of power system and electricity grid models for Europe https://www.sciencedirect.com/science/article/pii/S1364032121013174
  - Impact of model parametrization and formulation on the explorative power of electricity network congestion management models - Insights from a grid model comparison experiment https://www.sciencedirect.com/science/article/pii/S1364032122000910

Impressum

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