

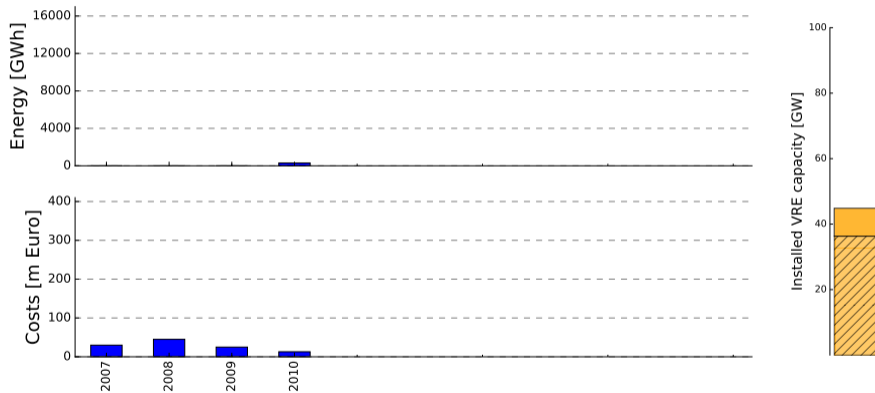


# NATURAL WIND VARIABILITY AND REDISPATCH

Understanding the 2015 to 2016 redispatch drop

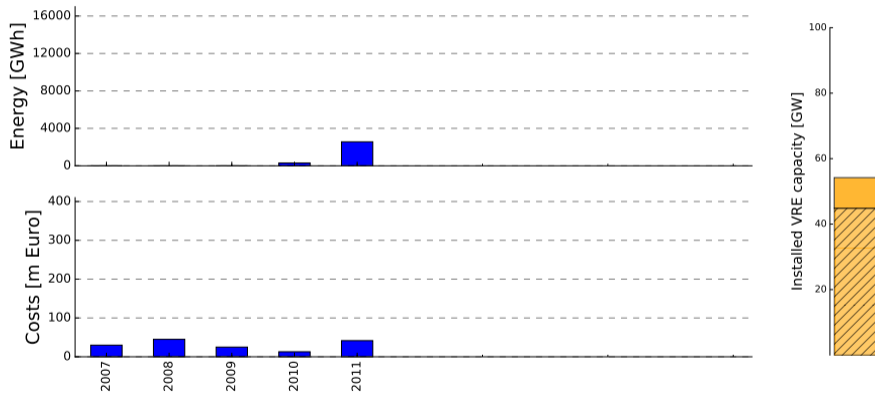
09.02.2018 | Jan Wohland ([j.wohland@fz-juelich.de](mailto:j.wohland@fz-juelich.de)) | Institute for Energy and Climate Research (IEK-STE)

# RECENT DEVELOPMENT OF REDISPATCH IN GERMANY



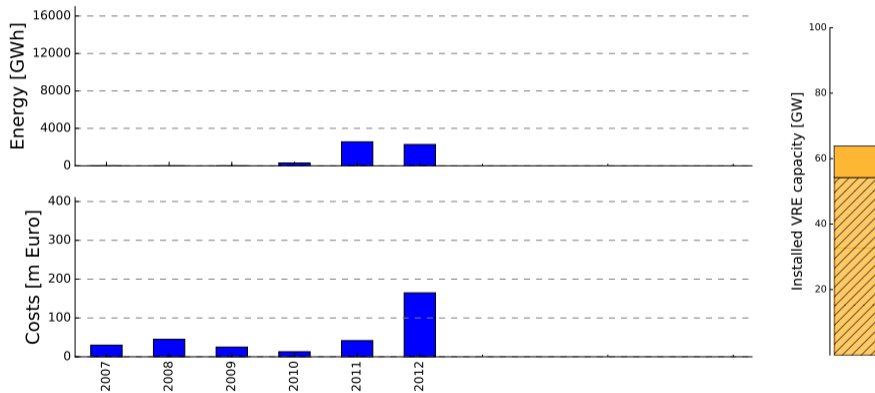
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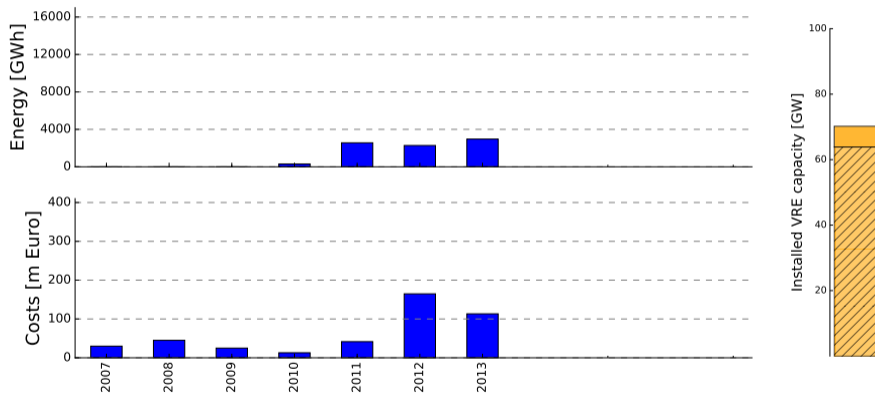
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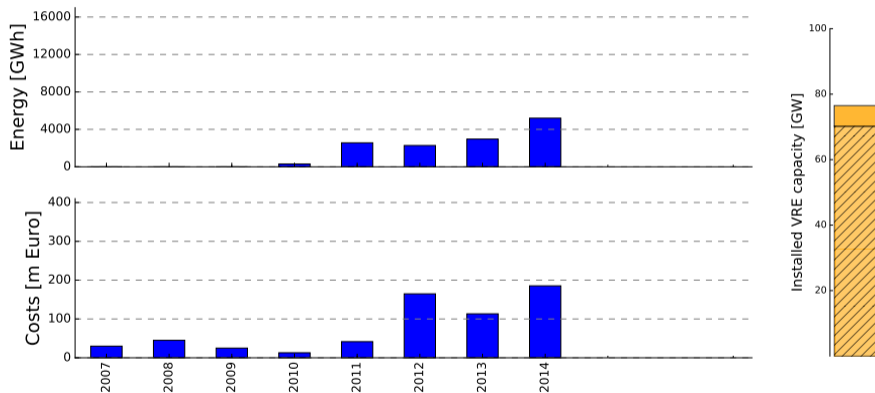
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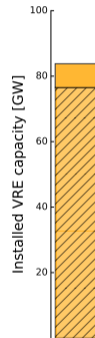
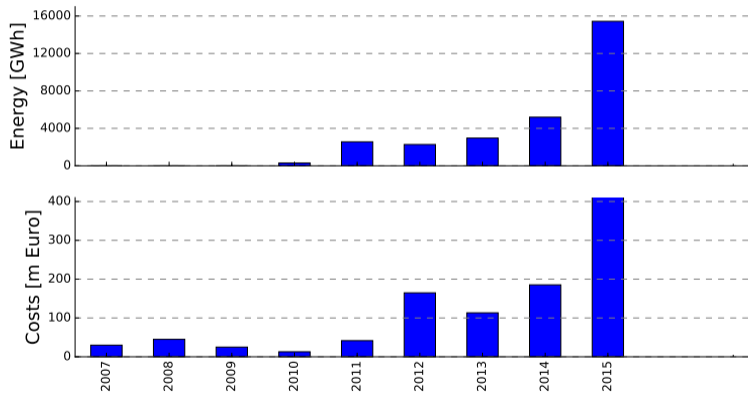
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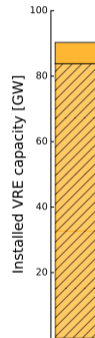
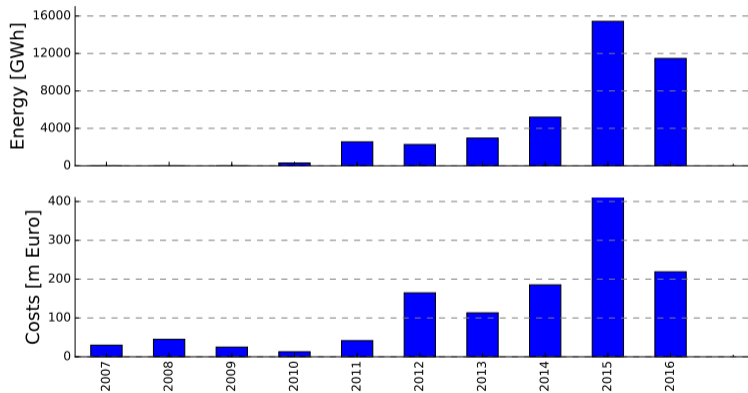


Exponential increase?

Political and public debate about EEG revision

Data: to 2014 BDEW<sup>2</sup>, 2015-2016 BNetzA<sup>3</sup>, installed capacity Fraunhofer ISE<sup>4</sup>.

# RECENT DEVELOPMENT OF REDISPATCH IN GERMANY



Did grid extension  
(Thüringer  
Strombrücke)  
solve the issue?

Data: to 2014 BDEW<sup>2</sup>, 2015-2016 BNetzA<sup>3</sup>, installed capacity Fraunhofer ISE<sup>4</sup>.



# WHY REDISPATCH MATTERS BEYOND TECHNOLOGY

## 1) Public interest

- Large media coverage of cost peak in 2015
- Fear of cost explosion with more renewables (e.g., minister for economics and energy expected further +50 % increase in from 2015 to 2016)

## 2) Political relevance

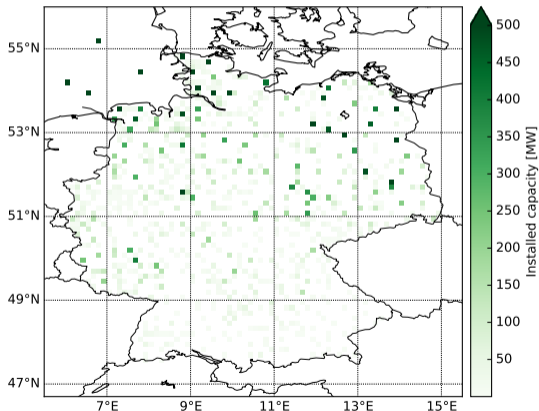
- Pressure on political decisions (e.g. modifications made to the EEG in 2016)

## 3) There is more to come

- Energy transition by far not complete
- Net zero carbon emissions require at least tripling of volatile renewable capacity

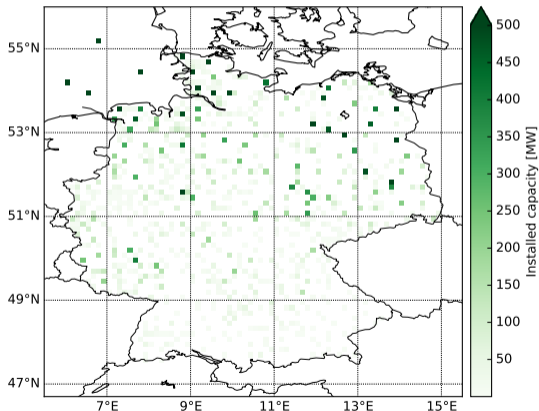
# WIND FLEET YIELD IN DIFFERENT WEATHER YEARS

## OPSD 2016 installed capacities<sup>5</sup>



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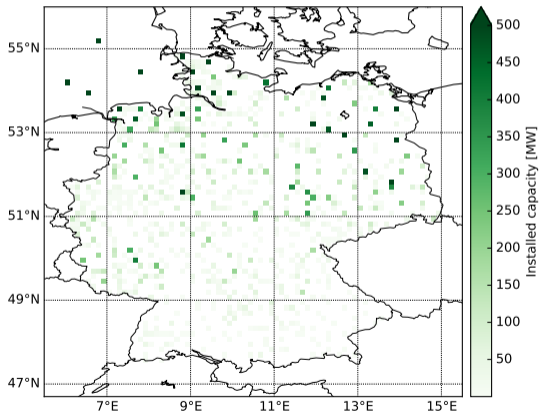


## Hypothesis

Natural wind variability triggered the drop in German redispatch from 2015 to 2016

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## Wind speeds

- ERAINT reanalysis (12 km)
- hourly wind speeds for 40 years

## Redispatch<sup>6</sup>

- reduction measures only (U & I)

## Method

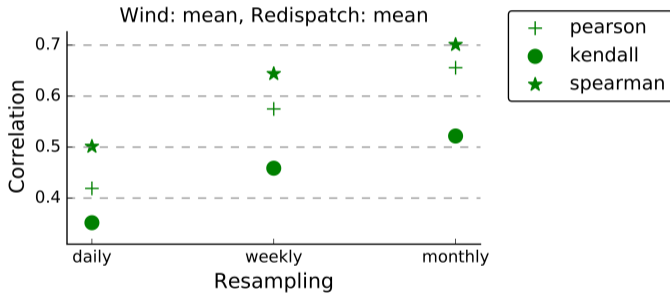
- single turbine power curve
- validated with 2015/16 data



# Statistical analysis 2015 and 2016

Dependence between redispatch and wind power generation

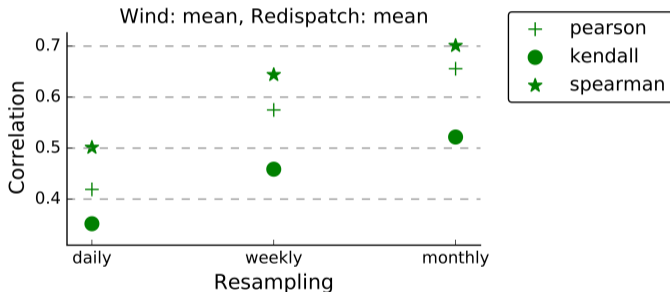
# WIND AND REDISPATCH 1: CORRELATIONS



## Correlation measures

- Pearson: standard
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# WIND AND REDISPATCH 1: CORRELATIONS



## Correlation measures

- Pearson: standard
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- Kendall: another rank measure

## Correlations substantial to high

- Monotonous increase  $\Rightarrow$  very high annual values expected
- Spearman  $>$  Pearson  $\Rightarrow$  **nonlinear** but monotonic

# WIND AND REDISPATCH 2: ROC

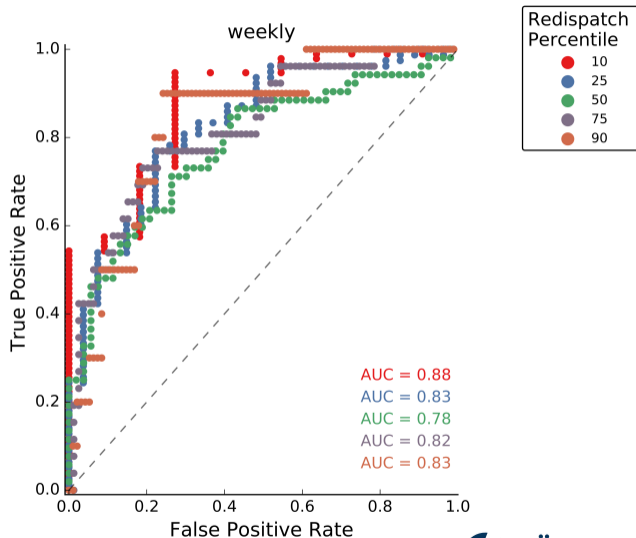
## Receiver Operator Characteristics (ROC)

Tests for a step-wise relation between wind generation and redispatch.

$$G_{\text{Wind}} \geq \sigma \Rightarrow R \geq \theta$$

## Area under the curve (AUC)

- no skill: AUC = 0.5
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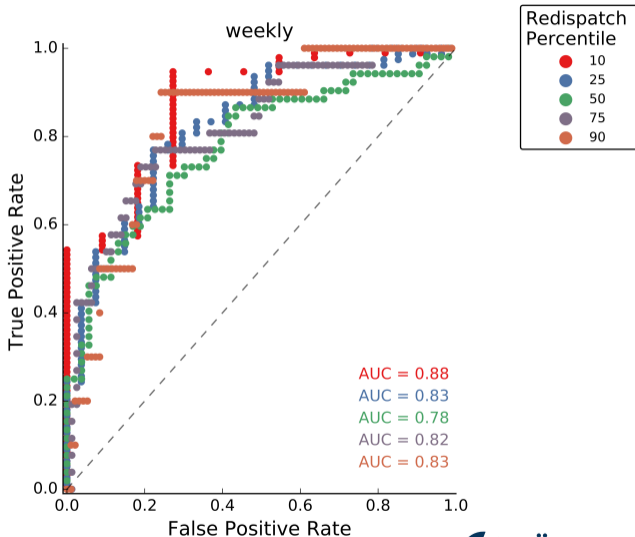
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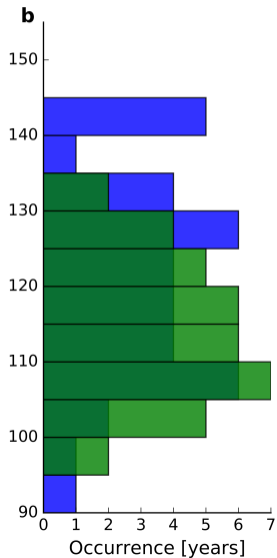
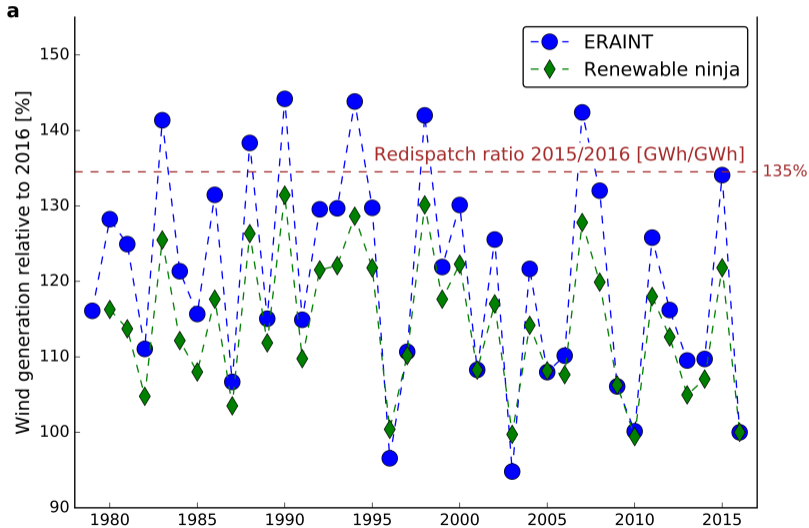
AUC > 0.8 prove high skill





# Investigating the natural spread of wind generation

# GENERATION TIME SERIES



# CONCLUSION AND IMPLICATIONS

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- Robust decision making under uncertainty instead of hectic reactions
- Flexibility on different timescales

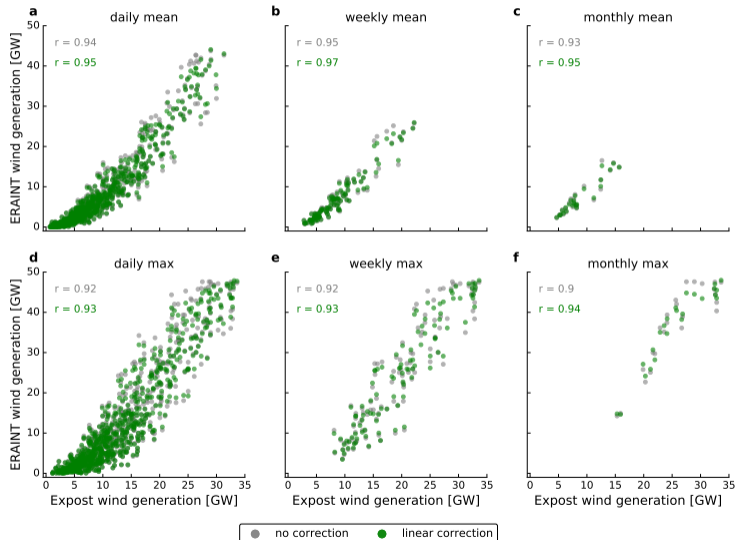
# REFERENCES

- [1] Jan Wohland, Mark Reyers, Carolin Märker, and Dirk Witthaut. Natural wind variability triggered drop in German redispatch volume and costs from 2015 to 2016. *PLOS ONE*, 13(1):e0190707, January 2018.
- [2] BDEW. Redispatch in Deutschland - Auswertung der Transparenzdaten. Technical report, Bundesverband der Energie und Wasserwirtschaft, Berlin, April 2017.
- [3] Bundesnetzagentur. Quartalsbericht zu Netz- und Systemsicherheitsmaßnahmen - Viertes Quartal und Gesamtjahr 2016. Technical report, Bundesnetzagentur, Bonn, May 2017.
- [4] Fraunhofer ISE. Net installed electricity generation capacity in Germany (accessed on February 2nd 2018).
- [5] OPSD. Renewable power plants, [https://data.open-power-system-data.org/renewable\\_power\\_plants/](https://data.open-power-system-data.org/renewable_power_plants/) (version 16/02/17), February 2017.
- [6] Netztransparenz. Netztransparenz Redispatch, <https://www.netztransparenz.de/EnWG/Redispatch> (accessed 02/06/17), February 2017.

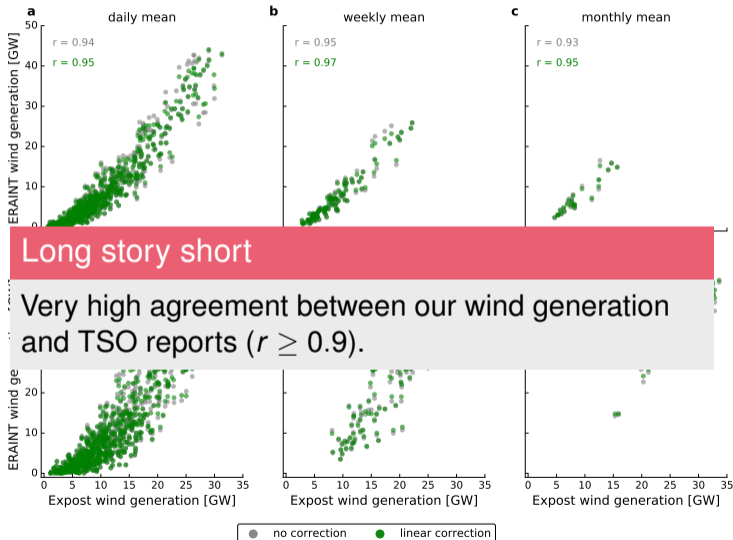


## Additional slides: Validation

# VALIDATION WITH EXPOST GENERATION DATA



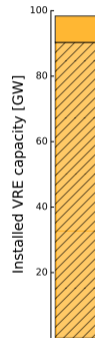
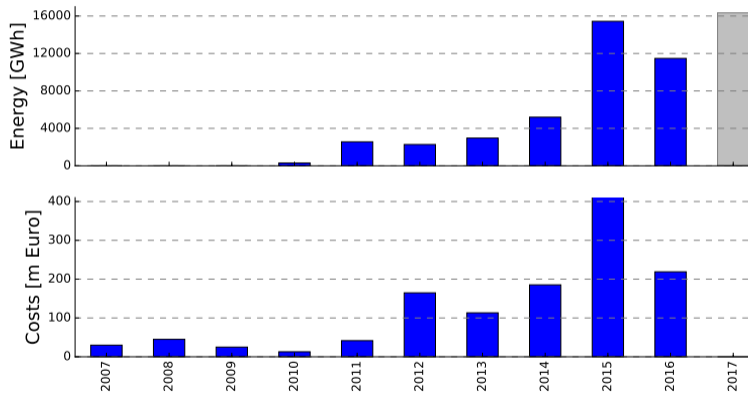
# VALIDATION WITH EXPOST GENERATION DATA



Long story short

Very high agreement between our wind generation and TSO reports ( $r \geq 0.9$ ).

# RECENT DEVELOPMENT OF REDISPATCH IN GERMANY



Don't take gray bar for granted!

Educated guess based on BNetzA Q1 data

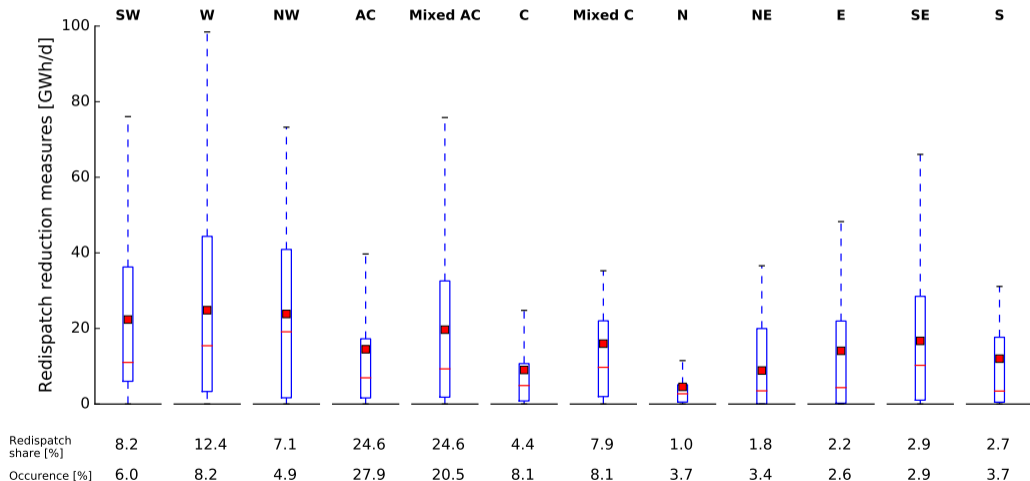
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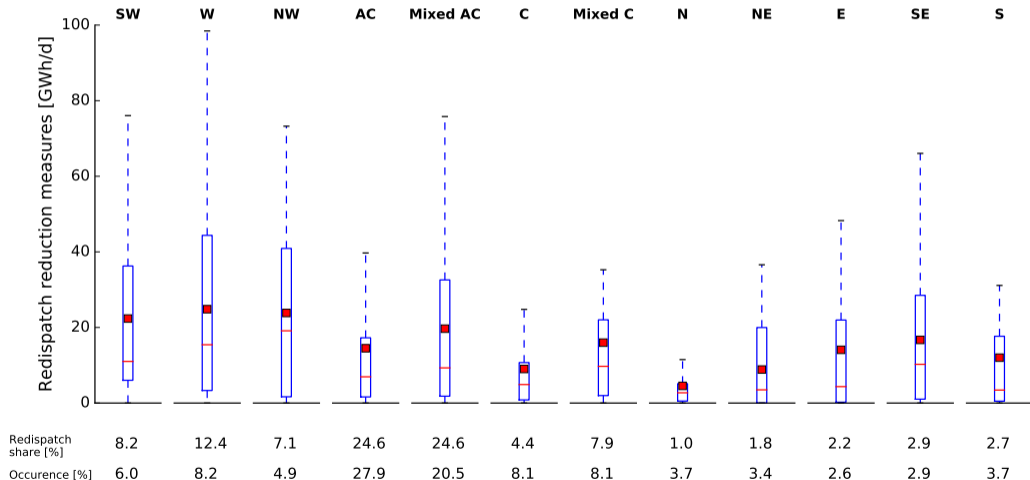


## Additional slides: CWTs

# DEPENDENCE ON CIRCULATION WEATHER TYPES

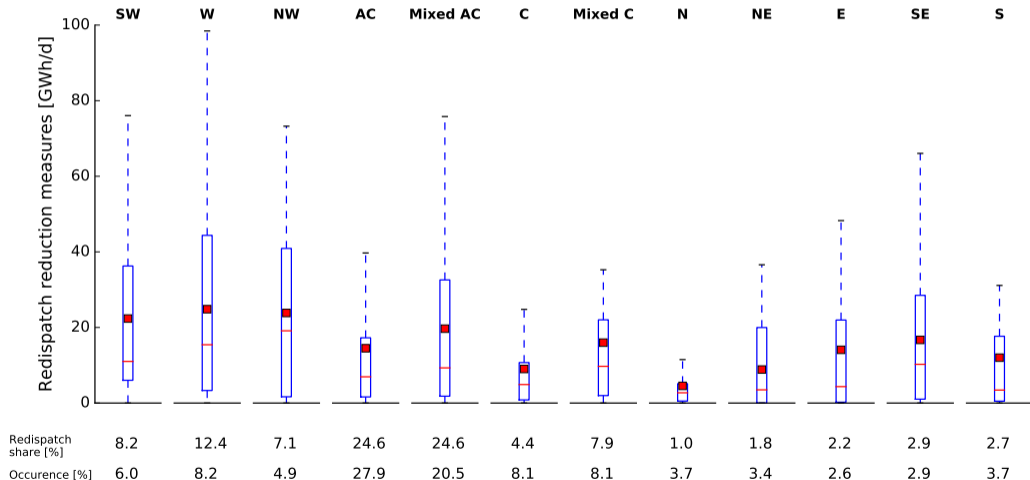


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Incentivize locations with high yields during non-westerly CWTs

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