

# The European Commission's science and knowledge service

Joint Research Centre



# Survey on distributed natural gas quality

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# Survey 2a - Data processing: expected results

- to produce maps at national and regional level (where regional means NUTS 3 level);
- to summarise and describe main statistical properties of aggregated and anonymised data for the Superior Wobbe Index and Superior Calorific Value;
- to elaborate the data to provide aggregated and anonymised descriptive statistical values covering the average behaviour and the rate of change by category of end-user.

# Data received

Member state	Total number of points
Austria (AT)	21
Belgium (BE)	3
Germany (DE)	33
Spain (ES)	3
France (FR)	1
Italy (IT)	14
Netherlands (NL)	7
Poland (PL)	11
Sweden (SE)	5
United Kingdom (UK)	?

Type of Point	Total number of points
Distribution Line	31
Residential	0
Commercial	2
Industry - combustion	16
Industry - non combustion	6
Power generation	4
District heating	0
Biomethane injection point	5
Multiple assignments	34

Time granularity	Total number of points
Month	2
Day	5
Hour	75
30 min	1
15 min	6
5-10 min	6
1 min	1
Irregular	2

30+ participants to the survey

Of the 98 data sets received, 69 were analysed for joint workshop

# Data processing

- All data is converted to the same unit of measure and reference conditions ( $\text{MJ/m}^3$ ,  $15^\circ\text{C}/15^\circ\text{C}$ ,  $101.325\text{kPa}$ ), using the conversion factors listed in ISO 13443:1996 Natural Gas – Standard reference conditions.
  - A check is carried out for missing values and 0's.
  - A filter on the WI values is applied, discarding all values outside a range of  $42 - 59 \text{ MJ/m}^3$ .
  - Calibration measurements and obvious errors were excluded.
- Further data processing is necessary for some of the data sets.*

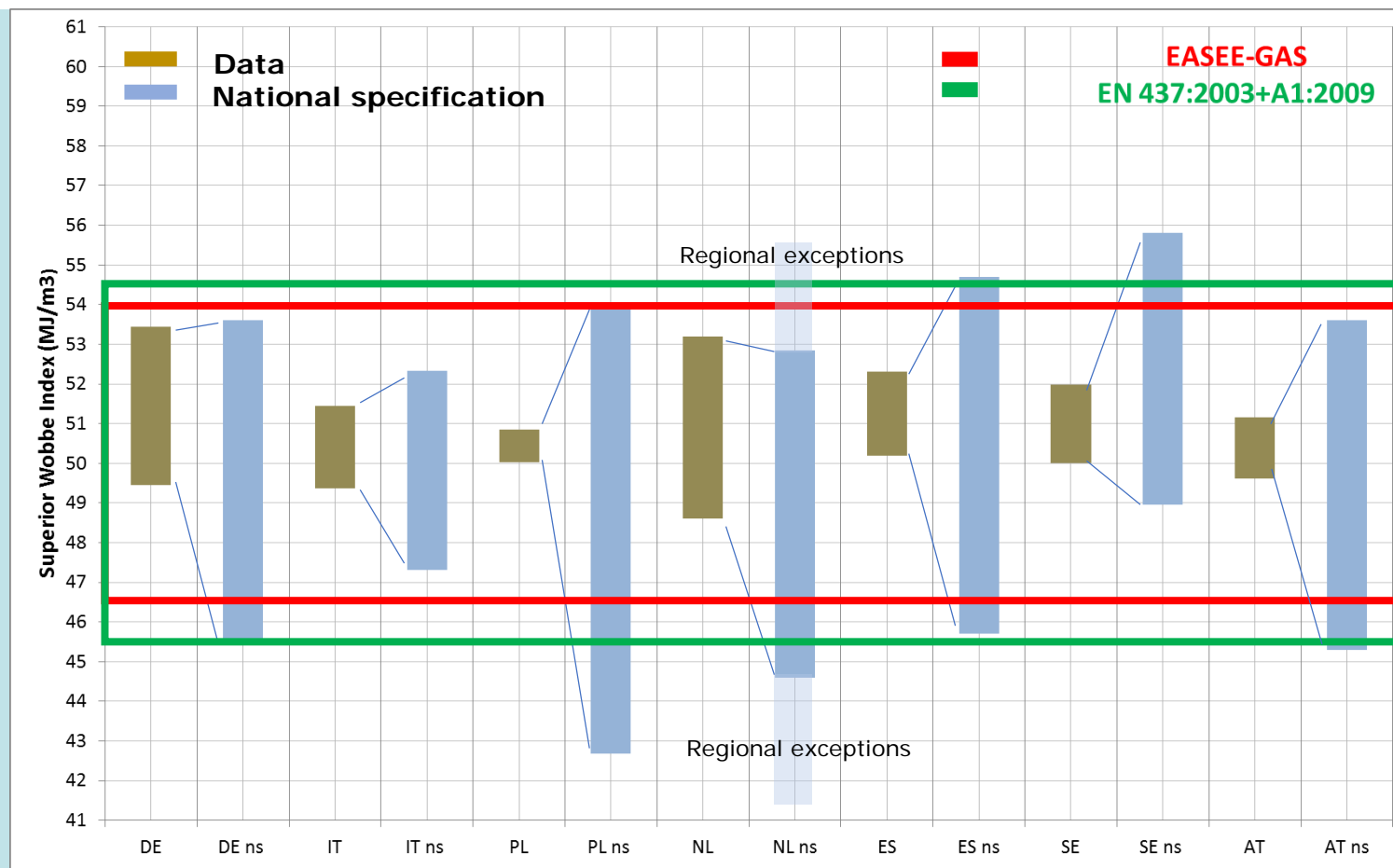
# Wobbe Index Range

## Data analysis:

- **Data is aggregated at MS level.**
- Determine summary statistics: Minima, maxima, mean and standard deviations are obtained after applying filter.
- Percentiles starting from the lowest values and covering 5%, 25% (Q1), 50% (Q2), 75% (Q3), 95% of the data, are obtained.

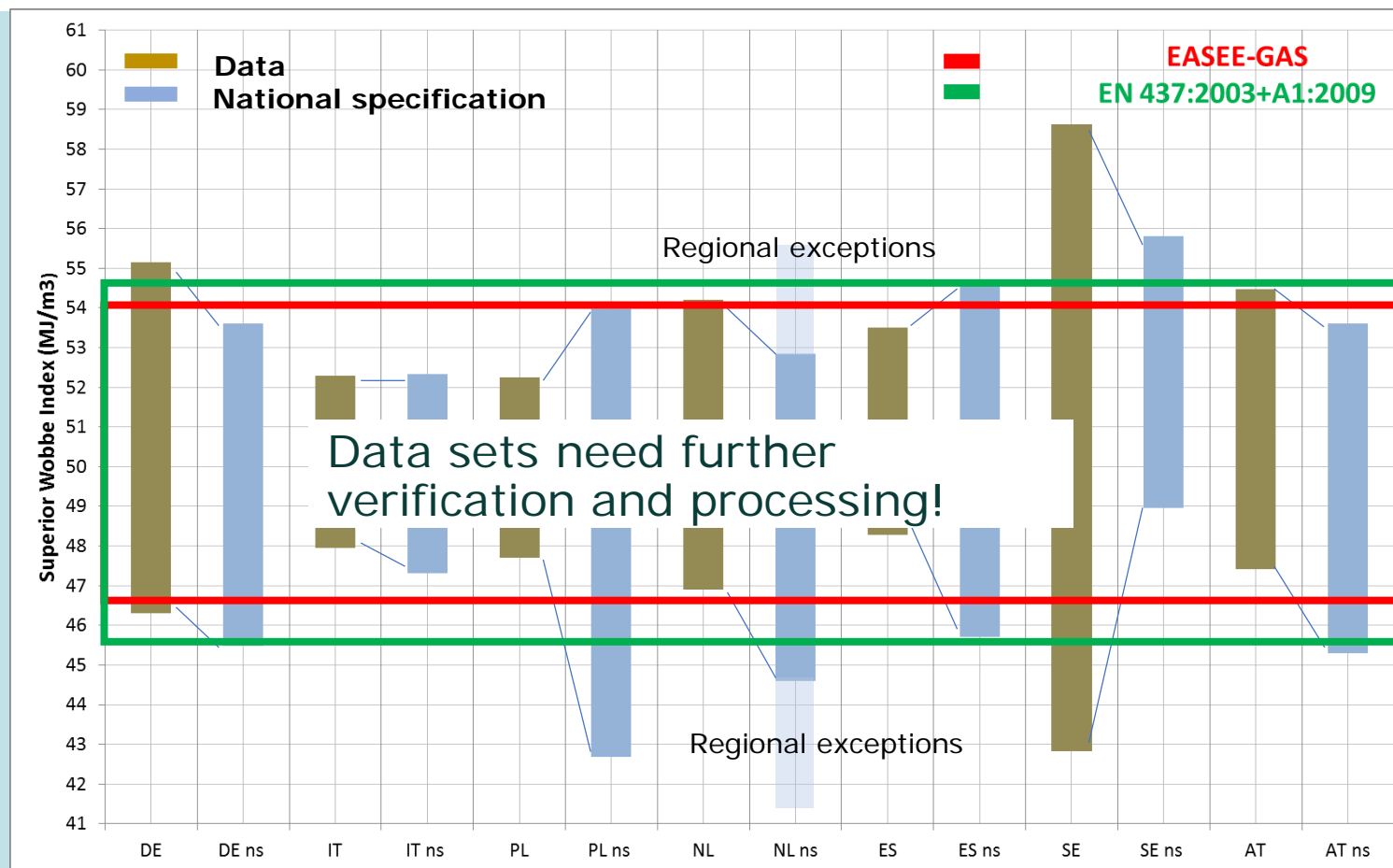
Data aggregation per type of end-user limited due to insufficient number of data sets.

# Wobbe Index range per MS



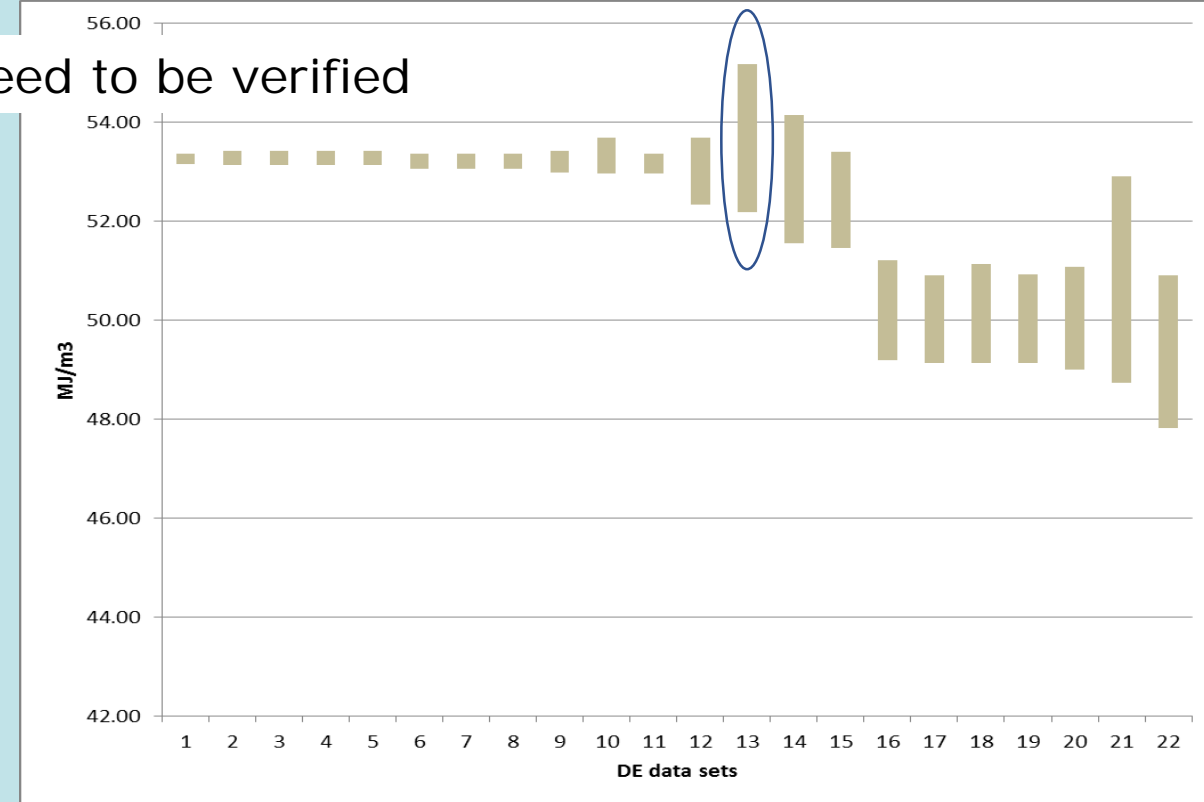
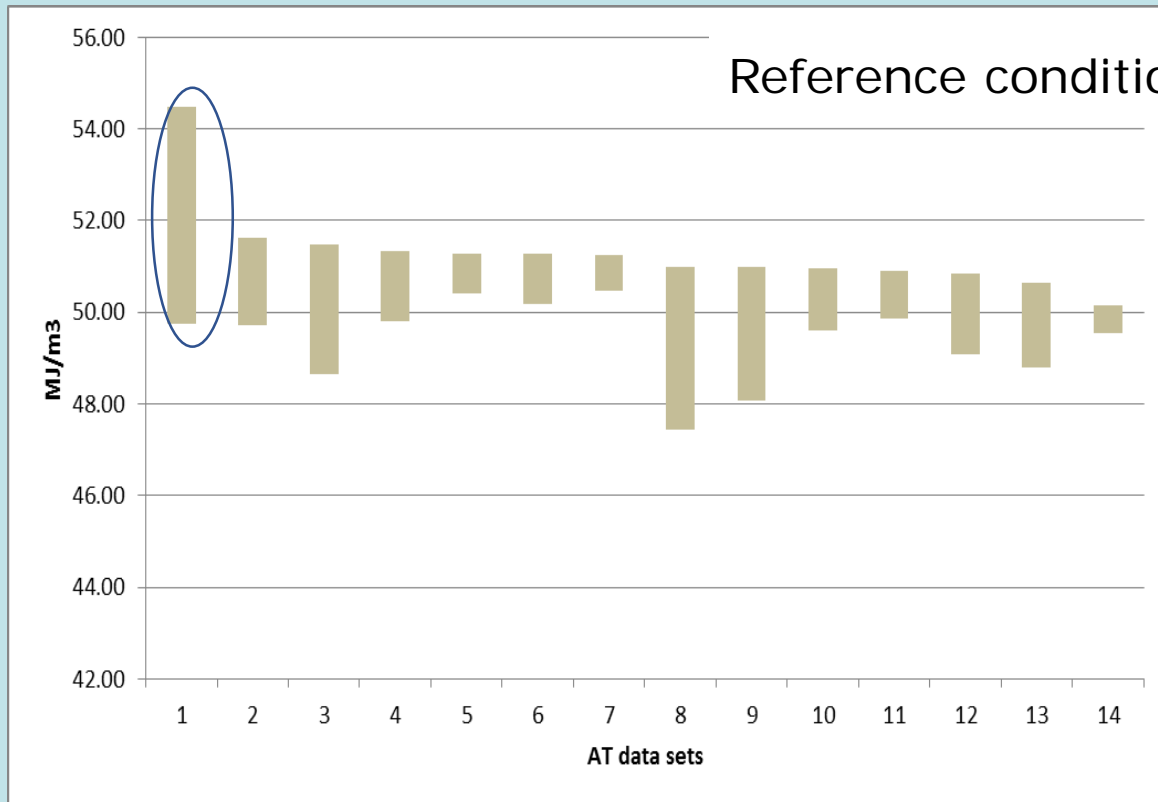
WI Range 5% to 95% percentile

# Wobbe Index range per MS



WI Range all data

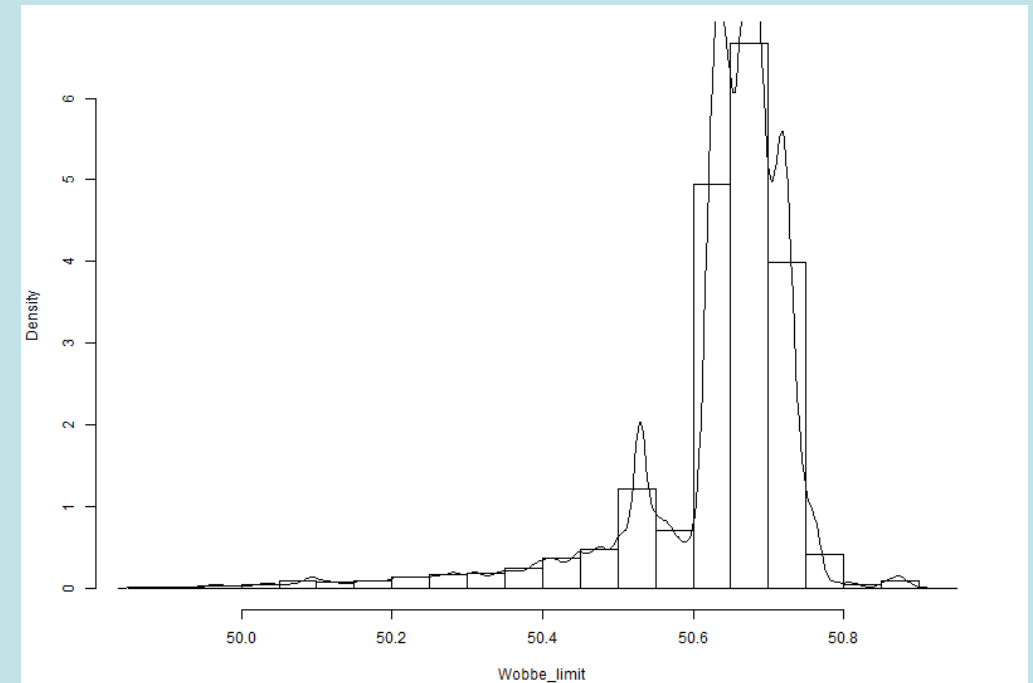
# Wobbe Index range per MS – individual data sets



# Wobbe Index: Frequency distribution

## Data analysis:

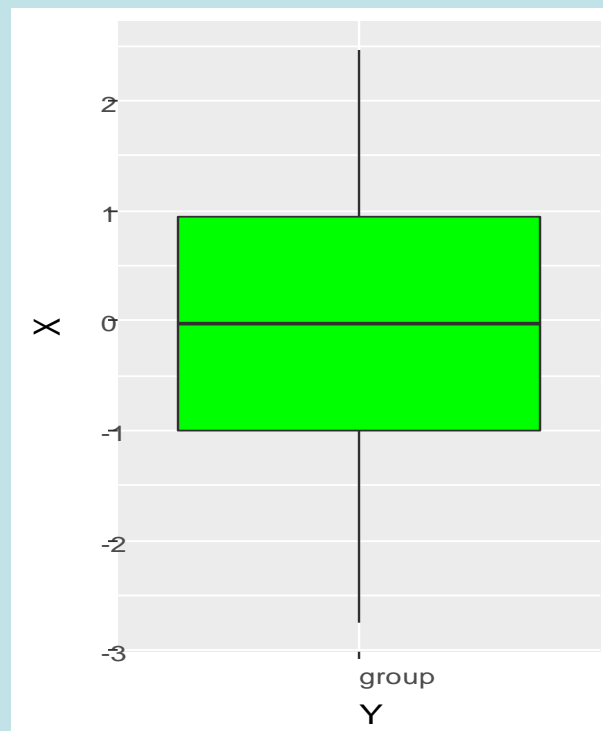
- The values are binned into frequency classes, and the resulting frequency distribution plotted.
- Each class is defined by a lower limit, an upper limit and a binning step.



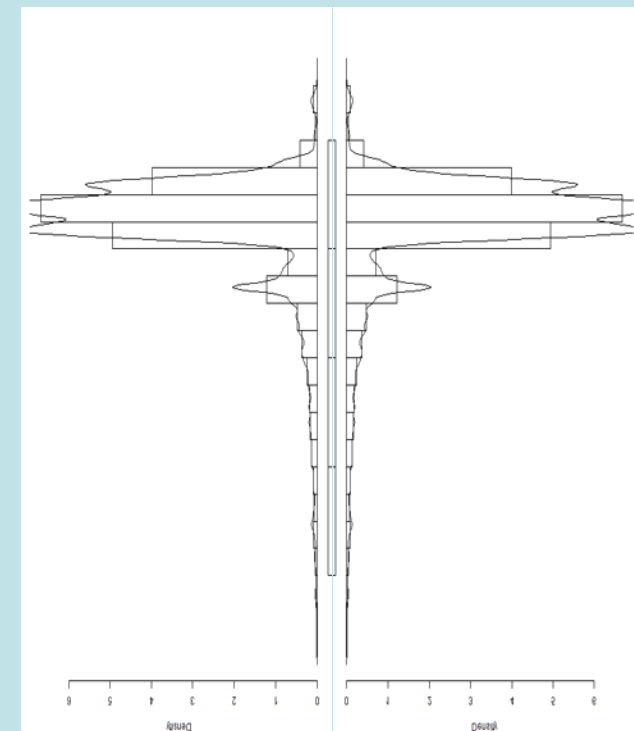
# Wobbe Index – Violin plot

## Data analysis:

A violin-plot provides a richer insight in the statistical properties of the distribution of a sample of data compared to a box-plot.



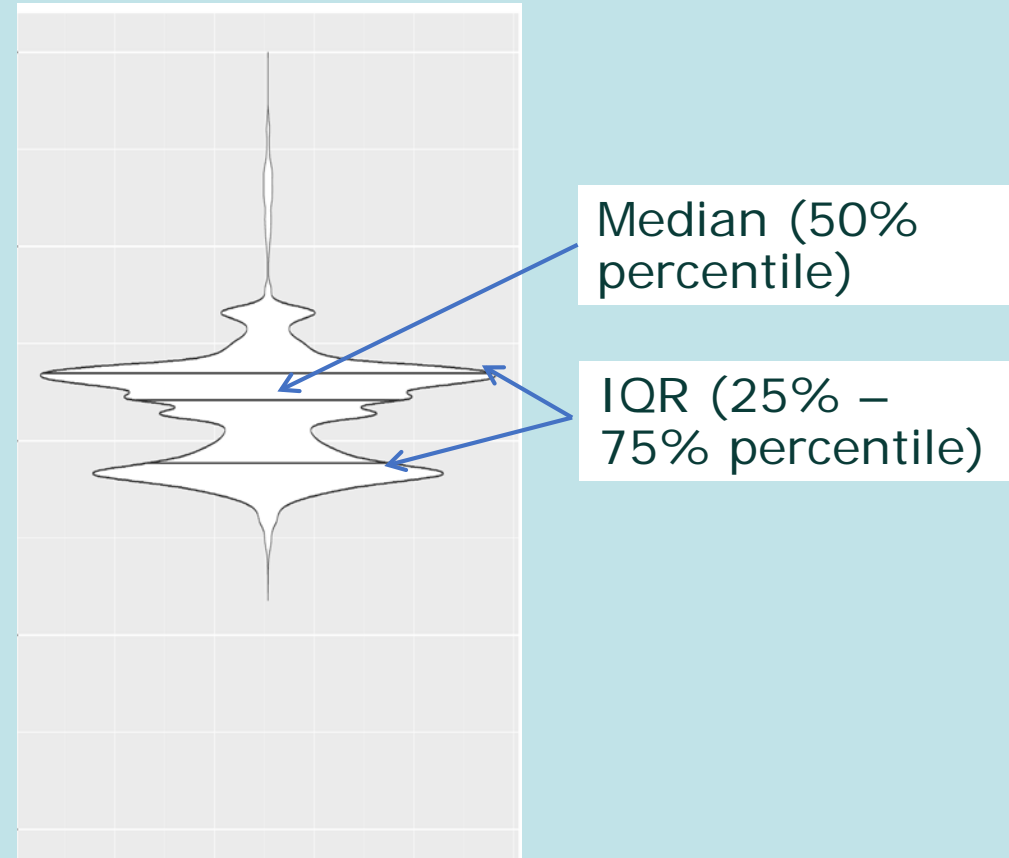
+



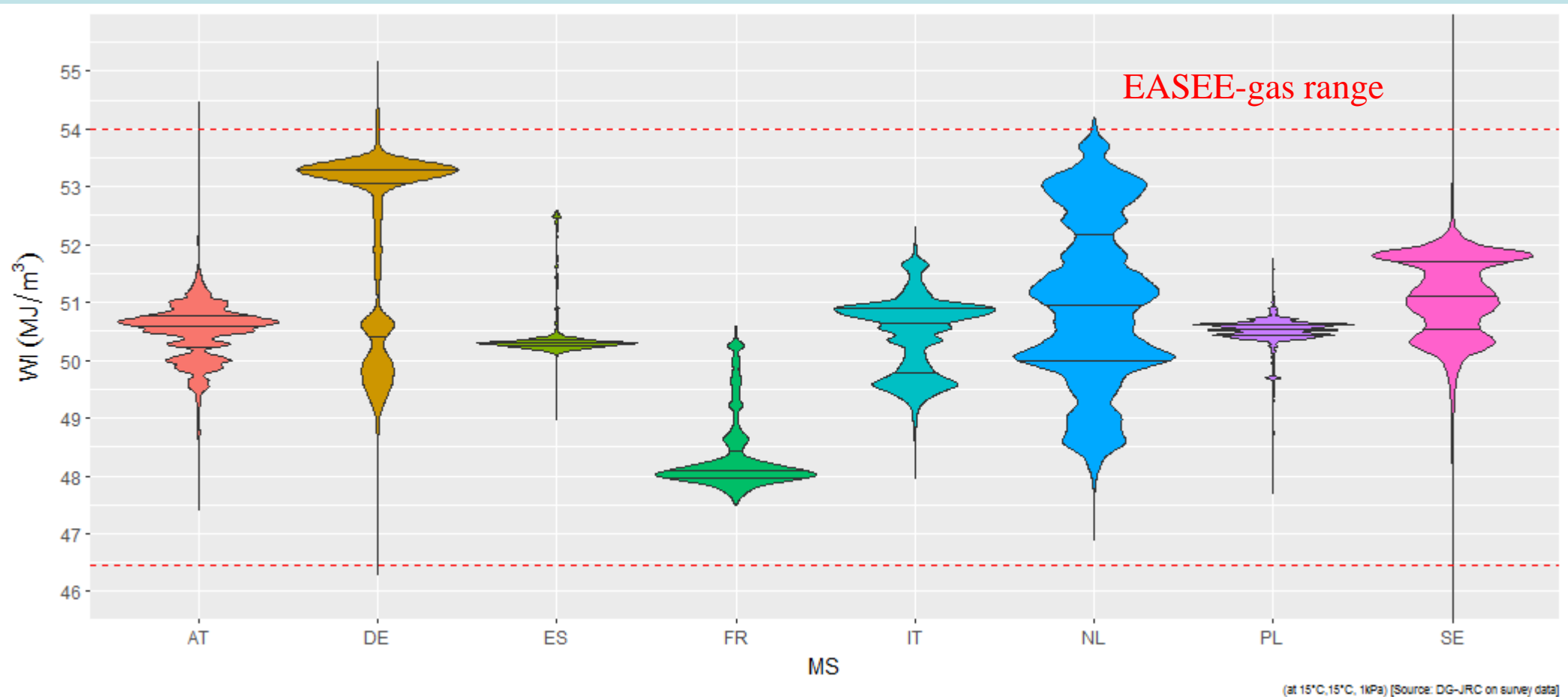
# Wobbe Index - Violin Plot

Data analysis:

- Violin plot – combination of box plot and frequency distribution
- Aggregated data at MS level

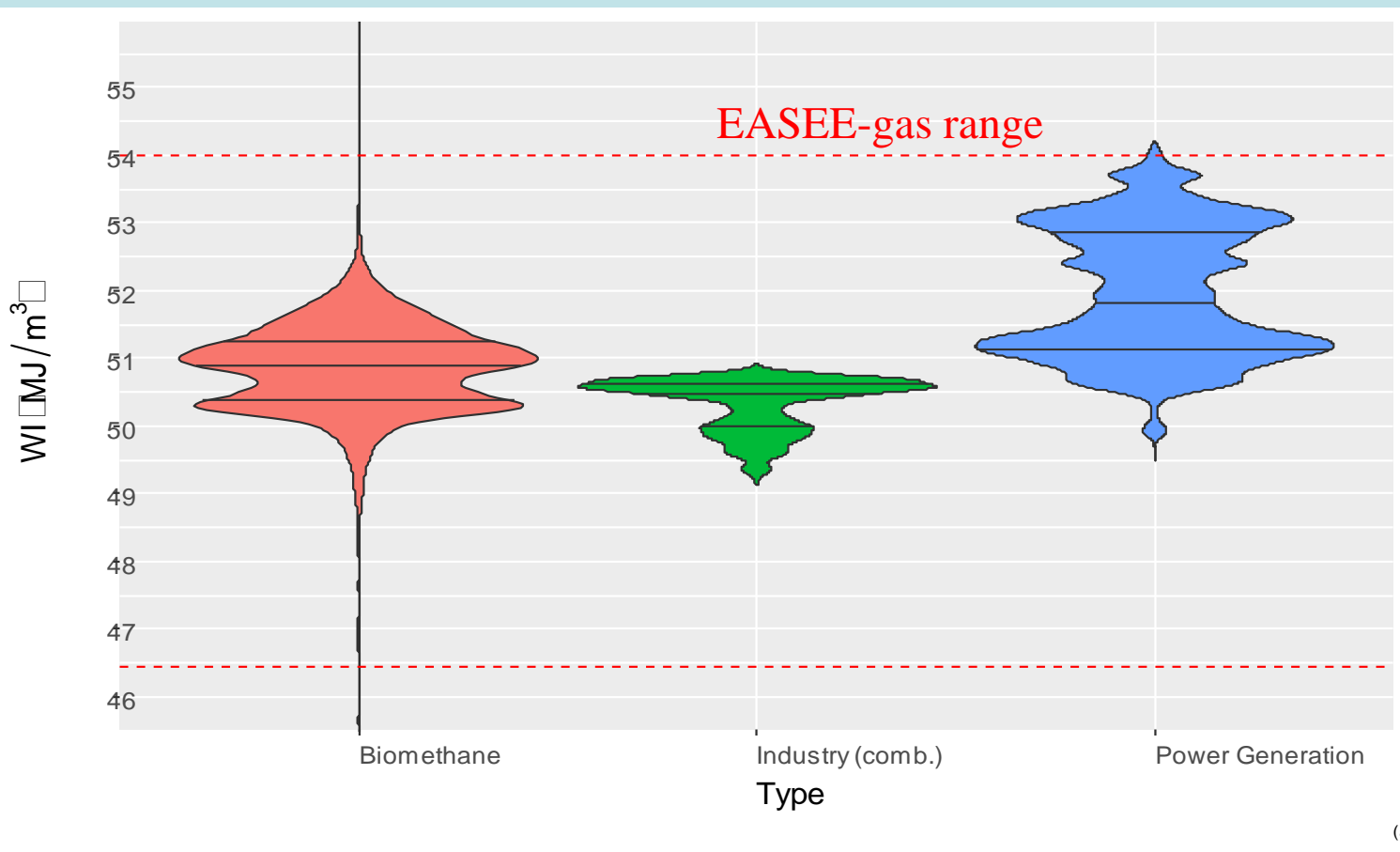


# Wobbe Index - Violin Plots per MS

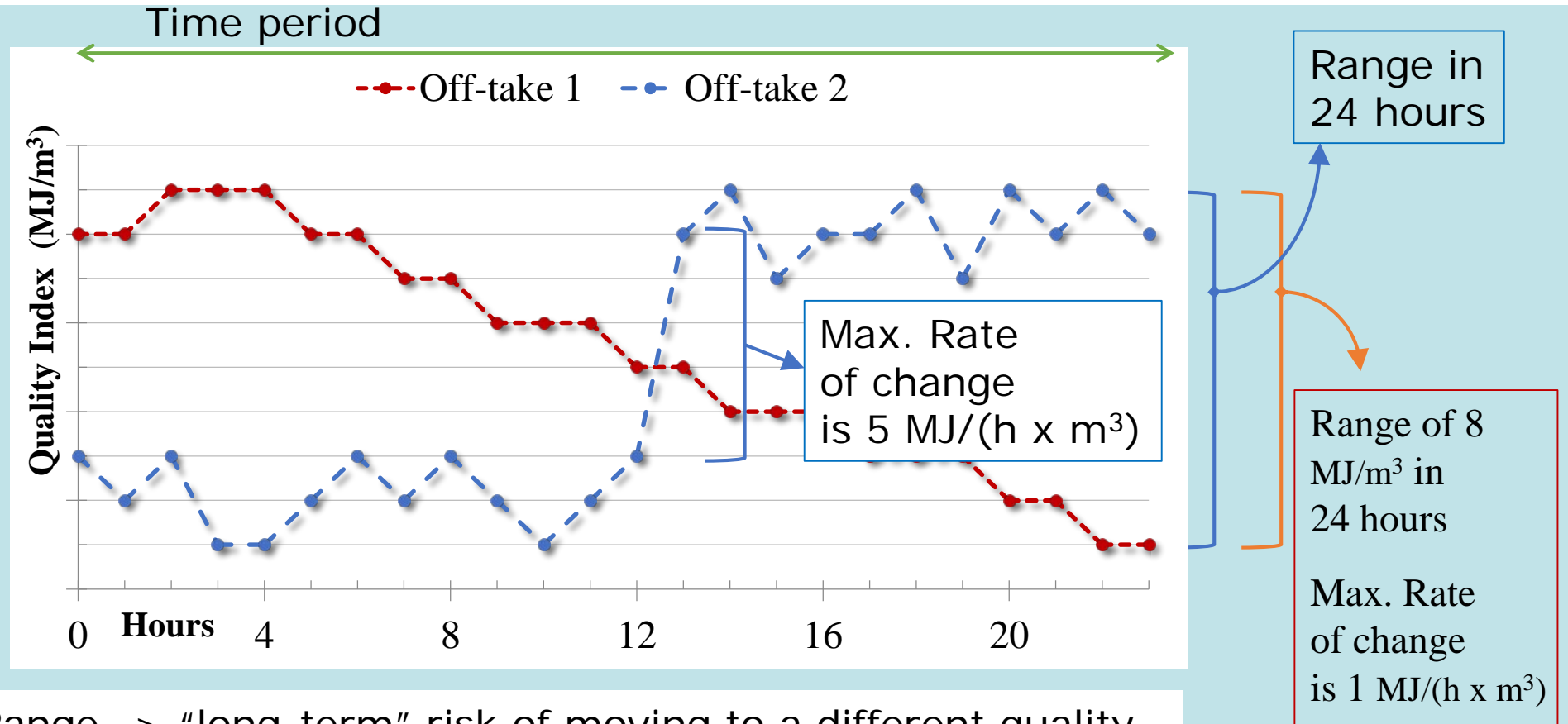


N.B. The violin plot for Sweden extends outside the plotted range. Only hourly data are used.

# Wobbe Index – Violin plot per type of point



# A measure of risk



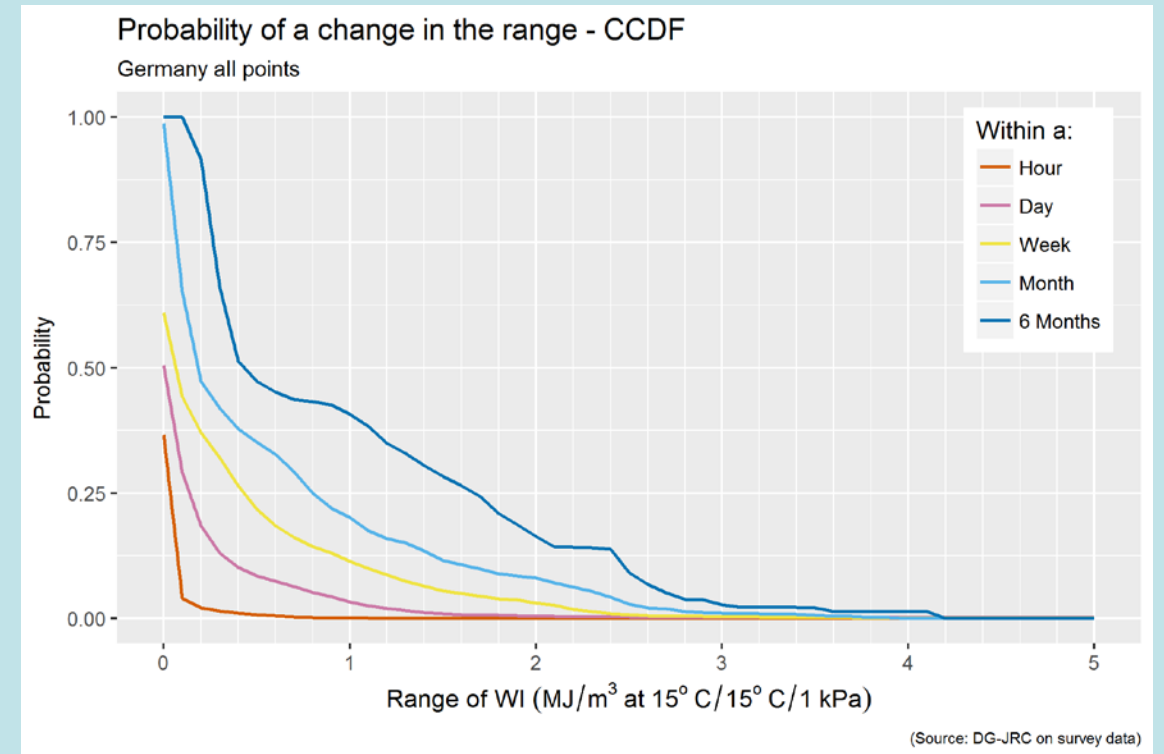
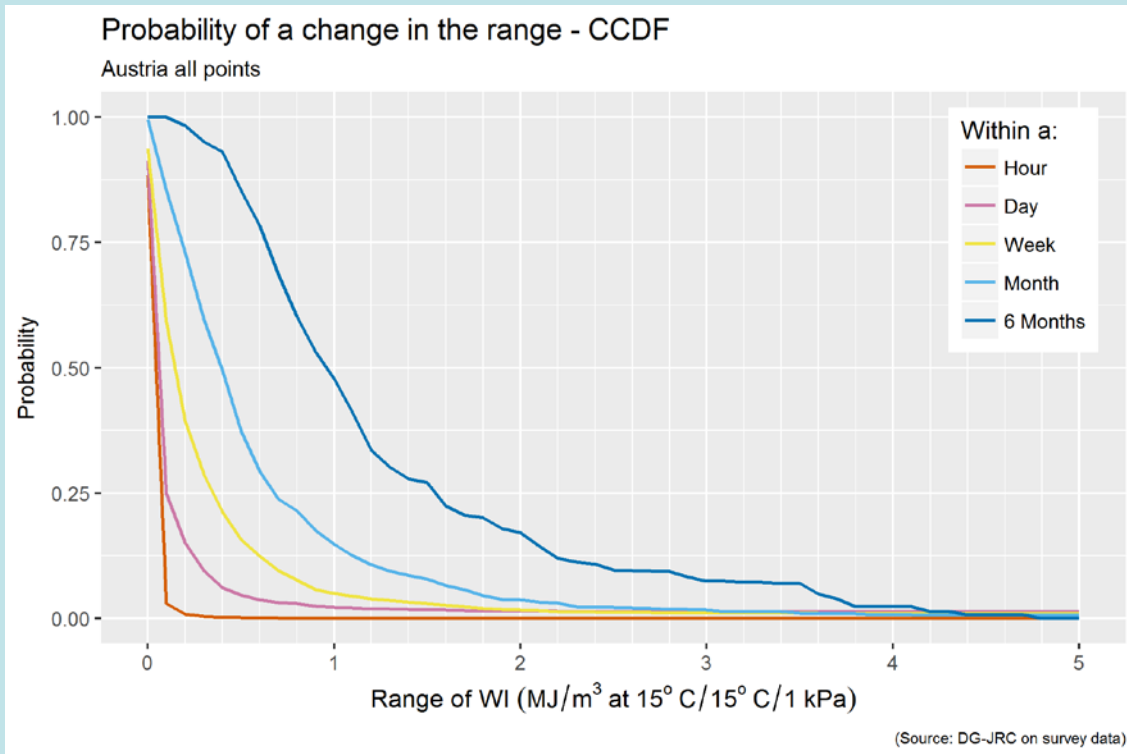
- A change in the Range -> "long-term" risk of moving to a different quality level within a time period (e.g., 24 hours)
- A change in the "Rate of change" -> "short-term" risk of a sudden (e.g., in one hour) change in the quality level within a time period (e.g., 24 hours)

# Wobbe Index – CCDF range per time period

## Data analysis – aggregated hourly data

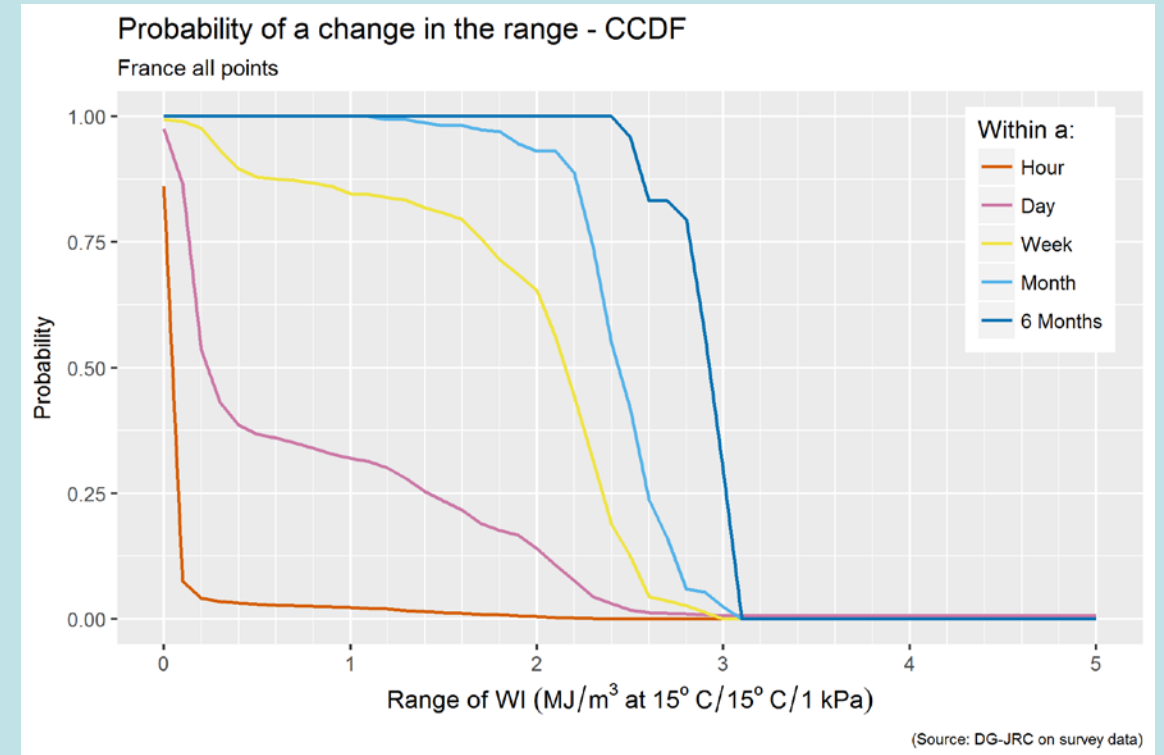
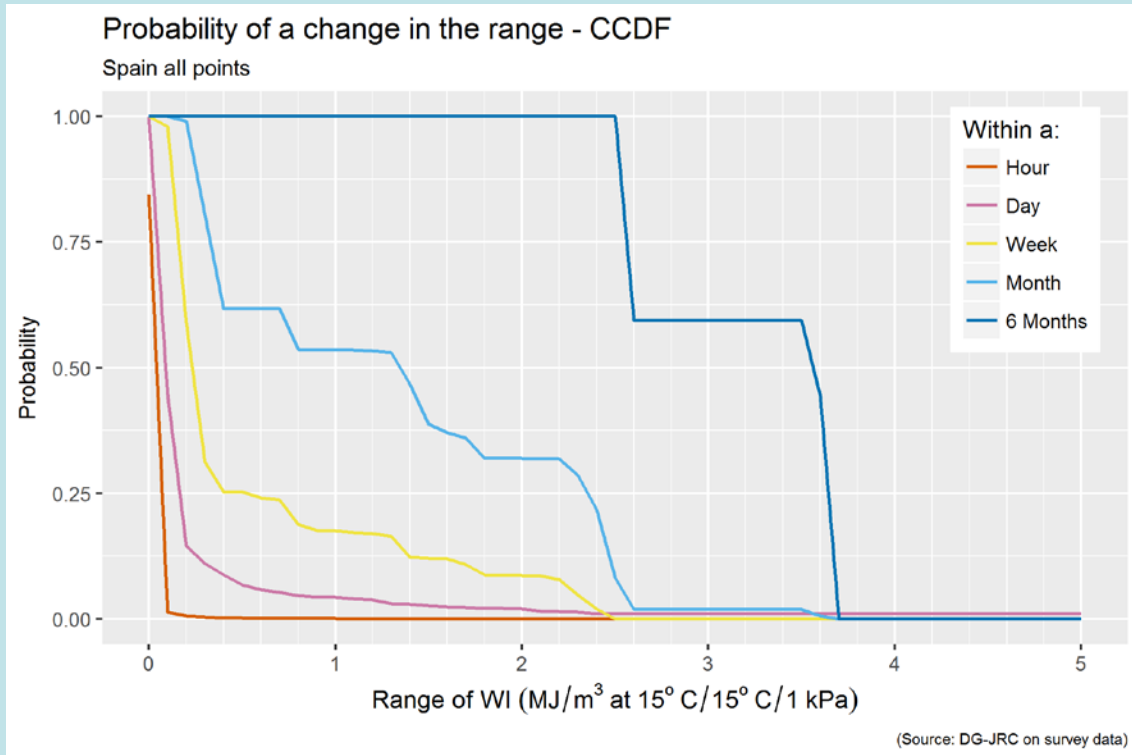
- For aggregated data per MS, determine absolute maximum and minimum WI values per time period, calculate **maximum range per time period** (hour, day, week, month, 6 months).
- Calculate frequency distribution of **WI ranges** per time period. Count occurrence of range, group by threshold exceeded (0.5, 1.0, 1.5, ... MJ/m<sup>3</sup>).
- The complementary cumulative distribution function (CCDF) is derived to express the risk of exceeding a certain threshold.

# CCDF: Wobbe index range probability

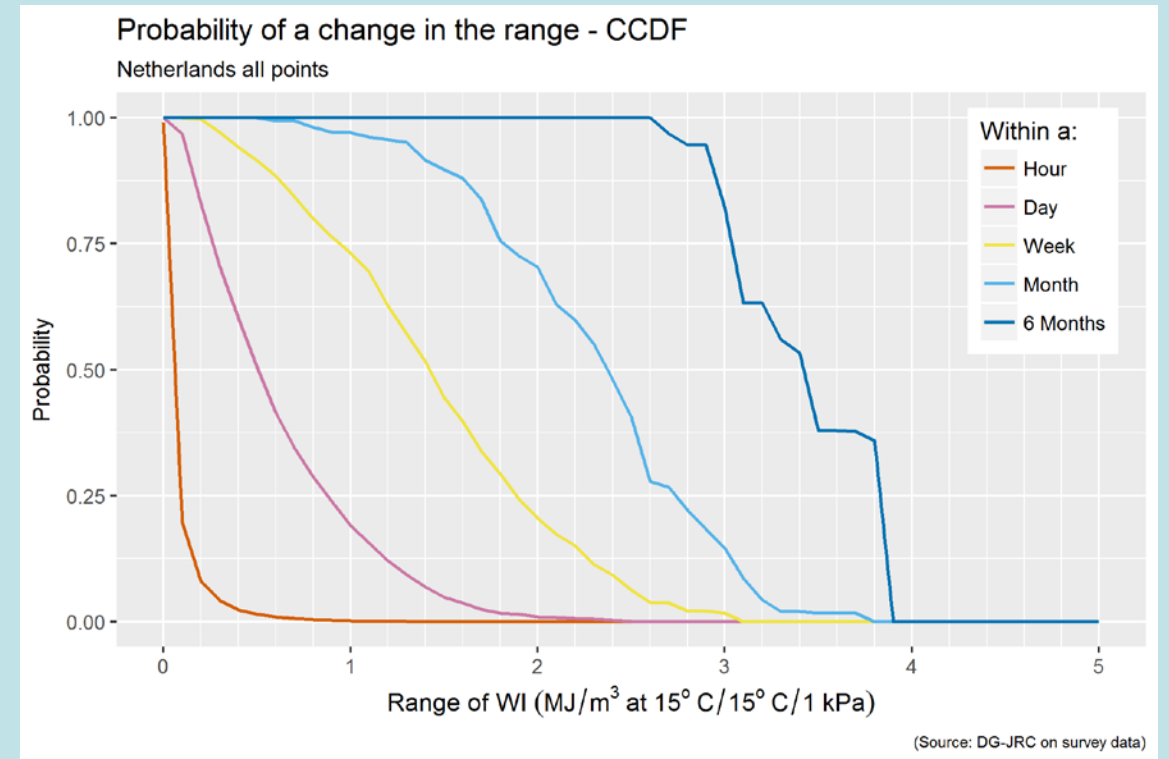
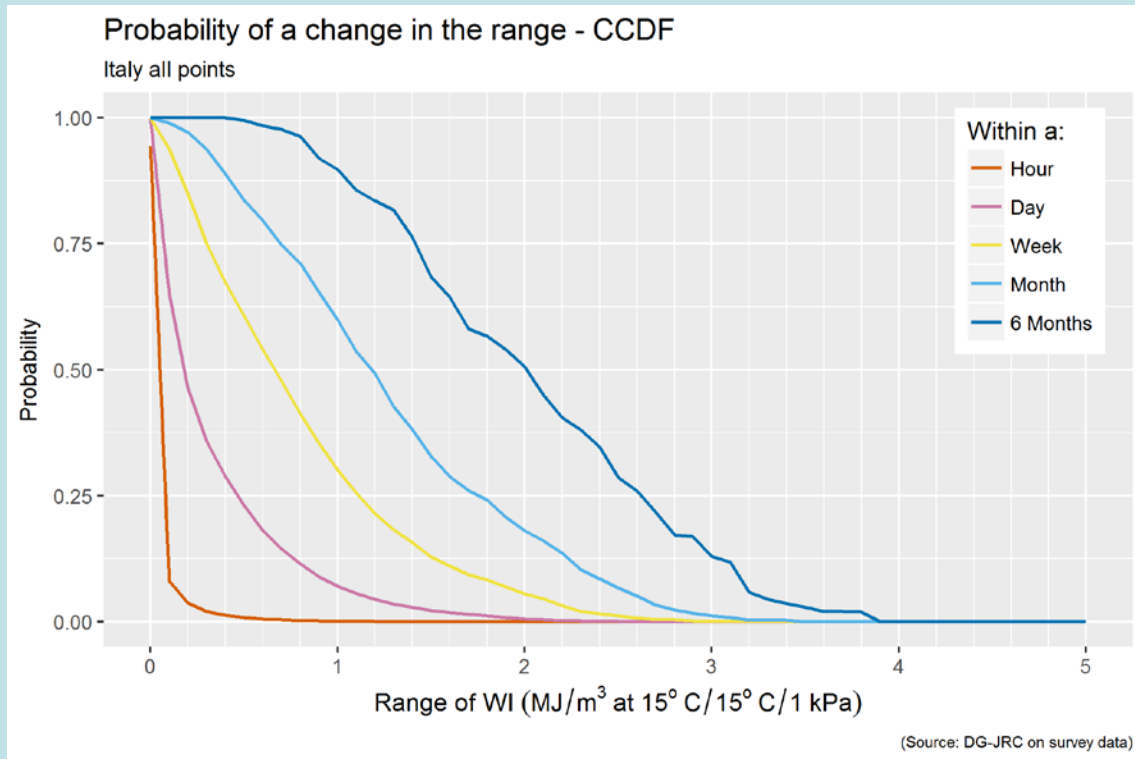


A CCDF represents the change in WI on the x axis and the probability of exceeding such value on the y axis.

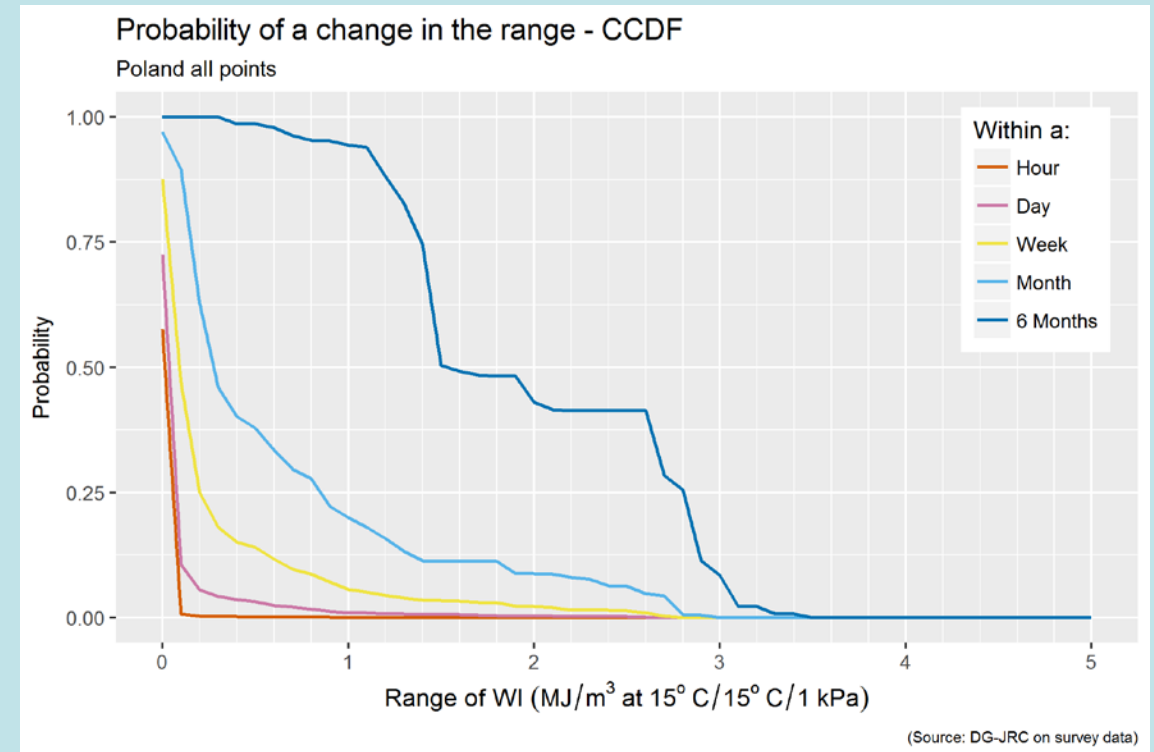
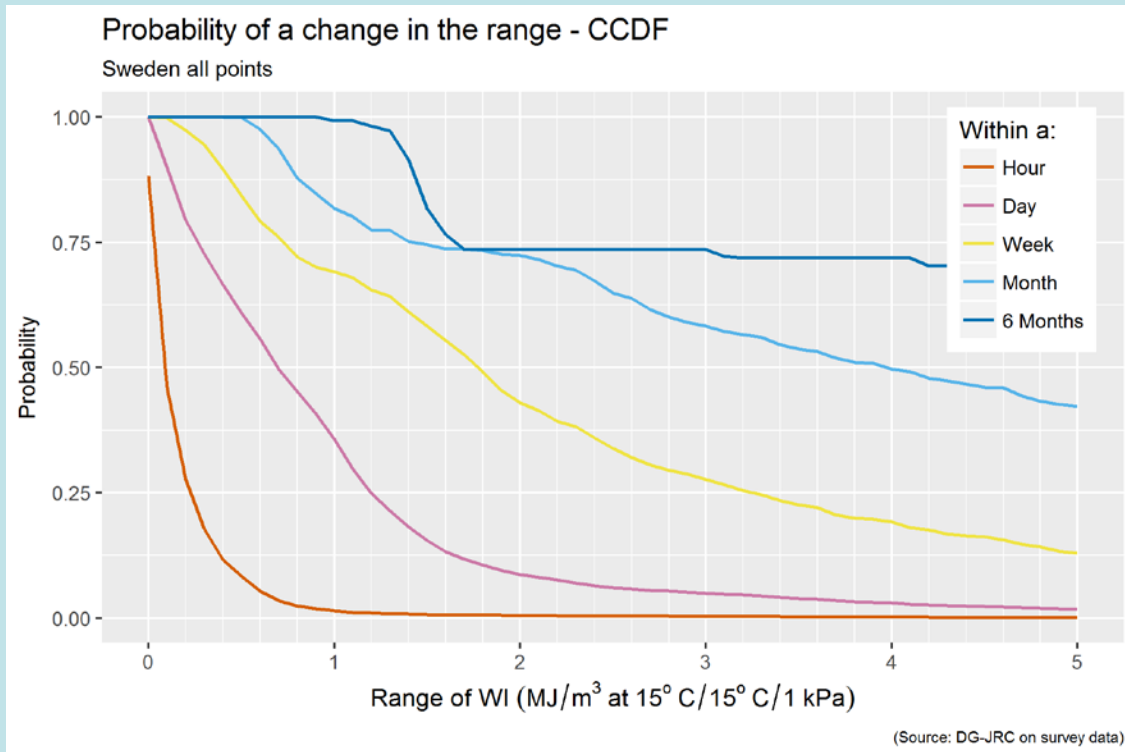
# CCDF: Wobbe index range probability



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# CCDF: Wobbe index range probability



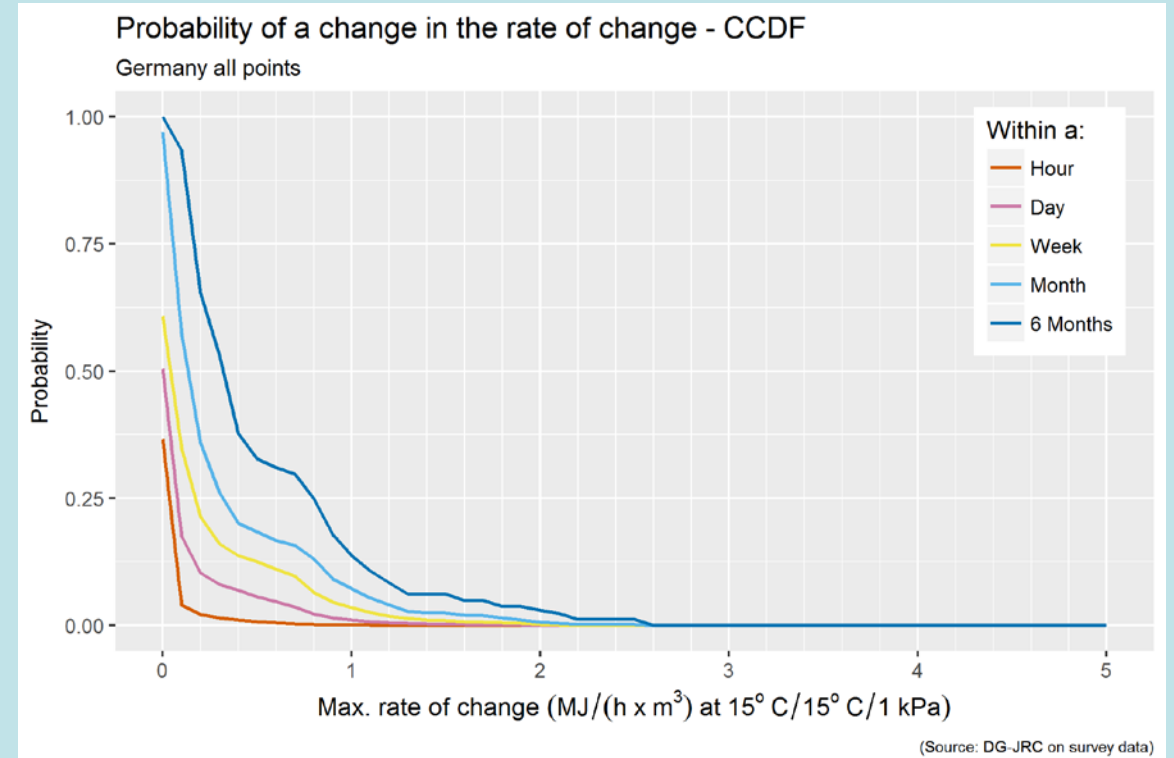
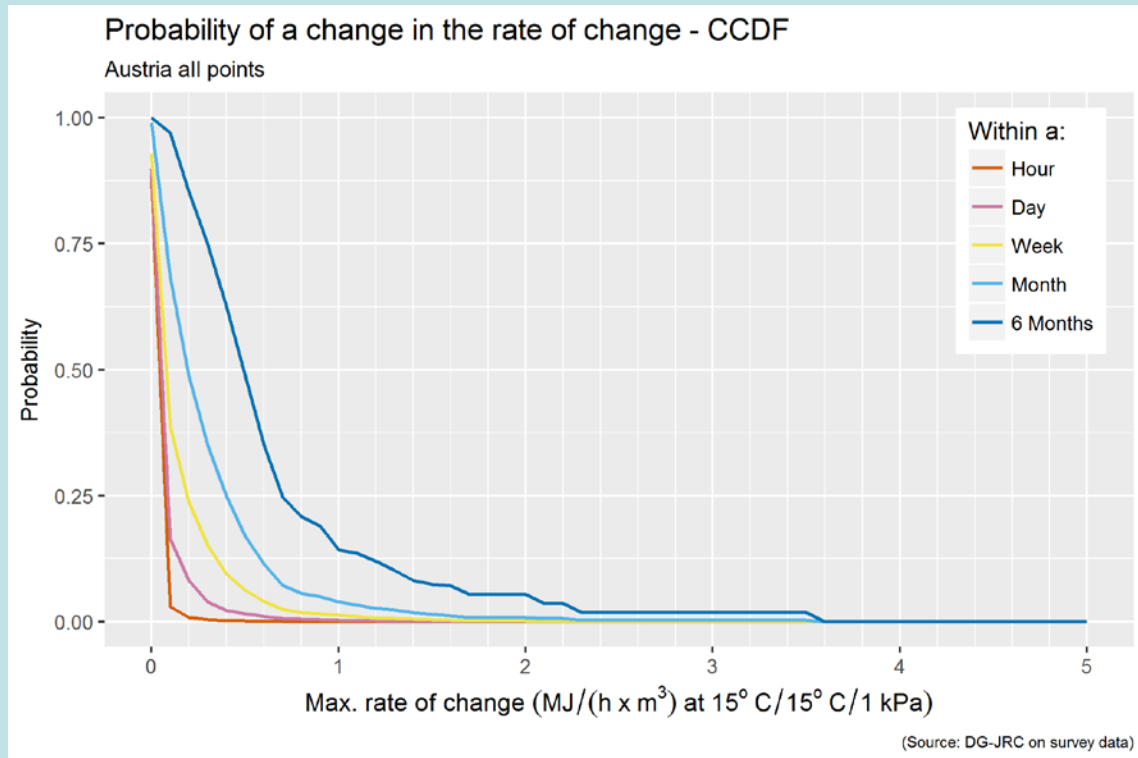
N.B. In the plot for Sweden the x-axis is cut-off at 5 for consistency with all other charts.

# Wobbe Index – CCDF rate of change

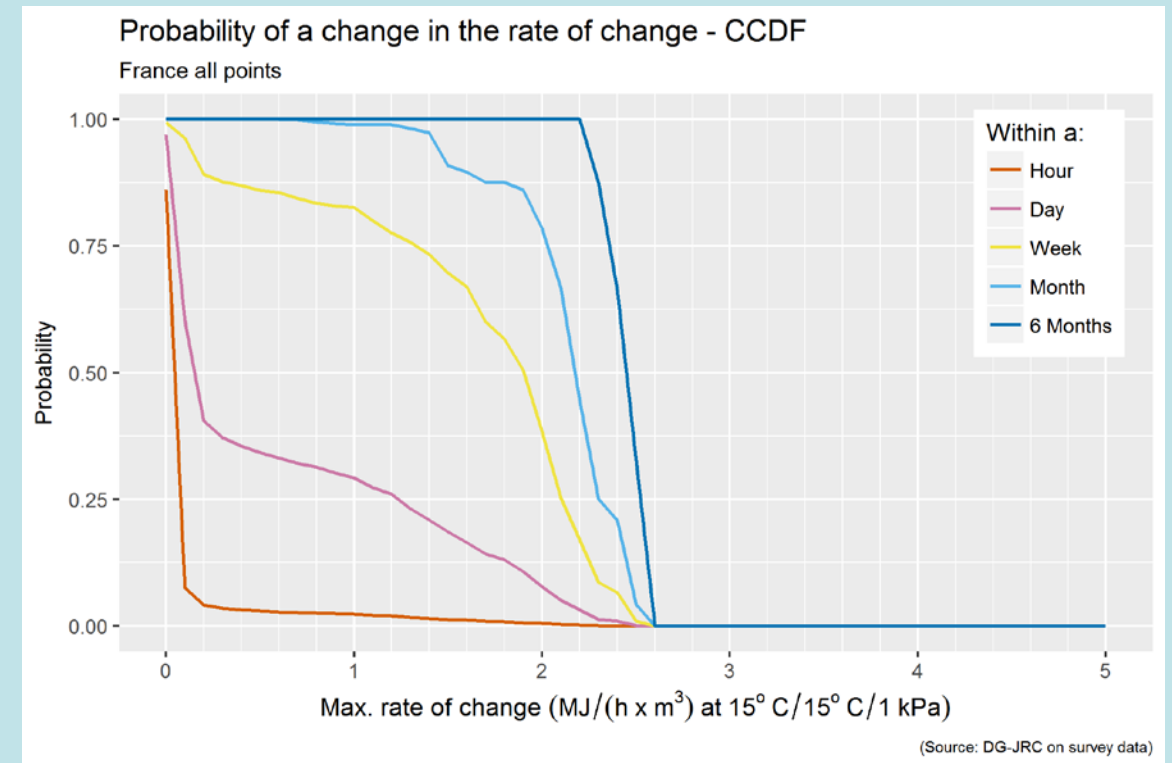
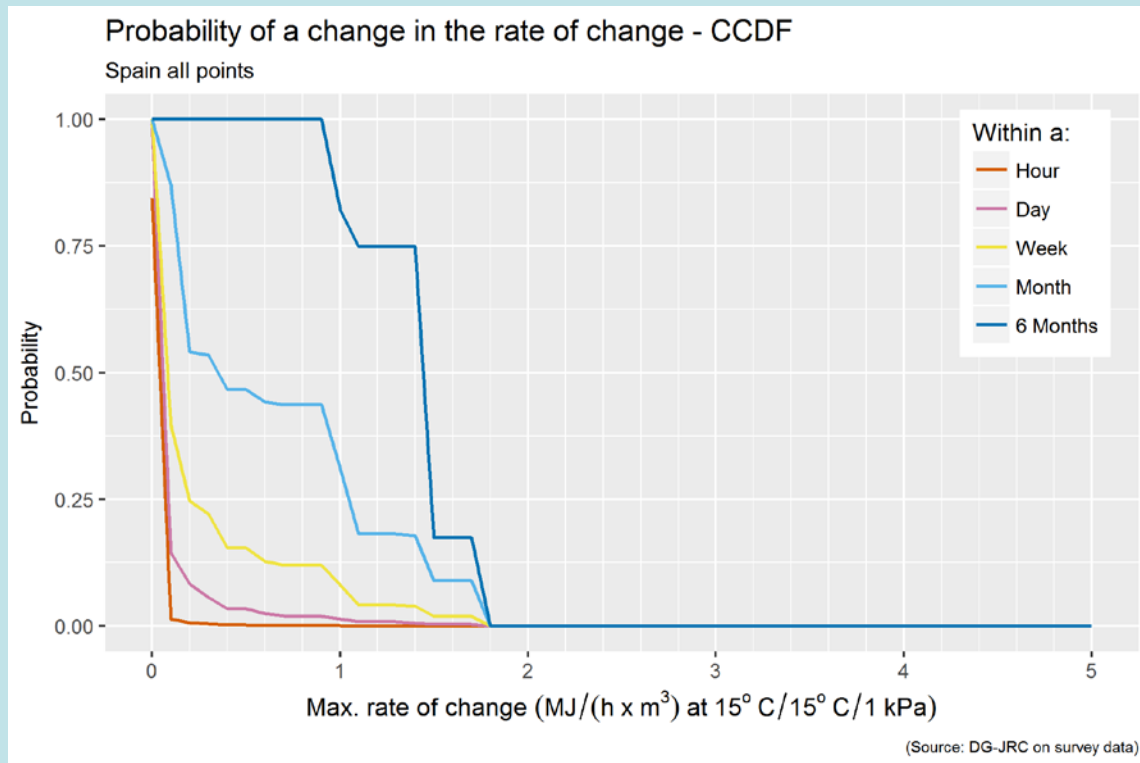
## Data analysis – aggregated hourly data

- For aggregated data per MS, determine **maximum rate of change** and 2.5% percentile of rate of change per MS.
- Calculate frequency distribution of **WI rate of change** per time period. Count occurrence of rate of change, group by threshold exceeded (0.5, 1.0, 1.5,... MJ/m<sup>3</sup>).

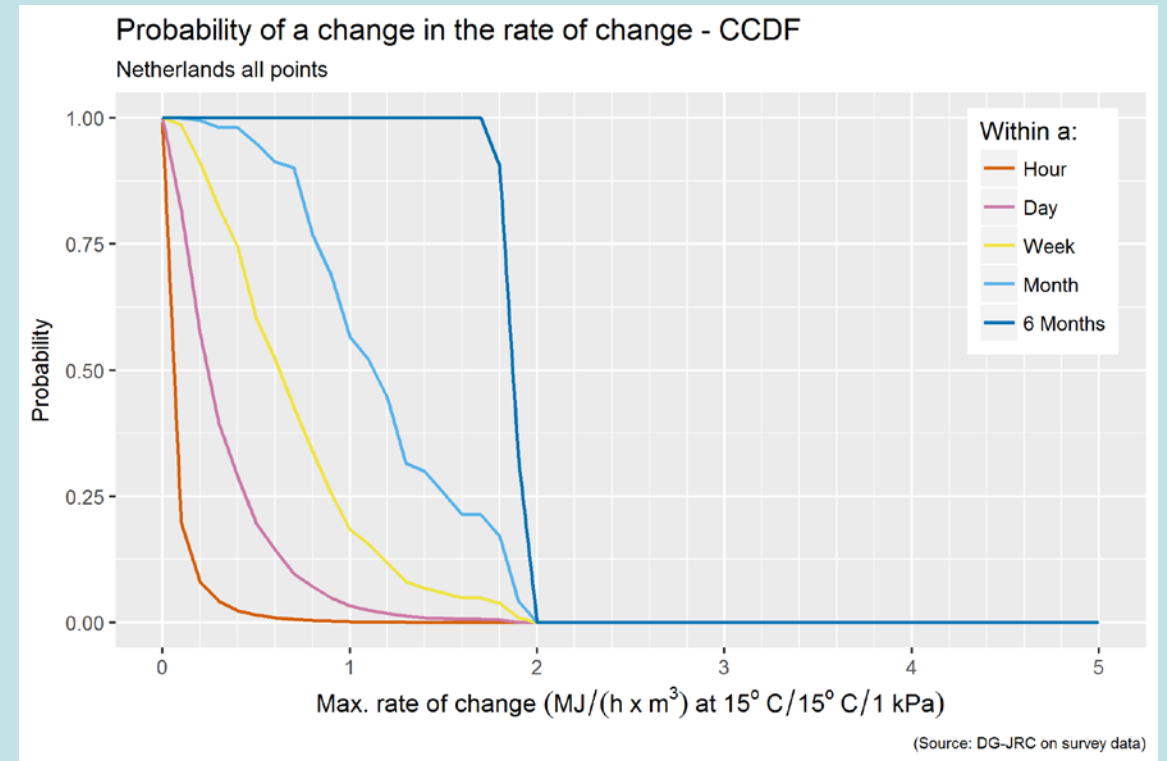
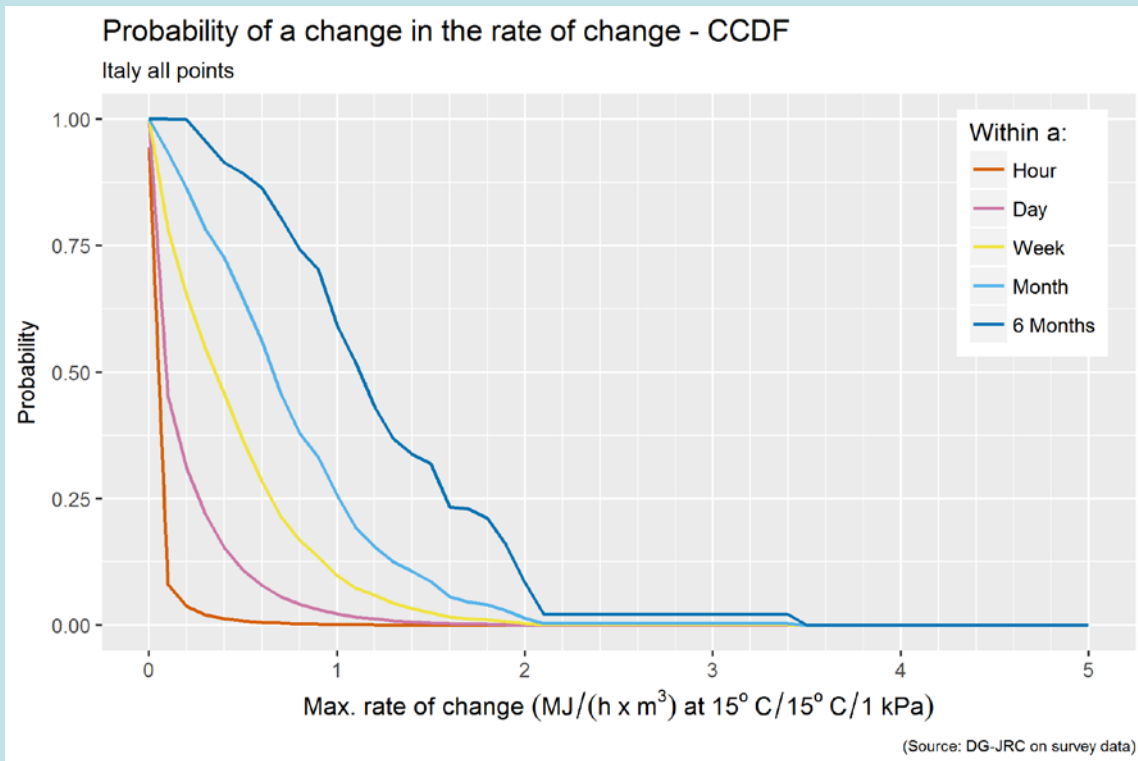
# CCDF: Wobbe index maximum rate of change



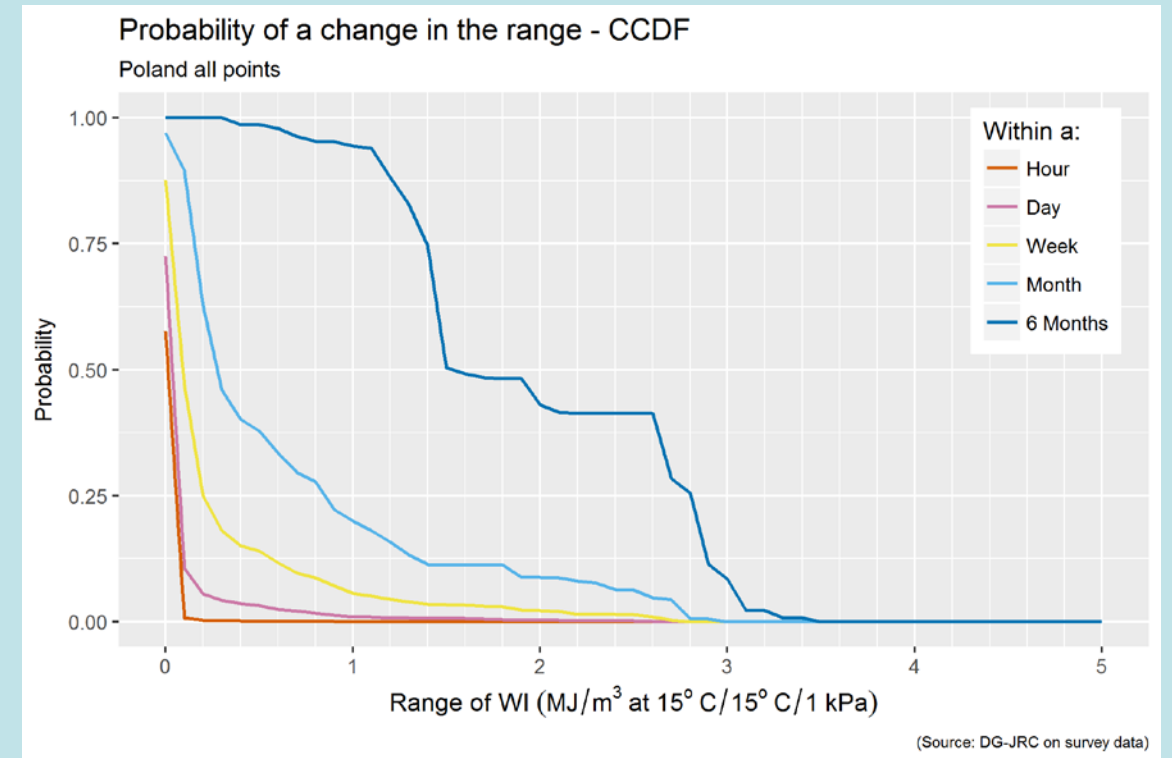
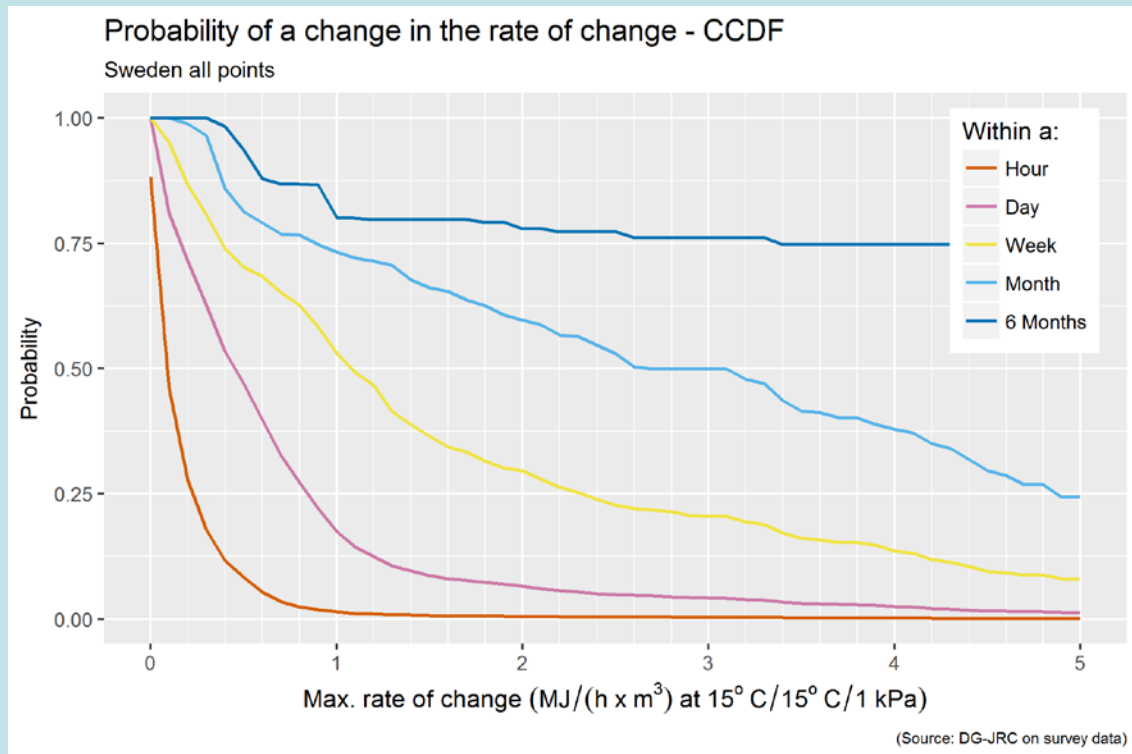
# CCDF: Wobbe index maximum rate of change



# CCDF: Wobbe index maximum rate of change

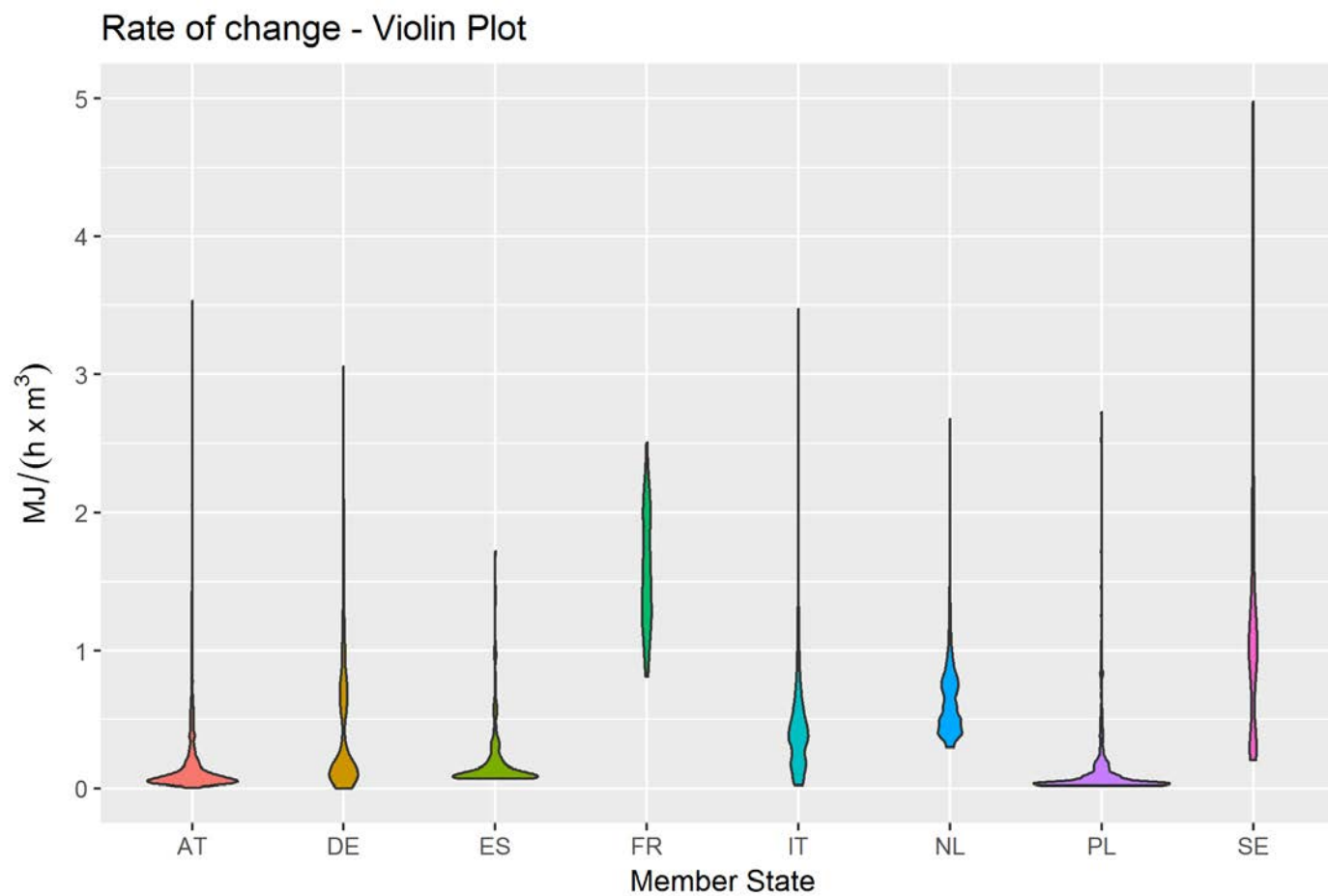


# CCDF: Wobbe index maximum rate of change



N.B. In the plot for Sweden the x-axis is cut-off at 5 for consistency with all other charts.

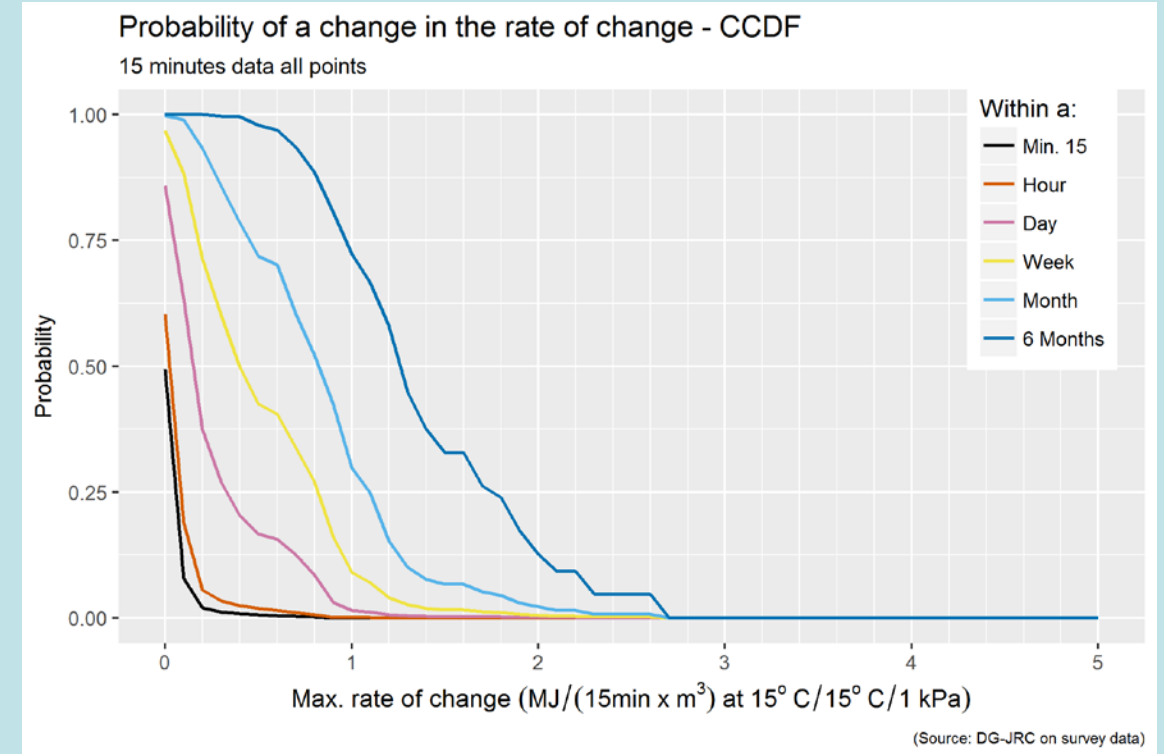
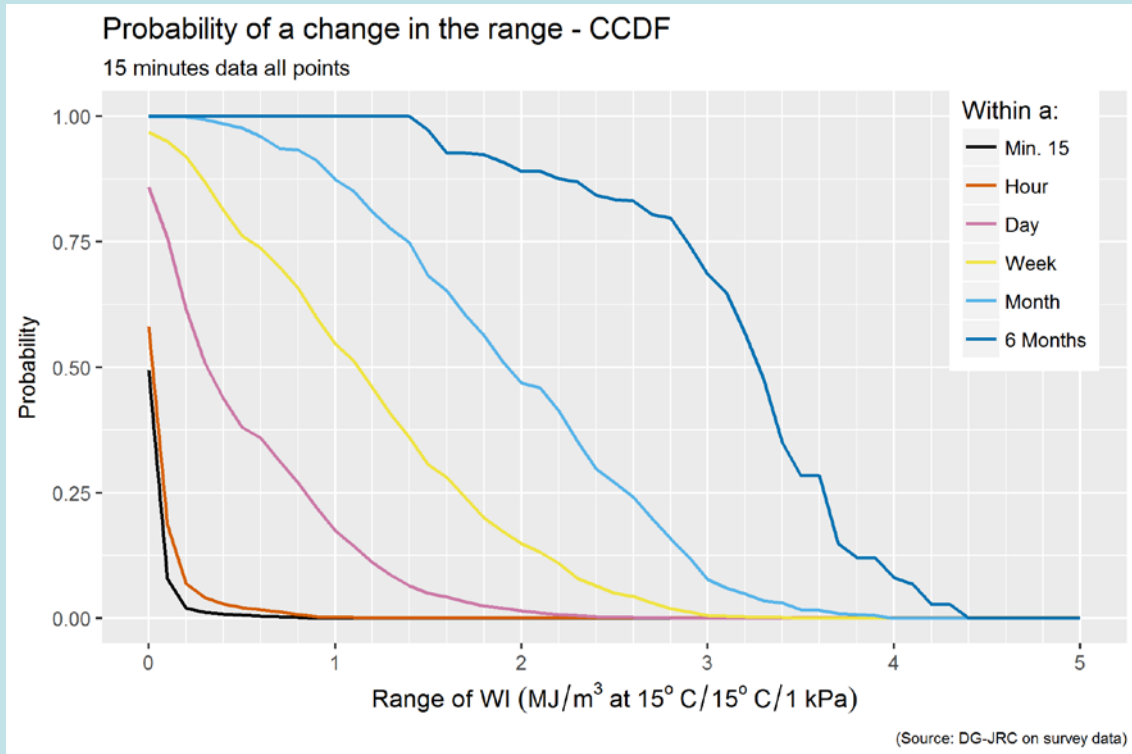
# Wobbe Index - Violin Plot rate of change



Plot of the 97.5% percentile (i.e., top 2.5% extreme values) by MS for the rate of change calculated on the hourly time series.

N.B. In the plot for Sweden the x-axis is cut-off at 5 for consistency with all other charts.

# Wobbe Index Range and Rate CCDF: 15min data



# Conclusions – preliminary results

- Individual data sets typically do not contain the full range of WI values for a member state.
- Full WI range in some cases goes outside national specifications: data needs to be verified.
- 95% range of WI values always within national specifications.
- Some MSs seem to have a low exposure to big/moderate fluctuation of the rate of change.

# Conclusions – data analysis

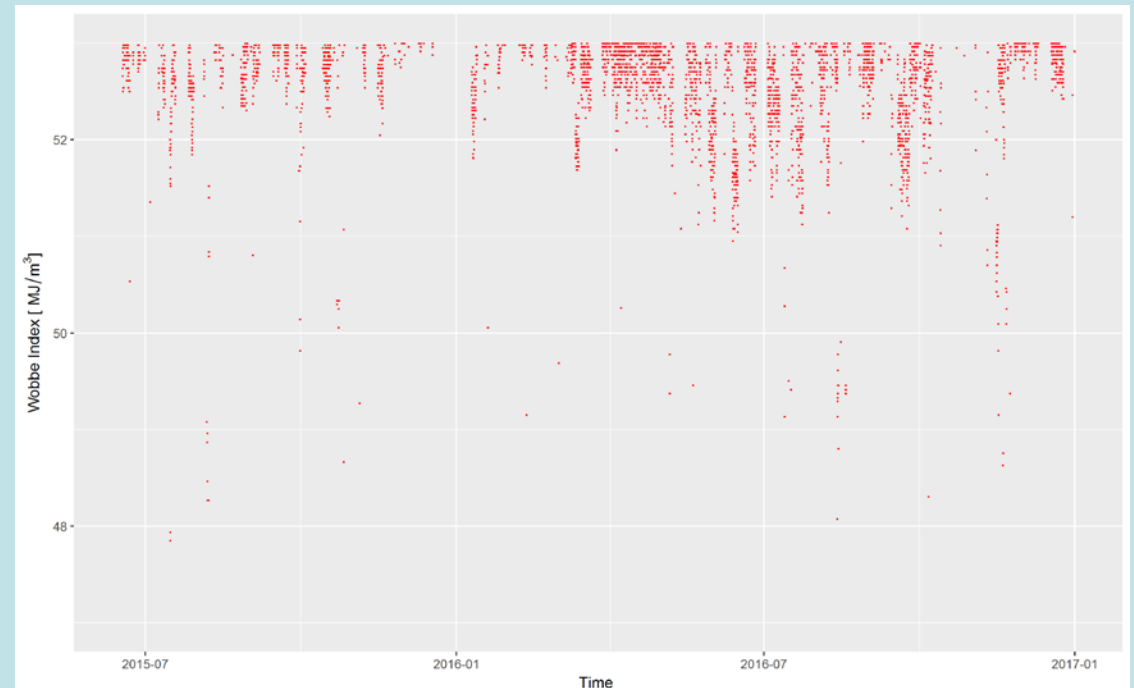
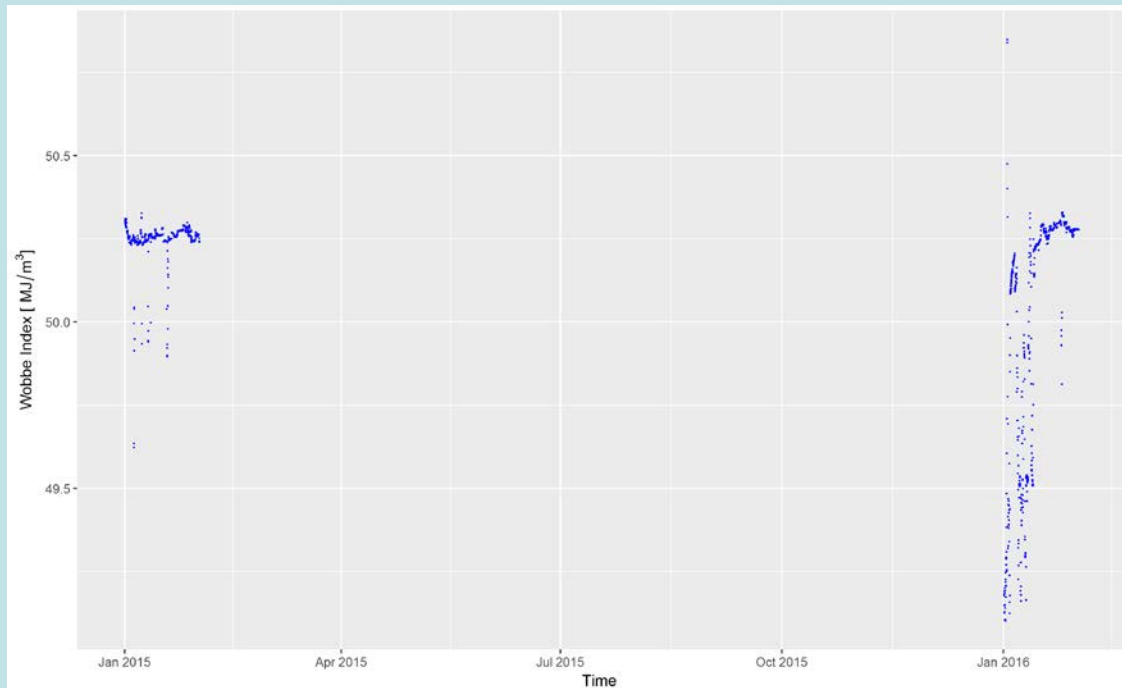
- The data analysis will be adapted according to the needs of TF1 (scenarios, assessment).
- Data processing not yet finalized, clarification and verification with data providers necessary.
- Additional filter to improve data quality to be discussed.

# Conclusions – preliminary results

- Overview aggregated data at MS level
- Datasets with other time granularities included

MS	WI min (MJ/m <sup>3</sup> )	WI max (MJ/m <sup>3</sup> )	WI range (MJ/m <sup>3</sup> )	Max RoC (MJ/(h x m <sup>3</sup> ))
AT	47.42	54.47	7.04	3.34
DE	46.31	55.16	8.85	3.11
ES	48.28	53.51	5.23	1.72
IT	47.95	52.29	4.34	3.48
NL	46.90	54.20	7.30	2.68
PL	47.70	52.24	4.54	2.73
SE	42.82	58.62	15.80	8.44

# Data quality issues

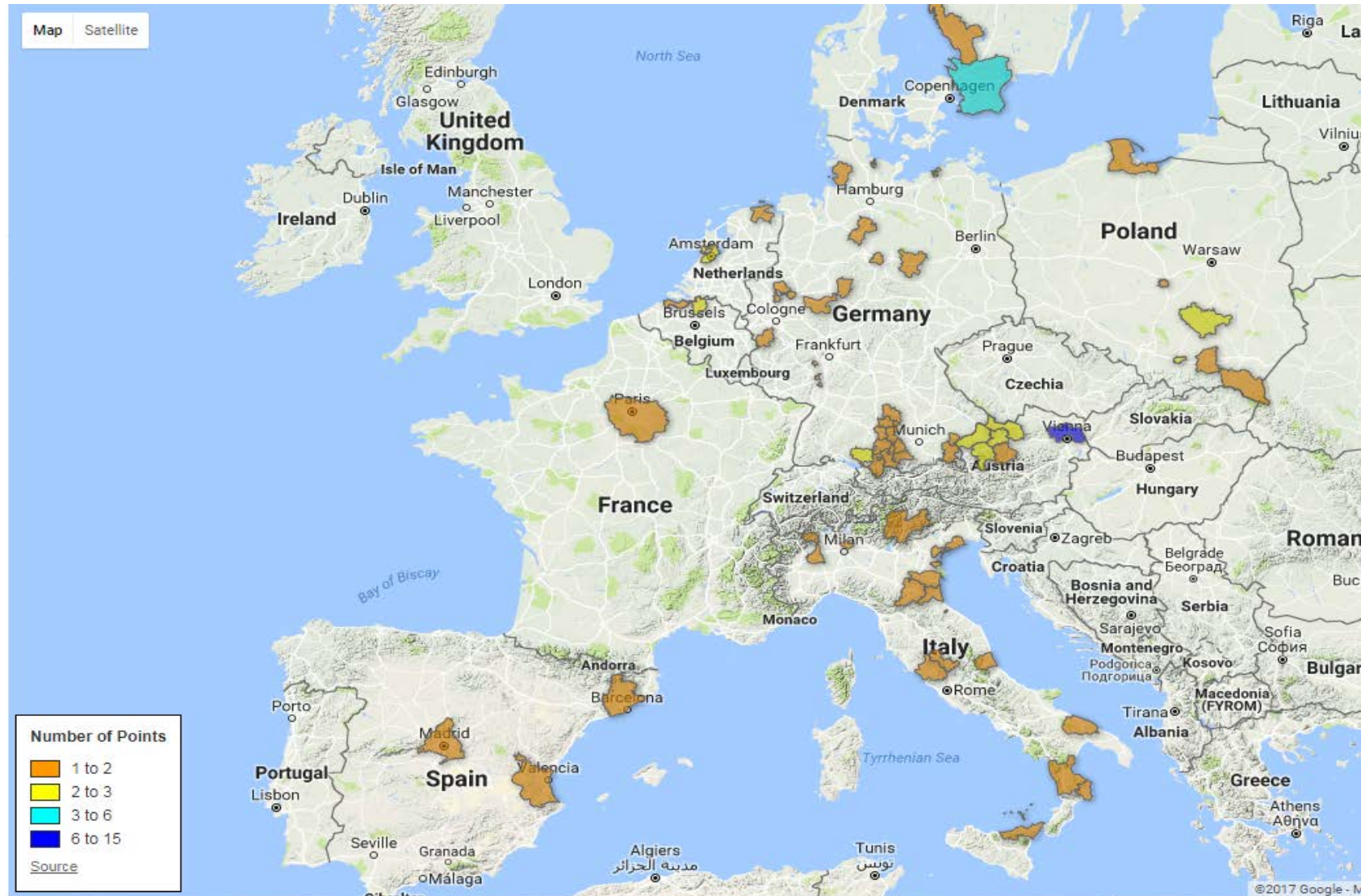


Variation in the resolution of data sets, noise, missing data, reference conditions, ...

# Conclusions: Data Collection

- Data coverage currently insufficient for detailed analysis at end-user level.
- We encourage a wider participation of stakeholders in sharing data.

# Data contributions to Survey 2a





# Any questions?

You can find us at:

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