

# Market Response 2019

Task Force ISR presentation

Brussels, July 2019



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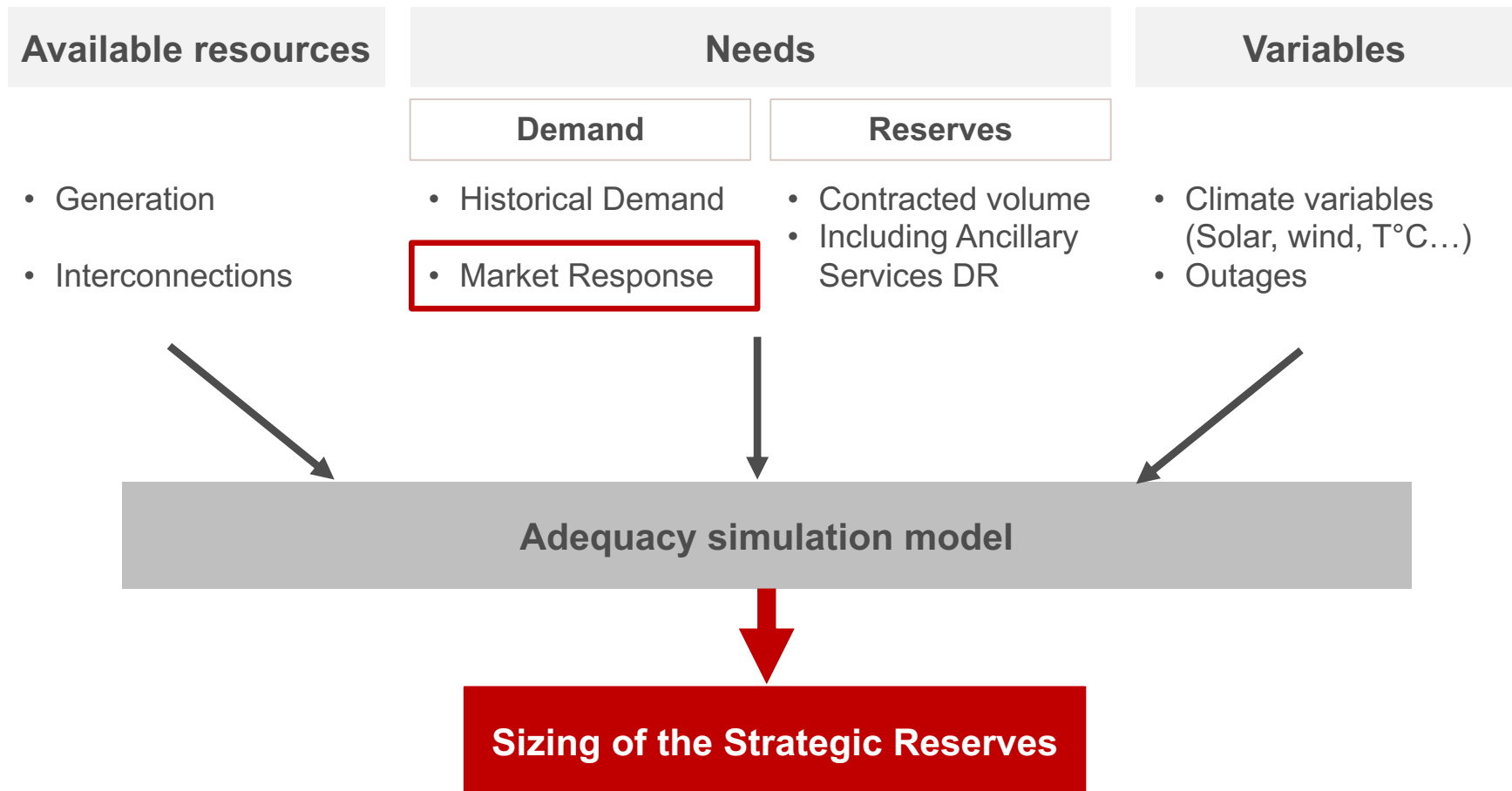
**1** | Goal, scope and planning of the MR update – *Reminder*

**2** | Results of the aggregated curves analysis – 2019 update

**3** | Conclusion

# Market Response volume determination is essential to size the volumes of Strategic Reserves

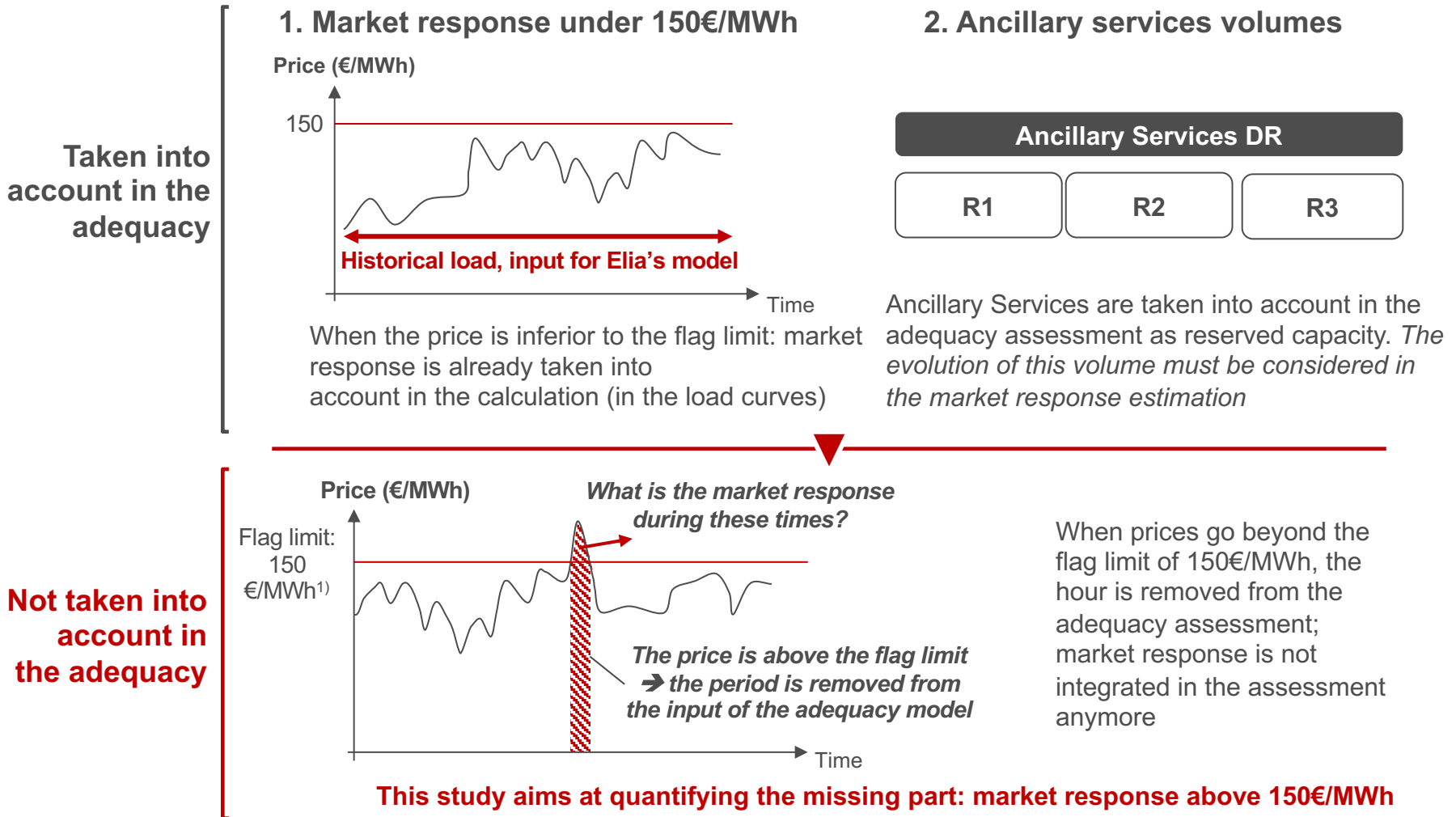
Market Response corresponds to the response of electricity consumers in periods of tension and high prices in the electricity grid



## 2017 project scope: Market Response encompasses all DR/DSR not subject to a contract with the TSO

DR type	Description	Associated product
<div style="border: 1px solid black; padding: 5px; width: fit-content;">Contract based</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-left: 20px;">With TSO</div>	<p><i>This type of DSR is directly activated by the TSO in periods of scarcity</i></p>	<p><i>Elia products</i></p> <p><b>Perimeter of the Market Response</b></p>
<div style="border: 1px solid black; padding: 5px; width: fit-content;">Contract based</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-left: 20px;">With BRP</div>	<p><i>This category is <b>contracted</b> between the customer and the BRP who reacts to prices</i></p>	<p><i>Demand response contracts from BRPs</i></p>
<div style="border: 1px solid black; padding: 10px; width: fit-content; background-color: #d9ead3;">Price based market response</div>	<p><b>Price based MR valued through market mechanisms:</b> <i>this type of MR is directly sold in the energy markets by the customer</i></p> <p><b>Price based MR valued within a portfolio:</b> <i>this type of MR is not directly sold but it is indexed on the market price</i></p>	<p><i>BidLadder, DA/ID DR</i></p> <p><i>Time of Use tariffs</i></p>
<div style="border: 1px solid black; padding: 10px; width: fit-content; background-color: #f4cccc;">Voluntary market response</div>	<p><i>Voluntary MR responds to signals without any incentive. Signals can be sent by the TSO or the BRP</i></p>	<p><i>SMS, notification...</i></p>

# 2017 project scope: under a certain threshold, market response is already taken into account in the load forecast by Elia – the methodology aims at assessing Market Response *above 150€/MWh, above normal conditions*



1) The price of 150€/MWh is used by Elia and the Creg in the design of SDR as a reference for high prices

## After a benchmark and a group reflection during the 4 workshops with stakeholders, a list of 8 possible methodologies was established

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<b>A</b>	<b>Load curve of Elia</b>	<b>Case by case analysis</b> of the volume variations of the <b>total load of Elia</b> . Market response would be seen as a load reduction in periods of high prices, all other parameters being constants
<b>B</b>	<b>Aggregated curves analysis</b>	Analysis of the EPEX DAM Belgium <b>aggregated demand and supply curves</b> , market response volumes are reflected in both the offer and demand aggregated curves
<b>C</b>	<b>Objective Q&amp;A</b>	<b>Questionnaire</b> sent to key players (customers, BRP, FSP) to assess their level of market response or other related characteristics
<b>D</b>	<b>Economic utility</b>	Assessment of the economic utility of industrial segments to <b>estimate their Market Response potential according to the price levels</b>
<b>E</b>	<b>Similar days comparison</b>	<b>Load comparison</b> of similar days: one without market response, another one with market response
<b>F</b>	<b>Price contracts</b>	Assessment of the total <b>contracted volume indexed on prices</b> (DA or balancing) and discount by a percentage depending on various factors (economical context, prices...)
<b>G</b>	<b>Extrapolation ratio</b>	<b>Extrapolation of the volume already established in other regions</b> , for example the voluntary MR volumes estimated in France.
<b>H</b>	<b>Activation threshold</b>	<b>Estimation of a price threshold</b> , above which it is considered that some players will completely reduce their load

# In 2017, all methodologies were then confronted to criteria established with the stakeholders, and key conclusions were drawn for each methodology

<p><b>Criteria assessment</b></p>	<p>The methodologies were confronted to criteria established during a brainstorm session during WS2:</p> <ol style="list-style-type: none"> <li><b>Perimeter of the study</b> : Each methodology was confronted to each segment of the project scope to ensure the assessment of the adapted perimeter</li> <li><b>Criteria confrontation</b>: Each methodology was confronted to the other criteria established: coherence with the adequacy, robustness over the years, simplicity, cautiousness, feasibility</li> </ol>			
<p><b>Key conclusions</b></p>	<p><b>A</b></p> <p><b>Load curve of Elia</b></p> <ul style="list-style-type: none"> <li>Limited by the lack of high prices situations, leading to a case by case analysis, which is far less robust</li> </ul>	<p><b>B</b></p> <p><b>Aggregated curves</b></p> <ul style="list-style-type: none"> <li>Overcomes the lack of pertinent days limit</li> <li>Provides a cautious and more robust approach of the volumes of all categories</li> </ul>	<p><b>C</b></p> <p><b>Objective Q&amp;A</b></p> <ul style="list-style-type: none"> <li>Enables to take into account activation details</li> <li>The known limits of the questionnaire can be overcome with an (joint) improvement of the questions</li> </ul>	<p><b>D</b></p> <p><b>Economic utility</b></p> <p>Limited by:</p> <ul style="list-style-type: none"> <li>The requirements of sensible information on industrial processes</li> <li>A strong variability depending on retained hypotheses</li> <li>Strong cost of implementation</li> </ul>
	<p><b>E</b></p> <p><b>Similar days comparison</b></p> <ul style="list-style-type: none"> <li>Not adapted to Belgium since there is no comparison signal set up for now</li> </ul>	<p><b>F</b></p> <p><b>Price contracts</b></p> <ul style="list-style-type: none"> <li>Limited by the lack of accessible data: the assessment of the price based contracts volume are not accessible except through a specific Q&amp;A</li> </ul>	<p><b>G</b></p> <p><b>Extrapolation ratio</b></p> <ul style="list-style-type: none"> <li>Cannot be used directly to estimate the volumes since it is specific to a region</li> <li>But, it can provide a sanity check of the overall volume</li> </ul>	<p><b>H</b></p> <p><b>Activation threshold</b></p> <ul style="list-style-type: none"> <li>Cannot be used as such since it is a rough approximation and the threshold is complex to justify</li> </ul>

**After the criteria confrontation, a first proposal was discussed with the stakeholders to come to a final methodology, validated by the stakeholders during the fourth workshop**

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### **Methodology selection**

#### **1. Perimeter of the study**

Each methodology was confronted to each segment of the project scope to ensure the assessment of the adapted perimeter

#### **2. Criteria confrontation**

Each methodology was confronted to the other criteria established during the second workshop:

- Coherence with the adequacy
- Robustness over the years
- Simplicity
- Cautiousness
- Feasibility

### **Methodology proposal and discussion**

**Based on the analysis, a first methodology proposal was presented during the a workshop with stakeholders.**

**The proposal was discussed during the following workshop.**

### **Final methodology proposal**

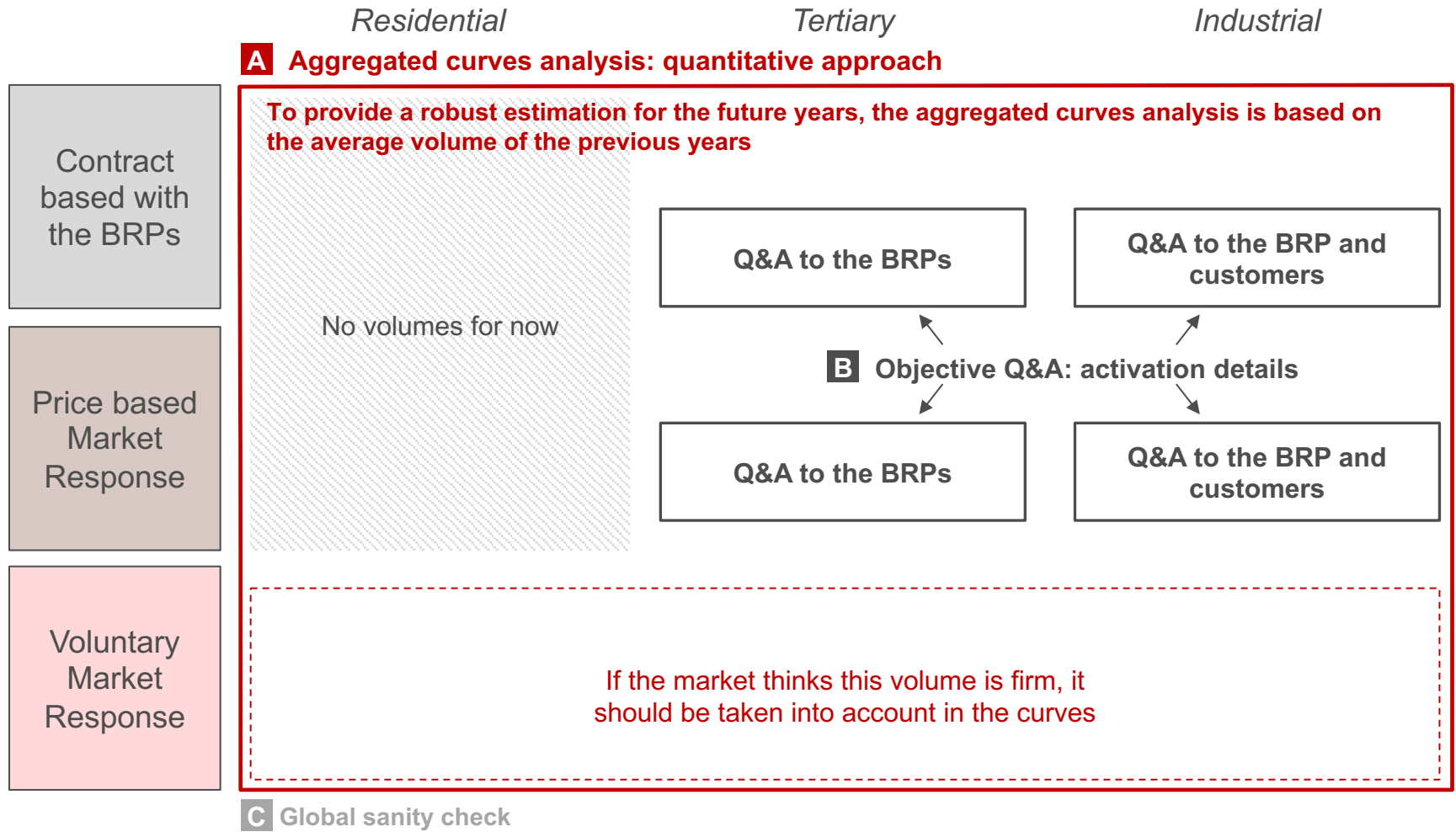
**The methodology proposal was adapted integrating the remarks of the stakeholders raised during the workshops.**

The methodology is divided into three different steps:

- A. Aggregated curves analysis**
- B. Objective qualitative Q&A**
- C. Global sanity check**



# In 2017, a robust methodology was established based on the aggregated curves, and complemented with a qualitative Q&A to define the details of the activation



# In the aggregated curves of EPEX DAM Belgium, Market Response volumes appear as a demand decrease or as an offer increase

## Market Response volumes valued in the DA market

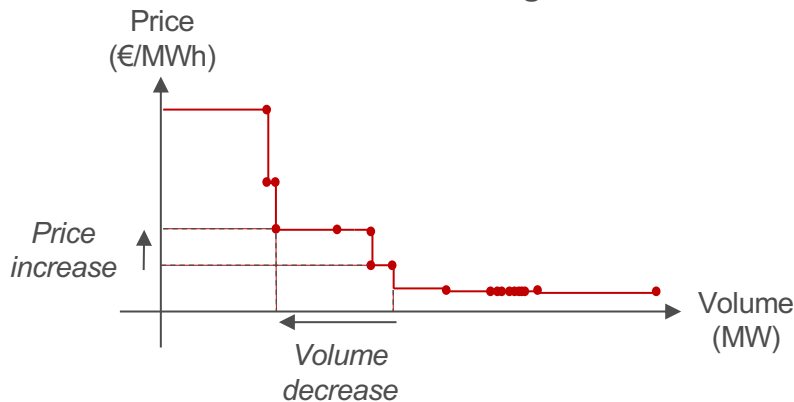
### Demand decrease

- This part can be analyzed directly in the aggregated demand curve, by studying the decrease of volume when price increases

### Offer increase

- Instead of a demand decrease, suppliers can value Market Response as new offer in the market: this part would appear in the supply curve
- Due to the possible presence of generation bids in the offer curve, two price thresholds have been set up:
  - Volumes above 150€/MWh, which correspond to the base case of Market Response volumes
  - Volumes above 500€/MWh, which enable to exclude all possible generation bids

**Demand curve for a given hour**



**Disclaimer:**

The details on the activation cannot be estimated with the aggregated curve methodology, it is not possible to extract it from the curves. This has been validated with EPEX

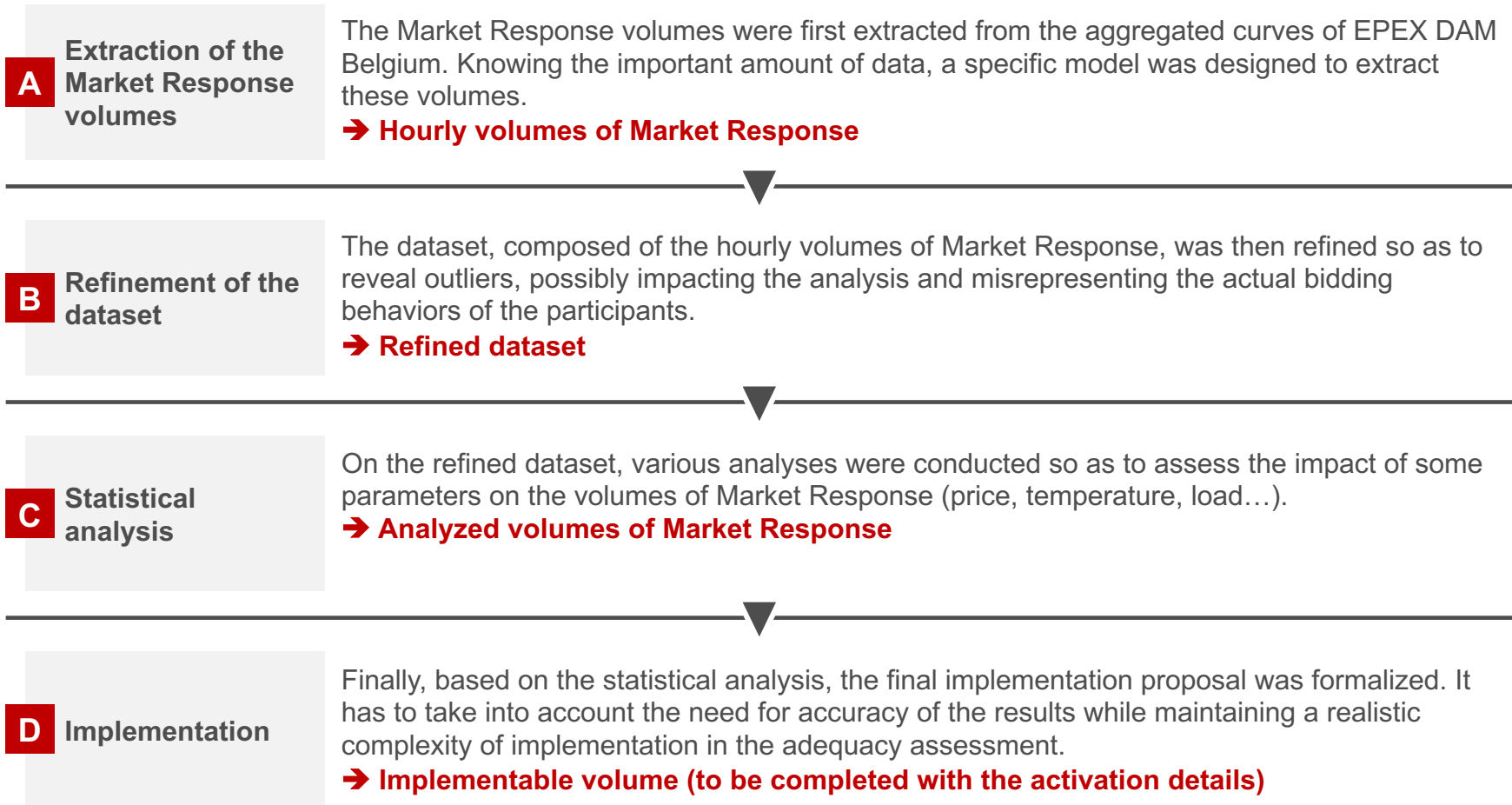
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- 1 | Goal, scope and planning of the MR update – *Reminder*
- 2 | Results of the aggregated curves analysis – 2019 update
- 3 | Conclusion

# The update of the Market Response Study is based on the exact same methodology as the one performed in 2017 and 2018

The process followed four key steps to come to a pertinent volume of Market Response:



# Agenda

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## 2 | Results of the aggregated curves analysis – 2019 update

**A** | Extraction of the Market Response volumes

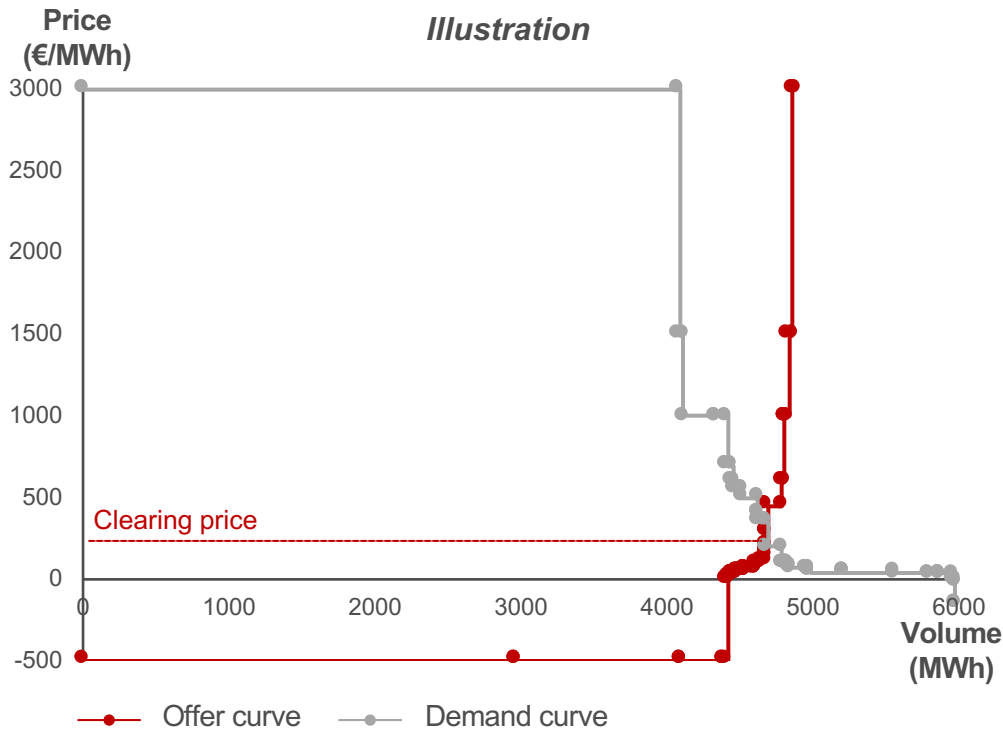
**B** | Refinement of the dataset

**C** | Statistical analysis

**D** | Implementation

# EPEX DAM Belgium provides hourly aggregated curves of the purchase and sale orders

## EPEX DAM Belgium aggregated curve

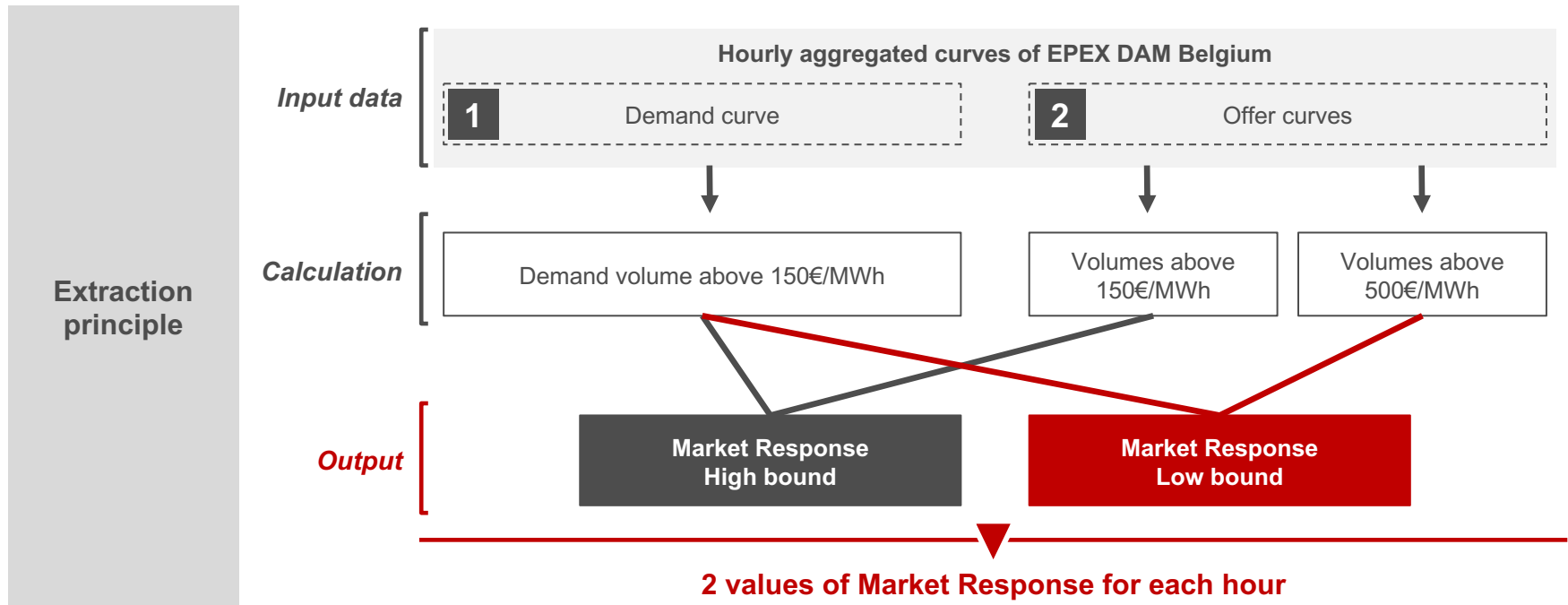
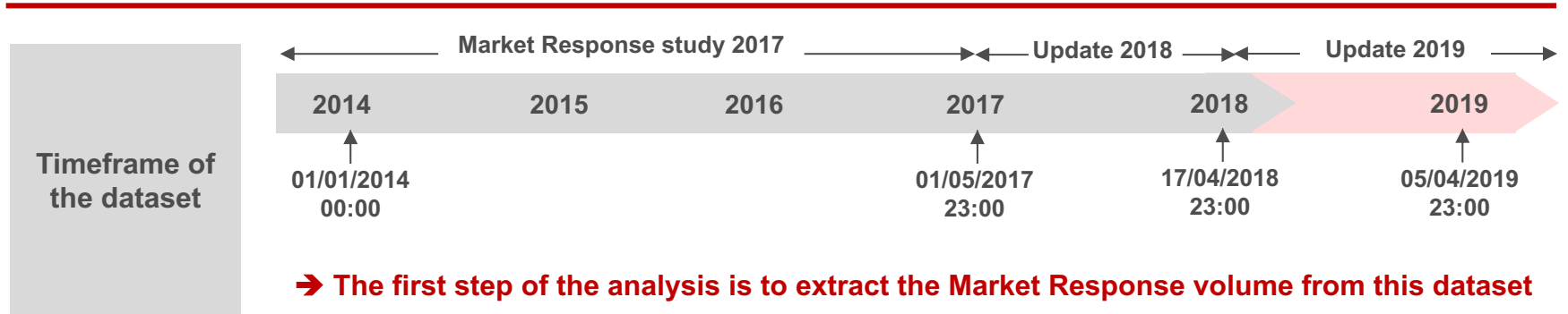


- **The curves determine the clearing price:** at the intersection of the demand and supply curve.
- From the curves, we can deduce the load variation corresponding to a given price increase
- This load variation **corresponds to the perimeter of Market Response** with contract based and price based MR but also voluntary DR. Indeed, if there are some volumes in the voluntary DR category, BRPs will anticipate voluntary DR events: it will impact their bidding behaviors and hence be reflected in the aggregated curves

**Disclaimer:**

The details on the activation cannot be estimated with the aggregated curve methodology, it is not possible to extract it from the curves

The Market Response volumes were extracted from the aggregated curves. The 2019 update added 8472 hours to the dataset



# Agenda

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## 2 | Results of the aggregated curves analysis – 2019 update

A | Extraction of the Market Response volumes

**B | Refinement of the dataset**

C | Statistical analysis

D | Implementation

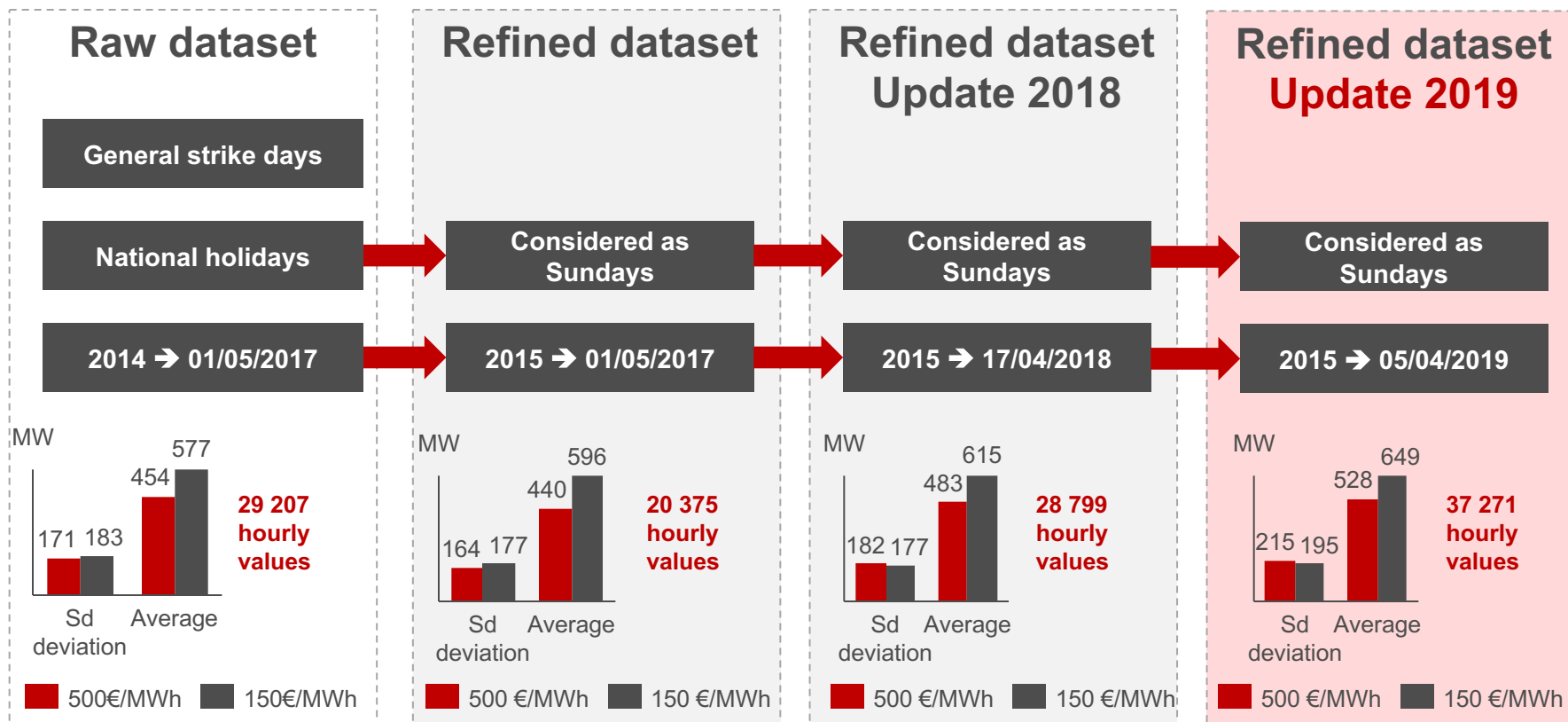


The aggregated dataset refinement follows the same approach as in the previous years

**Market Response study 2017**

**Update 2018**

**Update 2019**



The refined dataset was used in the following analysis

# Agenda

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## 2 | Results of the aggregated curves analysis – 2019 update

**A** | Extraction of the Market Response volumes

**B** | Refinement of the dataset

**C** | **Statistical analysis**

**D** | Implementation

## Numerous analyses were conducted to explain the volume patterns, yet without any strong correlations

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Various analyses were conducted :

- Simple correlations and multivariate regressions:
  - Day-ahead prices
  - Temperatures
  - Normal temperatures
  - Daily maximum price
  - Load
  - Gas prices
  
- Analysis of the tail of the distribution

**No satisfying results were found from these analyses, so the impact of the three main parameters (load, price and temperature) was assessed differently: by restricting the dataset to periods of important load, price, temperature etc.**

This documentation will be put on the Task Force ISR website

## Various correlations were computed (temperature, price, normal temperature) without any satisfying results: $R^2$ remains very low (1/2)

	Principle	Results – 2017 study	Results – 2018 study	Results – 2019 study
<b>Price</b>	A regression was conducted between the DA prices and the volumes of Market Response	<ul style="list-style-type: none"> <li>• 150€/MWh: <math>R^2 = 0.03</math></li> <li>• 500€/MWh : <math>R^2 = 0.03</math></li> <li>• P-value &lt; 0.05</li> </ul>	<ul style="list-style-type: none"> <li>• 150€/MWh: <math>R^2 = 0.06</math></li> <li>• 500€/MWh : <math>R^2 = 0.06</math></li> <li>• P-value &lt; 0.05</li> </ul>	<ul style="list-style-type: none"> <li>• 150€/MWh: <math>R^2 = 0.08</math></li> <li>• 500€/MWh : <math>R^2 = 0.09</math></li> <li>• P-value &lt; 0.05</li> </ul>
<b>Temperature</b>	The regression is here conducted between the hourly temperature (Uccle & Zaventem reference) and the volumes of Market Response	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.0003</math></li> <li>• 500€/MWh : <math>R^2 = 0.002</math></li> <li>• P-value &lt; 0.05</li> </ul>	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.0005</math></li> <li>• 500€/MWh : <math>R^2 = 0.004</math></li> <li>• P-value &lt; 0.05</li> </ul>	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.002</math></li> <li>• 500€/MWh : <math>R^2 = 0.01</math></li> <li>• P-value &lt; 0.05</li> </ul>
<b>Daily maximum</b>	The regression was computed between the maximum price of the day and the volumes of Market Response	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.004</math></li> <li>• 500€/MWh : <math>R^2 = 0.001</math></li> <li>• P-value &lt; 0.05</li> </ul>	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.02</math></li> <li>• 500€/MWh : <math>R^2 = 0.01</math></li> <li>• P-value &lt; 0.05</li> </ul>	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.02</math></li> <li>• 500€/MWh : <math>R^2 = 0.02</math></li> <li>• P-value &lt; 0.05</li> </ul>

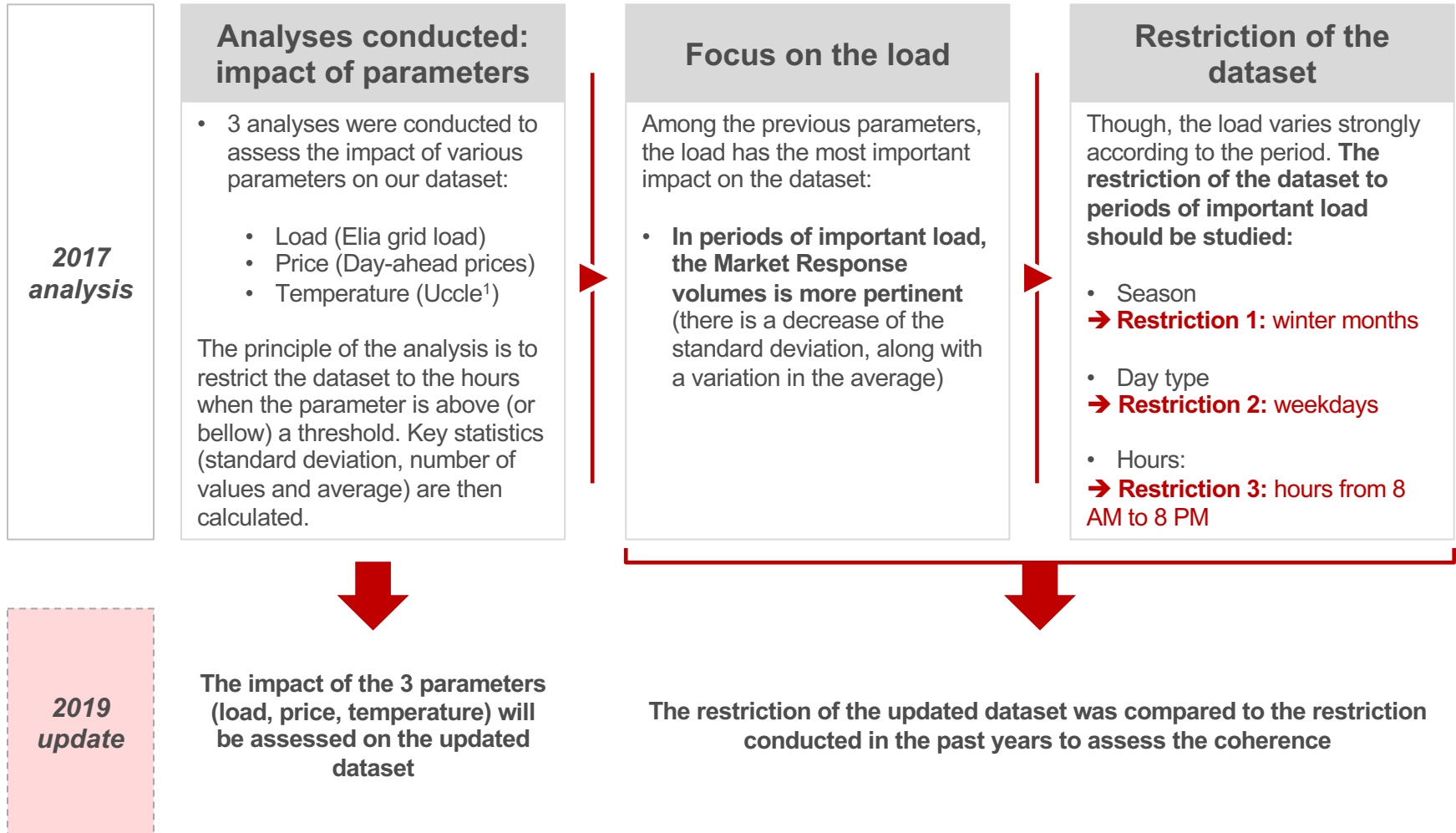
When computing regressions,  $R^2$ , the coefficient of determination, enables to assess the quality of the prediction of a linear regression. When variables are correlated, the  $R^2$  is close to 1. If this coefficient is equal to 0, there is no correlation between both variables  
 The P-value represents the probability to obtain the observed results if the 0 hypothesis is true. A P-value less than 0.05 indicates that the null hypothesis can be rejected.

## Various correlations were computed (temperature, price, normal temperature) without any satisfying results: $R^2$ remains very low (2/2)

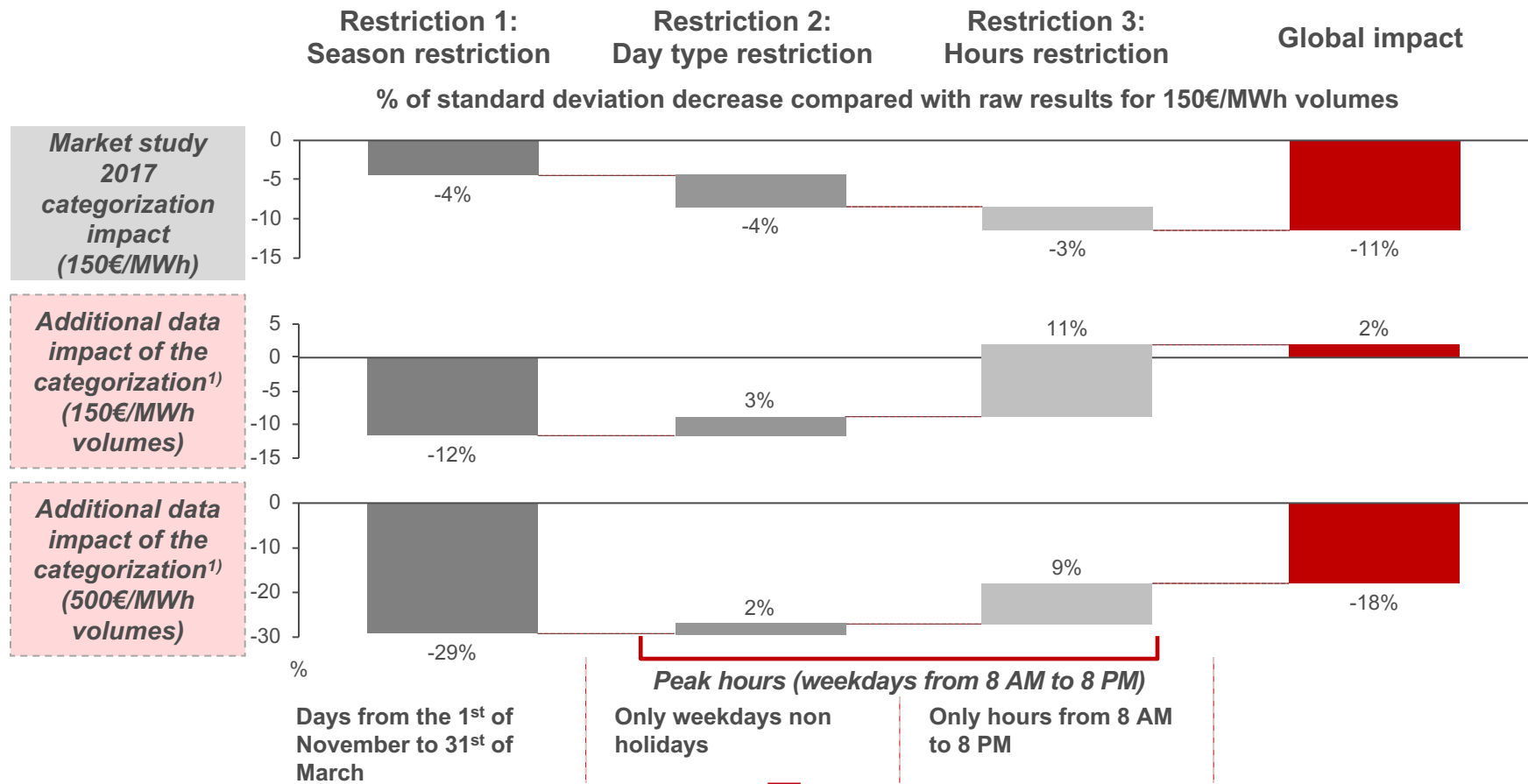
	Principle	Results – 2017 study	Results – 2018 study	Results – 2019 study
<b>Load</b>	The regression was computed between the daily volumes and the load of Elia	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.09</math></li> <li>• 500€/MWh : <math>R^2 = 0.06</math></li> <li>• P-value &lt; 0.05</li> </ul>	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.13</math></li> <li>• 500€/MWh : <math>R^2 = 0.10</math></li> <li>• P-value &lt; 0.05</li> </ul>	<ul style="list-style-type: none"> <li>• 150€/MWh : <math>R^2 = 0.06</math></li> <li>• 500€/MWh : <math>R^2 = 0.03</math></li> <li>• P-value &lt; 0.05</li> </ul>
<b>Gas price</b>	A regression was conducted between the daily gas prices and the volumes of Market response both for the offer side volumes and the overall volume	<p>Offer 150€/MWh: <math>R^2 = 0.06</math>                      Offer 500€/MWh : <math>R^2 = 0.004</math>                      P-values &lt; 0.05</p>	<p>Offer 150€/MWh: <math>R^2 = 0.05</math>                      Offer 500€/MWh : <math>R^2 = 0.1</math>                      P-values &lt; 0.05</p>	<p>Offer 150€/MWh: <math>R^2 = 0.006</math>                      Offer 500€/MWh : <math>R^2 = 0.1</math>                      P-values &lt; 0.05</p>
<b>Day-before adaptations</b>	A regression was conducted between the market response volumes and the prices the day before	<p>Total volume 150€/MWh : <math>R^2 = 0.001</math>                      Total volume 500€/MWh : <math>R^2 = 7,9 \cdot 10^{-6}</math>                      P-values &gt; 0.05</p>	<p>Total volume 150€/MWh : <math>R^2 = 0.01</math>                      Total volume 500€/MWh : <math>R^2 = 0.02</math>                      P-values &lt; 0.05</p>	<p>Total volume 150€/MWh : <math>R^2 = 0.04</math>                      Total volume 500€/MWh : <math>R^2 = 0.06</math>                      P-values &lt; 0.05</p>

When computing regressions,  $R^2$ , the coefficient of determination, enables to assess the quality of the prediction of a linear regression. When variables are correlated, the  $R^2$  is close to 1. If this coefficient is equal to 0, there is no correlation between both variables. The P-value represents the probability to obtain the observed results if the 0 hypothesis is true. A P-value less than 0.05 indicates that the null hypothesis can be rejected.

# The impact of various parameters was assessed on the new dataset to verify the coherence with the analyses conducted in the last years



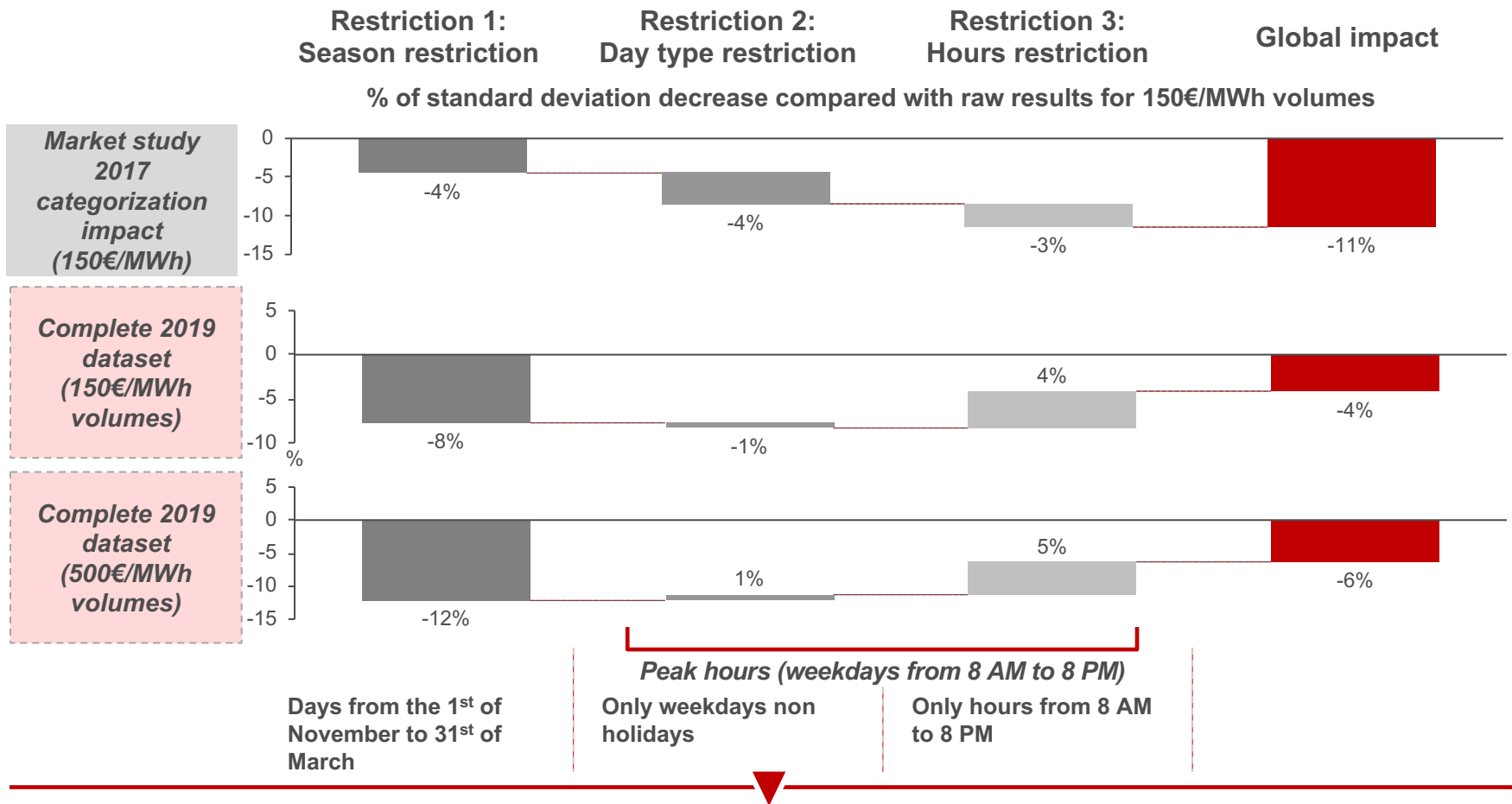
Contrary to the 2017 study, only the restrictions of the additional 2019 dataset to the winter period decrease the volatility, while further restrictions to weekdays and peak hours increase it



The focus on the most relevant hours in the context of the adequacy assessment (week days, peak hours of the winter period) is slightly less pertinent in the updated dataset compared to the previous years

1) The additional data goes from April 18<sup>th</sup>, 2018 to April 5<sup>th</sup>, 2019

Contrary to the 2017 study, only the restrictions of the complete dataset up to 2019 to the winter period decrease the volatility, while further restrictions to weekdays and peak hours increase it



The focus on the most relevant hours in the context of the adequacy assessment (week days, peak hours of the winter period) is slightly less pertinent in the updated dataset compared to the previous years

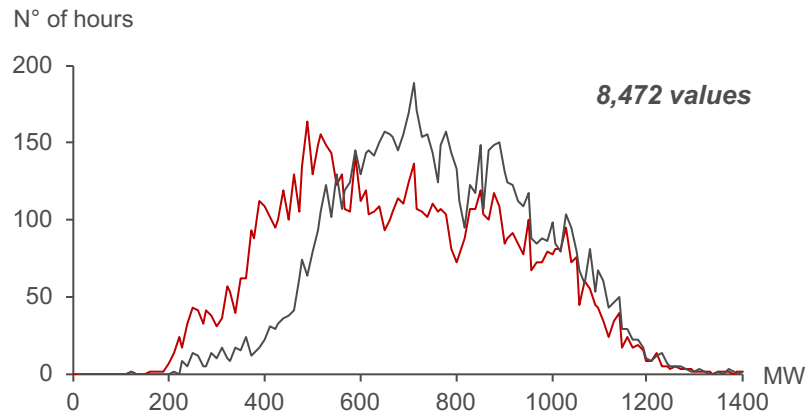
1) The additional data goes from April 18<sup>th</sup>, 2018 to April 5<sup>th</sup>, 2019



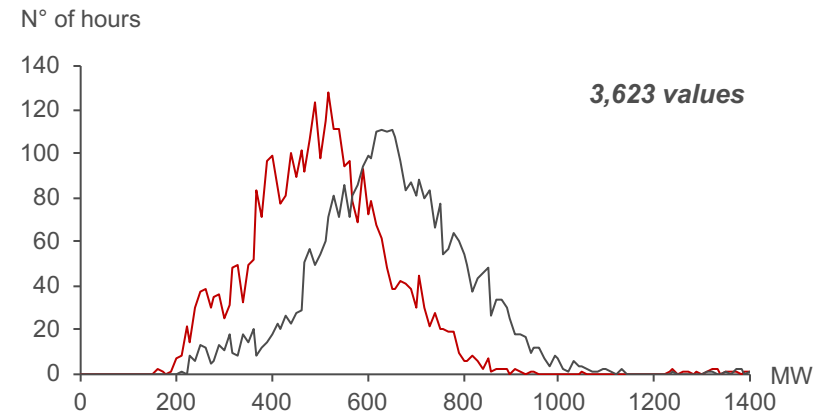
# In addition to amplifying the volatility of the dataset, the restrictions also decrease the average MR values

## EVOLUTION OF THE DISTRIBUTION WITH THE REFINEMENT

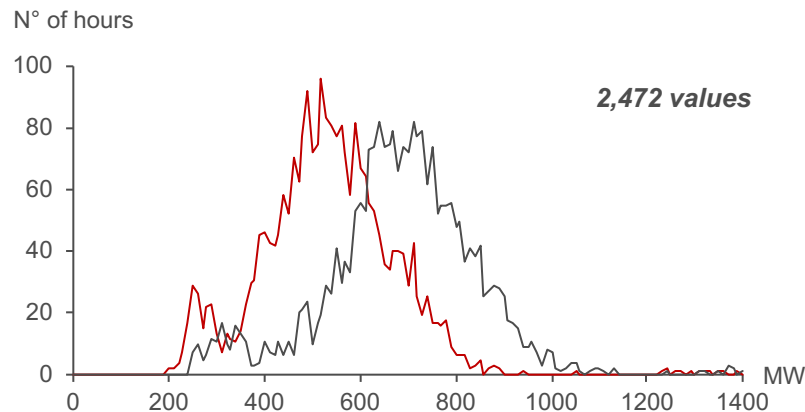
**Refined dataset distribution**



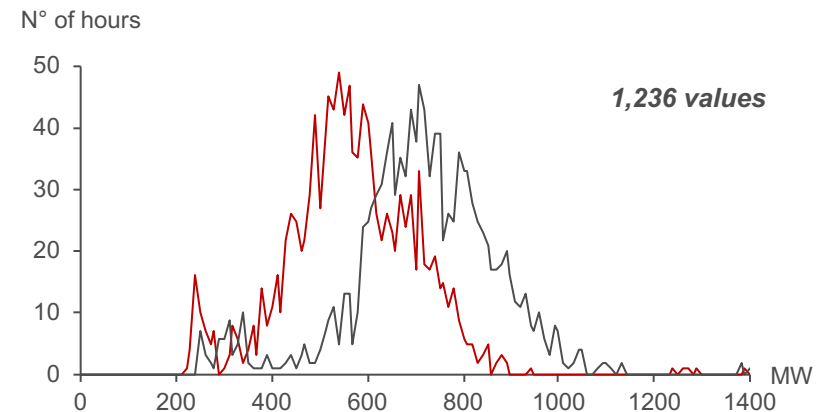
**Restriction 1 : season**



**Restriction 2 : day type**



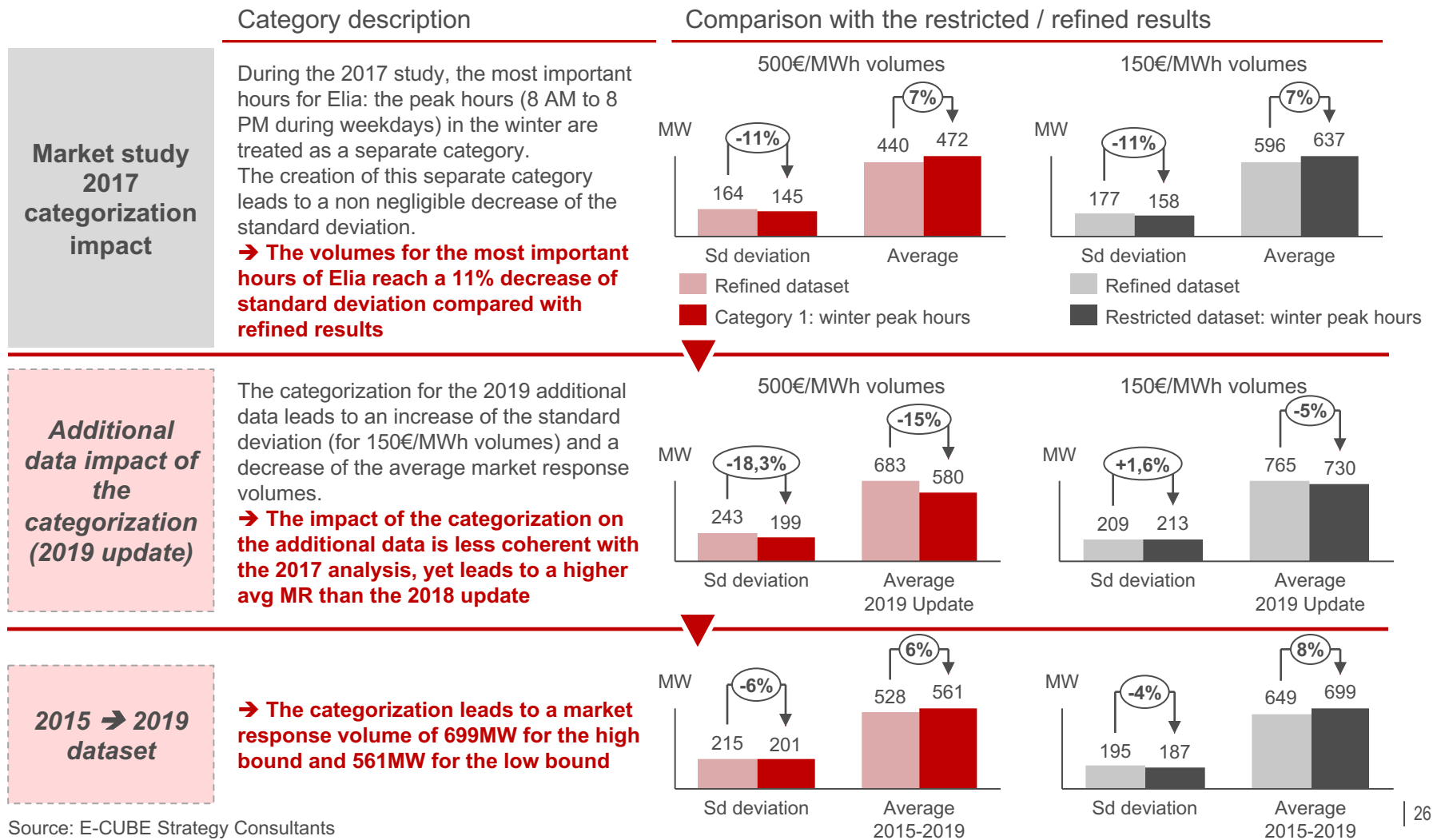
**Restriction 3 : hours**



— 500€/MWh — 150€/MWh

# Contrary to the previous years, the categorization of the additional data is less coherent with the 2017 dataset: it leads to a standard deviation increase, and to a slightly lower market response volume

## Summary of the two categories (refined and restricted dataset)



# Agenda

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## 2 | Results of the aggregated curves analysis – 2019 update

**A** | Extraction of the Market Response volumes

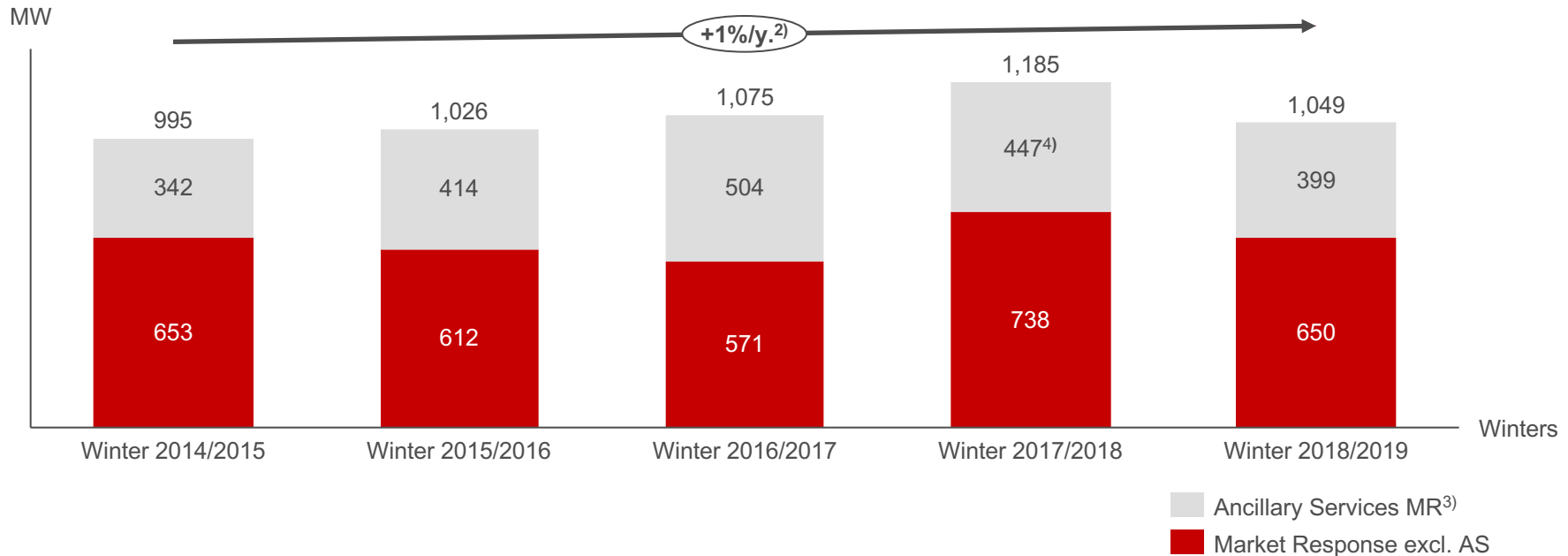
**B** | Refinement of the dataset

**C** | Statistical analysis

**D** | Implementation

Over the last winters, total Market Response has grown with +1% on average p.a. on the last 5 years

Evolution of the volumes of Market Response - Winter Months<sup>1)</sup>



**The extrapolation of the Market Response volume could be based on a global growth of +1%. As in the 2017 study, growth rates of +3%, or +5% could be added to the simulations, based on growth rates up to last year**

- 1) Winter months: from the 1st of November to the 31st of March, Volumes for lower bound (150€/MWh)
- 2) The rates are Compound Annual Growth Rate (CAGR) : the mean of the annual growth rate over the period
- 3) The volumes of DR in the Ancillary Services gather: up to 2016, the volumes ICH, R3DP and R1Up and for the year 2016, the volumes are ICH, R3Flex and R1Up. The volumes of Ancillary Services are contracted for yearly periods, the volumes were indeed weighted according to the number of month (November, December vs January, February and March)
- 4) This value differs from the value presented last year due to an update of the Ancillary Services volume for 2017/2018

### Several extrapolations can be defended

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#### 1% global volume growth

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- The +1% global market response volume is a more cautious approach based on the trends observed in the five previous years
- This +1% growth rate integrates the relatively lower MR and AS volumes for the 2018/2019 winter

#### 3% global volume growth

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- The +3% global market response volume corresponds to one of the extrapolation scenarios agreed upon with the stakeholders in 2017
- Yet, this doesn't correspond to a factual extrapolation from historical data

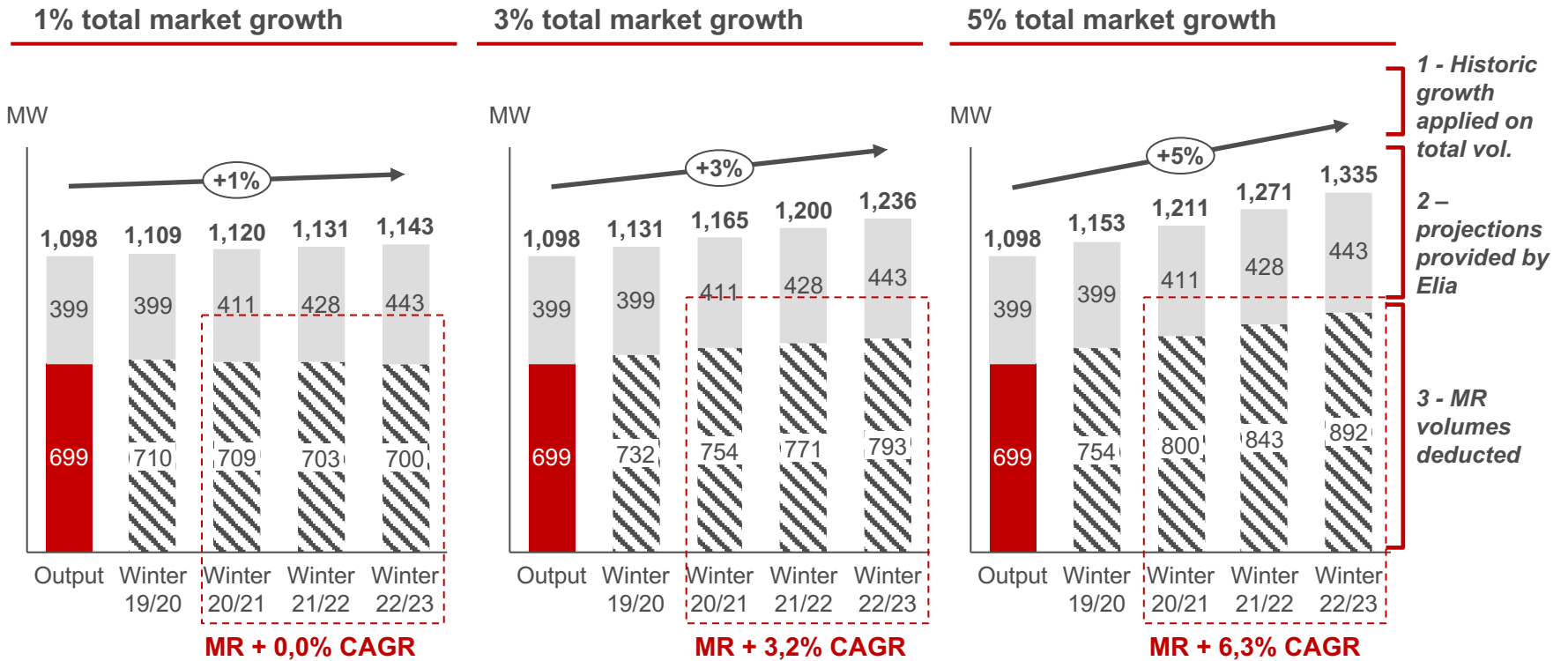
#### 5% global volume growth

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- The +5% extrapolation corresponds to the extrapolation factor agreed with the stakeholders in 2017
- This factor reflects the expected growth of Market Response volumes based on the qualitative approach of 2017
- Yet, this doesn't correspond to a factual extrapolation from historical data

# Based on the historical growth trends, the total market growth extrapolation growth varies from +1%/y. to +5%/y.

A historical extrapolation factor can be suggested : +1% based on 4 years (14/15 to 18/19).  
Two additional scenarios taking +3%, and +5% total growth per year, corresponding to the 2017 study extrapolation, can also be explored



-> **Volumes to be implemented in the adequacy assessment**

■ Ancillary services<sup>1)</sup> ■ Market Response excl. AS ▨ Extrapolated volumes

1) The yearly volumes were weighted according to the number of month (November, December vs January, February and March). Without definite volumes for 2019, the average between 2020 and 2018 was retained.

Source: E-CUBE Strategy Consultants, Elia

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**2** | Results of the aggregated curves analysis – 2019 update

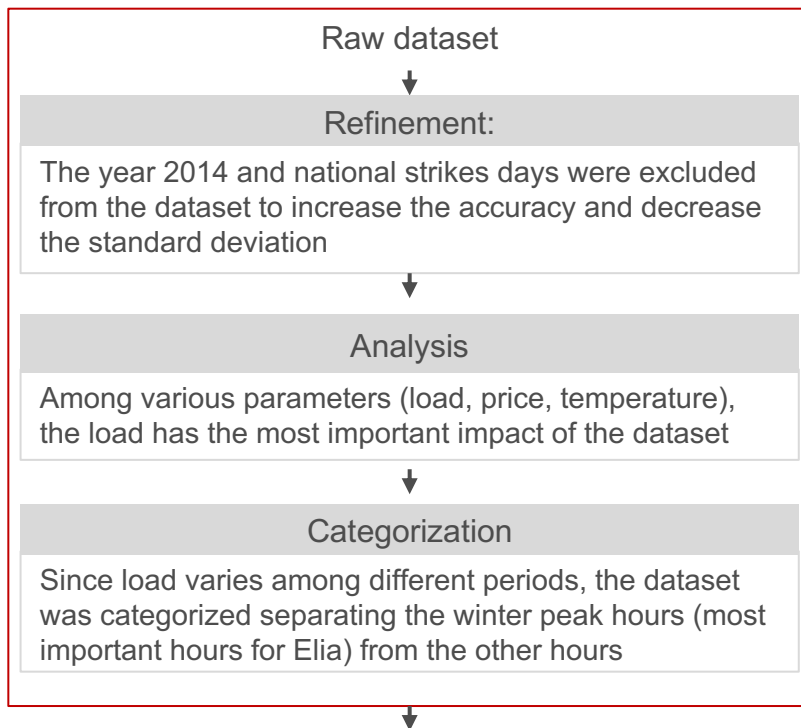
**3** | **Conclusion**

# According to the methodology designed in 2017, the quantitative part (aggregated curve analysis) was updated with recent data

## 2017 Market response study

## 2019 Study update

### A Aggregated curves analysis



- Verification of the coherence of the additional data  
→ **Coherent data addition**
- The analyses conducted in the 2017 study have a similar impact on the updated dataset  
→ **Price and load are still the most important factors**
- The restriction analysis shows that the winter months categorization is the most pertinent, but less so for the restrictions to weekdays peak hours  
→ **The CAGR analysis was conducted on the winter months, as the previous year**
- Updated Market Response volume above 150€/MWh
- New extrapolation of the results

- Volumes of Market Response above 150€/MWh
- Extrapolation of these results



The update of the study leads to a **699 MW Market Response volume** and **3 extrapolation scenarios ranging from 1% to 5% total volume growth**

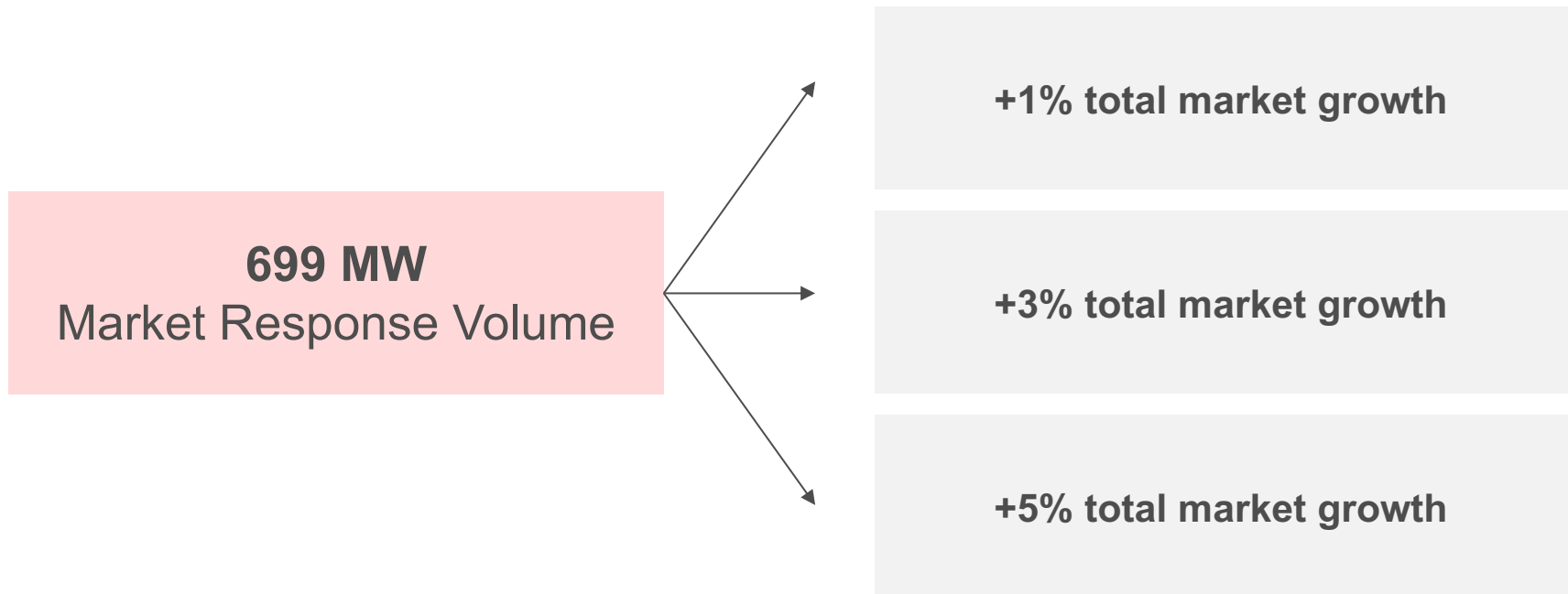
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**Output of the 2019 study**

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**3 extrapolation scenarios**

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**3** | Conclusion

**X** | Back-up

# Agenda

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## **X** | Back-up

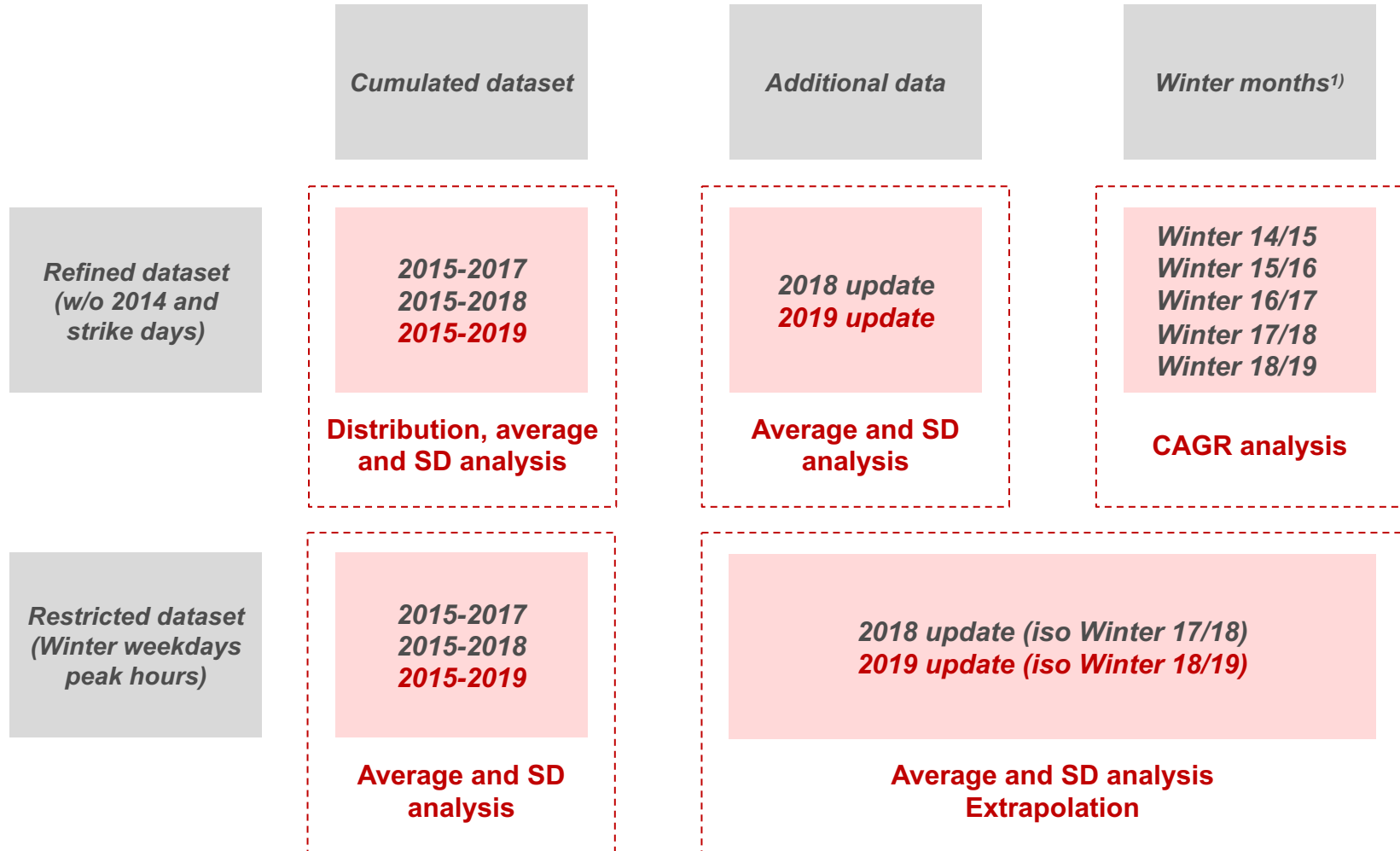
**A** | Extraction of the Market Response volumes

**B** | Refinement of the dataset

**C** | Statistical analysis

**D** | Implementation

# There are multiple ways of looking at the data, depending on the focus of the analysis



# The additional volumes of the 2019 update do not present a specific behavior of the customers and are coherent with the dataset of the Market Response study 2017 and 2018

## Distribution for the offer side only, cumulated dataset

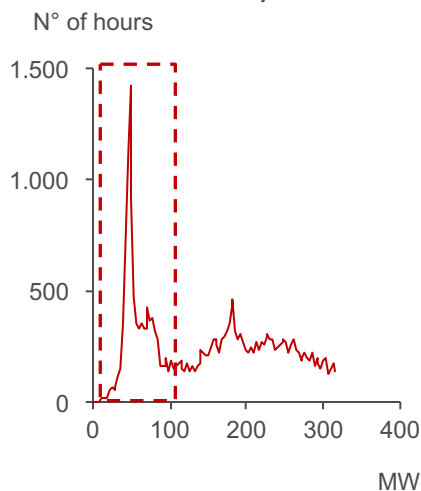
Raw dataset – 2017 Study

Dataset w.o. y. 2014 – 2017 study

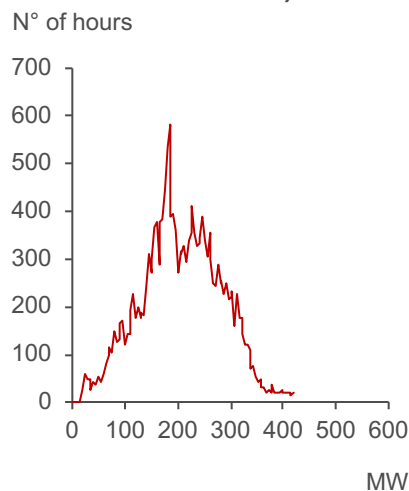
Dataset w.o 2014 - 2018 update

Dataset w.o 2014 - **2019 update**

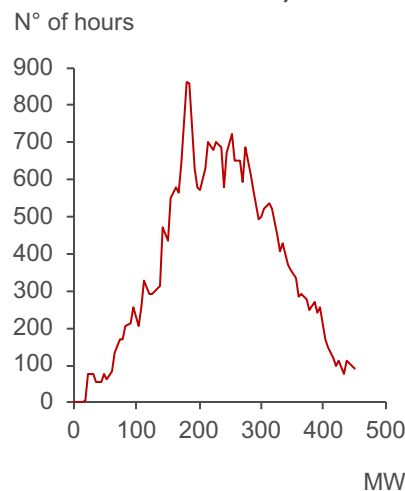
Offer side volumes distribution (150€/MWh threshold)



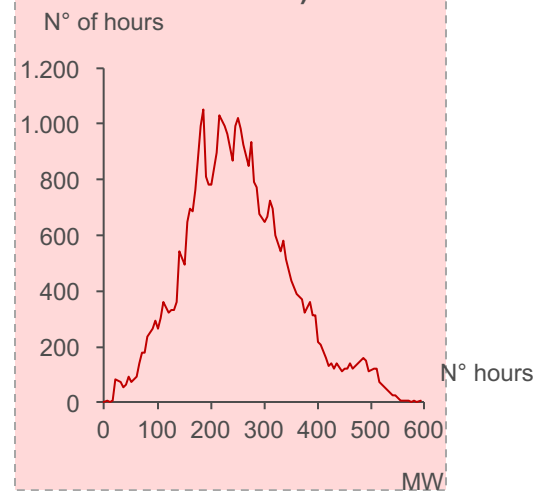
Offer side volumes distribution (150€/MWh threshold)



Offer side volumes distribution (150€/MWh threshold)

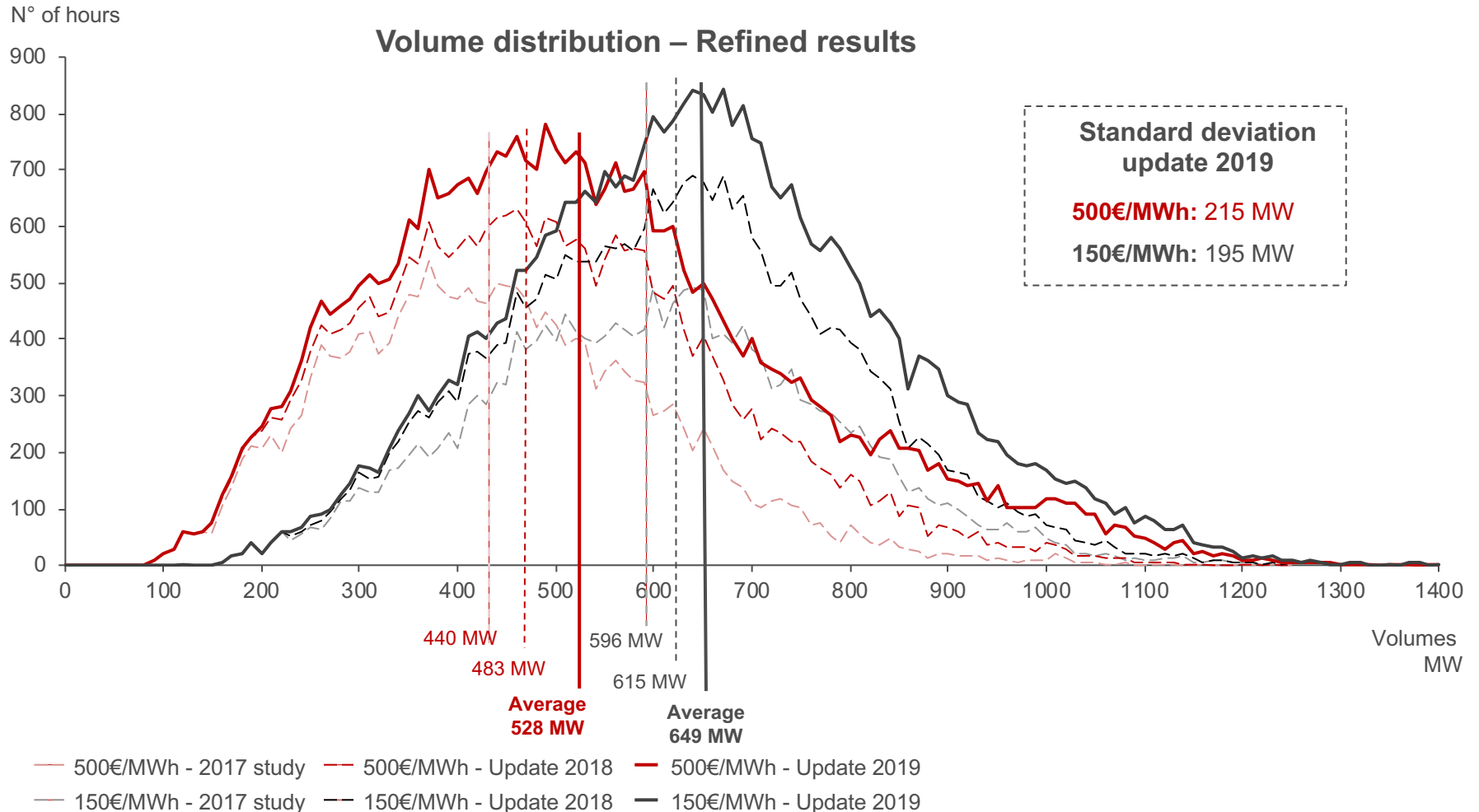


Offer side volumes distribution (150€/MWh threshold)



In the Market Response volumes of 2014, we noticed a specific behavior of the customers not present in the volumes of 2015, 2016 and 2017 → **The year 2014 was excluded of the dataset**  
 This type of behavior doesn't appear in the 2015-2019 updated dataset → **the volumes are coherent with the dataset of the Market Response study 2017**

# The distribution of the updated dataset (cumulated values since 2015) presents similar characteristics as the volume distribution of the 2017 study



**Standard deviation:** indicates the dispersion of the values of the dataset: whether the values are spread over a wide range of values

# Agenda

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## **X** | Back-up

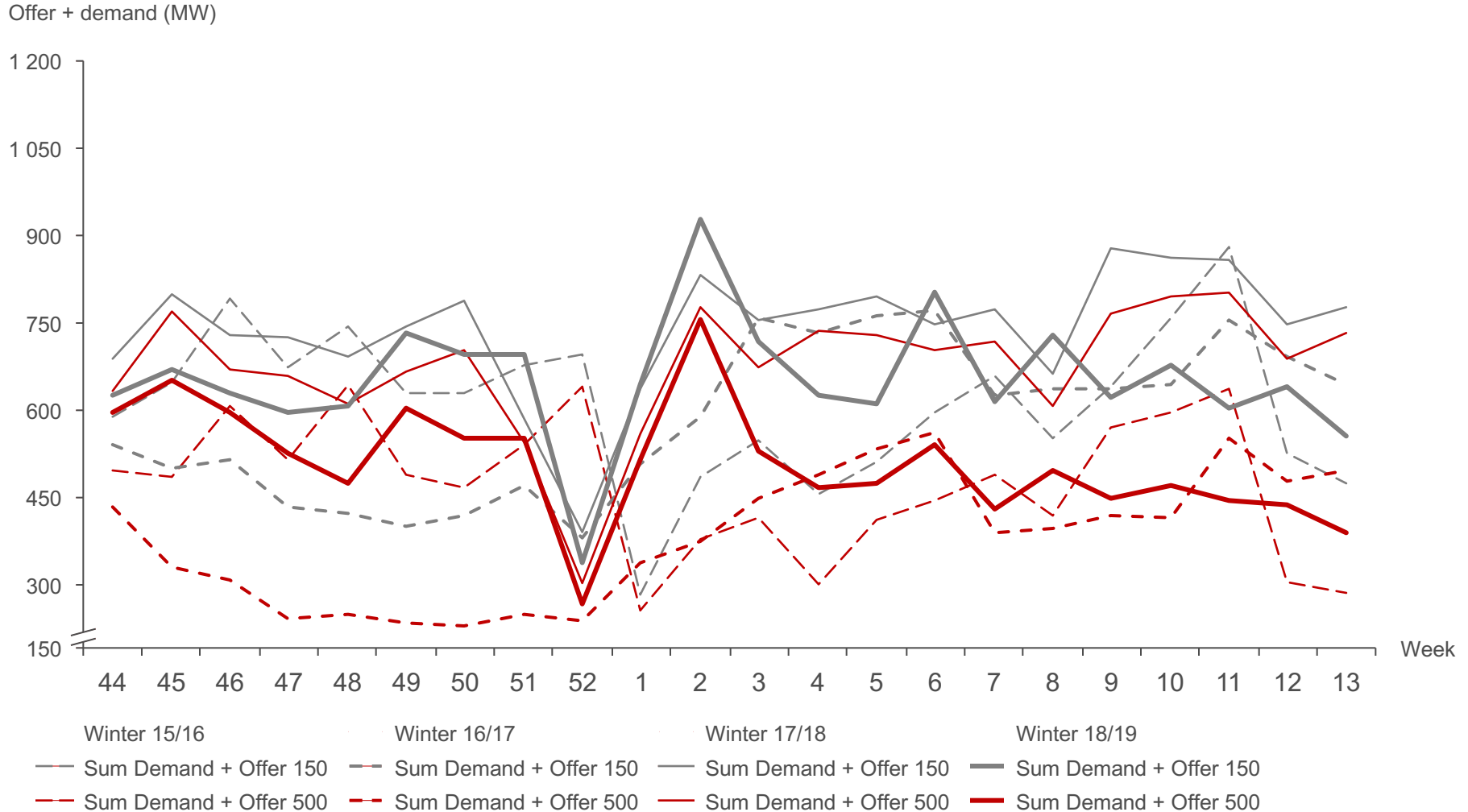
**A** | Extraction of the Market Response volumes

**B** | Refinement of the dataset

**C** | **Statistical analysis**

**D** | Implementation

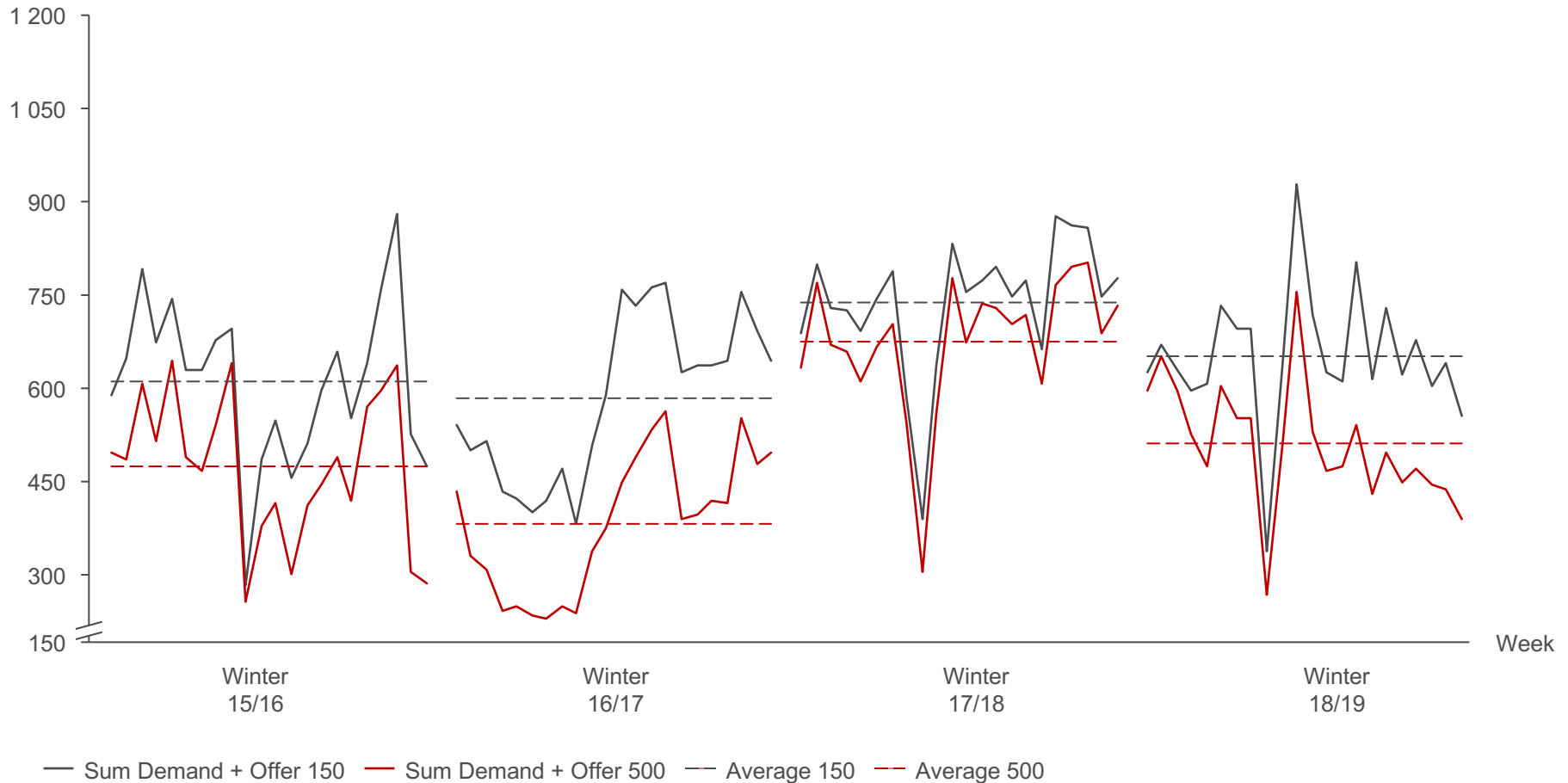
**Despite a higher yearly MR average, the market response in the 2018/2019 winter season is not higher than the previous years, except for a peak in the 2<sup>nd</sup> and 6<sup>th</sup> weeks of 2019**





The weekly averages for both the high and the low bounds are below those of last year (non-restricted hours), yet higher than winter periods 2015/2016 and 2016/2017

Offer + demand (MW)



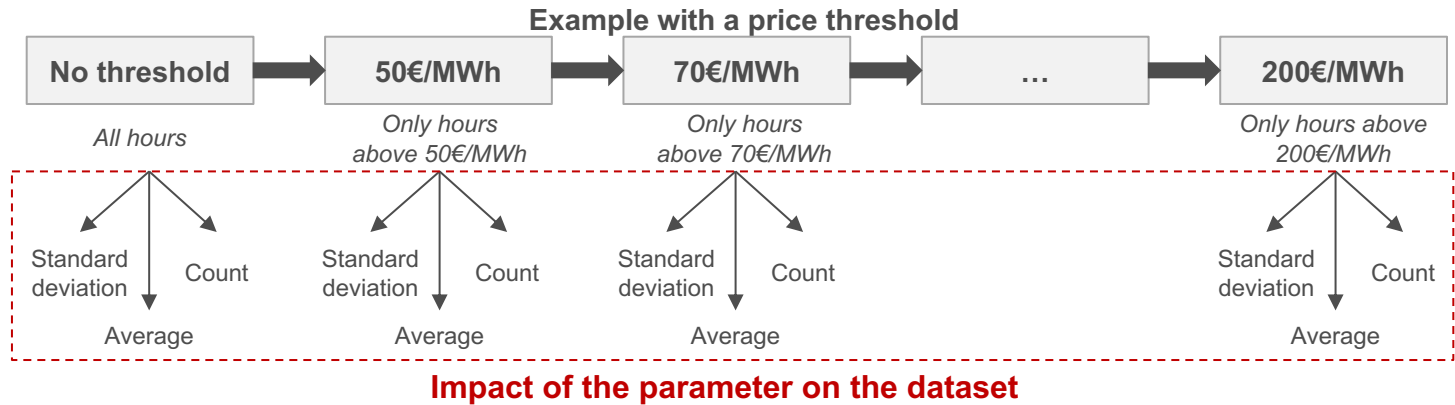
# The main analysis of the 2017 study was reconducted on the updated 2019 dataset, to assess the impact of Load, Temperature and Day-Ahead prices

## Goal of the analysis

The goal of this analysis is to assess the impact of various parameters (price, temperature, load on the Elia Grid) on the dataset<sup>1)</sup>

## Principle

The principle of the analysis is to restrict the dataset to the hours when the parameter is above (or below) a threshold. For each value of the threshold, the standard deviation is calculated, along with the number of data in the dataset and the average volume.



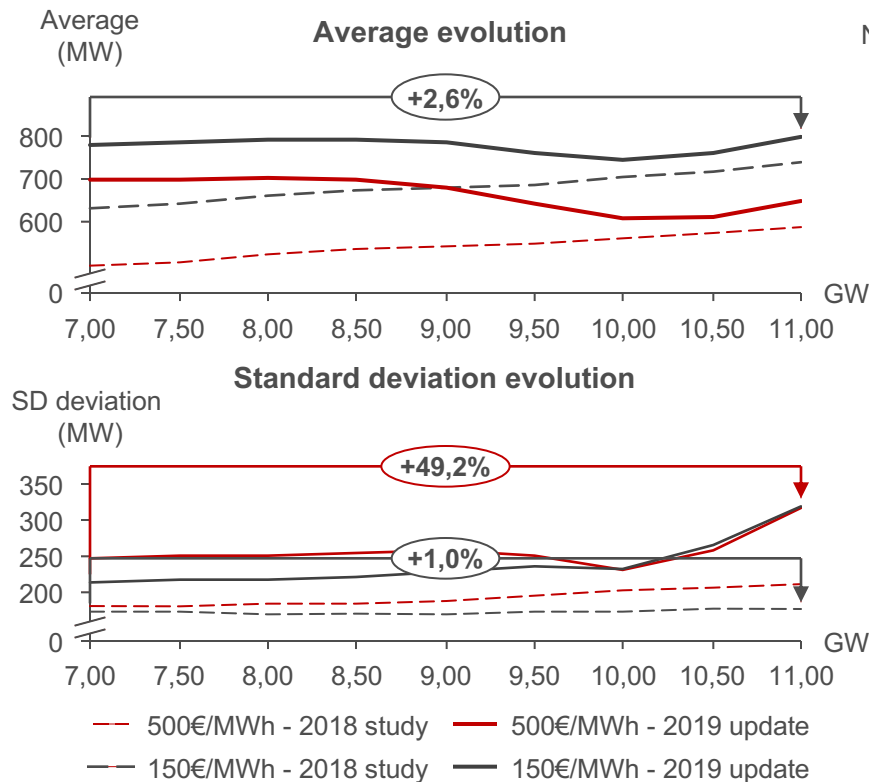
## Computed analyses

- We analyzed the impact of:
- **A load threshold** (Elia Grid Load)
  - **A price threshold** (Day-ahead prices)
  - **A temperature threshold** (Uccle reference)

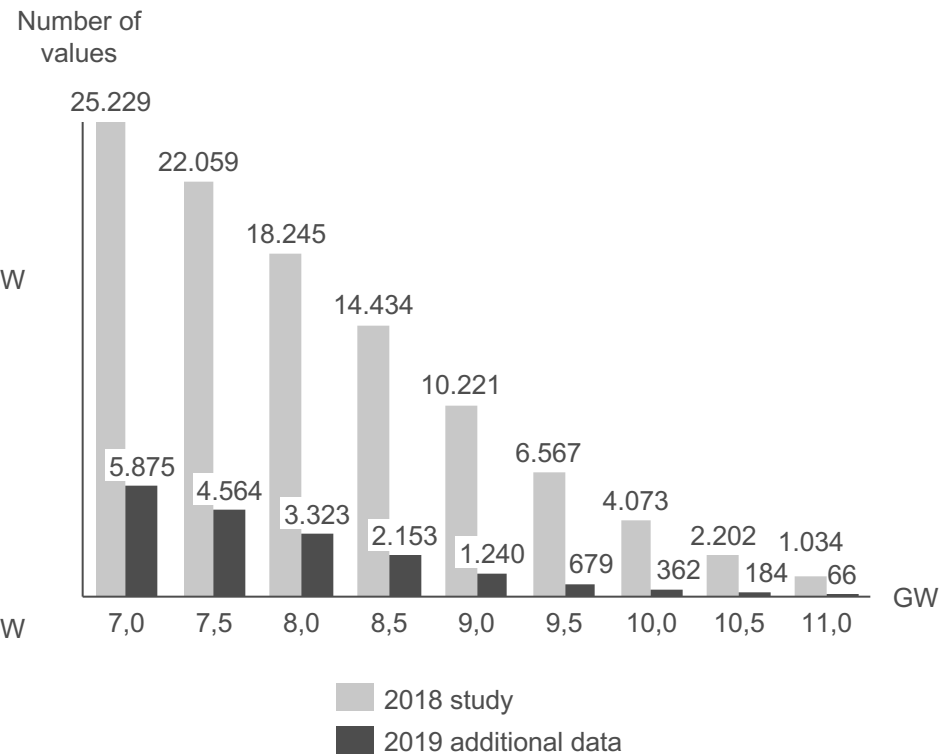
1) The relation between variables can also be assessed statistically thanks to linear regressions. This type of analysis was computed for our dataset but without any relevant results (See results in appendices).

# Restricting the dataset to situations of important load on the Elia Grid does not increase the precision of the dataset: there is no significant impact on the average, but the standard deviation increases

Average and standard deviation evolution



Evolution of the size of the dataset with the Elia grid load threshold<sup>1)</sup>



The Elia grid load, refined from the wind generation<sup>2)</sup>, does not impact similarly the new dataset and the dataset of both the 2017 and the 2018 study

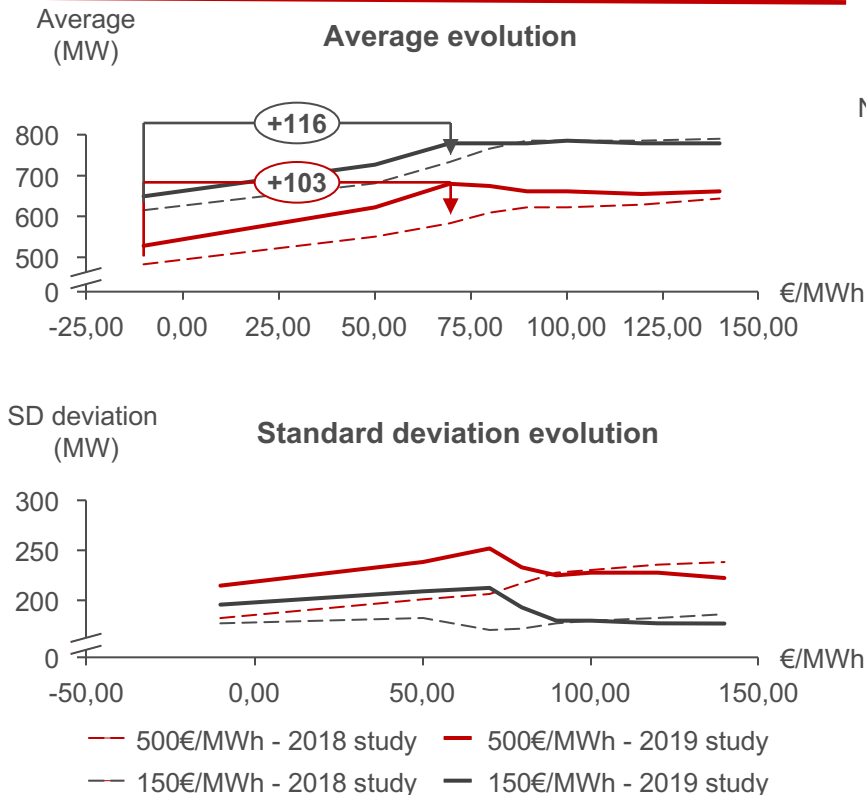
1) The Elia Grid Load is based on injections of electrical energy into the Elia grid

2) The analysis was computed with the Elia Grid load, refined from wind generation. Indeed, the goal is to assess the Market Response in periods of grid stress. The wind generation was excluded since it is not correlated with periods of stress but with periods of wind.

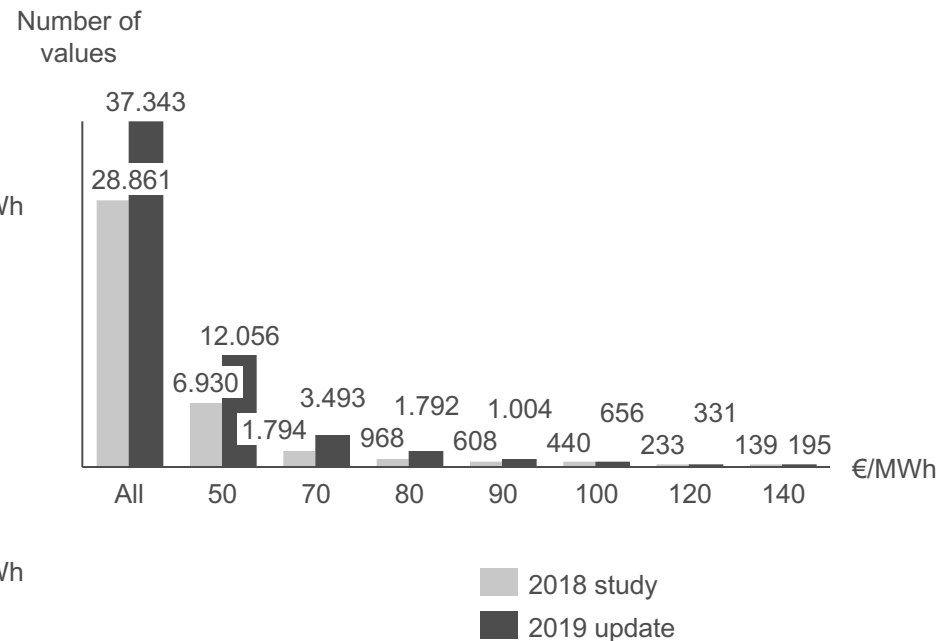
# Restricting the dataset to situations of high DA prices does not improve the precision of the dataset: there is no impact on the standard deviation despite an increase of the average

## Impact of an increasing Day-ahead prices threshold

Average and standard deviation evolution



Evolution of the size of the dataset with the DA prices threshold



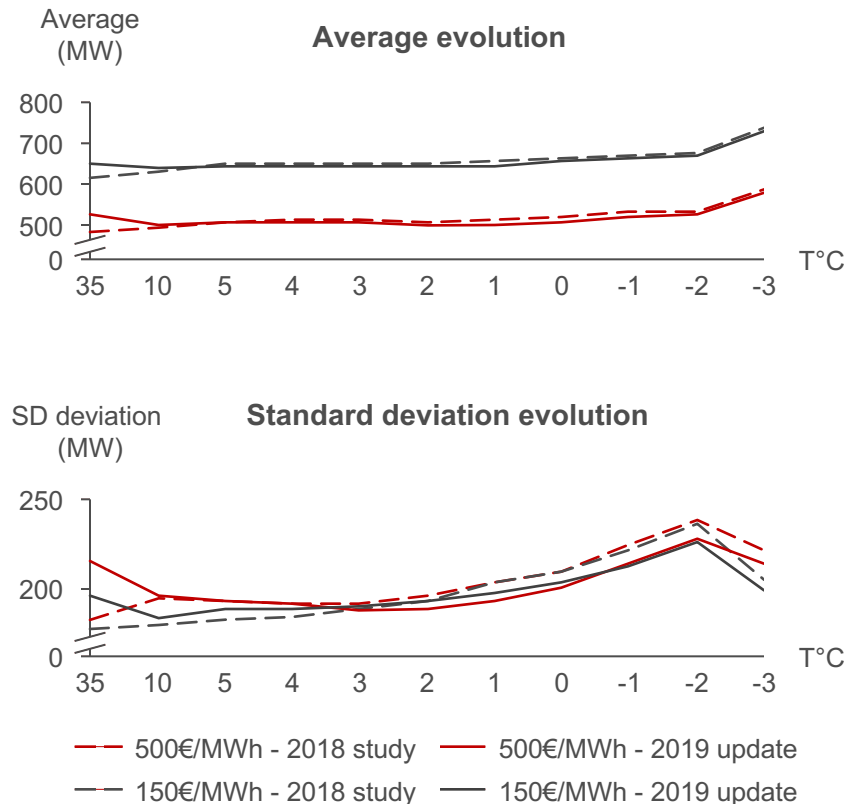
Compared to the 2018 study, we observe a similar trend in the dataset evolution when increasing the price threshold<sup>1)</sup>.

1) The analysis could not be conducted only on the new dataset as the number of data with high prices is too small : only ~300 values when prices are higher than 80€/MWh

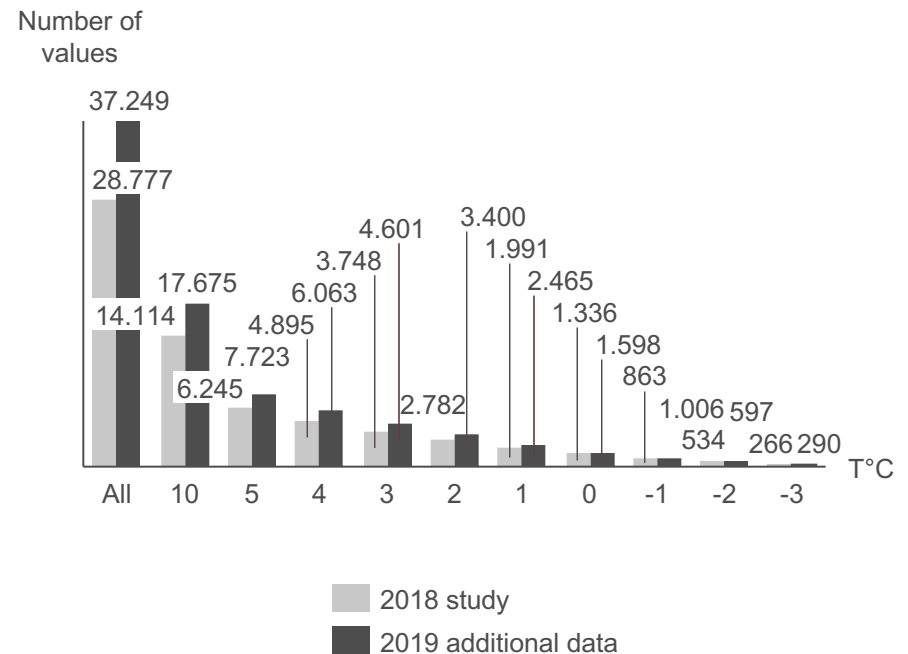
# Restricting the dataset to certain temperature conditions doesn't provide any satisfying results: the volumes remain stable while the standard deviation increases

## Impact of a temperature threshold: restriction to all hours with a temperature lower than x °C

Standard deviation and average evolution with the temperature<sup>1)</sup> threshold



Evolution of the size of the dataset with the temperature threshold

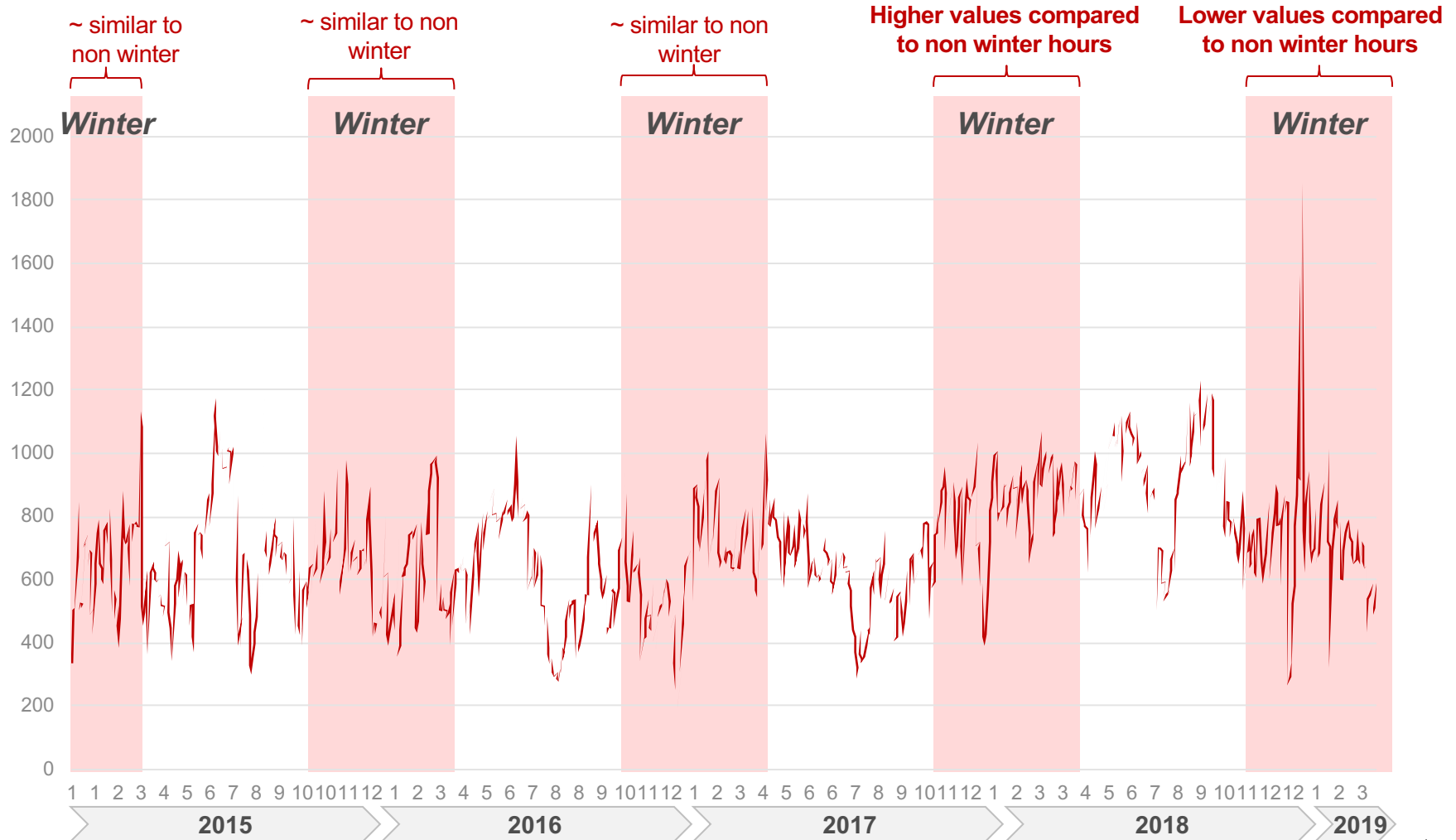


The analysis on the updated dataset reveals the same behavior as the one conducted for both the 2017 and the 2018 study

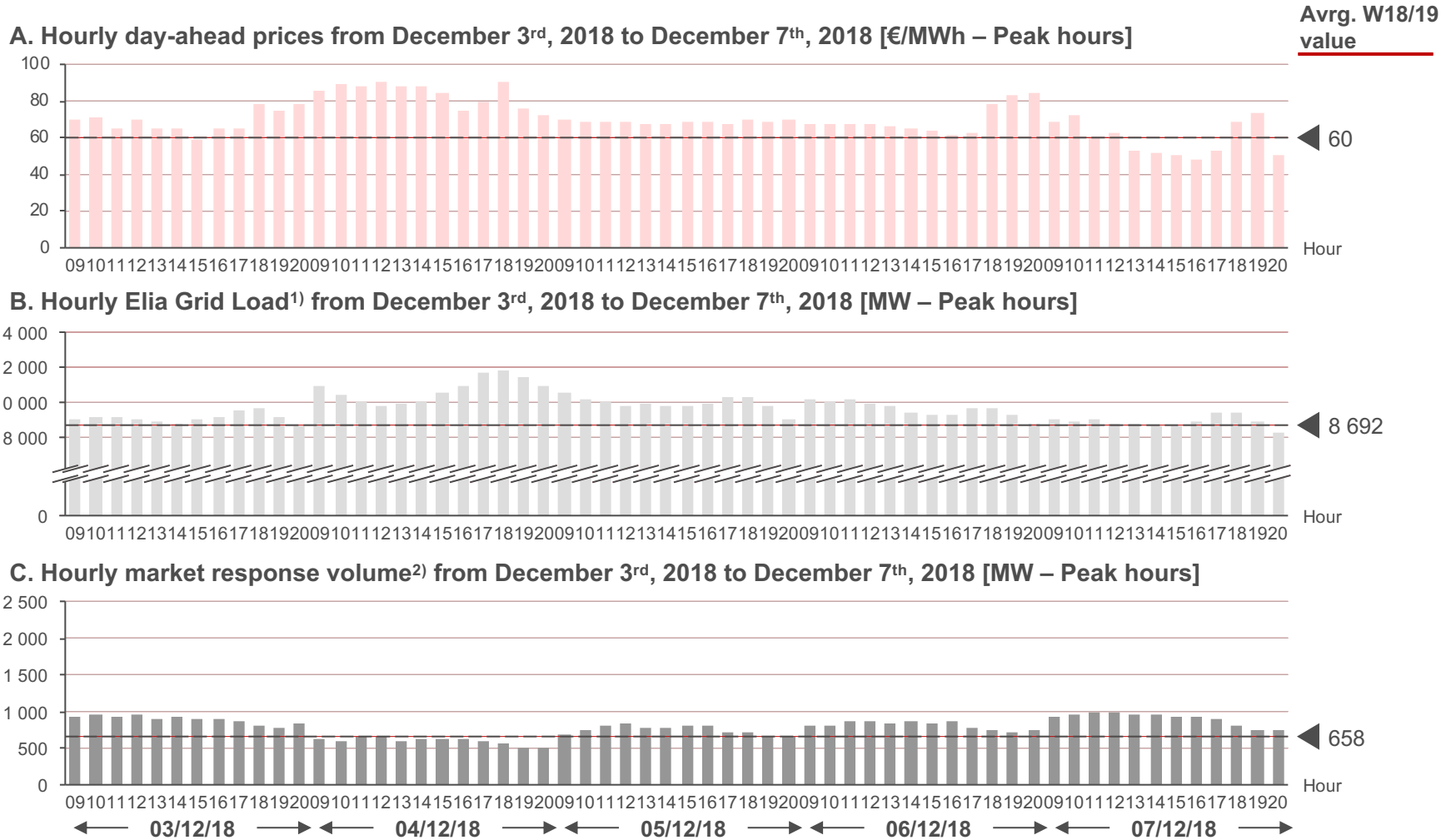
1) For this analysis the hourly values of the reference temperature of the Zaventem station were used.

# During winter 2018-2019, we observe a global decrease of the market response volumes compared to the other winters, but higher peaks

EVOLUTION OF THE DAILY AVERAGED MARKET RESPONSE VOLUME [01/01/2015-04/05/2019; Peak hours]



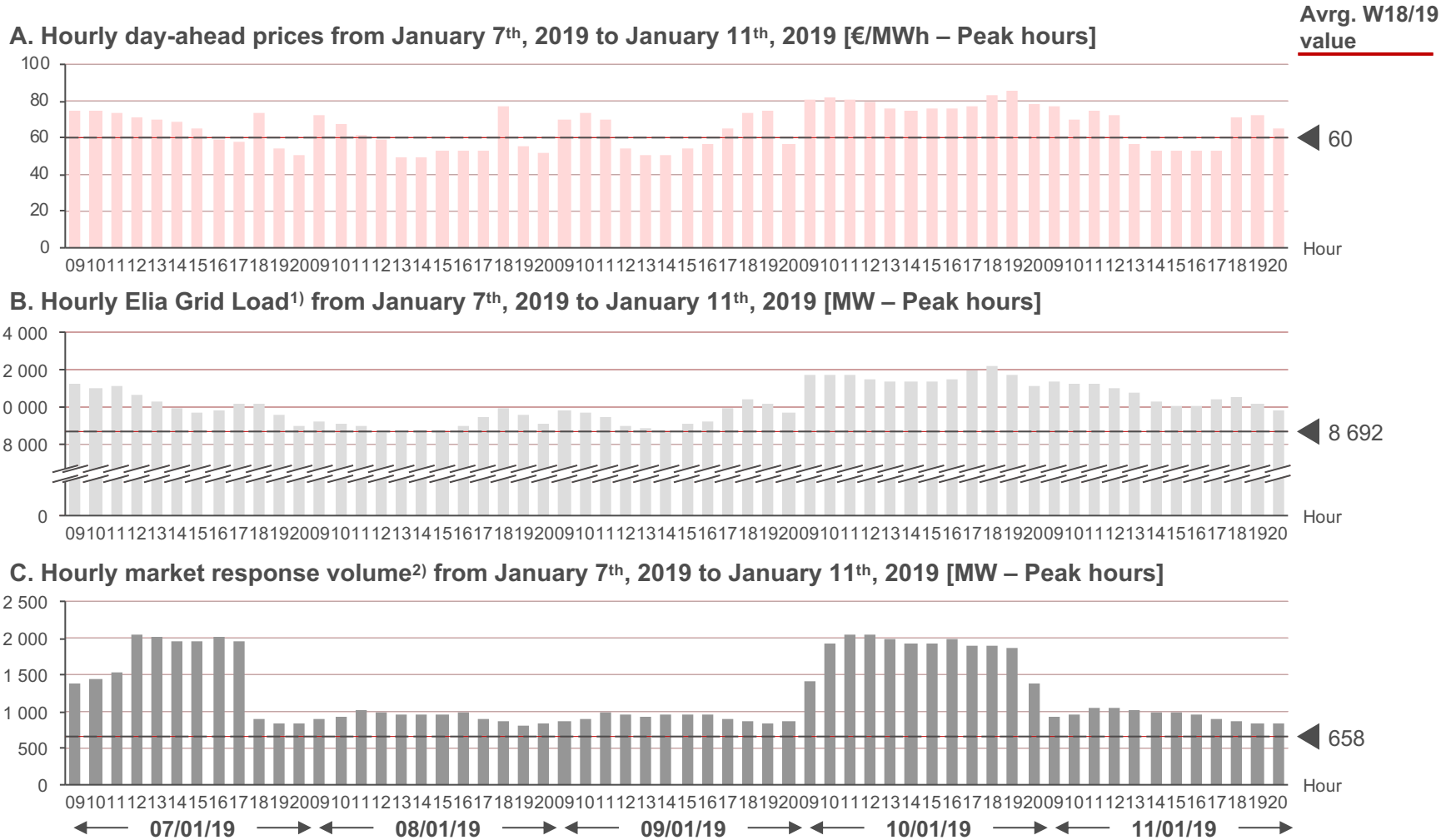
# In December, a week of tension on the electricity grid reveals important market response volumes, up to ~1000 MW



**This specific period of high prices and important load on the Elia grid reveals significantly higher market response volumes, with a limited participation to the final volume increase (654MW without these hours compared to 658MW)**

Source: E-CUBE Strategy Consultants 1) Retreated from wind generation 2) 150€/MWh volumes

# In January, a week of tension on the electricity grid reveals important market response volumes, from ~1000MW up to ~2000 MW

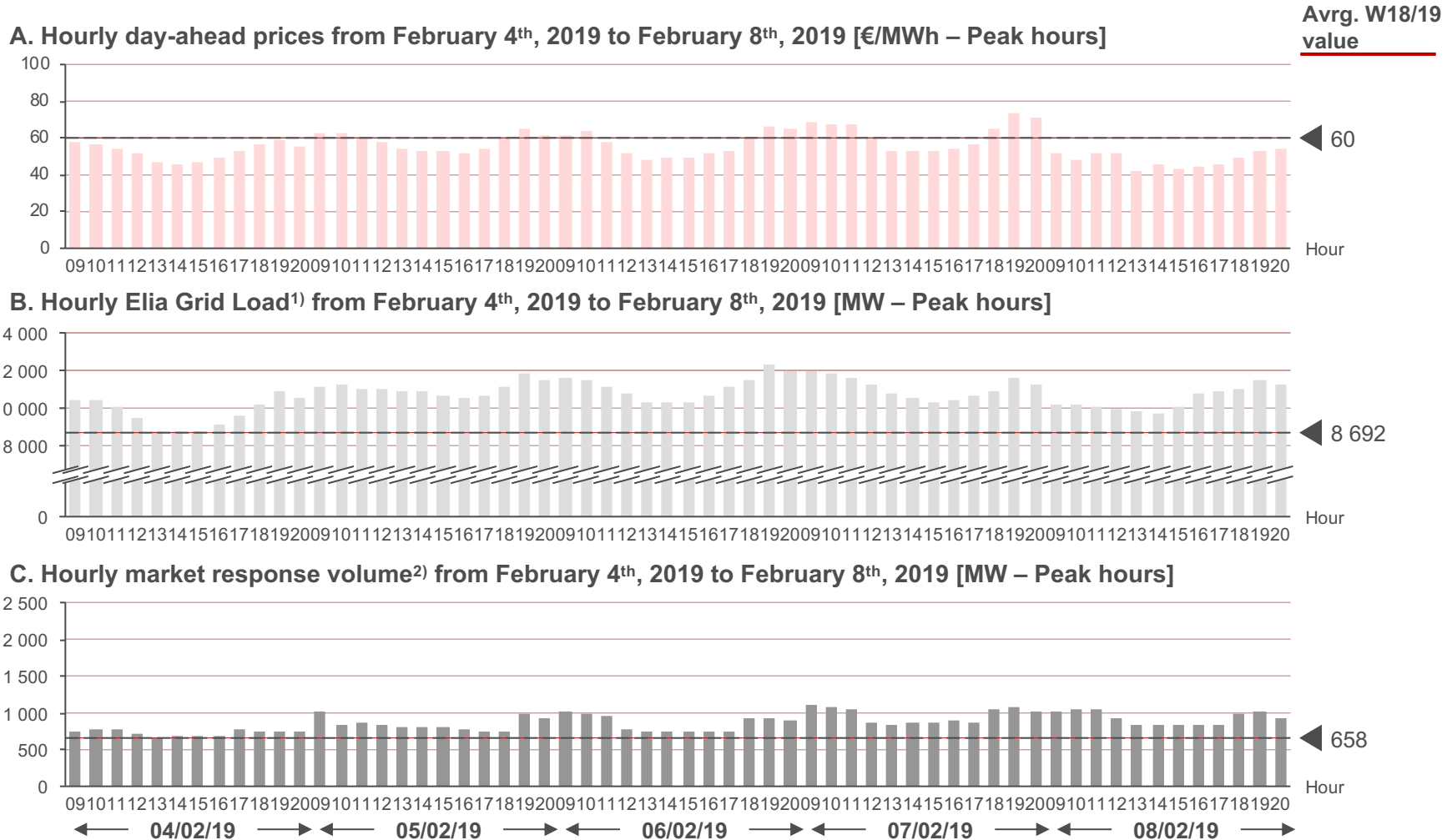


**This specific period of high prices and important load on the Elia grid reveals significantly higher market response volumes, with a large participation to the final volume increase (642MW without these hours compared to 658MW)**

Source: E-CUBE Strategy Consultants 1) Retreated from wind generation 2) 150€/MWh volumes



# In February, a week of tension on the electricity grid reveals important market response volumes, up to ~1100 MW



**This specific period of high prices and important load on the Elia grid reveals significantly higher market response volumes, with a limited participation to the final volume increase (649MW without these hours compared to 658MW)**

Source: E-CUBE Strategy Consultants 1) Retreated from wind generation 2) 150€/MWh volumes

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# Ancillary services projections provided for the 2019 update of the Market Response study

	FRR need	R1 Total	R1 DR Avg Min-max	% DR	R2 Total	R2 DR	R3+ Total	R3+DR Avg Min-max	% DR	Sum - DR
2017	1183 <sup>1a</sup>	68 <sup>1a</sup>	17 <sup>1b</sup> 9-34	25,0%	144 <sup>1a</sup>	0	1030 <sup>1a</sup>	515 <sup>1b</sup> 435-573	50,0%	532
2018	1190 <sup>1a</sup>	81 <sup>1a</sup>	10 <sup>1b</sup> 0-23	12,3%	139 <sup>1a</sup>	0	1080 <sup>1a</sup>	381 <sup>1b</sup> 260-494	35,3%	391
2019 <sup>1c</sup>	1040 <sup>1a</sup>	80 <sup>1a</sup>	12 <sup>1b</sup> 0-15	15%	145 <sup>1a</sup>	0	894 <sup>1a</sup>	392 <sup>1b</sup> 354-439	43,8%	404
2020	Dimensioning of Reserves 2020									
2021	1040 <sup>2</sup>	87 <sup>2</sup>	35	40%	150 <sup>2</sup>	10	890 <sup>2</sup>	392	45%	
2022	1040 <sup>2</sup>	88 <sup>2</sup>	35	40%	150 <sup>2</sup>	20	890 <sup>2</sup>	392	45%	
2023	1040 <sup>2</sup>	88 <sup>2</sup>	35	40%	150 <sup>2</sup>	30	890 <sup>2</sup>	392	45%	

<sup>1a</sup>Historic values FRRneed, R1, R2, R3 (dossier volume), <sup>1b</sup>R1up, ICH, R3DP and R3flex (website); <sup>1c</sup> Delivery Period January – mid March 2019; <sup>2</sup>Elia best estimate

- Weekly contracts: yearly averaged volumes (and weekly minimum and maximum); downward capacity is not relevant for the upward adequacy study
- Assumption concerning calculations (cells in yellow)
  - R1, increase of MR share and capacity following introduction of new technologies
  - R2, pilot R2 non-CIPU in 2018 resulting in increasing MR shares
  - R3, slight MR share growth

The figures shown are a rough estimation and do not represent any targets or ambitions.

The final share of DR is determined by the market as products (R1, R3) are open for the offers of different technologies.

The participation of new technologies in R2 is under investigation and estimations are based on Elia's best guess.

# Ancillary services projections provided for the 2018 update of the Market Response study

	FRR need	R1 Total	R1 DR Avg Min-max	% DR	R2 Total	R2 DR	R3+ Total	R3+DR Avg Min-max	% DR	Sum - DR
2016	1203 <sup>1a</sup>	73 <sup>1a</sup>	14 <sup>1b</sup> 0-30	19,2%	140 <sup>1a</sup>	0	1020 <sup>1a</sup>	447 <sup>1b</sup> 413-480	43,8%	<b>461</b>
2017	1183 <sup>1a</sup>	68 <sup>1a</sup>	17 <sup>1b</sup> 9-34	25,0%	144 <sup>1a</sup>	0	1030 <sup>1a</sup>	515 <sup>1b</sup> 435-573	50,0%	<b>532</b>
2018 <sup>1c</sup>	1190 <sup>1a</sup>	81 <sup>1a</sup>	12 <sup>1b</sup> 12-23	14,8%	139 <sup>1a</sup>	0	1080 <sup>1a</sup>	412 <sup>1b</sup> 365-494	38,1%	<b>424</b>
2019	Dossier Volume 2019									
2020	1365 <sup>2</sup>	86 <sup>3</sup>	<b>43,0</b>	50%	160 <sup>3</sup>	10	1105 <sup>3</sup>	<b>464</b>	42%	
2021	1365 <sup>2</sup>	87 <sup>3</sup>	<b>52,2</b>	60%	160 <sup>3</sup>	20	1105 <sup>3</sup>	<b>475</b>	43%	
2022	1365 <sup>2</sup>	88 <sup>3</sup>	<b>61,6</b>	70%	160 <sup>3</sup>	30	1105 <sup>3</sup>	<b>486</b>	44%	

Scope ↑



<sup>1a</sup>Historic values FRRneed, R1, R2, R3 (dossier volume), <sup>1b</sup>R1up, ICH, R3DP and R3flex (website); <sup>1c</sup> Delivery Period January – June 2018; <sup>2</sup>Dynamic Dimensioning Study; <sup>3</sup>Elia best estimate

- Weekly contracts: yearly averaged volumes (and weekly minimum and maximum); downward capacity is not relevant for the upward adequacy study
- Assumption concerning calculations (cells in yellow)
  - R1, increase of MR share and capacity following introduction of new technologies
  - R2, pilot R2 non-CIPU in 2018 resulting in increasing MR shares
  - R3, slight MR share growth

The figures shown are a rough estimation and do not represent any targets or ambitions.

The final share of DR is determined by the market as products (R1, R3) are open for the offers of different technologies.

The participation of new technologies in R2 is under investigation and estimations are based on Elia's best guess.

# Ancillary services projections provided for the 2017 Market Response study

	FRR need	R1 Total	R1 DR Avg Min-max	% DR	R2 Total	R2 DR	R3+ Total	R3+DR Avg Min-max	% DR	Sum - DR
2015	1240 <sup>1a</sup>	83 <sup>1a</sup>	23 <sup>1b</sup> 19-26	27.7%	140 <sup>1a</sup>	0	911 <sup>1a</sup>	321 <sup>1b</sup>	35,2%	344
2016	1203 <sup>1a</sup>	73 <sup>1a</sup>	14 <sup>1b</sup> 0-30	19,2%	140 <sup>1a</sup>	0	1020 <sup>1a</sup>	424 <sup>1b</sup> 390-457	41,6%	438
2017 <sup>1c</sup>	1183 <sup>1a</sup>	68 <sup>1a</sup>	18 <sup>1b</sup> 9-34	26,5%	144 <sup>1a</sup>	0	1030 <sup>1a</sup>	428 <sup>1b</sup> 390-480	41,6%	446
2018	Dossier Volume 2018									
2019	1212 <sup>3</sup>	90 <sup>3</sup>	25.2	28%	155 <sup>3</sup>	0	1048 <sup>3</sup>	440	42%	
2020	1226 <sup>3</sup>	90 <sup>3</sup>	26.1	29%	165 <sup>3</sup>	0	1057 <sup>3</sup>	444	42%	
2021	1240 <sup>2</sup>	90 <sup>2</sup>	27.0	30%	175 <sup>2</sup>	0	1065 <sup>2</sup>	447	42%	

Scope ↑



<sup>1a</sup>Historic values FRRneed, R1, R2, R3 (dossier volume), <sup>1b</sup>R1up, ICH, R3DP and R3flex (website); <sup>1c</sup> Until week 25; <sup>2</sup>Adequacy Study 2027; <sup>3</sup>Linear extrapolation

- Weekly contracts: yearly averaged volumes (and weekly minimum and maximum); downward capacity is not relevant for the upward adequacy study
- Assumption concerning calculations (cells in yellow)
  - R1, gradual increase of share and capacity towards 2021
  - R2, no contribution of DR (but under investigation towards 2020)
  - R3 , capacity growth following a constant share of DR in R3

The figures shown are a rough estimation and do not represent any targets or ambitions.

The final share of DR is determined by the market as products (R1, R3) are open for the offers of different technologies.

The participation of new technologies in R2 is under investigation and estimations are based on Elia's best guess.