Assessment of the balancing revenues earned by technologies in the Belgian electricity market

Adequacy Working Group

Compass Lexecon

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Agenda for today

- Introduction and project background (5min)
- Methodology for the calculation of net revenues (15min)
- Overview of econometric results (5min)
- Net revenue results (5min)
- Crisis adjustment and other adjustments (10min)
- Discussion and questions (20min)

1.

Project background and overview

As part of the Capacity Market yearly calibration, Elia needs to define global and intermediate price caps

As part of the yearly calibration of the Belgian CRM, Elia is required to calculate the missing money of different technologies

- **Elia provides input for defining CRM parameters** to be used for yearly calibration cycles, following the Royal Decree Methodology and the Electricity Act
- As part of the yearly cycle, **Elia is required to conduct a "missing money" assessment for different technologies**, feeding into: (i) the CRM demand curve (Art. 10; final proposal made by CREG) (ii) the global auction price cap (Art. 10), (iii) the intermediate price caps (Art. 19 and 22)

The evaluation of the missing money of different technologies requires an assessment of their net balancing revenues

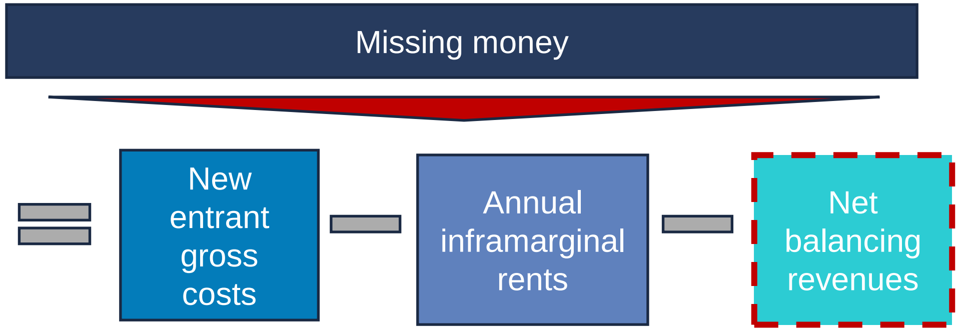
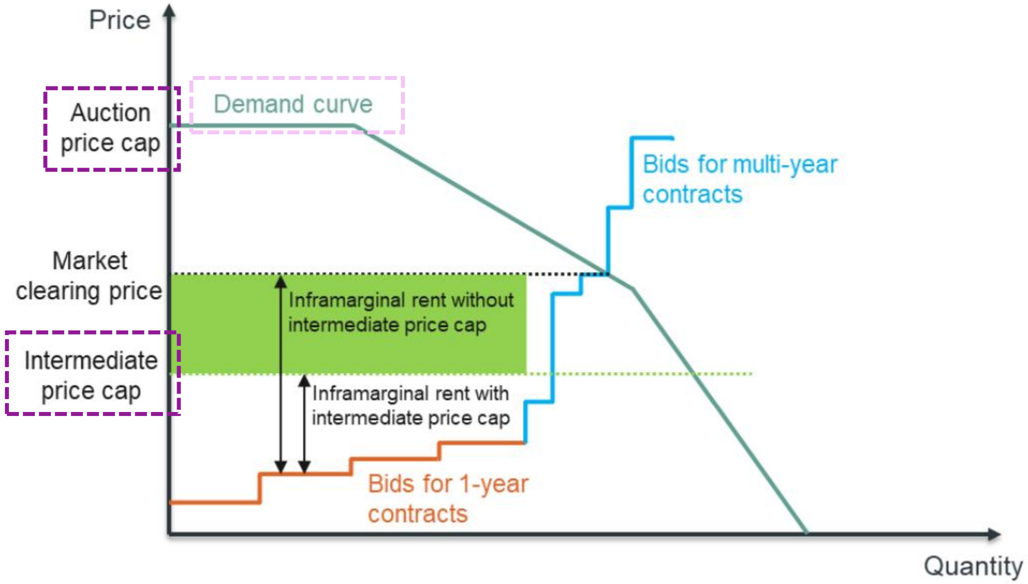


Illustration of the parameters requiring a missing money assessment for the yearly Belgian CRM calibration



Source: Elia (2019)

Elia is required by the Royal Decree Methodology to provide inputs to define the intermediate and global auction price caps, which requires the calculation of net balancing revenues for different technologies

Source: Royal Decree Methodology (2021), Electricity Act (1999)

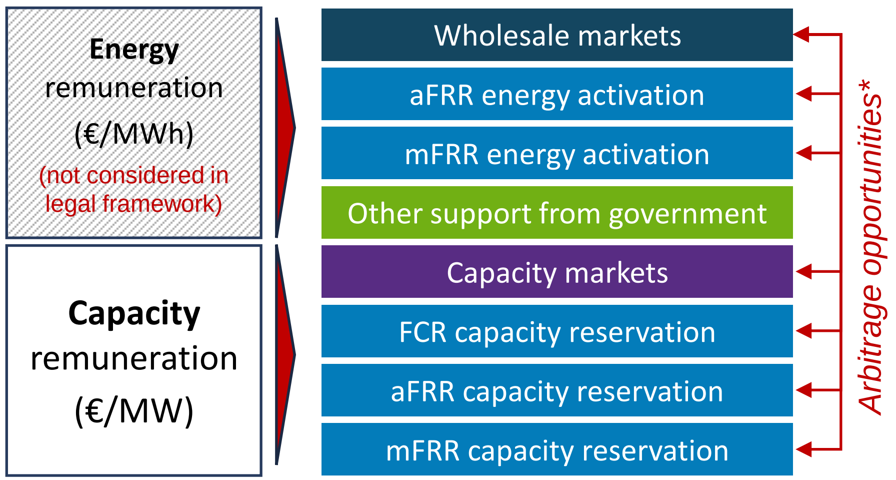
Note: The demand curve is defined by the Minister based on a proposal made by CREG and on inputs and calculations by ELIA.

The net balancing revenue calculation follows a general methodology set by Royal Decree, accounting for arbitrage opportunities across markets

- **According to articles 10, 19 and 22 of the Royal Decree Methodology**, the estimated net revenue obtained from the provision of balancing services:
  1. Is **evaluated for each relevant technology**, defined separately for the purpose of the global auction cap, as well as for intermediate price cap
  2. **Corresponds to the average historical costs of reservation** by the system operator for services intended for balancing regulation, for **the last 36 months**
  3. **Takes into account the costs, including opportunity costs, related to participation in balancing markets**, in order to avoid double counting between inframarginal rents and market revenues from ancillary balancing services.

- Indeed, **there is an arbitrage between balancing market participation and wholesale markets**, and this effect should be untangled to calculate net balancing revenues

Market participants have to arbitrage across multiple markets to maximise their revenues



Strictly speaking, the Royal Decree Methodology only considers reservation. However, the present assessment targets a broader framework by looking at both reservation & activation revenues.

Source: Royal Decree Methodology (2021)

*Due to the reliability option mechanism, there is an arbitrage between the CM and wholesale markets.

Overview of our proposed approach

4 workstreams in line with our understanding of Elia’s needs

Workstream 1 – Qualitative methodology analysis	**Qualitative assessment of Elia’s existing methodologies** for the calculation of net balancing revenues
Workstream 2 – Historical review of gross balancing revenues	**Quantify and review historical gross balancing revenues** by technologies in Belgium
Workstream 3 – Econometric analysis of gross balancing revenues	**Test the appropriateness of Elia’s methodology for calculating net balancing revenues**
Workstream 4 – Methodological recommendations	**Identify and assess methodological improvements** for the calculation of net balancing revenues

2.

Methodology for the calculation of net revenues

To calculate net balancing revenues, we propose a different approach to the one previously taken by Elia

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Compass Lexecon's proposed net balancing revenue methodology

Actual reservation and activation revenue for each technology by CCTU

Develop cost assumptions, including opportunity costs, for each technology in activation and reservation

Subtract direct and opportunity costs from revenues of each technology/ market, with a daily/ CCTU granularity

Convert revenues to €/kW/year using installed capacity data

Net balancing revenue by technology

Future revenue adjustments

elia

Elia's previous methodology (Y-4 auction 2027-2028)

Maximum theoretical annual reservation revenue
average reservation price x 8760

Correction coefficients

% coefficient depending on volume requirement compared to installed capacity

% coefficient depending on future market developments

% coefficient to factor in opportunity costs

Final net balancing revenue by technology

For this study, we focus on the net revenues of gas units, storage assets and demand side response

OCGTs | CCGTs | CHPs

Batteries | Hydro Pumped Storage

DSR

Key technologies in focus for this study

Note : hydro has been hidden from this presentation to preserve confidentiality on market participant data

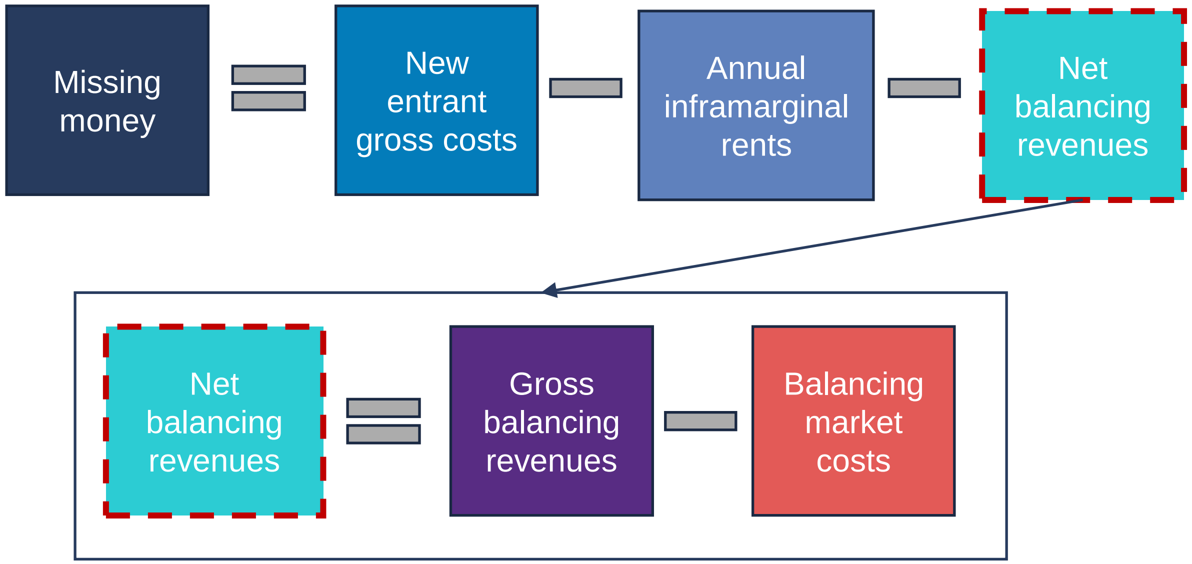
Onshore wind | Offshore wind | Solar

Turbo Jets | Diesel | Incinerators

Technologies deprioritised for this study, due to lower relevance for the CRM and/or negligible balancing revenues

The calculation of net balancing revenues first requires the calculation of gross balancing revenues

The evaluation of the missing money of different technologies requires an assessment of their net balancing revenues



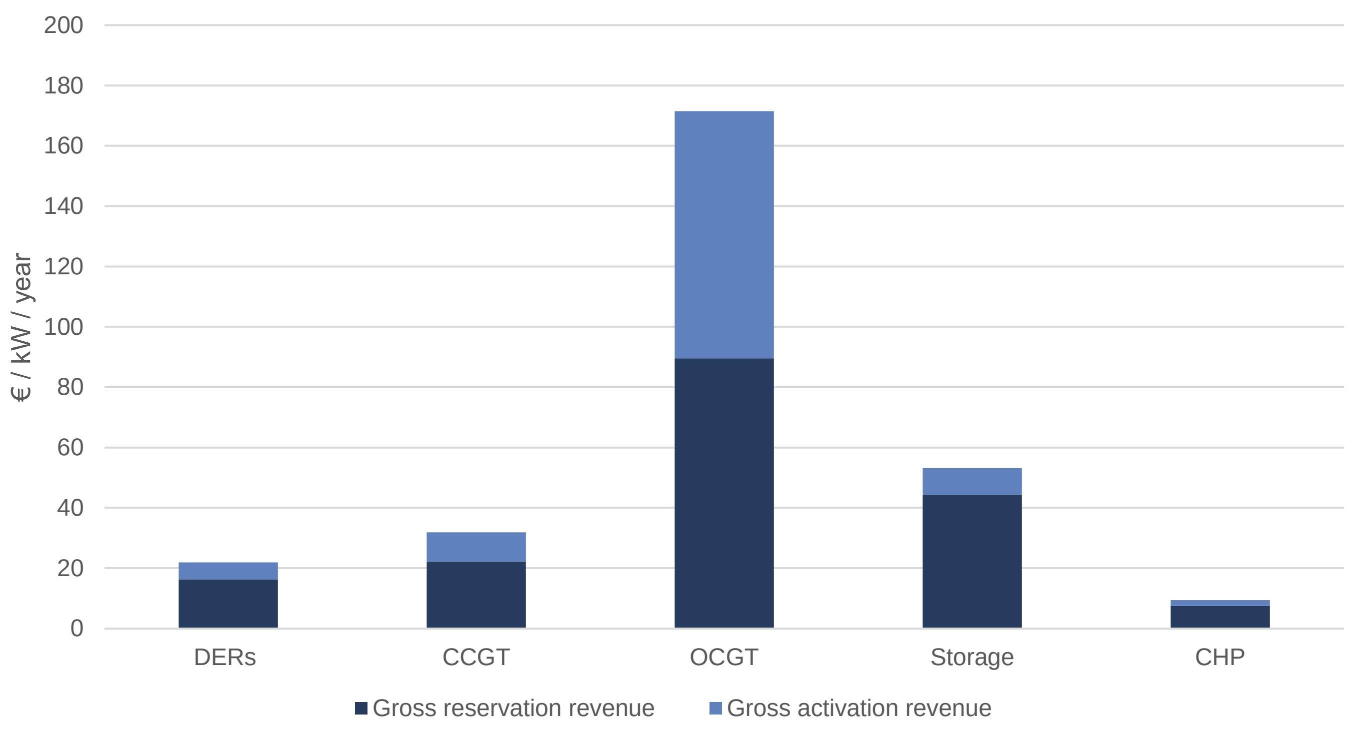
- **Gross balancing revenues** are the total revenues received by the different units for their participation in balancing services markets.
- **Balancing market costs** are the different costs associated with the provision of balancing services. This includes direct costs, as well as opportunity costs of reservation if applicable.
- **Net balancing revenues** are the additional revenues earned by the different technologies for the provision of balancing services compared to the commodity revenues on energy markets (inframarginal rents).

The net balancing revenues are calculated by subtracting balancing market costs to gross balancing revenues.

In the next two sections, we first detail our methodology and results for the calculation of gross balancing revenues, and then present our methodology and results for the calculation of net balancing revenues.

When corrected by historical installed capacity, our results show that OCGTs earn the highest gross balancing revenues per kW

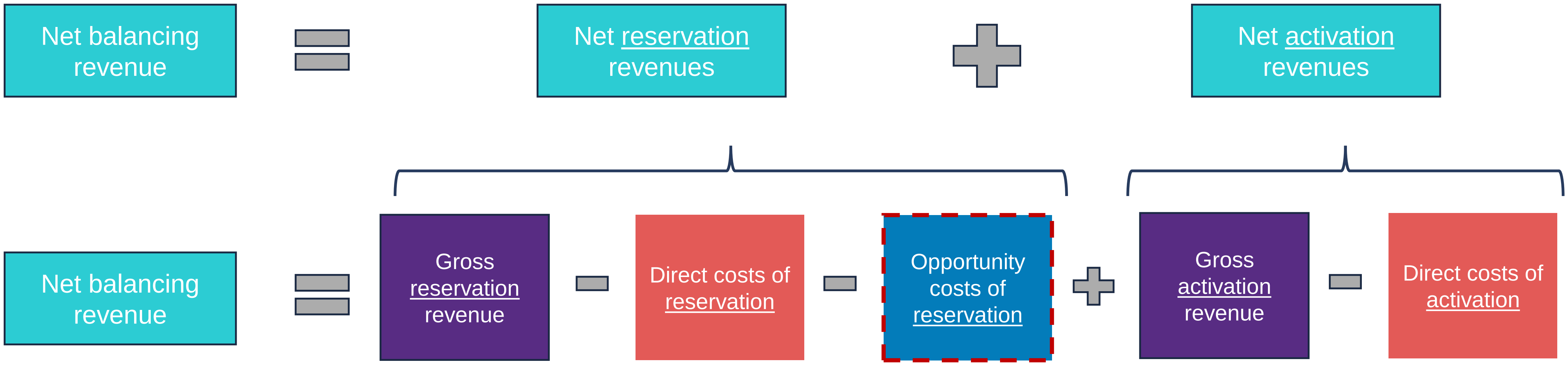
Yearly gross balancing revenue per kW of installed capacity (€/kW/year)



Source: Compass Lexecon analysis based on Elia data.

- **Using the installed capacity data, we computed the yearly gross balancing revenue per kW** of installed capacity for each technology
  - For more accurate results, we used a monthly extrapolation across years to capture installed capacity evolutions every month.
- **When corrected for installed capacity, OCGTs earn the highest gross revenues per kW,** driven by high revenues split equally across reservation and activation – at around 170 €/kW/year
- **Storage units also earn high revenues per kW**, in particular in FCR, since their total revenues is spread across still limited installed capacity, reaching >50 €/kW/year.
- As **CCGTs have a larger installed capacity, their revenues per kW are smaller** – reaching 30 €/kW/year.

We obtain net balancing revenues by subtracting reservation and activation costs from gross revenues



The quantitative analysis aims to test the arbitrage between energy and balancing markets

*We use the Zeebrugge Gas Hub price to calculate the gas SRMC

We obtain net balancing revenues by subtracting reservation and activation costs from gross revenues – direct costs of reservation

Net balancing revenue = Gross reservation revenue − (1) Direct costs of reservation − Opportunity costs of reservation + Gross activation revenue − Direct costs of activation

Thermal Technologies
- Start up costs
- Running at Pmin at a loss on DA

Batteries and Hydro PSP
- 0 direct costs of reservation

DSRs
- 0 direct costs of reservation

We assume that only thermal technologies have a direct cost for reservation in the case where they have to specifically start and run for the service provision.

We assume that there is no specific start-up cost for FCR. For mFRR Up, we assume that only CCGTs have a reservation cost, as OCGTs and CHPs can react more quickly if activated.

We obtain net balancing revenues by subtracting reservation and activation costs from gross revenues – opportunity costs of reservation

Net balancing revenue = Gross reservation revenue − Direct costs of reservation − (2) Opportunity costs of reservation + Gross activation revenue − Direct costs of activation

Thermal Technologies

CSS if CSS > 0 for Up reservation

Batteries and Hydro PSP

DA price volatility

Or

ID price volatility

DSRs

0 MC

- We assume that **DSR** has no opportunity cost of reservation.
- For **thermal units**, we assume that the Clean Spark Spread is the opportunity cost when it is positive for **upward reservation**.
- For **downward reservation**, we assume that the opportunity cost is 0 when the CSS is positive, but equivalent to the CSS when CSS is negative. However, since DA losses at negative CSS are already considered in the direct costs, we do not subtract them again as opportunity costs.

We obtain net balancing revenues by subtracting reservation and activation costs from gross revenues – direct costs of activation

Net balancing revenue = Gross reservation revenue − Direct costs of reservation − Opportunity costs of reservation + Gross activation revenue − Direct costs of activation (3)

Thermal Technologies

- Fuel & CO2 costs for up activation
- Avoided fuel & CO2 costs for down activation
- Start-up costs

For OCGTs and CHPs, for mFRR only

Batteries and Hydro PSP

- Optimised charge/discharge at Min/Max DA price

DSRs

- DA price for down activation
- Loss of consumption/ production if up activation

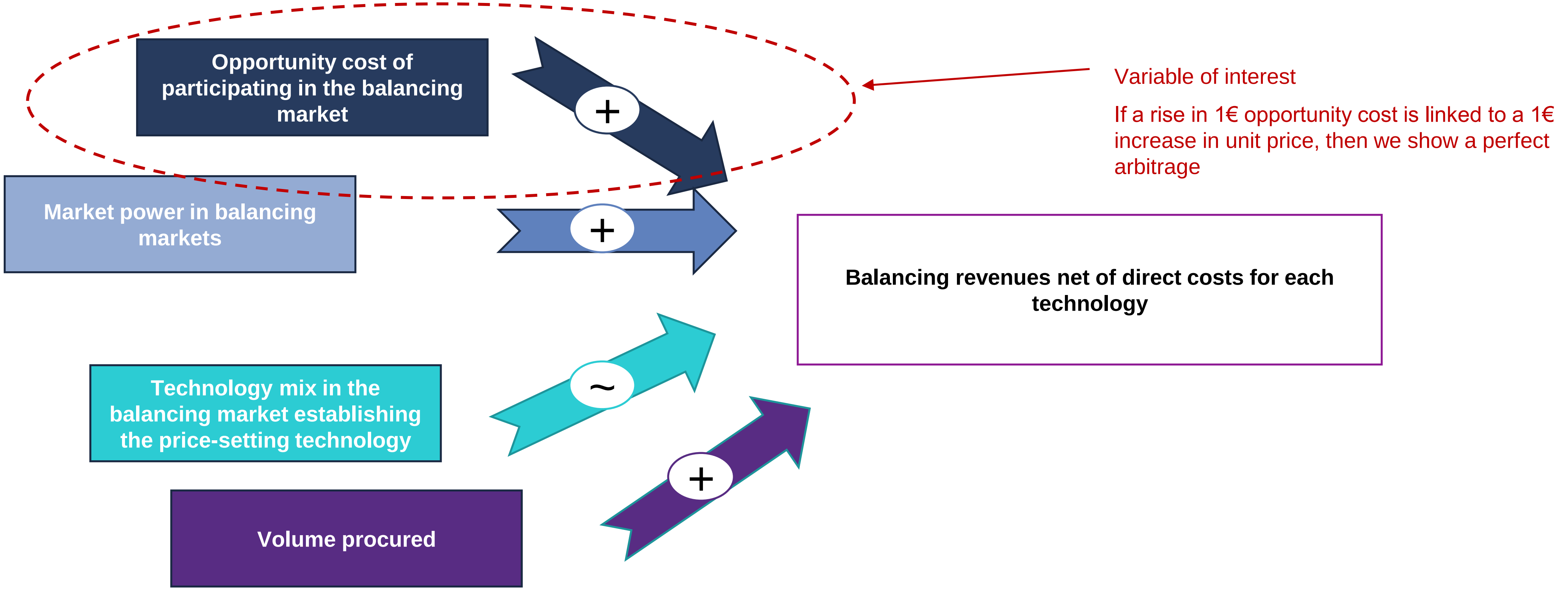
Proxied using bid data (next slide)

*We use the Zeebrugge Gas Hub price to calculate the gas SRMC

3.

Overview of econometric analysis

Reservation revenues – We conducted an econometric analysis to test whether there is a perfect arbitrage between balancing and energy markets



Reservation revenues - Proposed econometric methodology to test the effect of opportunity costs on balancing revenues

We ran the following general model framework to test the how the opportunity costs is translated into balancing revenues

1 **We calculate our revenue variable, accounting for direct costs to only capture the revenue part influenced by the opportunity cost, expressed in (€/MW)**

$$UnitpriceReservation_{m,t,d} = \frac{Balancing\ market\ revenue_{m,t,d} - Reservation\ Direct\ costs_{m,t,d}}{Volume\ Reserved_{\ m,t,d}}$$

2 **We run the regressions to test the impact of the opportunity costs on the reservation revenues (net of direct costs)**

$$UnitpriceReservation_{m,t,d} = \beta_0 + \beta_1 OppCostDriver_{t,d} + \beta_2 TechnologyMix_{m,d} + \beta_3 Marketpower_{m,d} + \beta_3 TotalVolumeProcured_{m,d} + u_{m,d}$$

t = technology

m = balancing market, or set of markets (reservation only)

d = CCTU

$\boldsymbol{OppCostDriver}$ = *Day ahead prices, Clean Spark Spread, volatility indicators if storage/ hydro*

$\boldsymbol{TechnologyMix}$ = *% of the different participating technologies in the market for each period (several variables needed)*

$\boldsymbol{Marketpower}$ = *market power variable (HHI or RSI) for the balancing market (or multiple if set of markets)*

$\boldsymbol{TotalVolumeProcured_{m,d}}$ = *the total volume procured for a given period.*

Our econometric analysis shows that opportunity costs influence captured prices, but to different extents across markets and technologies

Across most technologies and markets, our econometric analysis shows a statistically significant effect of opportunity costs on captured prices in balancing markets

- We find that for **mFRR reservation**, **the opportunity costs of the different technologies only explain small variations in unit prices** – indicating that the different technologies do make net revenues on this market
- In **aFRR, results for storage assets show that a 1€ increase in daily price spreads is linked to larger-to-1 increases in captured revenues** – which can be explained by reservoirs being larger than 1 MWh, multiplying the cost of being reserved
- In **aFRR, thermal technologies show closer relationships between opportunity costs and captured revenues**, indicating a closer arbitrage relationship, particularly for CCGTs.

Our econometric results are stable across the model specifications tested, but a large share of the variations in captured prices remains unexplained

- **The goodness of fit of our OLS models is usually around 0.2-0.6** depending on the market and technology, but can be around 0.05 in some cases (for example for CCGTs/storage in FCR, or OCGTs in aFRR)
- **In most cases though, the coefficients are stable across Tobit/OLS specifications** and exhibit limited fluctuation with the addition of control variables.

Result illustration – in the aFRR market, the clean spark spread of CCGTs is linked to a variation in aFRR prices

aFRR reservation unit price (Up+Down)	OLS	OLS	OLS	Tobit	Tobit	Tobit
1[CSS>0] × CSS	**0.727*** **	**0.762*** **	**0.474*** **	**0.748*** **	**0.852*** **	**0.474*** **
1[CSS<0] × CSS	**-2.111*** **	**-2.007*** **	**-1.886*** **	**-2.174*** **	**-2.045*** **	**-1.886*** **
aFRR volume control		Yes	Yes		Yes	Yes
RSI control		Yes	Yes		Yes	Yes
Technology mix control			Yes			Yes
Constant	1,116***	-161.2***	1,578*	1,056***	-2,358***	1,578*
Observations	1,095	1,094	1,002	1,095	1,094	1,002
R-squared	0.527	0.567	0.559	N/A	N/A	N/A

Note: aFRR is carried out on daily data to reflect daily block bids which are more prevalent in aFRR. aFRR Up and Down markets are considered jointly as participants may split their opportunity costs across markets.

Importantly, the fact that we do not observe an improvement in R2 when adding technology share data suggests that they do not add information that is not already contained in other controls. It seems plausible that the share of other technologies is a function of CCGT's CSS, implying that controlling for it absorbs part of the effect that should in fact be ascribed to the CSS.

Overall, our results indicate that there is a net revenue beyond the opportunity cost for the different technologies

Our econometric analysis generally does not find a perfect 1-to-1 arbitrage between generating revenues on energy markets and balancing markets across the technologies studied (although it is close to 1 for some technologies)

Different factors could play out to set the final unit price of the different technologies: market power, merit order effects, etc. which impact the revenues of the technologies in the balancing market. The lower explanatory power in some of our models imply that other factors influence the final unit price beyond the factors we have accounted for.

As a result, **our results highlight the possibility for the different technologies to earn a net revenue** beyond their opportunity cost

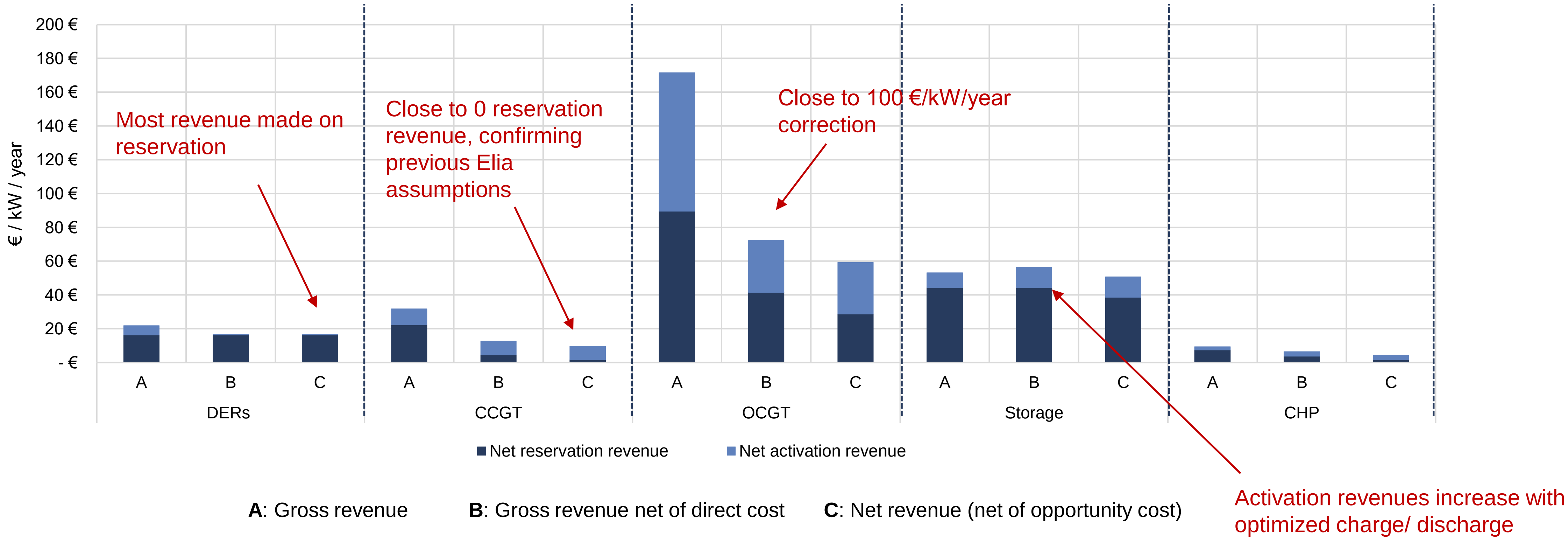
Therefore, we subtract the opportunity costs calculated to the gross revenues net of direct costs to find the net revenues across technologies.

4.

Net revenue results and crisis adjustment

Correcting the balancing market revenues by the opportunity costs of OCGTs and CCGTs reduce their net balancing revenues significantly

Average annual balancing revenue per kW of installed capacity [€/kW/year] – gross and net revenues



A large share of net revenues can be explained by revenues earned in activation, which was not accounted for previously

The key question on the net revenue analysis remains their future validity, particularly in a post-crisis market setting

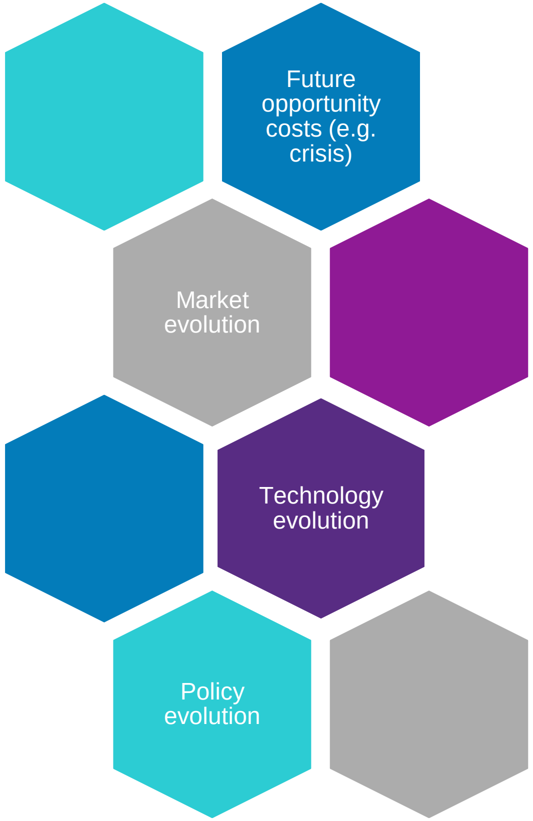
One of the important questions for setting the CRM parameters is to what extent historical analysis help us foresee future net revenues,

- **This is particularly the case with the crisis affecting past revenue data** – although it is also uncertain to assert that revenues will come back to their pre-crisis levels
  - **As we remove opportunity costs directly from revenues**, such as day-ahead price volatility or clean spark spread, **we control to some extent for the high revenues earned during the crisis** because these costs rose as well.
  - However, merit order effects could lead to higher revenues for inframarginal technologies on balancing markets during the crisis period

- **In its previous methodology, Elia corrected its net revenue estimations** with future FCR price convergence assumptions (60% for batteries) and future competitive pressure in mFRR (70% for DSR).

- **Different methods could be used to adapt net balancing revenues to these future evolutions, if applicable**
  - Accounting for the effect of the crisis could be carried out by filtering extreme events, or correcting by the crisis effect on average for instance.
  - For the crisis, corrections applied should account for the fact that although revenues increased, costs also increased during the period.

Possible future factors impacting future net balancing revenues

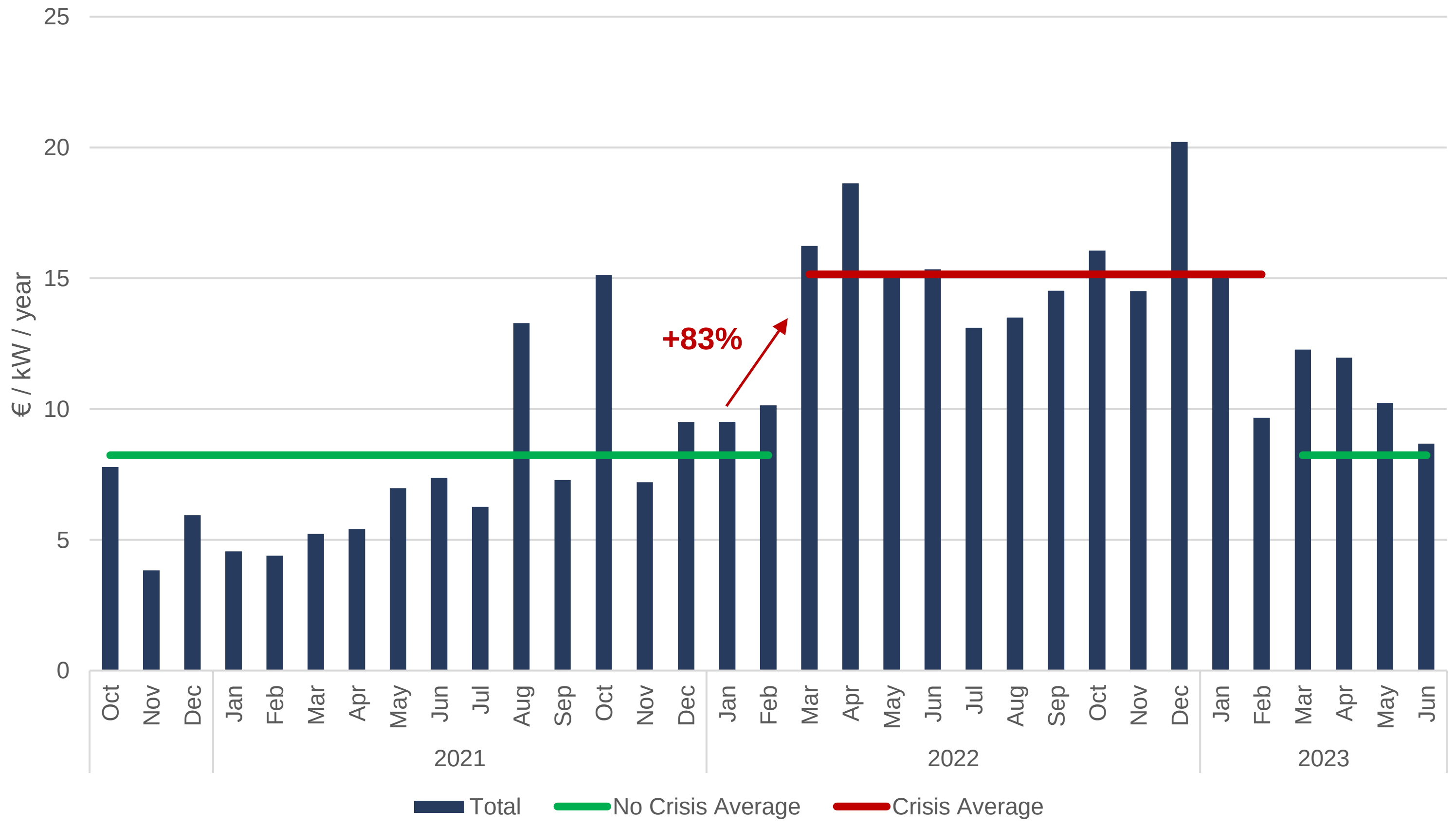


Across all technologies, there was a marked increase in revenues per kW during the crisis

There were higher net revenues observed during the second part of the crisis

- **There was a marked increase in net revenues across all technologies from Q2 2022** (+83% between the two average total revenues)
- **Interestingly, this increase happened after the September 2021 crisis**. This can be traced back to two factors:
  - Costs were also higher during the crisis, with higher gas prices and opportunity costs to participate in the balancing markets
  - OCGTs made significant revenues in the later part of 2022, which drove up the numbers in that period
- All in all, **correcting for the period of higher net revenues during the energy crisis would allow a better view of future revenues** for the different technologies

Annualized net balancing revenues per kW of installed capacity (Jul 2020 - Jun 2023)



We have tried different methods to control for the crisis, as the period of increased revenues can be different across technologies

Common crisis period

- We have used the overall revenue graph shown on the previous slide to define the **crisis period between March 2022 to February 2023** – 12 months are flagged as the crisis period in total

Market specific 1

- Alternatively, to account for the crisis effect hitting the various balancing markets at different points in time, we define a **market specific** approach. In each reservation and activation submarket, we define the **12-month period with the highest observed net revenues** as the crisis period.

Market specific 2

- We explore a sensitivity to the market specific approach. In this second version the various **aFRR submarkets are aggregated** to find a single 12-month period with the highest net revenues for aFRR. Other markets use the same crisis period as in "market specific 1"

Data driven approach

- Finally, we deploy a **data driven approach** to identify outlier months. This approach is **technology specific**, as it allows to identify, for each technology, which months of exceptional revenues to flag as the crisis
- The identification of outliers is based on a **1-sigma range**.

We have used these 4 approaches in parallel to calculate correction coefficients for the crisis

Note: The "market specific 2" method is considered to guarantee that the identified crisis periods in "market specific 1" are not skewed due to must-run and startup costs of thermal units being assigned to specific markets.

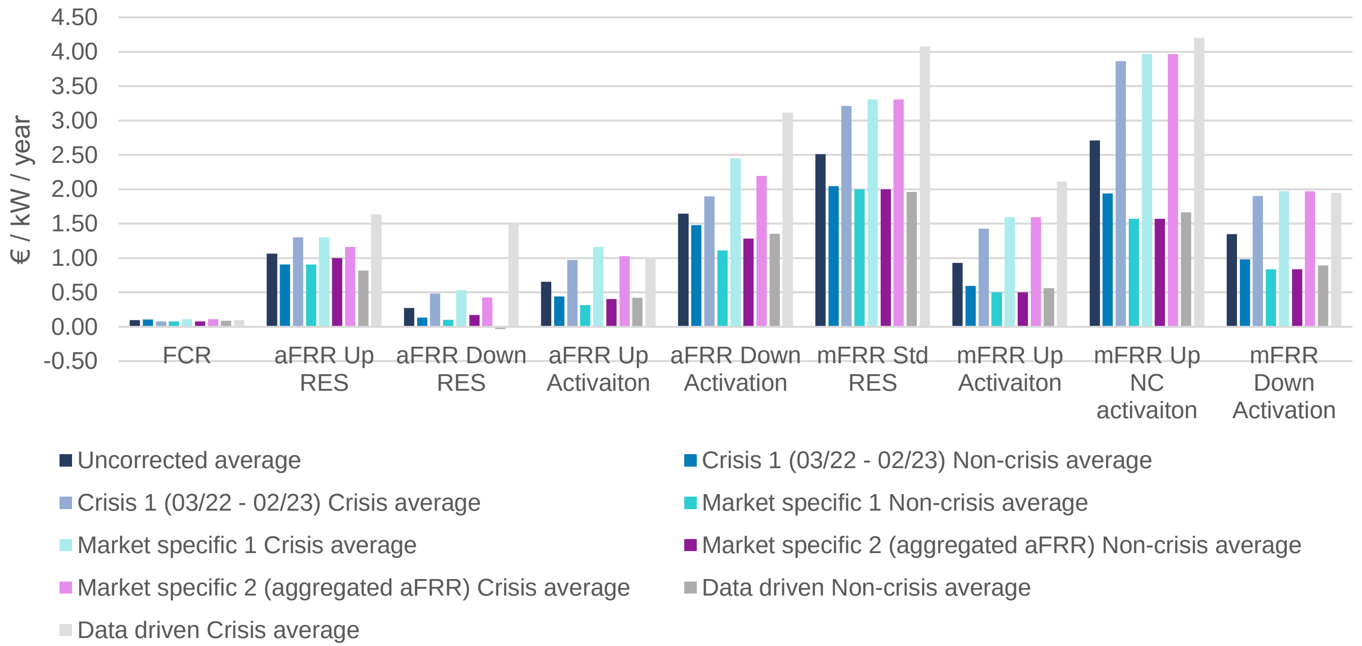
Average net revenues in submarkets differ between the crisis and non-crisis periods, but are fairly stable across methodologies

Crisis effects differ across markets, which leads to market-specific correction factors

- **Some markets show a large gap between their average net revenues in the crisis or non-crisis period**, such as aFRR and mFRR Up activation
- **Others show more modest increases,** such as aFRR Up reservation or aFRR Down activation
- From these differences in mean revenues**, we derive correction coefficients** which we can apply to crisis months in each approach, to account for the crisis effect

This could plead for a market-specific approach to correcting for crisis revenues, rather than setting a bulk period across markets

Average net revenues in the crisis vs. non-crisis period across methodologies

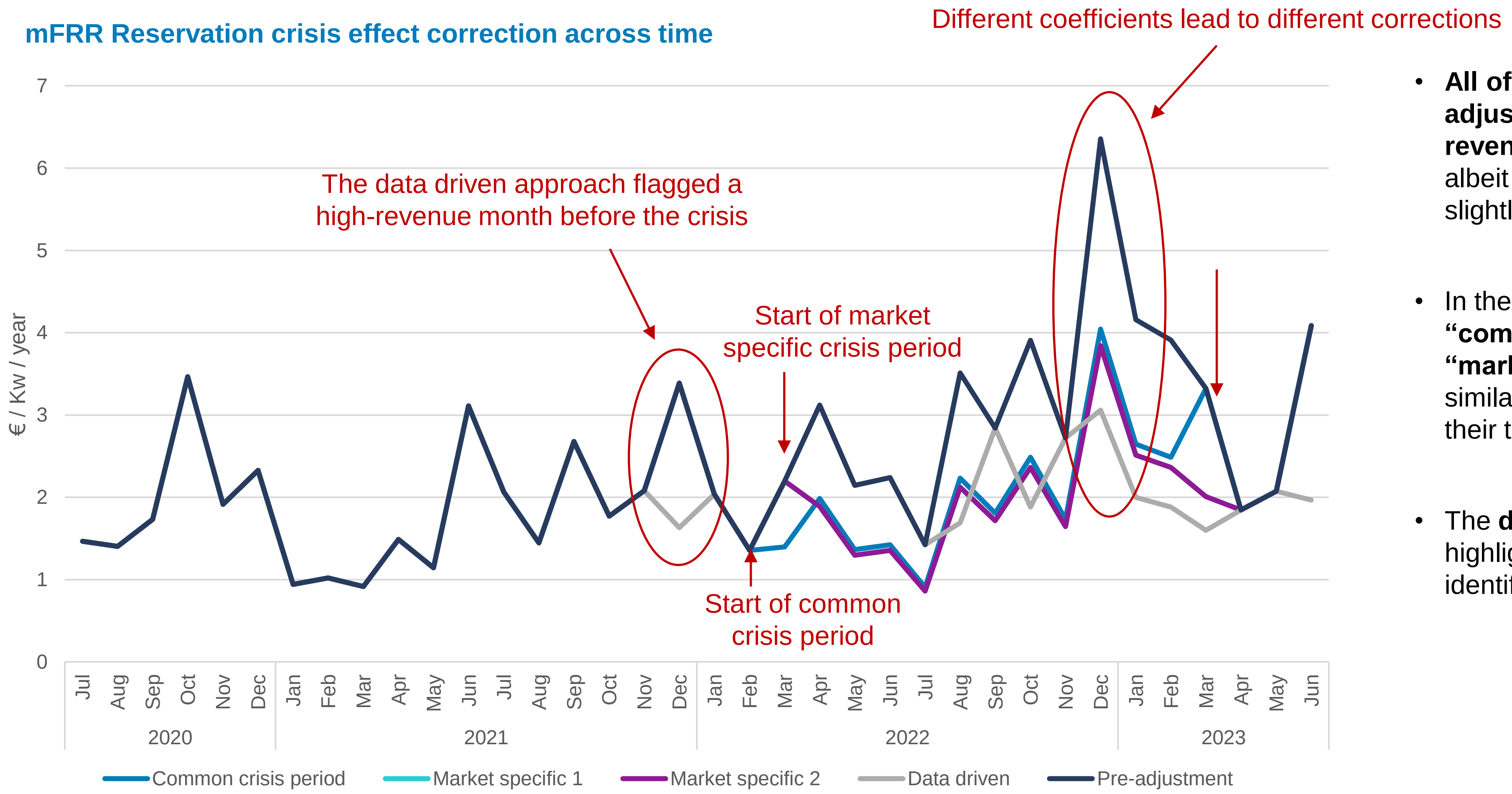


Corresponding coefficients to correct for the crisis average revenue difference

	FCR	aFRR Up RES	aFRR Down RES	aFRR Up ACT	aFRR Down ACT	mFRR Std RES	mFRR Up ACT	mFRR Up NC ACT	mFRR Down ACT
Crisis period	1.00	0.70	0.28	0.46	0.78	0.64	0.41	0.50	0.51
Market specific 1	0.73	0.70	0.18	0.27	0.45	0.60	0.31	0.40	0.42
Market specific 2	0.73	0.86	0.41	0.39	0.58	0.60	0.31	0.40	0.42
Data driven	0.89	0.50	0.00	0.42	0.43	0.48	0.27	0.40	0.46

Zoom on mFRR Std reservation correction to account for the crisis effect in each methodology

mFRR Reservation crisis effect correction across time

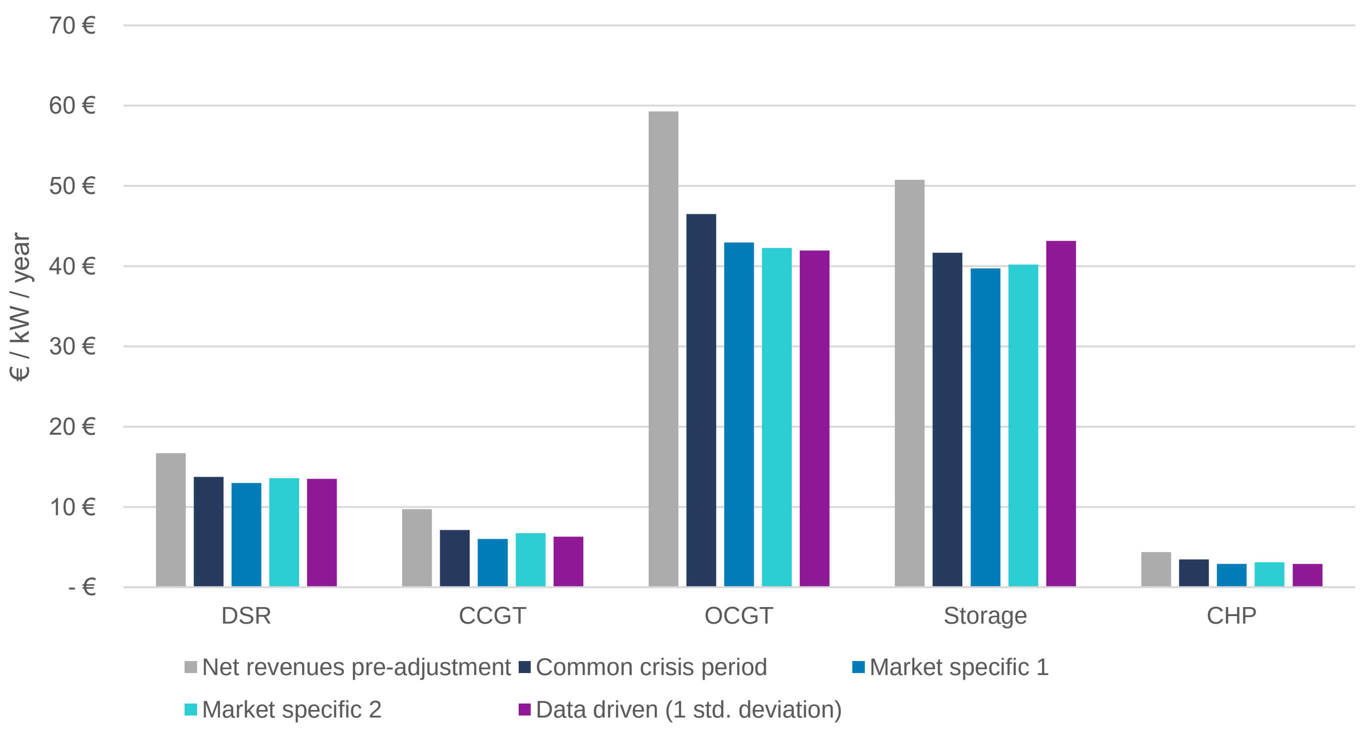


- **All of the deployed crisis adjustment methods reduce net revenues during the crisis period,** albeit to a varying extent and at a slightly varying point in time
- In the case of mFRR reservation the **"common crisis period" and "market specific" methods** yield similar results, only slightly varying in their timeframe
- The **data driven approach** also highlights anomalies outside of the identified crisis periods

Note: Approaches "market specific 1" and "market specific 2" only differ for aFRR, but are equivalent for mFRR.

Correcting for the crisis impact brings down net revenues across all technologies, but especially for OCGTs and Storage

Net balancing revenues post crisis adjustment by technologies (€/kW/year)



- **Net revenues are fairly stable across the different crisis adjustment methods**
- **Overall, the correction factors reduce total net revenues** by:
  - 18-22% for DSR
  - 27-38% for CCGT
  - 22-29% for OCGT
  - 15-22% for Storage
  - 21-34% for CHPs
- **In absolute terms, the by far largest adjustment concerns OCGTs (ca. 17 €/kW/year) followed by storage (ca. 10 €/kW/year)**
- Still, crisis-adjustment revenues for OCGT and storage remain higher than expected and **may require further adjustments to reflect future earning potentials**

Correcting for expected future FCR price convergence leads to a decrease in FCR revenues for storage, depending on the FCR target price

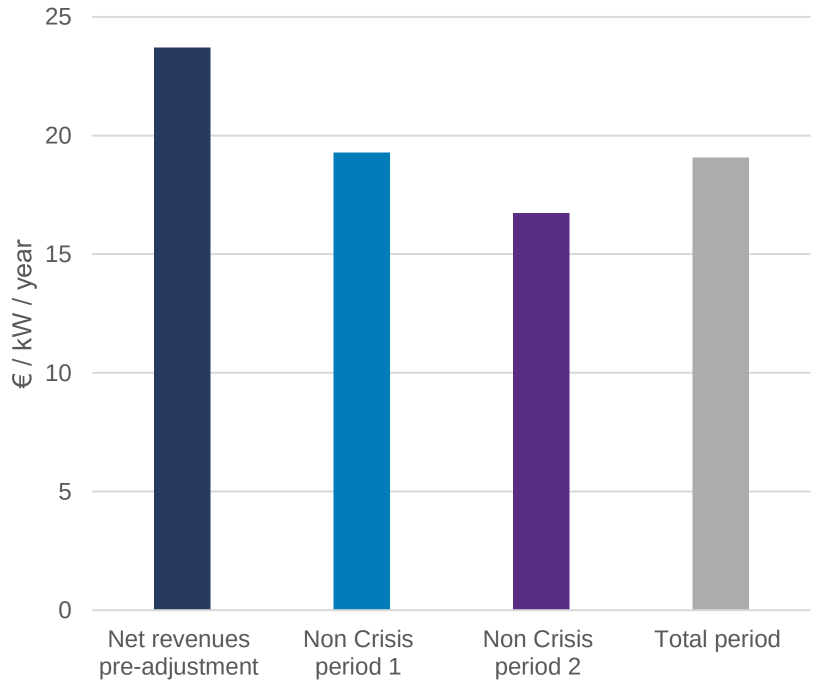
We also can correct FCR revenues to account for the expected future convergence of prices with Germany.

- We assume that this convergence will gradually occur **starting in 2025 towards 2028**, reaching full convergence then
- Here, the correction coefficients can take different values **depending on the expected price towards which FCR prices start converging**
- We calculate **three correction coefficients** based on the difference between Belgium average FCR prices over the 2020-2023 period, compared to different German average prices
- From this, we can correct FCR net revenues for storage and CCGTs, for which **assuming a gradual convergence towards pre-Sept 2021 prices lead to biggest effect on net revenues**

FCR average prices in Germany and Belgium, by period

		DE average	BE average
Crisis 1 (04/22)	*Non-crisis average*	18.28	34.92
	Crisis average	21.87	27.84
Crisis 2 (09/21)	*Non-crisis average*	11.98	29.63
	Crisis average	23.20	32.67
Total	*Total period*	17.72	29.09

Storage FCR net revenues pre and post FCR adjustments comparison



The revenue adjustments for FCR link back to the question of defining the crisis period. Consistency in the definition could be desirable, but a technology/market specific approach could also be defended.

There are other options to adjust net revenues in order to better reflect future expected revenues for each technology

There is a range of options to better account for future revenues for each technologies in the CRM

Future FCR price convergence

- **Correction on FCR revenues to account for the expected future convergence of prices with Germany** – expected effect for the CRM Y-4 auction, but not yet in Y-1
- The key methodological question is the price level of assumed convergence in Germany

Installed capacity evolutions

- **Installed capacity in Belgium is expected to evolve** in the coming years, which will affect future revenues per kW (particularly: DSR, storage, CCGTs)

Technological share of markets evolutions

- **Movements in installed capacity also translate to shifts in the technology mix** in certain balancing markets.
- Certain technologies could capture a higher share of the volumes, and so increase their revenues – which could be corrected

Merit order price effects in markets due to technology share evolutions

- At the same time, the **shift in technology mix could also affect prices due to a merit order effect** and the entry of cheaper technologies – which could be accounted for

Future evolutions of balancing markets

- **Potential market design changes** (e.g. Elia partial procurement in mFRR reservation) could also affect future revenues
- **Future market dynamics**, as well as **volume/price evolutions**

5.

Q&A and next steps

Q & A

Locations

Europe

Berlin
Brussels
Copenhagen
Düsseldorf
Helsinki
London
Madrid
Milan
Paris

North America

Boston
Chicago
Houston
Los Angeles
Miami
New York
Oakland
Washington, DC

Latin America

Buenos Aires
Santiago

Asia Pacific

Beijing
Singapore

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6.

Annex

Gas Turbines - We subtract day ahead market losses for running at Pmin when reserved for balancing services at negative CSS

We consider the theoretical Pmin required for technology *t* to provide the reserved volume in each CCTU as

$$Pmin_{MW,t} = \frac{Reserved\ Volume_{MW,t}}{1 - \%\ Pmin_t} \times \%\ Pmin_t$$

For instance, if we observe 400 MW reserved capacity for CCGTs in mFRR Up and assuming that %Pmin = 40% this implies

$$Pmin = \frac{400}{0.6} \times 0.4 = 267\text{ MW}$$

aFRR Up Reservation

- We subtract DA losses from reservation revenues for CCGTs, OCGTs and CHPs
- Whenever $CSS_t < 0$: DA loss = Pmin x CSS_t

aFRR Down Reservation

- To avoid double counting, we subtract DA losses for running at Pmin whenever $CSS_t < 0$ and no aFRR Upward reservation is present for technology *t*
- In addition, we subtract DA losses for running at the reserved capacity above the Pmin whenever $CSS_t < 0$.

mFRR Up Reservation

- We only subtract DA losses for CCGTs, since OCGTs are assumed to be able to start-up in time for aFRR activation
- To avoid double counting we subtract DA losses for running at Pmin whenever $CSS_t < 0$ and DA losses are not already subtracted from aFRR for the CCTU

Different factors could explain why we do not find a perfect arbitrage in some markets

Market power

- **Concentration and pivotality could grant market power to market players**, thus allowing higher margins in certain markets.
- **It is not possible to wholly capture this in our model**, since variations in market power indicators might not be relevant if market power is always or never present over the period observed

Activation revenue expectations

- **Market participants may factor in their expected activation revenue within their reservation bids** – this could help explain a part of the unexplained variations in unit prices depending on market players' bidding strategies (but this may depend on their risk / bidding strategy)

Merit order effects

- In our model we controlled for technology shares in an attempt to capture possible merit order effects, particularly in pay-as bid markets. If a participant expects a particular technology to be price-setting, it should **attempt to bid according to that technology's own bid structure.** In that case, this pleads for the presence of net revenues beyond perfect arbitrage.

Imperfect price foresight

- As reservation auctions are carried out before the day ahead market, an **imperfect forecast of opportunity costs (whether looking at clean spark spread or price volatility) might lead to the unit prices not perfectly reflecting the actual opportunity cost of participation**

Assumptions taken for our analysis

- In our analysis, we have also taken some **assumptions to build our opportunity costs indicators**, for instance a particular efficiency factor for each technology to calculate the clean spark spread. While it is necessary to choose a value, the opportunity costs might be different in practice depending on which specific units provide balancing market services on each particular day; Other assumptions, such as gas sourcing strategies etc. could also limit the accuracy of our results

Model robustness

- **While informative from a correlation perspective, our results should be interpreted with care** – pooled econometric analysis without control groups limits 'causal' interpretations between our variables. In addition, we observe that a large share of variations in unit prices is not explained by our model, which could lead to other omitted variables impacting the coefficients observed.