# Market Response study 2017

# I. Executive summary

The response of electricity consumers in periods of high prices, e.g. during system stress in the electricity grid, called here Market Response (MR), is a key market dynamic to ensure market stability. Market Response must be taken into account **in the context of the volume determination of strategic reserves**: the estimated volume of Market Response impacts the adequacy assessment, which in the end aims at sizing the volumes of strategic reserves required when system stress arises.

In the context of the "Implementation Strategic Reserve" task force, a subgroup "Market Response Study" was created in January 2017 to design the **most adequate methodology to determine the volumes of Market Response** in the context of the volume determination of the strategic reserve. The methodology was designed based on interactions with stakeholders, over the course of four workshops and several bilateral interviews[1]. Based on these interactions and on an international benchmark (of Norway, Finland, PJM, the UK, and France), a review of the possible methodologies enabled to obtain an exhaustive outlook of the possibilities. After the confrontation of each methodology to the most relevant identified criteria, a first proposal was discussed with the stakeholders, to finally come to the final methodology at the end of March 2017.

The adequacy assessment conducted by Elia has to take into account all Market Response in the market. A certain share of this volume is reserved as Ancillary Services and another share is already included in the demand profile. Indeed, market reactions under 150€/MWh (Day-ahead (DA) prices) are already implicitly taken into account in the load forecast used by Elia in its adequacy assessment.

**Therefore, this study aims at assessing all Market Response[2] (MR) volumes, which are not already included in the adequacy assessment**.

The Market Response volume assessment methodology indeed targets the types of flexibility able to respond to periods of high prices, when there are tensions on the electricity grid. Globally, **four categories** can be distinguished:

- Contract with the Transmission System Operator (TSO);
- Contracts with the Balancing Responsible Parties (BRPs);
- Price based MR;
- Voluntary MR.

The first category gathers the volumes directly activated by the TSO for balancing purposes (ancillary services) or adequacy purposes. This type of flexibility is excluded from the perimeter of Market Response since it is already reserved for TSO purposes. However, this study acknowledges that Market Response capacities may transfer from DR contracted with the TSO to Market Response and the way around over time.

[1] All material presented to the stakeholders can be found on the website of the Task Force (User's Group > Working Group Balancing > Task Force iSR > Agenda), including the Minutes of Meeting.

[2] In this text, the scope is referred to as both Market Response or Demand Response. However, in general, DSR is seen as the reduction of consumption (not including distributed generation or storage technologies), while MR should be understood in a broader sense making abstraction of the technology (including distributed generation or storage technologies). In such sense, it is the Market Response which is investigated as input for the Adequacy Study.

For this exercise, the project scope therefore gathers the three other types of MR: the contracts between the customer and the BRP; the price based MR, valued in a market (R3 non-reserved, or energy DA/ID markets) or valued within a portfolio (Time of Use tariffs); and the voluntary MR, implicit load reduction based on a clear signal sent by an impactful authority (TSO, DSO, supplier, government). In the voluntary MR section, the load reduction of customers due to a risk for their own interests[1] is considered as "pre-curtailment" and is not taken into account in the scope of the Market Response.

Finally, knowing that market reactions under 150€/MWh (Day-Ahead (DA) prices) are already implicitly taken into account in the adequacy assessment, **the perimeter of the study is restricted to three categories: Contract based with BRPs, Price based MR and voluntary MR, with prices above normal conditions, i.e. above 150€/MWh.**

From the work with market stakeholders and the benchmark, a list of 8 possible methodologies was established to assess the volumes of Market Response above normal conditions. While some methodologies are based on extrapolations, others provide a statistical approach of grid/market data. A third category is based on economic modeling. All methodologies were then confronted to 8 criteria to assess their relevance: 1) the methodology has to assess the defined **perimeter**; 2) it needs to be **feasible**, with accessible data; 2) the methodology has to be **coherent with the adequacy assessment** model; 4) it has to be **robust** to the future evolution of Market Response over the next 3 years minimum; 5) it has to be **simple**, intuitive and transparent; 6) for the overall benefit to the society, the approach needs to be **cautious,** 7) while being **accurate** and finally, 8) the results should be **verified**.

The final methodology was established after the criteria confrontation and various group discussions with stakeholders, to fine-tune the methodology proposal. The global Market Response volumes in the framework of the volume determination of SR will be estimated based 1) on the analysis of the aggregated demand and supply curves[2] of the day-ahead market of EPEX Belgium (EPEX DAM Belgium), 2) complemented with a qualitative questionnaire sent to stakeholders (BRP, aggregators, customers) to assess the activation details (e.g. number of weekly activations and maximum activation duration) and finally 3) verified with a sanity check. This will lead to a robust result and takes into account the feedback and the remarks from stakeholders.

To implement these methodologies, several elements are required.

1 - Firstly, the hourly aggregated curves of the purchase and sale orders on EPEX DAM Belgium are acquired. In these curves, Market Response can appear as a decrease in the demand side, or an increase in the offer side if market parties value Market Response as a new offer. The analysis of the aggregated curves has to take into account the possible presence of conventional generation bids, which shouldn't be integrated in the Market Response estimation, as they are modelled as such in the adequacy assessment. The curves will firstly be refined from the generation bids by, for example, considering that above 500€/MWh, generation bids are very unlikely.

[1] The load reduction of consumer due to a real risk for their own interest should not be taken into account in the sizing of the SR as its role is actually to avoid this type of situation

[2] In the EPEX DAM Belgium aggregated curves, Market Response volumes are reflected in both the offer and demand aggregated curves

This methodology enables to assess the whole perimeter of the study, with contract and price based MR but also voluntary MR. Indeed, contrary to “pre-curtailment”, voluntary MR as the reaction of individual customers in tight situations is in the scope of the project. If existing, this volume should be taken into account by the BRPs and, in theory, reflected in their bids.

The output of the methodology, namely the hourly Market Response volumes, will be analyzed according to the type of day: more than a simple average calculation, the distribution of the results will be studied, taking into account, if statistically relevant, the impact of various parameters (temperature, day type…). This analysis will enable to refine at best the methodology. The aggregated curves analysis shall finally provide a capacity estimation without any activation details (number of activations per week, activation duration), still required to integrate the volumes of Market Response into the adequacy assessment.

2 - Therefore, a qualitative questionnaire will complete this analysis: details on the activation will be obtained with this questionnaire, focused on gathering key qualitative information (e.g. number of weekly activations and maximum activation duration). The objective is to establish a relevant link between the adequacy assessment and the volumes of Market Response, through these activation details. It will be sent to key players (BRPs, aggregators and TSO connected customers), leaving them the possibility to fulfill a Non-Disclosure Agreement if required.

3 - Finally, to conduct a sanity check, an international comparison point will also be formalized, putting the Market Response volumes in proportion of the maximum peak load in the electric system. The questionnaire will also provide estimations of the volumes currently contracted by the respondents. This volume will then be compared to the previously established volumes to assess the global coherence of the Market Response volumes, on an indicative basis.

The results of these methodologies should be available by the end of June 2017, after further interaction with the stakeholders.

# II. Context & objectives of Market Response

The response of electricity consumers in periods of tension in the electricity grid, Market Response, is a crucial market dynamic during difficult situations on the electricity grid when adequacy issues arise. In conditions of high prices, the market will indeed react and some players will reduce their load due to the price increase. The adequacy assessment conducted by Elia has to take into account all Market Response (MR) in the market. A certain share of this volume is reserved as Ancillary Services and another share is already included in the demand profile. Indeed, market reactions under 150€/MWh (Day-ahead (DA) prices) are already implicitly taken into account in the load forecast used by Elia in its adequacy assessment.

**Therefore, this study aims at assessing all Market Response[1] (MR) volumes, which are not already included in the adequacy assessment.**

When European (2009/72/CE and 2012/27/CE) and national policy makers, as well as European regulators, are pushing for an increased development of demand side response (DSR) and Market Response (MR), reflections around the estimation of the volumes associated become more and more essential. The global effort is mirrored by market stakeholders' (Flexibility Service Provider (FSP), Balance Responsible Parties (BRP), producers, suppliers, third party aggregators and customers) demand to fine-tune the methodology used to grasp the potential of Market Response in Belgium.

In Belgium, the estimation of Market Response is even more essential as it is carried out in context of the volume determination of strategic reserves. The strategic reserve is handled by Elia to solve shortage situations during the winter period. The volumes of Market Response are taken into account in the adequacy study, which then sizes the volumes of strategic reserves required. Indeed, a correct Market Response estimation is essential to obtain an accurate sizing of the strategic reserves.

In 2015, Elia has launched a questionnaire to the BRPs, the consumers and the aggregators to estimate the Market Response in moments of grid stress. After 2 years of implementation, key stakeholders of the market have expressed[2] their willingness to contribute to the development of a new methodology to determine the volumes of Market Response in Belgium.

In this context, the objectives of this first phase for which E-CUBE was mandated are to design the methodology or methodologies to determine the volume of Market Response in the context of volume determination of the strategic reserves, for the winter 2018-2019 and should be valid for the periods covering 2019-2020 and 2020-2021. In this context, a task force subgroup "Market Response Study" was created in January 2017 to design the **most adequate methodology to determine the volumes**

[1] In this text, the scope is referred to as both Market Response or Demand Response. However, in general, DSR is seen as the reduction of consumption (not including distributed generation or storage technologies), while MR should be understood in a broader sense making abstraction of the technology (including distributed generation or storage technologies). In such sense, it is the Market Response which is investigated as input for the Adequacy Study.

[2] Task Force « Implementation Strategic Reserves » 2017/2018, September 19, 2016

**of Market Response**. The methodology was designed based on interactions with stakeholders, over the course of four workshops and several bilateral interviews[1].

A second phase will follow and implement the methodology to come up with a Market Response volume and its characteristics to take into account in the adequacy assessment.

[1] All material presented to the stakeholders can be found on the website of the Task Force (User's Group > Working Group Balancing > Task Force iSR > Agenda), including the Minutes of Meeting.

# III. Benchmark of the methodologies

During the project work, a benchmark was performed to identify the Market Response methodologies and practices in different countries. This allowed the project team to identify potential methodologies, their current use and their level of quality for an adequacy assessment by a TSO. This benchmark was performed by the consultants' project team, mainly through literature review and targeted interviews of stakeholders from the different countries, and presented to the stakeholders.

## 1) Market Response in the benchmarked countries

During the project, key players from UK, France, PJM, Norway, and Finland were benchmarked so as to assess the different ways of integrating Market Response in the adequacy assessment.

- **In the UK**, Market Response is limited to two products (Triad management and Red Zone avoidance) of which only the first one has a dedicated estimation methodology: it is based on load comparison of days with & without these Triad events.
  ➔ *The estimation of the Market Response by comparing loads of different days can be efficient when day with or without Market Response can be clearly differentiated (for example for voluntary MR).*

- **In PJM**, there are two mechanisms in the perimeter of the project: the "Economic Demand Response" (valued in the energy markets) and the "Price Responsive Demand Response" (load reduction associated to price increase). Regarding the volume determination methodologies, "Economic Demand Response" is implicitly integrated since peak load estimation is based on historical data. "Price Responsive Demand Response" has been transformed in a capacity product: the supplier has to commit to an amount of Price Responsive Demand and is attributed penalties in case of failure.
  ➔ *In PJM for the Price Responsive Demand mechanism, the supplier carries the responsibility of the volume of implicit demand within its portfolio, making it a capacity product.*

- **In France**, in the adequacy assessment, DR is integrated as an additional generation source. Implicit DR is directly estimated by the suppliers of this type of contracts.
  ➔ *In situation of high prices, it is difficult to anticipate the behavior of players. This explains a cautious approach in the adequacy assessment in France. Neither resiliency analysis nor load comparison is therefore conducted.*

- **In Finland and Norway**, peak load forecasts are based on actual load curves, which include the effect of Market Response (i.e. there is no correction of the extremum).
  ➔ *Taking into account historical data in the peak load estimation is considered as sufficient in some countries to estimate Market Response.*

The detailed descriptions and analyses of the benchmark can be found in appendix of this document.

## 2) Key conclusions of the benchmark for the study

**In the context of the adequacy assessment, a cautious approach is widespread** across the benchmarked countries regarding the integration of Market Response. This is the case, for example, when choosing between various hypotheses: the most prudent one is usually retained. The same approach is applied when integrating voluntary DR in the adequacy assessment: in France, voluntary Demand Response is not taken into account in the adequacy assessment.

When considered in the demand side, like in the UK or the Nordic countries, most of **Market Response is generally implicitly taken into account since peak load estimation is based on historical data**. Though, specific situations can be treated separately: highest peak load periods in the UK (with the Triads), periods of peak prices in Norway (with the deactivation threshold).

**When considered as a generation asset, Market Response is to be estimated separately**. In France, RTE, by conducting bilateral exchanges with the suppliers, can benefit from the estimations conducted by the suppliers who provide implicit DR.

In the PJM market, dominated by a strong **capacity market**, **implicit Demand Response gathered under the** "**price responsive demand" was transformed in a capacity product**, placing the volume and reliability responsibility on the suppliers of this type of program.

# IV. Approach followed with the stakeholders

In the context of the task force “Implementation Strategic Reserve”, a subgroup “Demand Response Study” was created with key stakeholders to design the new methodology.

Besides Elia, this sub-group was composed of:

- Michael Van Bossuyt, *Febeliec*
- Peter Schell, *Restore*
- Bénédicte Vignoboul, *Energy Pool*
- Alain Vandevenne, *Energy Pool*
- Steven Harlem, *FEBEG*
- Dieter Jong, *Anode*
- Valentijn Demeyer, *Electrabel*
- Mattijs Van Bruwaene, *EDF Luminus*
- Bram De Wispelaere, *EDF Luminus*
- Jean-Francois Williame, *Uniper*
- Francois Brasseur, *Direction Générale Energie*
- Sylvie Tarnai, *EPEXSpot*
- Aurélie Gillieaux*, Engie*

In order to involve stakeholders in the methodology definition, the sub-group interactions were divided into 4 interactive workshops:

- **Workshop 1:** brainstorm on the possible methodologies
- **Workshop 2:** exhaustive review of the possible methodologies
- **Workshop 3:** selection of the methodologies
- **Workshop 4:** final methodology proposal and first steps of the implementation

The **first workshop** aimed at conducting an open discussion with the stakeholders so as to identify the requirements of the potential methodologies and discuss the first potential candidates. The workshop enabled to agree on the perimeter of the study, gathering contract based with BRP, voluntary MR and price based MR (to be detailed in the chapter V – Project scope).

The stakeholders were also involved through bilateral interviews, conducted between the first and second workshop. The interviews aimed at understanding the point of view of the stakeholders and their suggested methodologies.

To provide quality content for the workshop, a back-office analysis was conducted by E-CUBE. The current Market Response methodologies were reviewed with a benchmark of relevant countries (UK, France, PJM, Norway and Finland). The benchmark consisted in an exhaustive literature review and interviews with at least one stakeholder per country. The results of the benchmark were presented in the preceding chapter.

Based on the insights of the first workshop, the interviews with the stakeholders and the benchmark, an exhaustive review of the possible methodologies was presented to the stakeholders during the **second workshop**. A group discussion was then conducted on the possible criteria to select the most relevant methodology in the Belgian context and according to the stakeholders.

The main conclusion of the workshop concerned the possible methodologies: the exhaustive list enabled to present a global view, methodologies then have to be graded with the different criteria to assess their relative adaptation to the study. Since no candidate seemed to appear as the perfect methodology, it seemed pertinent to combine the methodologies to increase the robustness of the methodology.

After a confrontation of the criteria with the possible methodologies, the selection process was presented to the stakeholders during the **third workshop** along with a first volume determination methodology proposal. When presenting the details of the proposal, stakeholders were invited to react. This workshop concluded that a quantitative approach could provide the global volumes, to be complemented with a qualitative approach, provided by a second methodology. The overall volumes would have to be verified with a global sanity check to assess the coherence.

Considering these remarks from the stakeholders, a final methodology was presented during the **fourth workshop**, along with the first reflection on the implementation of this proposition.

As presented in the following calendar of the study, the methodology was then presented to the Task Force "Implementation Strategic Reserve" on the 20th of April 2017.

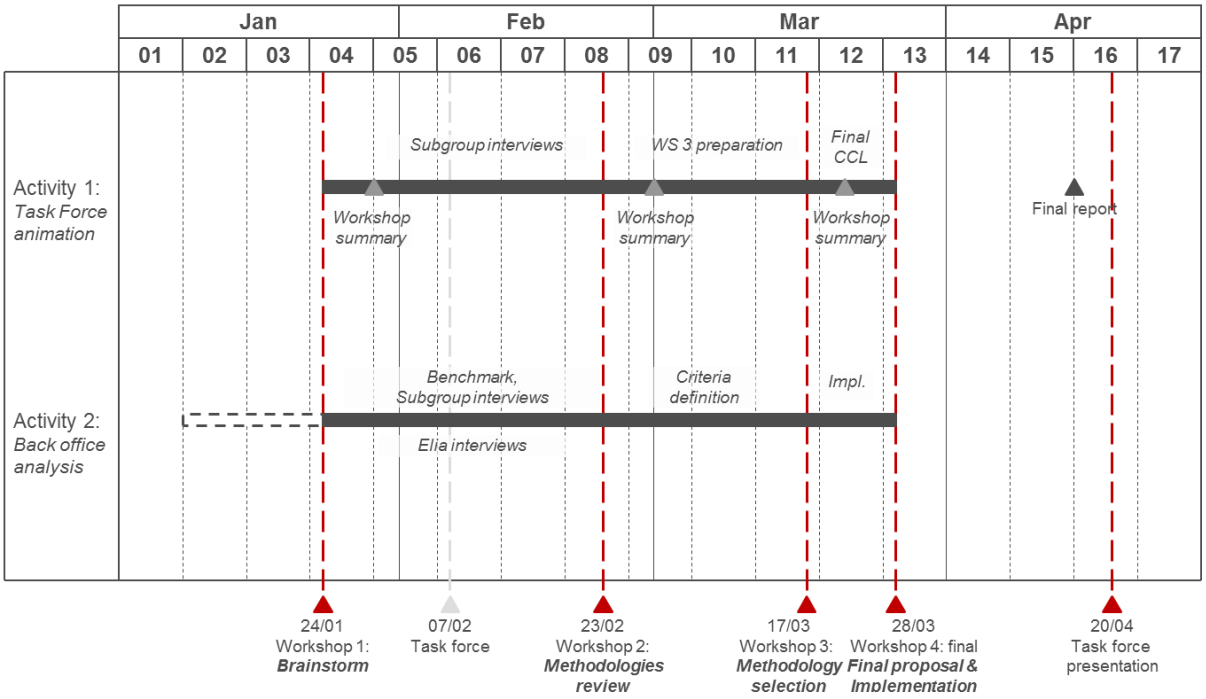


**Figure 1: Market Response study calendar**

# V. Project scope

This section will present the project scope. It encompasses all Market Response not subject to a contract with the Transmission System Operator (TSO), above normal conditions (prices >150€/MWh). A specific focus will be made on voluntary MR and on the ancillary services.

## 1) Scope of the project: Market Response

The scope of the project includes all volumes of Market Response except the volumes contracted directly by Elia. This volume in periods of stress cannot be directly handled by Elia, and indeed needs to be estimated. Market Response can be grouped in categories, as shown in the Figure 2.

The different MR products can first be separated according to their valuation:

- **MR can be valued in a market**, trough market mechanisms like R1, R3 Flex and R3 standard[1], BidLadder[2] and potentially in the future in the day-ahead and intraday market (DA/ID).
- **MR can be valued within a portfolio,** not explicitly sold on any energy/flexibility or capacity market. Suppliers/BRPs optimize their portfolios according to prices or tariffs levels. TSOs do not have to trigger this type of DR.

Four categories can then be separated:

- **Contract based with TSO**: this type of MR is directly activated by the TSO in periods of scarcity. Products in this category are R1, R3Flex, R3Std and ICH (until end of 2017). **These products have been excluded from the perimeter of the study since they are directly contracted with Elia and can therefore not be counted twice.** Though, the relationship between this volumes and Market Response must be taken into account and will be detailed thereafter, especially knowing the evolution of the DR products with the replacement of R3DP and ICH by R3Flex and R3Std.
- **Contract based with BRP:** this category gathers the contractual agreements on Market Response between a BRP and a customer. This load reduction is valued afterwards by the BRP within its portfolio.
- **Price based MR**: this category is divided into two parts, it can be:
    - **Valued in a market**: in this section, Market Response is directly sold in the energy markets by the customer. It can be the case for example when the energy markets (DA / ID markets) are open to Market Response, or with specific products like the BidLadder. Indeed, the BidLadder platform enables market players to value their flexibility directly within the platform
    - **Valued within a portfolio**: Market Response can also be valued by the suppliers within their portfolio without any specific contract: this type of MR is not directly sold but is indexed on the market price, like for example the Time of Use tariffs.
- **Voluntary MR**: this type responds to signals without any incentive. The signals can be sent by impactful entity (TSO, DSO, supplier, government…) via SMS or any other formal public notifications.

[1] Replacing R3DP (until end of 2016) and ICH (until end of 2017)

[2] BidLadder is expected in 2017 and also known by official name as R3 non-reserved

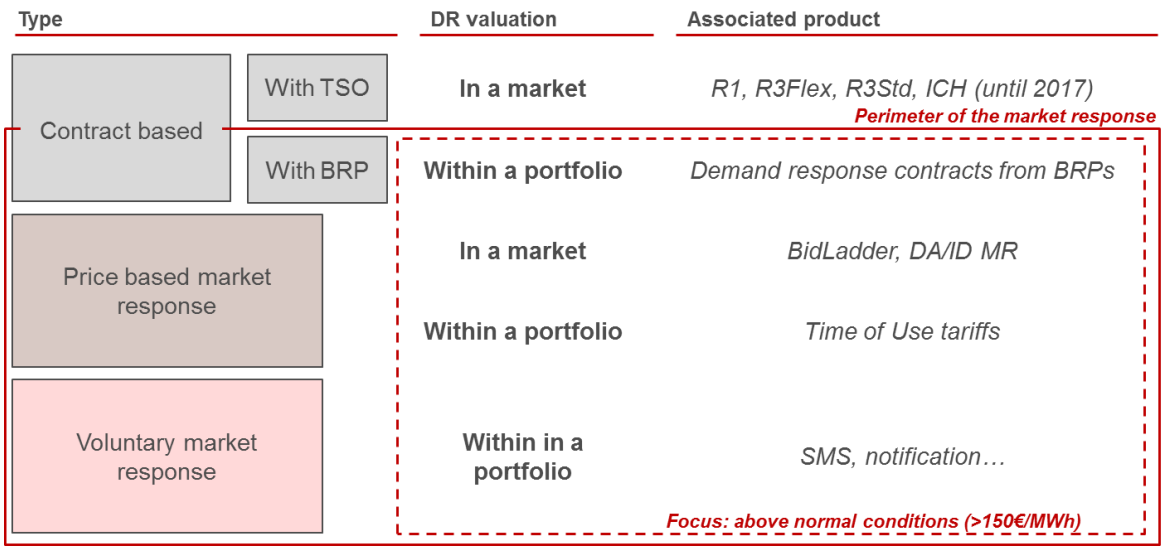


**Figure 2: scope of the project**

Moreover, the perimeter of the study encompasses these categories with prices above "normal conditions". Indeed, under a certain threshold, Market Response is already taken into account in the load forecast conducted by Elia since the input of the model is based on historical load. When prices go above the flag limit of 150€/MWh, the hours are flagged and not taken into account in the construction of the normalized load profile. Market Response is indeed not taken into account. This threshold has been taken as 150€/MWh, which is the price level used by Elia in the design of SDR as a reference for high prices. **The methodology indeed aims at assessing Market Response above normal conditions (price > 150€/MWh).**

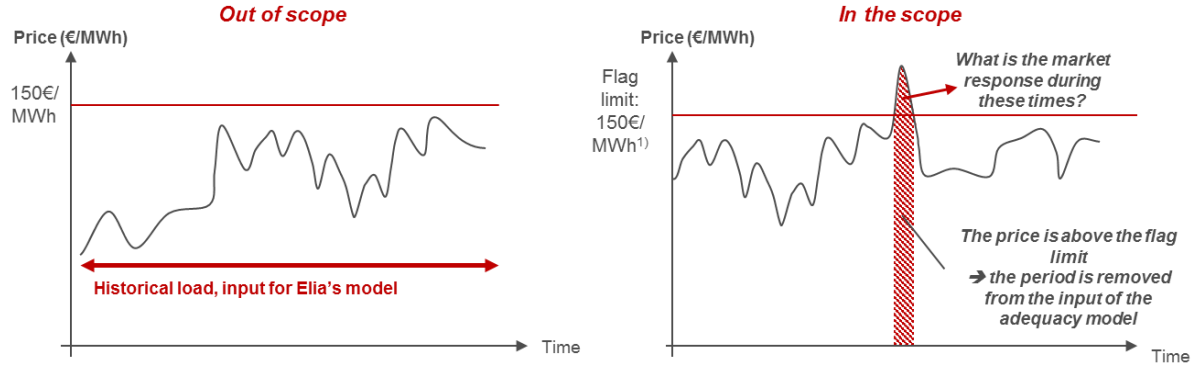


**Figure 3: input load profile calculation**

When confronting the different categories with the customer segments (Residential, tertiary and industrial), all MR types are not (yet) relevant to some customer segment:

- Contract based with the BRPs MR doesn't concern the residential sector for now, and rarely the tertiary, as they rarely have flexibility contracts with BRPs
- Price based MR is, for now, limited for residential customer
- Voluntary MR gathers all types of MR but is limited to MR foreseen by the BRPs (specific focus thereafter, in chapter 2) below)

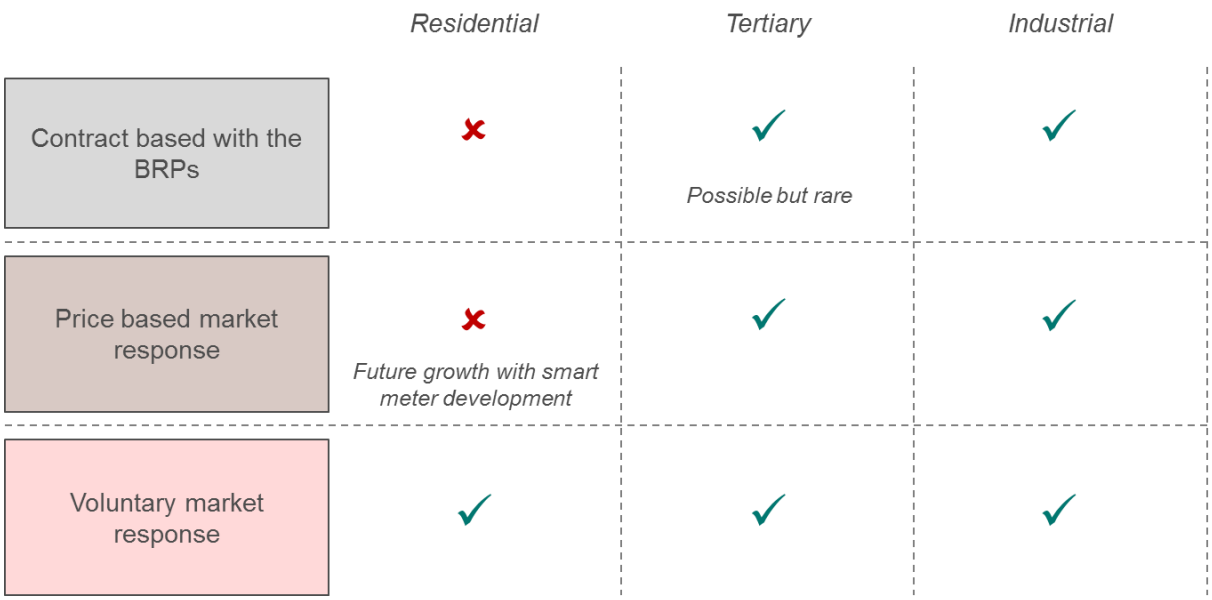


**Figure 4: perimeter of Market Response**

Indeed, even if some categories are not present yet, they will be taken into account in the methodology in case of future evolution, making the methodology robust.

### 2) Voluntary MR

A focus is to be made on voluntary MR since its definition needs to be clarified for this study. The following elements are the results of the discussions held with stakeholders during the workshops.

- **First, load reduction, considered as "pre-curtailment", shouldn't be taken into account in the scope of the project.**

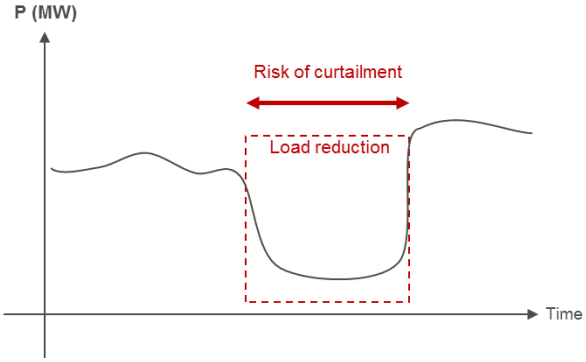


**Figure 5: « pre-curtailment » situation**

  In this type of situation, the customers reduce their load because of a risk for their own interests, for example a risk of machine failure. The SR aims at avoiding exactly this type of situation, so, this type of load reduction should not be taken into account for its sizing.
- Though, voluntary MR as the reaction of individual customers in tight situations was defined as part of the scope of the project during the discussions. In this kind of situation, the customers adapt their behaviors following a message sent by an impactful entity: government, TSO, DSO, suppliers…

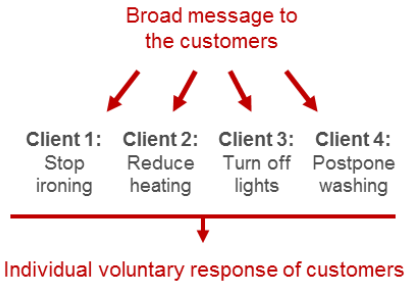


**Figure 6: example of voluntary MR situation**

This type of message is sent before any activation of the strategic reserve and the response of the customer is purely voluntary, as they are not directly impacted by the risks. This type of reaction is in the scope of the project. As we will see, the stakeholders agreed that BRPs should integrate this in their bids if assessed as firm.

### 3) Volumes contracted in the ancillary services

Even if not in the scope of Market Response, the volumes contracted in the ancillary services communicate with the volumes of Market Response and should indeed be studied.

In the volume assessment, the system operation is simulated, especially the scheduling of power plants in the energy market. The adequacy assessment is also taking into account that some capacity is "reserved" for operation after the energy market, i.e. the ancillary services (AS). AS can be provided by generation or Demand Response in the adequacy exercise:

- For generation units, the capacity is "blocked" with constraints in optimization
- For Demand Response, the capacity is removed from the Total DR in the optimization

The different DR types can be represented in the following graph:

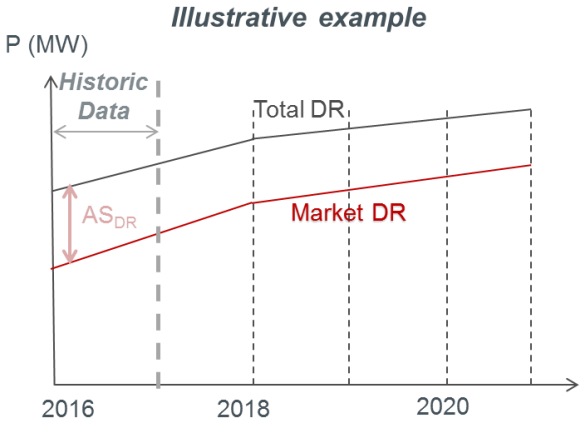


**Figure 7: link between the different types of DR**

Ancillary Services DR and Market DR determine the total DR capacity equipped to react during extra-ordinary conditions. The impact of the evolution inter-yearly and intra-yearly (yearly, monthly contracts)

of DR providing reserved ancillary services[1] on market DR has to be assessed within this methodology.

Using a methodology based on historical data enables to integrate the currently contracted Ancillary Services. But, the share of Demand Response can change over time. So, extrapolations of the market DR may require a correction with the expected evolution of DR:

- A decreasing DR in the ancillary services will increase Market Response, assuming that the total DR is not reduced,
- An increasing DR in the ancillary services will decrease Market Response, assuming that this increase exceeds the total DR growth

A consistency check with the total DR capacity evolution is required. This would be integrated in the methodology thanks to a correction factor for the Market Response, estimated on:

- The projections of ancillary services needs
- The historic DR contribution

The projections of the ancillary services needs will be based on the expected contracted operating reserves volumes evolution over the years. Only parts of these Contracted Operating Reserves are procured from Demand Response, amongst other technologies. This varies inter-yearly and intra-yearly (consider for instance the projected average).

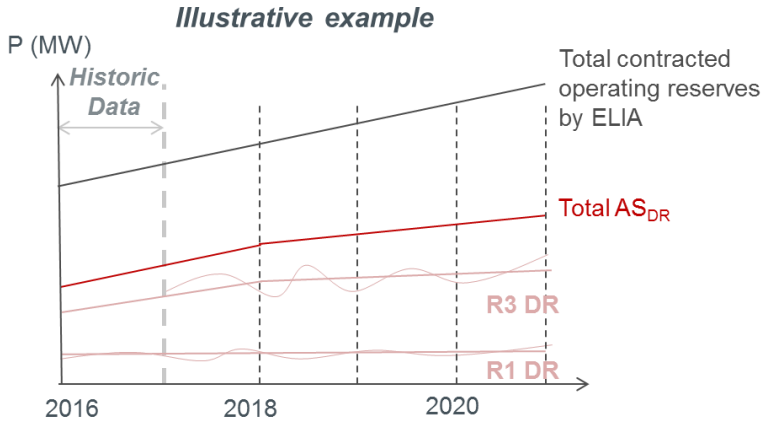


**Figure 8: illustrative operating reserve projections**

[1] Currently limited to R1 and R3; non-reserved R3 is considered in the energy market following its non-reserved nature)

# VI. Review of the possible methodologies

During the second workshop, the exhaustive review of the possible methodologies was presented to the stakeholders. This review is based on a group reflection, conducted with the stakeholders during the first workshop. The benchmark, conducted on the most relevant countries (Great Britain, France, PJM, Norway, and Finland) also brought some arguments to the discussions and the analysis.

The 8 following methodologies were listed:

- **Load curve of Elia:** case by case analysis of the volume variations of the total load of Elia in high prices situations
- **Aggregated curves analysis:** analysis of the EPEX DAM Belgium aggregated demand and supply curves in periods of high prices
- **Objective Q&A:** questionnaire sent to key players (customers, BRPs and aggregators) to assess their level of Market Response
- **Economic utility:** assessment of the utility of industrial segments to assess their MR potential according to the price levels
- **Similar days comparison**: load comparison of similar days: one without Market Response, another one with Market Response
- **Price contracts:** assessment of the total contracted volume indexed on prices (DA or balancing) and discount by a percentage depending on various factors (economic context, prices…)
- **Extrapolation ratio:** extrapolation of the volume already established in other regions
- **Activation threshold:** estimation of a price threshold, above which an estimated load is reduced

In the following sections, each methodology will be further explained.

### 1) Load curve of Elia

The methodology aims at looking for correlations during periods of peak prices so as to assess the subsequent level of Market Response. Peak prices have to be properly defined and made transparent.

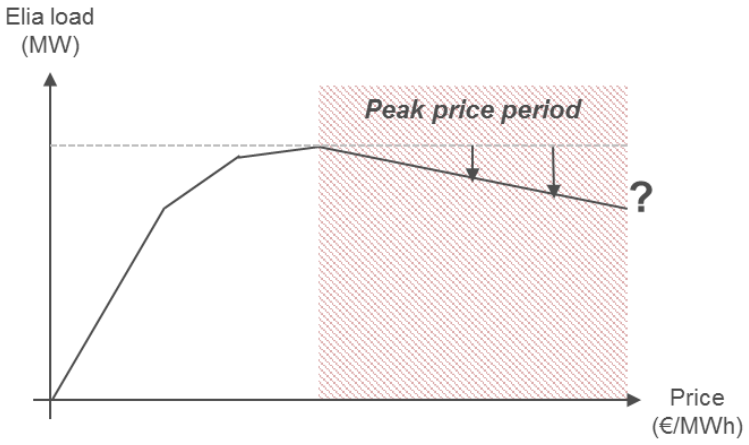


**Figure 9: theoretical evolution of the load with the prices**

This could be conducted using the total load of Elia, and the EPEX DAM Belgium prices. The temperature, the balancing prices and the intraday prices conditions should also be taken into account, in order to normalize the load curves.

### 2) Aggregated curves analysis

The aggregated curves of EPEX DAM Belgium could be studied to assess the level of Market Response associated. Indeed, in the curves, Market Response can be seen as a demand decrease in the demand curve above the price threshold, or as an increase of the offer, in the offer curve.

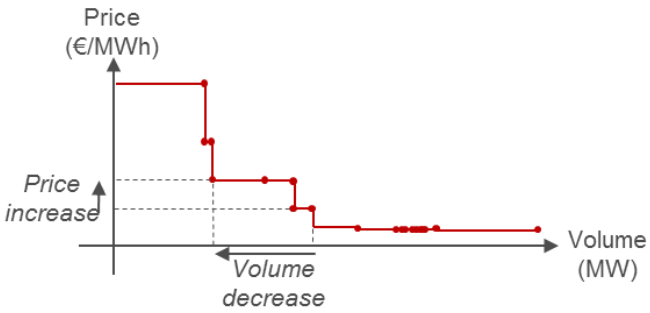


**Figure 10: Market Response in the demand curve**

The relation between the volume and the price is shown in Figure 10 for the demand curve. During the workshops, the threshold of 150€/MWh has been discussed and agreed by the stakeholders. It is considered that above this threshold, only Market Response behaviors appear in the curves: the Market Response volumes are indeed calculated looking at the volume reduction associated to a price increase from 150€/MWh to 3000€/MWh.

On the offer side, since the offer curve integrates the generation, it has to be retreated so as to assess only the effects of Market Response. Indeed, generation bids higher than 150€/MWh can be justified by extraordinary variable costs like, for example, a foreign sourcing.

### 3) Objective Q&A

As discussed with stakeholders, a questionnaire aims at asking directly to the relevant stakeholders (consumers, BRPs or aggregators) to estimate the volumes of Market Response in extra-ordinary conditions. Such a questionnaire could present various structures (exhaustive review with complex and numerous questions or limited number of simple questions), goals (assess quantitative hypothetical content or be restricted to qualitative content) and targeted respondents (to all the stakeholders (BRPs, aggregators and customers) or be limited to some types). This methodology was previously established to estimate Market Response in Belgium. It was agreed that if used again, the questionnaire should be reviewed in order to be simple, intuitive and avoid too many quantitative questions, as questionnaire recipients have difficulties projecting themselves and anticipating their behavior on extra-ordinary conditions.

### 4) Economic utility

The economic utility analysis aims at reconstructing the economic context of Belgium with a bottom up approach. Then, assess the economic utility of the defined branches. The economic utility enables to determine the price level when it becomes profitable for a player to reduce its load. With this value, the associated volume of Market Response can be estimated when prices increase.

**a.** The methodology would first start by a segmentation into different categories, for example

| Industry | Tertiary | Residential |
|---|---|---|
| • Metal working<br>• Steel<br>• Chemical<br>• Paper<br>• Agri-food<br>• Water<br>• … | • Cold<br>• Air conditioning<br>• Heating<br>• Ventilation<br>• .. | • Cold<br>• Air conditioning<br>• Heating<br>• … |

**b.** The Market Response potential of each category would then be estimated by assessing the economic utility. This step should consider also that it depends also on other factors like the day of the week, the external conditions, and the economic context.

**c.** Finally, the total volume could be estimated with the estimations of the volumes of each category

### 5) Similar days comparison

This methodology compares similar days, with and without Market Response.

1. The methodology first starts by selecting two similar days, with different Market Response profiles.
2. The load of these days is then adjusted to delete the effects of the temperature and the embedded generation.

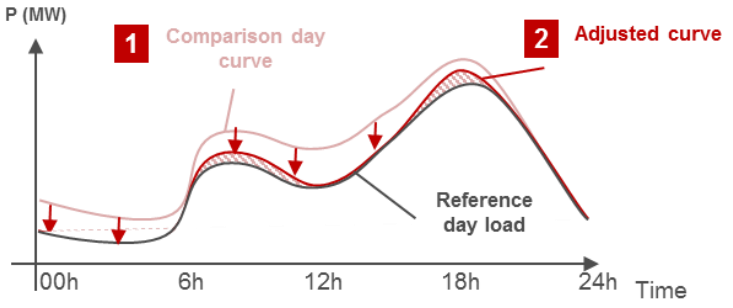


**Figure 11: similar days comparison**

This methodology is used in the UK thanks to a specific context: it is set up to estimate the impact of Triad Avoidance mechanism. During the peak load period (Triad periods) the customers are charged for the cost of the network according to their load. Customers try to anticipate and reduce their load during peak load periods, creating indeed a Market Response mechanism. With this mechanism, the comparison between “Triad days” and non “Triad days” is possible because specific warnings are sent

to the customers during the periods of Triad. This comparison enables to have an estimation of the impact of the Triad warnings in the reduction of the peak load.

### 6) Price contracts

This methodology starts by assessing the total contracted volume indexed on price (Day-ahead, balancing or both) and discounts it by a percentage depending on various factors: the economic context, the prices… Both the volume estimation and the percentage would then be updated every year, to take into account the contextual changes.

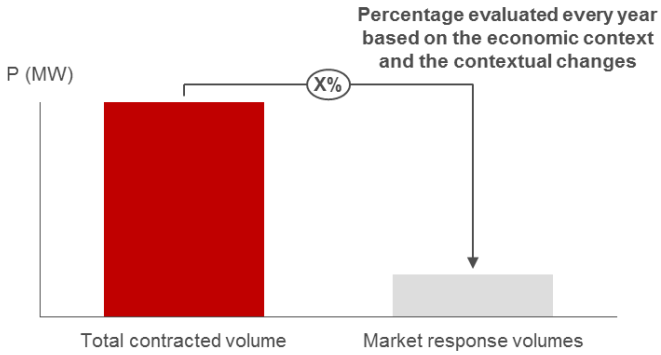


**Figure 12: price contracts methodology**

### 7) Extrapolation ratio

This methodology extrapolates the results established in one region to another region. For example, the two regions A and B could be compared according to their peak load:

- The region A estimates the Market Response of its region with a specified methodology
- The peak load ratio between the two regions is then applied to the Market Response volume of the region A

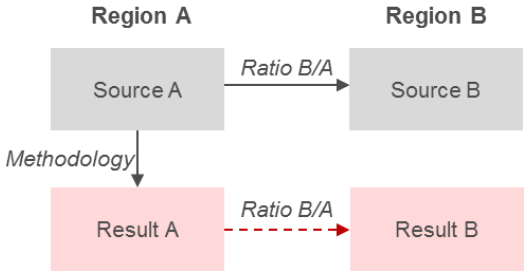


**Figure 13: extrapolation ratio methodology**

This methodology has however to pay attention to the different market conditions in the different regions compared.

### 8) Activation threshold

This methodology uses a threshold, above which players would completely reduce their load. The volume of Market Response associated is the total volume of the designated category.

For example, a solution would be to state that above 1000€/MWh, the entire industry volume shuts down. In the design of the methodology, two key elements have to be assessed:

- The level of the price threshold
- The volume associated

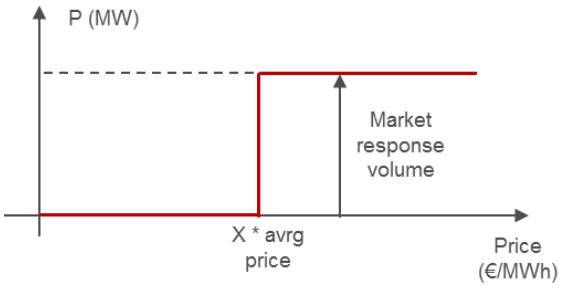


**Figure 14: activation threshold methodology**

# VII. Methodology selection

The 8 methodologies were confronted to various criteria so as to select the more adapted ones in the Belgian context. Along with the stakeholders and the project team, a series of criteria have been established to assess the suitability of the different methodologies:

- **Perimeter of the study:** the methodology has to assess the defined perimeter of the study
- **Feasibility:** the data required for the study needs to be accessible (and not confidential)
- **Coherence with the adequacy assessment:** the methodology has to be implementable in the adequacy assessment methodology afterwards
- **Robustness:** the study needs to be adapted to the future evolution of Market Response and to the yearly updates, conducted for the adequacy assessment
- **Simplicity:** the methodology has to be simple, intuitive and transparent
- **Cautiousness:** for the overall benefit to the society, the approach has to be cautious, but it is important to avoid adding layers of cautiousness at every step
- **Verification:** since one volume estimation cannot provide the exact amount, it is important to have a range, and then conduct sanity checks
- **Accuracy:** the study needs to come to a rather precise estimation by avoiding "double counting" or "zero counting" some volumes

The selection of the methodology was divided into two steps:

- **Perimeter assessment**: each methodology was first confronted to each segment of the project scope to ensure the assessment of the adapted perimeter
- **Criteria confrontation:** each methodology was then confronted to the other criteria previously listed.

The following section reviews these two steps in more detail.

### 1) Analysis of the perimeter of each methodology

Each methodology was first confronted to each segment of the project scope to ensure the assessment of the adapted perimeter: when matching the methodologies with the segments, some have to be excluded because they cannot be applied to certain categories or customer types.

- **For the contract based and price based MR,** the extrapolation ratio and the similar days methodologies don't apply. There are no inputs from other regions in the extrapolation ratio methodology and the similar days methodology doesn't provide any differentiation criteria between days with Market Response and days without Market Response.
- **For the voluntary MR,** the price based contracts methodology, the load curve of Elia and the activation threshold don't apply as there are no price signals in voluntary DR. Indeed, these methodologies are based on the analysis of specific situations of high prices, which doesn't make any sense for voluntary MR. The economic utility neither applies since the concept of utility doesn't exist for voluntary MR.

This can be synthetized in the following perimeter:

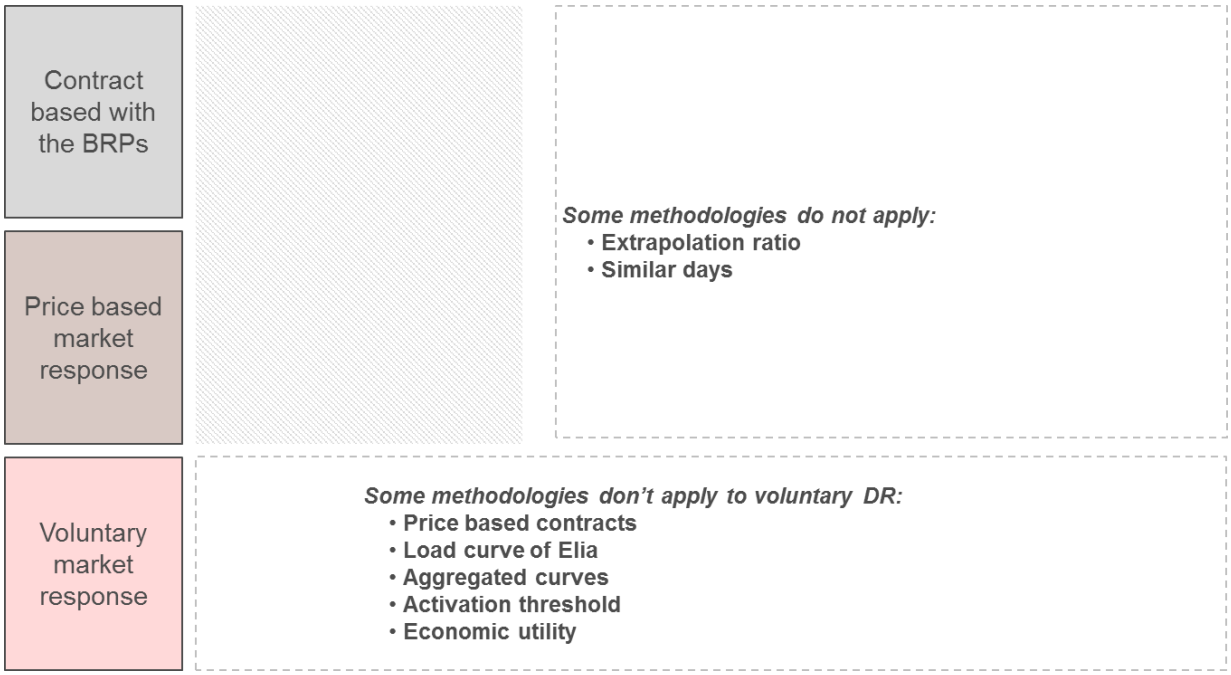


**Figure 15: matching between the perimeter and the methodologies**

Some other methodologies apply to wider categories, and not only for the individual segments:

- The load curve of Elia assesses the total volume of price based MR and contract based with BRPs
- The aggregated curves methodology estimates the overall volume of Market Response
- The economic utility analysis cannot estimate the individual segments but can estimate the global industrial volume

### 2) Criteria confrontation

Besides the perimeter, each methodology was confronted to the other criteria established: feasibility, coherence with the adequacy, robustness over the years, simplicity and cautiousness. The assessment of each methodology is detailed bellow in Figure 16 while the subparts focus on the key conclusions for each methodology.

| Methodology / Criteria | A Load curve of Elia | B Aggregated curves | C Objective Q&A | D Economic utility | E Similar days comparison | F Price contracts | G Extrapolation ratio | H Activation threshold |
|---|---|---|---|---|---|---|---|---|
| Feasibility | Curves are accessible | Curves are accessible | Depends on the answers of the stakeholders | Depends on interviews with stakeholders | Comparison signal is not accessible | Contract volumes are not accessible | Depends on the source methodology | Accessible data |
| Coherence with the adequacy | It doesn't provide details on the activation | It doesn't provide details on the activation | Activation details can be integrated | Activation details can be integrated | It doesn't provide details on the activation | It provides a single volume value | It provides a single value | It provides a single value |
| Robustness over the years | Case by case update of the methodology | Yearly updates would integrate the evolutions | It has to be re-conducted every year | The entire analysis has to be re-conducted | Yearly updates would integrate the evolutions | Percentage update is based on the evolutions | Depends on the external source of extrapolation | Depends on the update of the volume estimation |
| Simplicity | Complex to understand | Complex to understand | Simple to understand | Not intuitive in the hypotheses justification | Day selection methodology can be complex | Rather simple to explain | Very simple to understand | Very simple to understand |
| Cautiousness | Case by case analysis due to limited data | Methodology based on past data | Customers can answer with their interests | Depending on the hypotheses of the model | Methodology based on past data | Depending on the percentage of decrease | Needs to be adapted to the region | Strongly depending on the threshold |

**Figure 16 : individual assessment of the methodologies**

### a) Load curves of Elia

The number of high prices events (>150€/MWh) is, for now, limited to 80 hours over the past 3 years, as depicted in the graph of the Figure 17.

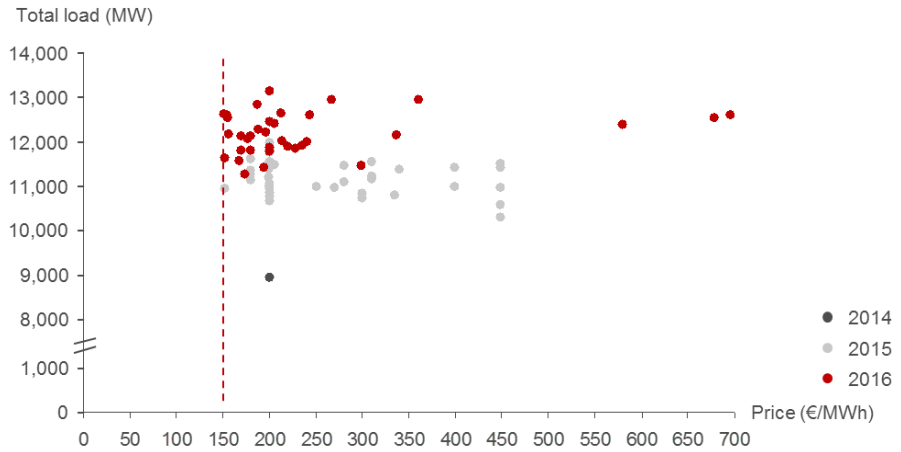


**Figure 17: hourly DA prices and total load of Elia when prices are above 150€/MWh**

Even if the number of high prices situations has been increasing during the recent years, the size of the available data sample is still not important enough to perform a proper statistical analysis (~80 hours). We are then restricted to finding high prices periods like the 22/09/2015 with 14 hours above 150€/MWh, the 15/10/2015 with 10 hours above 150€/MWh etc. Therefore, more than a correlation, a case-by-case analysis of the load curves of Elia seems to be more suited for this methodology. As an example, a more precise study of the 22/09/2015 can be conducted.

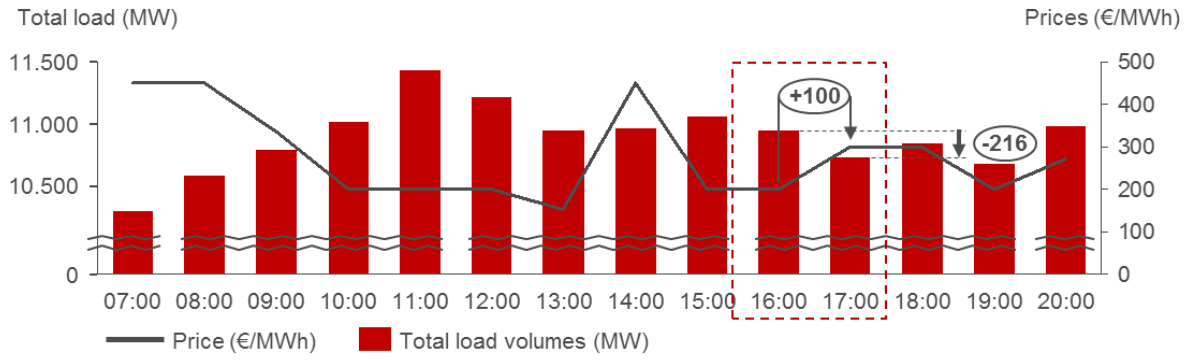


**Figure 18: DA prices compared to Elia load on the 22/09/2015**

During this day, there is a price increase in the DA market from 16 to 17 with a load decrease. The next step would be then to exclude the parameters influencing the load. During the same period, the temperature is stable at 11,6°C and the balancing prices are quite high at 250€/MWh.

**But, excluding exhaustively all the parameters influencing the total load is very complicated. The robustness of this methodology is indeed very difficult to justify.**

Also, as this methodology is based on historic data, it would have to be adapted to integrate the possible future situations.

**➔ This methodology is limited by the lack of high prices situations with only 80 hours with prices above 150€/MWh since 2014. This would lead to a case by case analysis of the curves, which would be way less robust**

### b) Aggregated curves analysis

The aggregated curves methodology enables to overcome the main limit of the load curve methodology: there are no limits to the dataset used. Indeed, the bids above 150€/MWh are present in the aggregated curves no matter the clearing price.

On the contrary, some limits of the methodology will have to be tackled:

- The curves may not target the entire perimeter of Market Response (like the volumes of voluntary DR, the OTC bids or the smart orders);
- The methodology is limited to historic events: it requires to be adapted to integrate future evolutions.

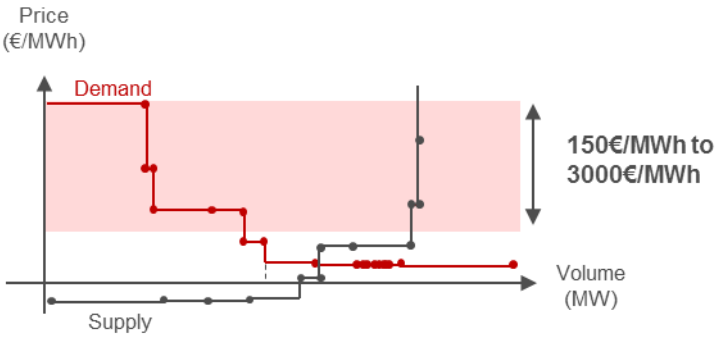


**Figure 19: available data from the aggregated curves analysis**

➔ **This methodology overcomes the lack of high prices situations problems. It provides a more robust approach of the overall volumes of Market Response**

### c) Objective Q&A

The Q&A methodology presents certain limits, raised by the stakeholders during the workshops. The following main elements have been raised:

- **Overall complexity:** it might be too laborious to fill if there are too many questions, thus reducing the willingness to participate of the respondents.
- **Hypothetical situations description:** the answers can be non-adapted to the knowledge or the reality of the respondents, leading to approximated answers.
- **Lack of objectivity:** each player may have an incentive to overestimate or underestimate their volume as they are impacted by the end-result
- **Participants:** a significant number of participant is required

But, the questionnaire presents specificities: it enables to integrate the details of activation, making it very coherent with the adequacy and is also robust towards the future evolutions since the updates will enable to take into account the changes in the behaviors of the customers.

Knowing these limits, it seems very difficult to obtain from the questionnaire hypothetical volumes like the possible reaction to prices of 3000€/MWh. This situation being not realistic for the respondents, the robustness of their response seems difficult to justify. But, the questionnaire can be pertinent to obtain qualitative content from the different players. Indeed, if the questionnaire remains simple and focuses on qualitative content, the preceding limits can be overcome.

➔ **The known limits of the questionnaire can be overcome with an improvement of the questions and by focusing on qualitative questions. Globally a questionnaire must be simple, intuitive and provide questions anchored in the reality.**

### d) Economic utility analysis

The economic utility enables to integrate potential higher prices: it is not limited to historical data, and also takes into account the activation details of the volumes. But, various limits reduce the attractiveness of this methodology:

- **Strong variability of the results**: the results of the methodology strongly depend on the hypotheses used during the estimation of the potential of each category
- **Difficult justification of the hypotheses**: the profitability of the activation doesn't necessarily implicate the activation. The economic reality of the players has to be taken into account, and is difficult to assess.
- **Weak robustness towards future evolutions**: the hypotheses of the model will need to be verified yearly one by one regarding the evolving context
- **Complexity of implementation**: the methodology would require an important amount of resources, making it costly and difficult to comply in the required timeframe
- **Strong dependence on key requirements**: the study entirely depends on the inputs of the industrial players who are not necessarily willing to share sensible information. Without, the results will be mostly inaccurate

➔ This methodology is clearly limited by the requirements of **sensible information** on the industrial processes, a **strong variability** depending on the retained hypotheses and a **strong cost of implementation**.

#### e) Similar days comparison

This methodology selects pertinent days so as to be sure of the Market Response presence in the curves. But, it is limited by the fact that the functioning completely depends on a selection criteria so as to differentiate a day with Market Response and a day without Market Response.

Such signal doesn't exist for price based MR in Belgium. For example, this type of signal could be found for voluntary MR using the actual signals launched by the impactful entity (TSO, DSO, supplier or government) to the targeted customers. It would then be possible to compare two similar days: one with the signals and one without. But, this type of signal is, for now, not measurable in Belgium since no formal event happened in the past.

➔ This methodology is **not adapted to Belgium** since there is no comparison signal set up for now

#### f) Price contracts

This methodology provides a rather simple calculation of the volumes, easily renewable every year and with the possibility to adjust to specific evolutions. But, it is limited by dependence on the estimation of the volumes of price indexed contracts. Elia doesn't have access to this type of information directly. Another solution would be to estimate the volumes separately, with specific questions in the Q&A for example.

➔ This methodology **is limited by the lack of accessible data**: the assessment of the price based contracts volume is not possible, except through a specific Q&A.

#### g) Extrapolation ratio

This methodology provides easily and intuitively, an estimation of the volume of Market Response based on international experiences. But it is limited by:

- **The adaptation to the specificities of the country**: it does not take into account the specific context of the region, which can strongly influence the potential of estimation.
- **The output of the methodology**: it provides a unique value for the volume of Market Response without any integration of activation specificities (number of activation, duration…). This methodology has a weak coherence with the adequacy assessment

➔ **This methodology cannot be used directly** to estimate the volumes since it is specific to a region (thermos-sensitivity, behavior, pressure / incentive to react…) but it can provide a sanity check of the overall volumes

#### h) Activation threshold

This methodology provides a simple way to estimate the volume by considering that above a certain price level, a given volume is reduced. But, it is limited by:

- **A rough approximation of the reality**: players will reduce their loads gradually
- **The threshold determination**: it is complicated to justify

- **Its output:** this methodology provides an unique value of the price dependent volumes without the activation specificities (number of activations, duration…), leading to low adaptation to the adequacy requirements
- **Its perimeter**: The methodology also provides a limited volume (for example the industrial sector) and cannot cover the entire perimeter of the methodology

➔ **This methodology cannot be used as such** since it is a rough approximation of the reality and the threshold is complex to justify.

*

*  *

Finally, the main conclusion on the analysis of the methodologies can be summarized in the following table:

| | |
|---|---|
| **Load curve of Elia** | This methodology is limited by the lack of high prices situations with only 80 hours with prices above 150€/MWh since 2014. This would lead to a case by case analysis of the curves, which is less robust |
| **Aggregated curves** | This methodology overcomes the lack of high prices situations problems. It provides a more cautious approach of the overall volumes of Market Response. |
| **Objective Q&A** | The known limits of the questionnaire can be overcome with an improvement of the questions and by focusing on qualitative questions. Globally a questionnaire must be simple, intuitive and provide questions anchored in the reality. Also, if focused on qualitative content, the problem of lack of objectivity mentioned previously is reduced. |
| **Economic utility** | This methodology is clearly limited by the requirements of sensible information on the industrial processes, an important variability depending on the retained hypotheses and a strong cost of implementation. |
| **Similar days comparison** | This methodology is not adapted to Belgium since, for now, there is no comparison signal, like the warnings sent for Triad Days in the UK for example. |
| **Price contracts** | This methodology is limited by the lack of accessible data: the assessment of the price based contracts volume is not possible, except through a specific Q&A. |
| **Extrapolation ratio** | This methodology cannot be used directly to estimate the volumes since it is specific to a region (thermos sensitivity, behavior, pressure / incentive to react…) but it can provide a sanity check of the overall volumes. |
| **Activation threshold** | This methodology cannot be used as such since it is a rough approximation and the threshold is complex to justify. |

# VIII. Final methodology

In the following section, the final methodology is presented: the global Market Response volumes in the framework of SR will be estimated based on the analysis of the aggregated curves of EPEX DAM Belgium. This analysis will be complemented with a qualitative questionnaire to assess the activation details and finally verified with a sanity check.

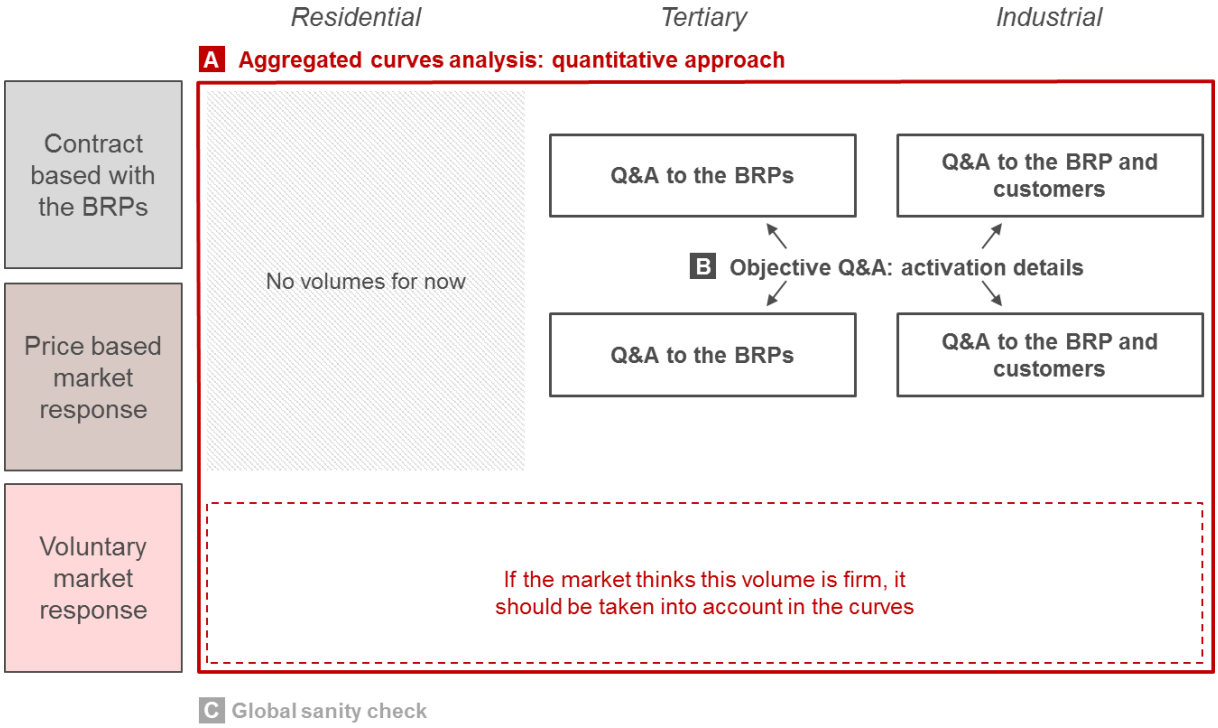


**Figure 20: global methodology perimeter**

### 1) Aggregated curves analysis: global volume estimation

As shown in Figure 20, the aggregated curves methodology enables to estimate the entire perimeter of Market Response. It integrates the volumes of voluntary MR foreseen by the BRPs: if there are some volumes in the voluntary category, the BRPs will anticipate such events. In theory, their anticipation will be reflected in their bidding behaviors, voluntary MR being indeed implicitly taken into account in this methodology. The volumes of residential MR, even if not relevant for now, are also taken into account in the methodology, hence making the methodology very robust towards the future evolution of the volumes. On the contrary, the methodology doesn't enable to provide separate volume estimations of the categories. This is as such not a problem for the adequacy assessment (but it will have to be considered when assessing the technical characteristics of the volumes).

The analysis of the aggregated curves has to take into account possible presence of generation bids, which shouldn't be integrated in the Market Response estimation. In the aggregated curves, Market Response volumes can be valued:

a) As a demand decrease
b) As an offer increase

### a) Demand decrease

The demand decrease due to a price increase is directly seen in the aggregated curves by looking at the volume decrease associated to the price increase from 150€/MWh to 3000€/MWh. Since, the aggregated curves are provided for each hour, this volume comparison is computed hourly.

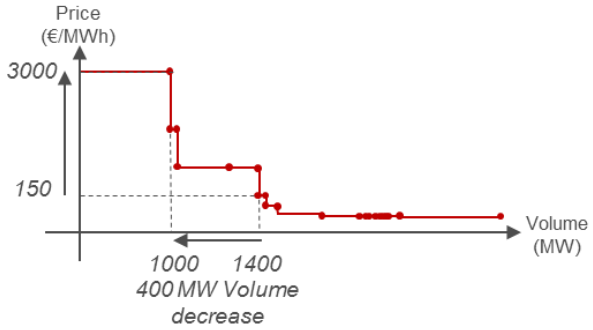


**Figure 21: Market Response in the demand curve**

On the demand side, the output is the volume of Market Response for each given hour.

As an example, if 400 MW is above the limit of 150€/MWh, the estimated volume of Market Response for this particular hour is estimated to be 400MW.

### b) Offer increase

Instead of a demand decrease, suppliers can value Market Response as a new offer in the market. This volume would appear in the supply curve. These curves cannot be analyzed as such since they can also integrate the bids of generation assets higher than 150€/MWh. Indeed, generation bids higher than 150€/MWh can be justified by extraordinary variable costs like, for example, a foreign sourcing.

To refine the analysis of the supply curve, we consider two price thresholds:

- **150€/MWh**: it is generally considered as the limit bid for generation assets, even if some generation assets can justify higher bids in specific cases
- **500€/MWh:** Above this value, it is considered very difficult to justify the price, and we can consider that only Market Response bids appear in the curves

The analysis of the supply aggregated curves indeed provides us a range with:

- **a low estimation** of the offer side: this estimation doesn't take into account the potential value under 500€/MWh but definitely excludes generation
- **a high estimation**: this estimation integrates the adequate Market Response perimeter but possibly takes into account additional volumes of generation assets

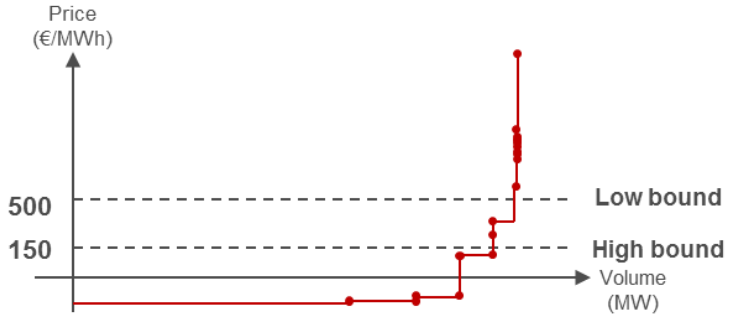


**Figure 22: analysis of the supply aggregated curve**

As an example, if the volume above 150€/MWh is 150MW and the volume above 500 €/MWh is 100MW, it can be considered that the volumes of Market Response valued in the supply curve will be in the range of [100-150] MW.

After the description of the perimeter of the aggregated curves methodology in the chapter VIII.1), the remaining limits found in the chapter VII.2).b) have to be treated.

Smart orders are linked block orders (one block is executed if the other is also) or exclusive block orders. With linked block orders, the execution of a block is linked to the execution of another block. The exclusive block order regroups various block orders, but only one being executable.


**Figure 23: smart orders principle**

In the aggregated curves, the smart orders are not taken into account. It indeed reduces the total volume estimated. Though, the volumes of Demand Response smart orders are very limited, most of it being from generation assets. The impact for the Market Response volumes assessment is hence very limited.

Concerning the OTC bids, they are implicitly taken into account in the curves. If not in the curves, it would correspond to irrational behavior of the stakeholders, which is not to be taken into account in our study.

### 2) "Objective qualitative Q&A": qualitative content to complement the aggregated curves analysis

The aggregated curves analysis provides a capacity estimation and not an hourly volume to integrate in the model. For the integration into the adequacy assessment of Elia, it is required to obtain the number of activation per week and the maximum activation duration.

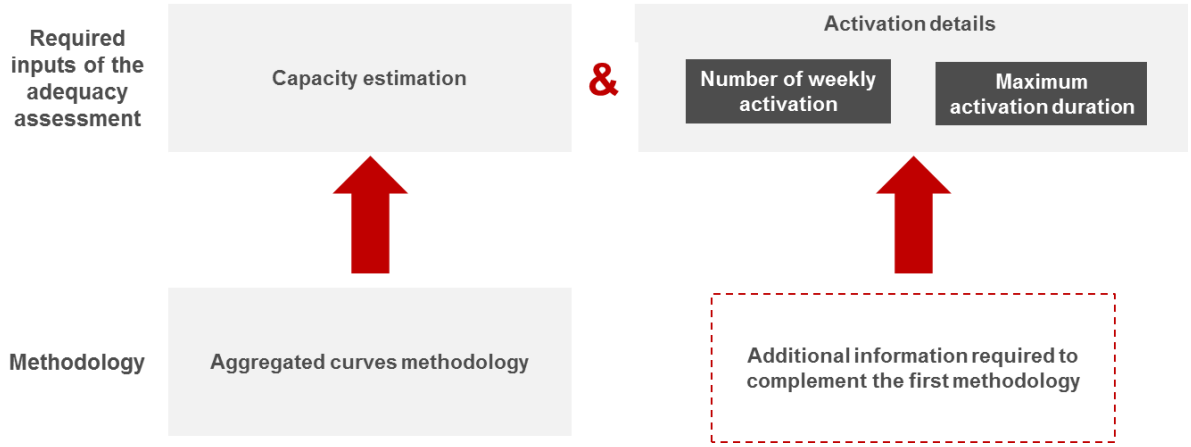


**Figure 24: integration of the methodology into the adequacy assessment**

The details on the activation will be obtained thanks to a Q&A. This questionnaire will be **objective**, to avoid unrealistic and non-answerable questions. It will also be **qualitative**, focused on gathering the required information on the activation in order to establish a correct link between the adequacy assessment and the methodology.

According to the discussion conducted with the stakeholders, the Q&A must be simple, intuitive, and have questions anchored in the reality. Its main objective will be to obtain qualitative information to complement the aggregated curves methodology. The key information is the number of possible activation per week and the duration of the activation.

### 3) Global sanity check

To conduct a sanity check, the questionnaire can provide an estimation of the volumes currently valued. This volume can be asked with direct questions, leading to direct answers. This would enable to avoid the main limit of the questionnaire raised by the stakeholders: the hypothetical situation description.

An international comparison point will also be formalized by the project team, putting the Market Response volumes in proportion of the maximum peak load in the electric system.

This volume will then be compared to the volumes previously established so as to assess the global coherence of the volumes.

# IX. Phase 2 – Implementation of the selected methodologies

This chapter reviews the next steps discussed with stakeholders in order to implement the jointly selected methodologies to determine the volume of Market Response in extra-ordinary conditions.

## 1) Aggregated curves analysis: distribution of the results

As previously explained, the output of the aggregated curve analysis will be hourly values of Market Response volumes. So as to integrate the results in a pertinent manner into the adequacy assessment, the statistical distribution of the results will be analyzed, to provide confidence intervals and go beyond a simple average calculation.

The impact of different parameters will also be assessed to reveal specific patterns, if present. The impactful parameters could be the day types (week day vs weekend), the time (peak hours), the temperature or the season. If specific patterns appear, they will be taken into account when integrating the results in the adequacy assessment. For example, a possible pattern could be a seasonality in the values of Market Response:

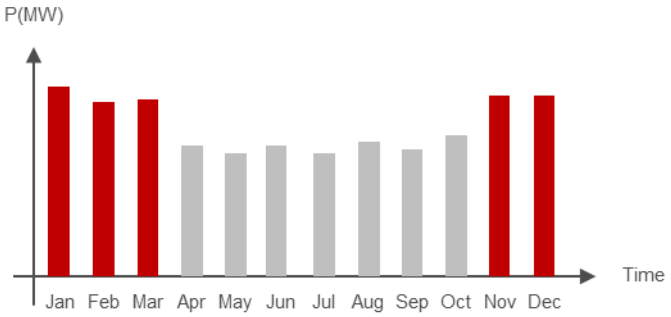


**Figure 25: example of possible pattern**

This specific pattern could be integrated by separating the volumes of the winter months from the volumes of the other months.

## 2) "Objective qualitative Q&A": operational set up

To have the feedback of all the players at stake, the questionnaire will be sent to the BRPs, the aggregators and the TSO connected customers and sector federations (i.e. Febeliec). The confidentiality of the questionnaire can be essential for some players and can sometimes improve the pertinence of their response. In this perspective, the respondents will have the possibility to fulfill a NDA or to provide their own NDA to a third party (the consultants).

The Q&A will be sent by email, as it is the most convenient way to answer. A specific questionnaire will be developed for each type of player (suppliers, aggregators and customers), in order to take their specificities into account. The questionnaire will be developed in close cooperation with the respondents so as to ensure useful answers.

The repetition of the questionnaire, as it depends on the context, will be assessed considering the insight of the methodology implementation, in the coming years.

Also, the methodology should provide volumes estimation for the three following winters. The output of the methodology, valid for next winter, will indeed be extrapolated based on the evolution of Market Response volumes during the three previous years, provided by the aggregated curves analysis. This extrapolation could also be validated by inputs provided by the qualitative questionnaire. Also, a correction factor can be applied due to the evolution of volumes of ancillary services. This correction factor will be based on the projections of ancillary services needs, conducted by Elia and on the historic MR contribution.

The methodology will then provide a volume estimation of Market Response for the three following winters.

### 3) Calendar of implementation

The final results, consisting of a volume of Market Response in extra-ordinary conditions, as well as characteristics required for the adequacy assessment, will be worked on together with stakeholders in two more workshops, and aim at finishing by the end of June 2017.

The aim of workshop 5 will be to present intermediary results. Specifically, the calculations and possible assumptions on aggregated curves analysis will be transparently presented to stakeholders.

Workshop 6 will discuss the final results of the application and integration of both methodologies with stakeholders, and prepare the presentation to the ISR TF.

The final results will be presented to the ISR TF.

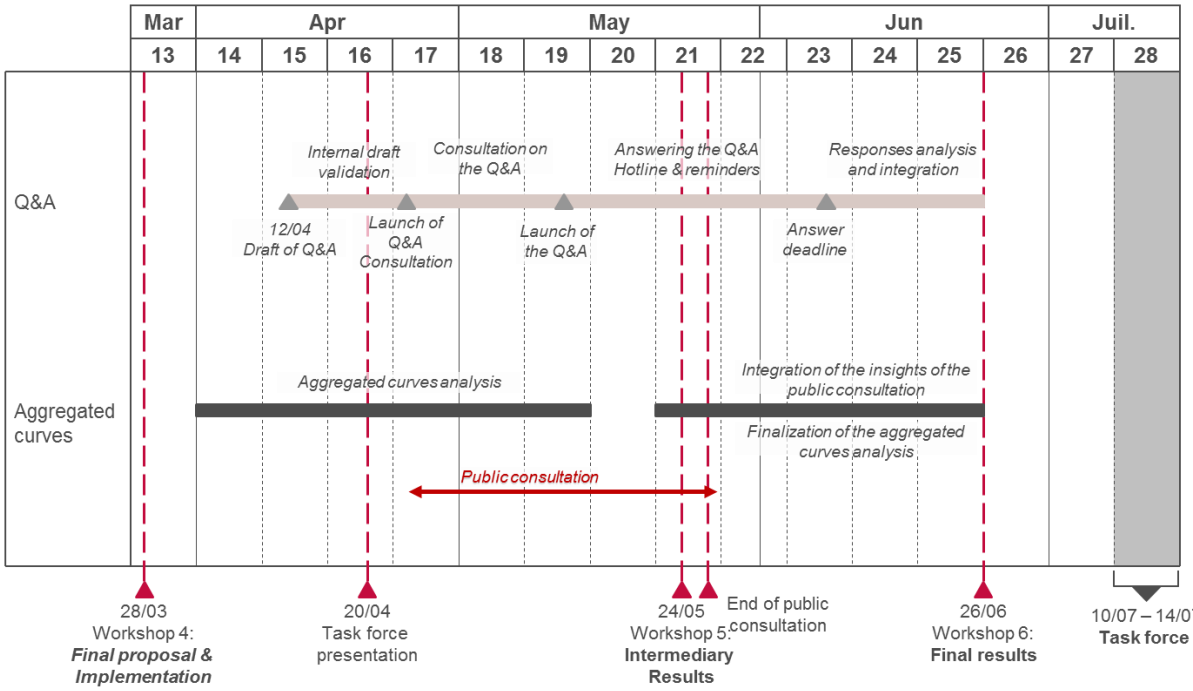


**Figure 26: implementation calendar**

# X. Appendices

## 1) Glossary

- MR: Market Response
- DR/DSR: Demand Response / Demand Side Response
- DAM: Day-ahead Market
- FSP: Flexibility Service Provider
- BRP: Balance Responsible Party
- TSO: Transmission System Operator
- SDR: Strategic Demand Reserve
- DA: day-ahead
- ID: Intraday
- AS: Ancillary Services

## 2) Details of the benchmark

### a) The United Kingdom

In the UK, Market Response is limited to 2 products (Triad management and Red Zone avoidance), only the first one has a dedicated estimation methodology based on load comparison of days with & without DR signals. The other one is implicitly estimated.

There were ~2GW of Demand Response capacity in 2016[1] in the UK. Among this capacity ~0.3 to 0.9GW is explicit DR. It can be valued through the main balancing mechanisms but it is mainly provided by 2 mechanisms: STOR (Tertiary reserve) and FCDM (Frequency response by Demand Management).
The other part ~0.7 to 1.5 GW is generated through implicit DR via the Customer Demand Management program with two products:

- **Red zone management (DUoS)**[2]: assumed as constant, indeed implicitly taken into account in the correlations of the demand forecasts (3-4 years correlations)
- **Triad avoidance (TNUoS)**[3]: explicitly taken into account with a dedicated methodology based on load comparison

The Triad Avoidance methodology is based on the comparison of the load during a Triad day and a Non Triad day, adjusted to eliminate the effects of the external conditions. The methodology is divided into two steps:

1. **Selection of a Triad day and a non-Triad day so as to compare them**
   The selection of two comparable days is based on similar day types (weekdays) and with similar conditions (from one year to the other for example). The difference between a "Triad day" and a "non-triad day" is done thanks to the signals sent by the providers: the triad day is compared to a day with a similar profile but without any Triad warnings sent to the customers

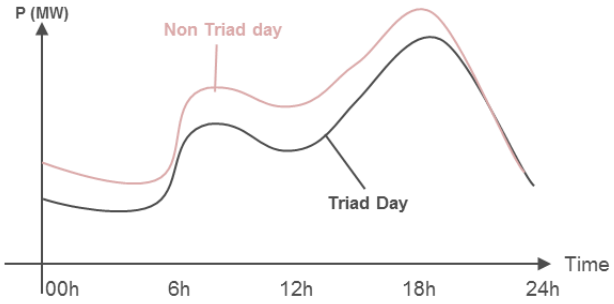


**Figure 27: selection of a non-Triad day**

2. **Adjustment of the load curves so as to eliminate the external conditions**
   The selected curve is then adjusted so as to eliminate the effects of external conditions (temperature and embedded generation adjustment (Wind and solar)). The difference during both load curves is then attributed to Triad Avoidance

[1] National Grid – 2016 – "Winter outlook report"
[2] Red Zone Management consists in higher tariffs during a certain period of the day (16h->19h) so as to pay the distribution charges of the system
[3] Triad Avoidance consists distributing the charges of the transmission network based on customers consumption during periods of peak load

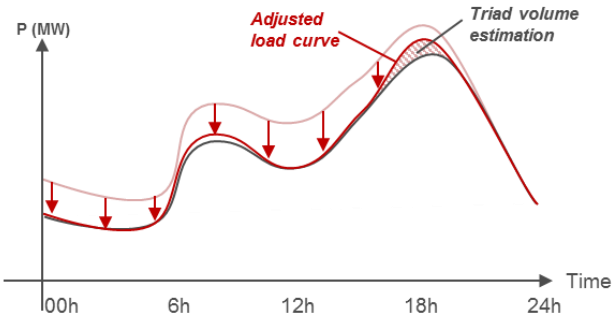


**Figure 28: adjustment of the load curves**

National Grid estimated a maximum of 2GW of Triad avoidance. Typical values are between 0,7GW and 1,5GW. So as to take into account the uncertainty, they use ~1GW in the winter outlook (adequacy assessment).

***Conclusion for the Market Response study***

The estimation of the Market Response by comparing loads of different days can be efficient when day with or without Market Response can be differentiated (for example for voluntary DR).

### b) France

In France, DR was introduced in the 80's with implicit DR, gathering up to 6 GW of capacity, and has been decreasing since 2008 due to the reduction of capacity under peak-pricing tariffs (EJP). DR now represents 3GW and is forecasted to remain around this level by RTE. As shown in the graph bellow, market mechanisms have been replacing implicit DR and now represent ~75% of DR capacity in France.

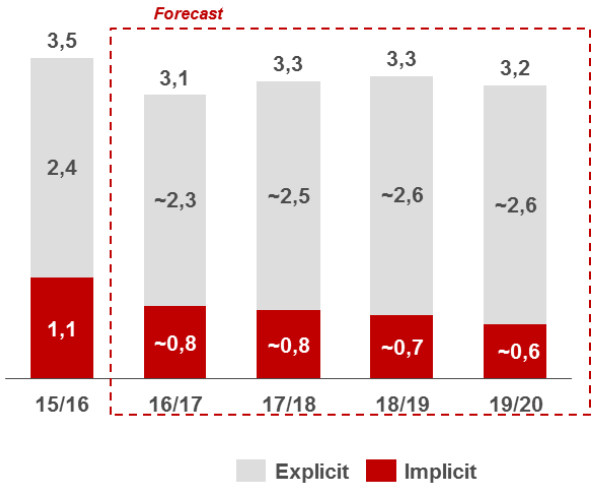


**Figure 29: DR capacity breakdown in France [GW]**

Regarding the estimation of Demand Response volumes in the adequacy:

- Firstly, explicit Demand Response is directly estimated by the tender offer.
- Secondly, implicit Demand Response is directly estimated by the suppliers of this type of contracts and double-checked by RTE. Indeed, the suppliers of the implicit DR contracts provide to RTE an estimation of the DR volumes available. For the integration in the "Bilan prévisionnel", RTE validates these numbers by conducted bilateral discussions with various key stakeholders of the market (large providers but also smaller players).

- Finally, voluntary Demand Response, even if very implemented in some regions with the EcoWatt program, is not taken into account in the adequacy assessment: it is considered as an emergency procedure.

***Conclusion for the Market Response study***

In situation of high prices, it is difficult to anticipate the behavior of the players. This explains a cautious approach conducted by RTE in the adequacy assessment.

### c) PJM

In PJM, DR is mainly generated for the capacity market but is also present in the DA/ID markets and the ancillary services (~3 GW). The Figure 30 shows the split of revenues: more than 90% of DR revenues at PJM come from capacity.

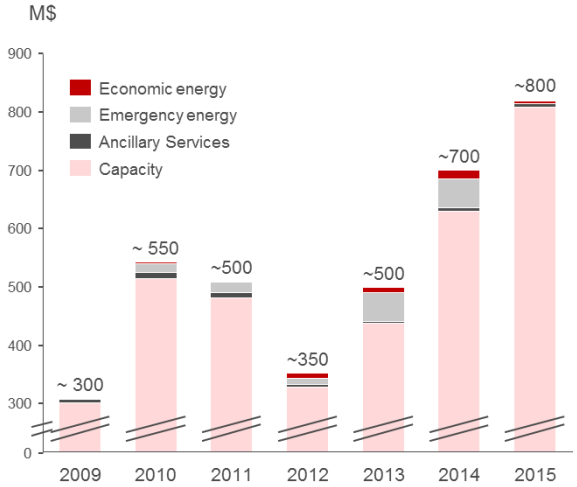


**Figure 30: DR revenues in the PJM market**

The perimeter of Market Response is then limited to three products:

- **Economic Demand Response**: Demand Response valued in the energy markets. This type of Demand Response is implicitly taken into account when conducting the peak demand estimation. The total amount currently registered is 2,605MW
- **Price Responsive Demand**: this type of Demand Response is taken into account, as the providers of PRD have to guarantee a level of load reduction in case of high prices. The total amount registered for DY 2020/2021 is 558MW
- **Emergency Voluntary Energy Only Demand Response Reductions:** this is one of the emergency procedures of PJM, customers registered in the program are asked to reduce their loads in periods of peak stress. There is currently no volume contracted in this category.

A specific focus can be made on the Price Responsive Demand (PRD) since the methodology associated is specific. PRD providers have to commit to a certain level of load reduction in case of peak prices.

First, Price Responsive Demand (PRD) gathers all types of Demand Response depending on price signals (like supply contracts indexed on market prices or DR valued in the energy markets). If not very developed for now in PJM, this type of Demand Response is expected to grow in the future years. Indeed, PJM had to take it into account in its adequacy assessment. In this perspective, the PRDs were transformed in a capacity product thanks to:

1. **The set-up of a predictable demand curve**

PRDs are contracted by suppliers or aggregators. The PRD provider has to commit to a PRD plan, before the Residual Auction of the year. In this plan, the provider commits to a certain amount of PRD to provide in response to price signals

➔ **PJM is able to create the associated demand curve and takes it into account in the forecasts**

2. **The set-up of a predictable demand curve**

During peak load stress periods, the PRDs also have to prove their ability to reduce their load during "Maximum Emergency Events". For that, a load test is conducted in periods of peak stress during one hour and in case of failure, strong penalties have to be paid by the PRD provider

So as to progressively take into account the impact of PRD in the market structure, a cap has been set up for the three following delivery years[1].

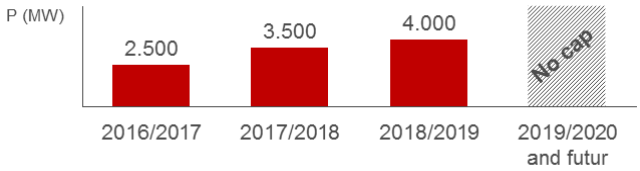


**Figure 31: maximum quantity of PRD during a 3 years transition period**

***Conclusion for the Market Response study***

In PJM for the Price Responsive Demand mechanism, the supplier carries the responsibility of the volume of implicit demand within its portfolio, making it a capacity product.

**d) Norway**

In Norway, Demand Response has been increasing so as to anticipate the increase of electric heating and the growth of electric vehicles. Demand Response is mostly valued in the reserves (~700 in total, among 1600MW of reserve).

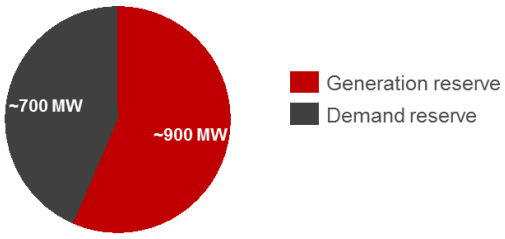


**Figure 32: reserve breakdown in Norway**

DR can also be traded in the Day Ahead and Intraday markets but there is no estimation of the actual market size.

It is to be noted that the specific energy mix of Norway, dominated by the hydro (96% of the mix), reduces the importance of the peak load calculation. Though, price responsive Demand Response is still estimated: it is calculated differently for the general demand and for the industrial players.

[1] PJM – 2016 – "Manual 18"

For the general demand (except industries), a price elasticity is estimated. This elasticity estimation is based on several studies conducted in the 2000's and is also estimated internally. They compute it by looking at historical data, at their market model simulation and also at the "urgent messages" of the operator.

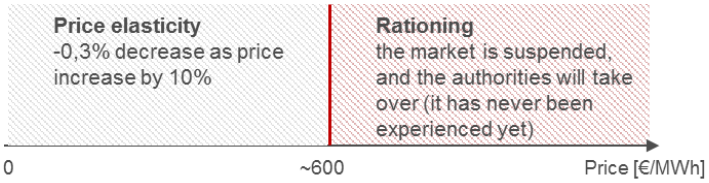


**Figure 33: general demand methodology**

Simulations show an average of 10MW over the past years.

For the industrial part, instead of varying gradually as price increases; it is approximated that industrial players will disconnect at a price higher than 10 times the average price. This amounts for 5000 MW. The threshold was estimated based on the internal knowledge and with discussion with key player. This model is used for simplicity reasons in Norway.

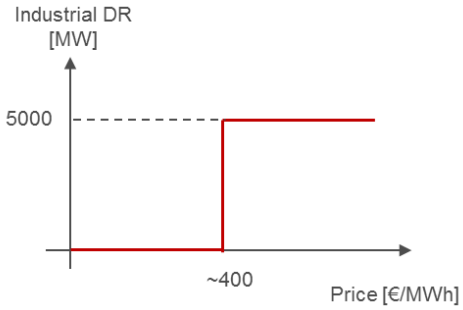


**Figure 34 : industrial DR methodology**

### e) Finland

Contrary to Norway, Finland has a deficit of capacity, making the country strongly dependent on electricity imports from neighboring countries (maximum deficit of 3,5GW in severe conditions). In this context, Finland has been working to allow and increase Demand Response. Half of DR capacity is available on the Day Ahead and Intraday markets. The bids information being not public, the estimation is made by Fingrid, based on its knowledge of the market. The other half is valued on the reserve markets: primary (FCR) and tertiary reserve (mFRR) through bilateral agreements with Fingrid.

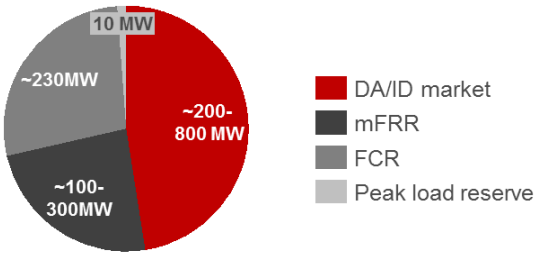


**Figure 35: DR capacity breakdown in Finland**

Since the peak load calculation is based on the actual load curve which does take into account price dependent Market Response, Fingrid considers that this estimation is already taken into account in the

peak load estimation. This assumes that Market Response doesn't vary a lot from one year to the other.

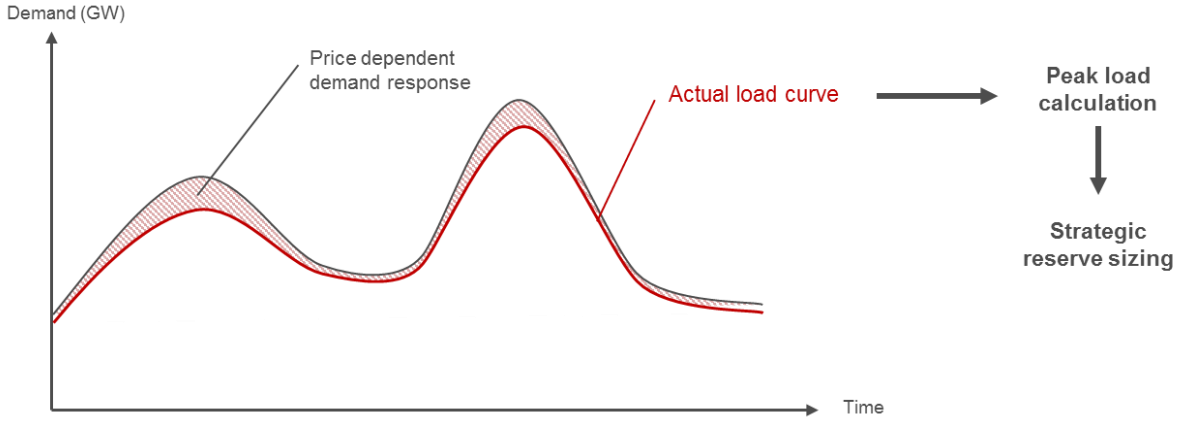


**Figure 36: Market Response estimation methodology in Norway**

***Conclusion for Finland and Norway***

Taking into account historical data in the peak load estimation is considered as sufficient in some countries to estimate Market Response.