

2022 BALANCING INCENTIVE REPORT

Analysis on the possible optimizations to the estimations and compensations of grid losses.

POC results and Implementation Plan

Report to CREG – 15 December 2022



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Compensation of network losses

1. Introduction

This report is a deliverable of the 2022 balancing incentive on the compensation of the network losses. It builds on the previously delivered study to the CREG (June 2022) and the Proof-Of-Concept (POC) on short-term forecasting that took place from July to September 2022. The focus of this report is on the results of the Proof-Of-Concept, which follows the initial study phase, and a subsequent implementation plan. The latter could be realized proceeding the promising outcomes of the POC and study.

As a reminder, the study - delivered by 30/6/2022 to CREG in the context of this incentive and also published on Elia's website¹ - responded to two main research questions which were posed with regards to the incentive:

- In a first instance, Elia was asked to analyse their potential to procure both federal and regional losses and therefore benefit from a more efficient procurement. In the outcome of the study, it is stated that Elia currently, in the short term (≤ 2027), does not deem a change of compensation in kind by BRP's to a procurement by Elia as a possible or recommendable approach. In the longer term, on top of a set of questions regarding the accuracy of such an approach, Elia also identifies a set of boundary conditions, which would need to be fulfilled in order for Elia to avoid or mitigate potential side effects. Hereby Elia points at the fact that due to the nature of its role and position in the system, Elia is not well placed to assess those boundary conditions.
- As a second point, Elia was asked to investigate the relevance of developing a short-term procurement component based on short-term forecasting as part of the compensation approach. The June study hereby found that a short-term procurement, based on short-term forecasting, could help mitigate the effect on the balancing market functioning and price formation in real-time caused by the supply gap and eventually lead to closer coverage of the losses. Out of the study, Elia brings forward two options with regards to installing a short-term procurement approach. These options being: (1) Elia procures the volume in day ahead necessary to minimize the total supply gap; (2) Elia procures the volume in day ahead necessary to minimize only the regional supply gap.

Note also that, beyond the requirements of the incentive description, Elia organised on 17th of November 2022, a workshop dedicated to the study report, POC results and the implementation plan for interested members of the Users' Group WG Balancing. The presented slides are also available on the same webpage as the study. The Minutes of Meeting of that workshop, that also contain viewpoints expressed by the stakeholders, will also be published there as soon as they are fully validated through the WG Balancing. Doing so, Elia invested in involving stakeholders into the topic and enriching the debate with their viewpoints.

The two research questions above, which both rely on Elia's ability to provide a good quality forecast for both the federal as the regional losses, were further explored in the Proof-Of-Concept (POC) part of this document. In this part, the set-up of the POC is explained and the results of the POC are discussed. On top of this, this part will look at the overall validation of the feasibility from a forecasting perspective of acting towards the two questions raised above. For the

¹ [Balancing incentive study on the estimation and the compensation of the grid losses \(elia.be\)](#)

options Elia identified as feasible, an implementation approach is worked out in the last part of this report. This implementation plan gives an idea of the technical needs of such implementation, whilst also looking into the regulatory and legal needs that would be required to further progress with the feasible options. In a last phase, as a further input towards a concrete implementation, a purchasing approach has been suggested by Elia. This is one important aspect to be further picked up in the implementation steps. All aspects are then brought together in an indicative timeline for its actual implementation.

2. Proof-Of-Concept (POC) on short-term losses forecasting

As required by the incentive, a 3-month POC was set out in order to gain insights on the short-term forecasting approach for both the regional and the federal term losses and hereby assess its feasibility in view of a potential change in losses compensation approach. This POC complements the analyses, findings and design proposals put forward by Elia in its study report of June'22.

The POC worked in general on two axes. The first one being the assessment of forecasting quality, where Elia wants to aim for a functioning good quality model minimizing forecast errors. From the study – and as also hinted upon by CREG in the description of the incentive - it could be concluded that, with regards to the federal losses, certain challenges can be expected for that forecasting approach. While expectations for regional losses on delivering a good quality forecast were deemed higher, it was yet to be proven in practice. On the second axes, the POC wanted to identify the efficiency of the operational process behind the short-term forecasting and procurement approach as a stepping stone towards a full, robust implementation. It is important to note that for the POC, the product/service deliverance and the management of risks are obviously not on the same level as running a real-life business process with operational and financial consequences. The POC had overall a stronger reliance on manual intervention, less checks and balances, a less strict approach against data availability and a design which did not support 7/7 availability. These are of course typical elements that differentiate a POC from an actual implementation but allowed to move quickly and deliver results within the foreseen timing.

Practically, the Proof-Of-Concept relied on machine learning processes from which the federal and regional losses forecasts could be gained. A regular re-training of these processes ensures an up-to-date forecasting approach. As the working of such machine learning models depends strongly on the quality of its input data, a thorough analysis on the reliability and granularity of these data inputs was performed.

In what follows first the data used in the machine learning model used in the POC are discussed, next the results are presented. Finally, the lessons learned from the POC are summarized.

2.1. Data feeding the POC

The first step to correctly develop the POC consisted of establishing the right amount of data and the validation of their sufficient availability and accessibility. As the idea would be to forecast the losses as precisely as possible, the utilisation of datasets with a granularity of 15-minutes was required. In addition to this, the data needed to be available on D-1, at least a few hours before the gate close of the day-ahead market closes (hence, rather early in the morning), in order to be able to gather the data, process them where needed and run them through the model. When selecting the input data, both the regional and federal forecasting tracks were taken into account as both might gain influence from differing data inputs. Overall, the accessibility and trainability (important for a Machine Learning model to actual produce reasonable forecasts) of the data, with regards to this POC approach, was also a crucial factor when selecting relevant data.

Data considered based on initial correlation analysis and/or expert understanding		Data used in the POC
Total Load Forecast [MW]	→	Total Load Forecast [MW]
CIPU Forecast [MW]		CIPU Forecast [MW]
NCNR Forecast [MW]		NCNR Forecast [MW]
Solar Production Forecast per Region [MW]		Solar Production Forecast per Region [MW]
Wind Production Forecast per Region [MW]		Wind Production Forecast per Region [MW]
Recent Measured Losses (Last 7 days)		Recent Measured Losses (Last 7 days)
Weather Forecasts (Temperature, Sun, Wind)		
Planned/Forced unavailability of main power units		
Planned/Forced unavailability of grid components		
Data related to DA Core Flow-based		

Table 1: Data input selection

From the list of data initially considered, a selection was made. The main criteria of selection however consisted of the correlation of the data input and the target data (i.e. the grid losses), but also data availability and sufficient business understanding of the data in view of the losses were taken into account. Hereby a higher correlation was preferred whilst avoiding the use of too much data in order to find a good compromise with the error to avoid overfitting of the machine learning model.

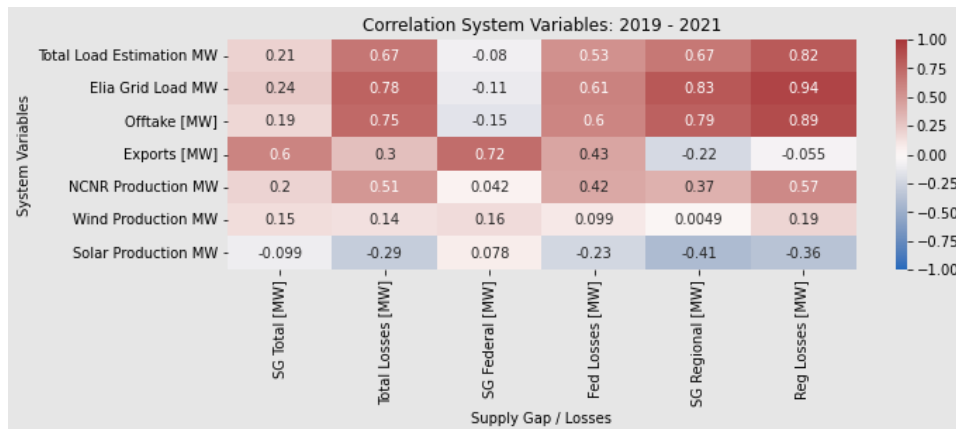


Figure 1: Correlation general variables 2019-2021

In addition to these main inputs, Elia also investigates deeper the potential benefits of using the CORE data, i.e. data available from the capacity calculation in the flow-based market coupling context which received on a daily basis. In particular the data related to the so-called Common Grid Model seem at least conceptually very promising. The Common Grid Model cannot be used directly as input to our AI-model. The information is too complex and the forecasting model will not be able to process it. Finding the best way of post-processing the data in a way that it can be fed to the machine learning model and that it makes a contribution to the forecasting is not easy task. Moreover, to be useful also a sufficiently large historical training set of data is to be available. Note that the quality of this data highly depends of the correlation between Common Grid Model and any potential post-processed data based on it and the real flows in real-time that actually determine the losses. For the POC it wasn't possible identify yet a dataset, incl. training data, that matched all criteria to be added to the model in functional way and making a contribution. It is clearly one of the aspects deemed interesting and promising for further increasing the accuracy of the forecast, not the least for the federal losses. Therefore, as also mentioned in the implementation plan, this is a research priority when further developing the model.

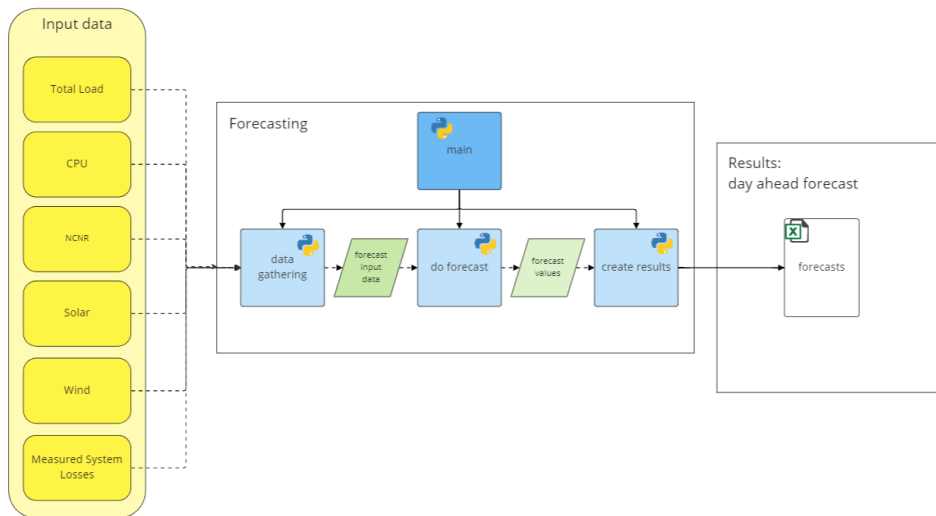


Table 2: POC operational process

2.2. Results of the POC

Elia performed a POC from the 1st of July until the 30th of September 2022 as required by the incentive. The aim of this POC is testing the possibilities for forecasting the federal and the regional losses. The challenges for this Proof-Of-Concept were double: the necessity to deliver the forecast in time, which means each day before the day-ahead market and the willing to provide a high-quality forecast.

For this POC, robust and full IT implementations were not possible given the limited amount of time for the implementation (cf. below, a robust implementation is estimated on a year, already taking the POC experience into account). On the positive side, the POC context allowed to continuously look for improvements and allowed a very flexible, hands-on, approach when problems occurred. Therefore, in order to respect the timing, the operational process has a strong reliance to manual intervention. In addition to this, we had to accept a stronger risk of data unavailability. This could have impact on the final quality even if this impact was lowered due to the active manual monitoring put in place.

Concerning the quality of the forecasted value, the main objective was to reduce as much as possible the difference between the forecasted value and the measured values, knowing that for federal losses this would be tougher. To obtain the best forecast, we used a machine-learning algorithm based on a Standard Neural Network, more precisely a “Multi-layer Perceptron”. This is a three layer neural network, including one input layer, one hidden layer and one output layer.

For the POC period, the following inputs were used: the solar and wind forecasts, total load forecast, CIPU load, the production of the Non CIPU and Non Renewable (NCNR) units and the historical losses. These inputs were selected after a correlation analysis as described in the previous subsection. The workload to add an input in the machine-learning model is non-negligible as an important pre-processing is required to do it. By limiting the number of inputs, focus could be on the most relevant ones and making those work best. Importantly, for machine-learning models the addition of unnecessary input can even deteriorate the forecast quality as if ‘noise’ would be added to data making it harder to find the relevant information in it. Therefore, assuming good data quality and access, simply adding more data vectors to the model is not a sound strategy.

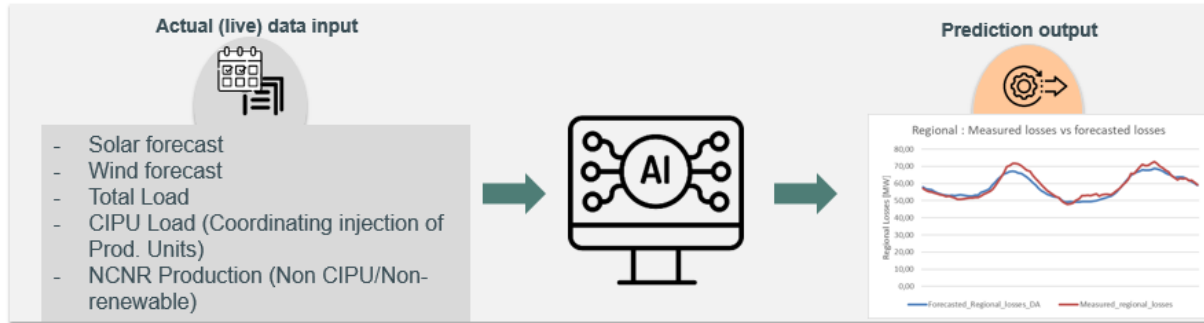


Figure 2: Data input & output

Once the most relevant inputs are determined, there is first a preprocessing required. This first step is to collect and pre-process historical data and use them to train the machine-learning model. The model is obviously also fed by the real measured losses on our network on the same historical period, which are the optimal outputs of our model. The data from this period were used to train the AI model.

The next phase is the test period. In our context, the test period corresponds to the POC period. During this period, the trained AI model received daily the selected inputs. From the inputs, the AI model derives the forecasted losses for the next day. Once the forecasted federal and regional losses are calculated, an Elia operator performed manual checks on quality before sending the forecast to the CREG. This manual checking allowed to filter out unexpected data issues or other problems which sometimes led to a rerunning of the model. Important to note is that the 3-month POC period is short and currently can't be taken as a complete representation for future forecasting taken into account the impact of seasonal effects, but also evolving flow patterns, energy mix, etc. this further validation of the model over a longer-period will be important, but even then it will remain important to keep the model up-to-date as also flow patterns across Europe, the grid, energy mix,... can evolve and those aspects obviously impact the losses and hence the way of forecasting them. For instance, a new wave of offshore wind is likely to have an impact on flow patterns and losses, the training of the model based on representative data will be a challenge when such new wave enters the system.

In D+1 (i.e. two days after the forecast), Elia also performed a forecast analysis, which like the daily forecast has also each time been sent to CREG. In this forecast analysis Elia compares the forecasted losses with the actual losses measured in the network. The forecast analysis contained a statistical analysis about the losses (average, min, max, P25,...), the federal and regional supply gap and the mean absolute error which is often used to assess the quality of such AI-model.

2.2.1. Effect on the supply gap

From a system perspective, the supply gap can be considered as a good indicator for evaluating the losses compensation. As a reminder, the supply gap is the difference between the real losses measured in the network and the procured losses, which are in the context of the incentive the forecasted losses. A positive supply gap (>0) means that there were more losses occurring than being compensated. A negative supply gap (<0) means that there were less losses occurring than being compensated. Mind that any results shown are related to the considered 3-month period and any extrapolation of the results or impact is to be done prudently.

Figure 3 shows the comparison of the supply gap with the current compensation methods and the supply gap obtained if Elia would have procured on Day Ahead the losses based on the forecasting model created for the POC.

Figure 3 shows, using the supply gap as key indicator, the comparison between the current compensation mechanism (orange) and the procurement via short term forecasting (blue) of the regional (left part) and the federal (right part) losses. The comparison is performed graphically by means of boxplots. These boxplots allow highlighting the distribution of the supply through different parameters, among them the median, the quartiles, the upper whisker (maximum supply gap without considering the outliers), the lower whisker (minimum supply gap without considering the outliers) and the outliers. In order to increase the readability of the information shown by the boxplots, the main parameters are also detailed in Table 3.

	ST forecast federal losses [MW]	Current approach federal losses [MW]	ST forecast regional losses [MW]	Current approach regional losses [MW]
Upper whisker	41,5	42,9	7,4	30,0
Quartile 75	9,9	9,9	1,4	16,8
Median	-1,1	-6,1	-0,8	11,8
Quartile 25	-11,2	-17,4	-2,6	8,0
Lower whisker	-42,6	-46,8	-8,7	-2,2

Table 3: Detailed parameter of the boxplots

For the regional part, the procurement via short-term forecasting leads to a supply gap median closer to zero compared to the current compensation mechanism, more precisely the supply gap median comes from 11,8 MW to -0,8 MW. This means that the total supply gap energy can be significantly reduced by changing to a short-term forecast approach. In addition to this, the interquartile (quartile 75 – quartile 25) of the short-term forecast approach is 4 MW which is lower than the interquartile of 8,8 MW obtained with the current approach. As the interquartile is one important indicator of the spread, the short-term forecast leads to a lower spread of the supply gap compared to the current approach. The lower and upper whiskers are also significantly reduced, i.e. the distance between the two changing from 32,2 to 16,1 MW. However, compared to the current compensation approach, the short-term forecasting leads to more outliers, which can be explained by the limited spread of the supply gap obtained and they can be interpreted as the forecast errors in day-ahead.

The obtained results can also be explained from a business perspective. For the regional losses, compared to today's approach, where limitations in forecasting lead to an under-procurement (cf. Elia report June 2022, section), the supply gap can be structurally reduced with a limited remaining forecast error. Indeed, the determination of the volume to procure in today's approach is limited by the number of degrees of freedom at disposal per month (one peak and one off-peak volume). In addition to this first limitation, the estimations of the losses for the next months are performed year(s) or month(s) ahead. As the regional losses mainly depend on the load and they are more and more affected by the increase of decentralized production, the year and /or month ahead forecasting strategy does no longer allow catching efficiently these two main drivers of the regional losses. The forecasted approach, as proposed in the POC, unlocks the possibility to take into account the latest available information on the load and the decentralized production. Therefore, better coverage of the losses is reached with the short term forecast compared to today's approach. The remaining errors are due to the AI-model's inherent limitations and the remaining forecast errors in day-ahead.

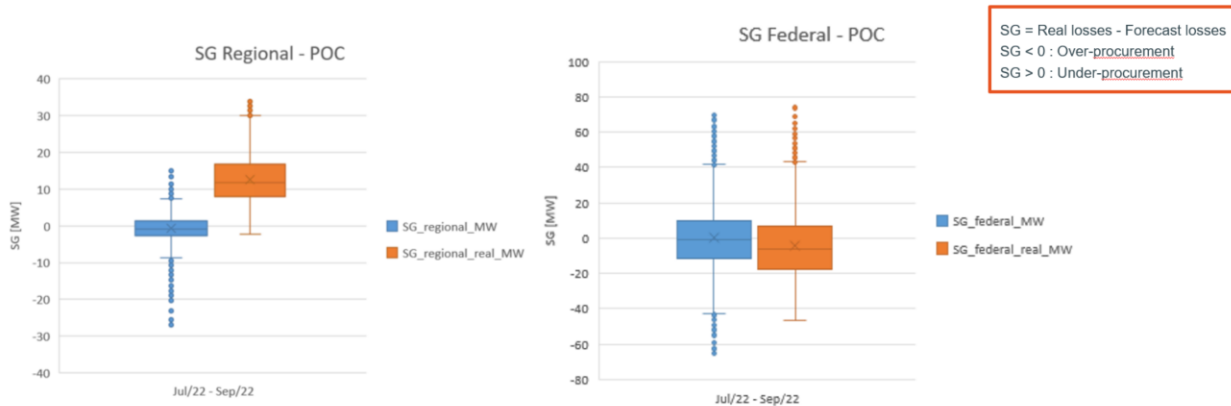


Figure 3 : Supply Gap impact comparison of current compensation mechanism (orange) and the procurement via short term forecasting (blue) of the regional (left part) and the federal (right part) losses.

For the federal part, the improvement is more limited compared to the improvement observed for the regional losses. Although the supply gap median decreases from -6,1 MW to -1,1 MW, the spread remains significant. This means that the procurement of the federal losses can be improved using the short-term forecasting, however as the spread remains quite high, there are still improvements to be done in the forecasting of the federal losses. Nonetheless, the interquartile is reduced from 27,3 MW to 21,1 MW. The lower and upper whiskers are also slightly reduced, the distance between the two change from 89,7 to 84,1 MW. However, compared to the current compensation approach, the short-term forecasting leads to more outliers, which can be explained by the forecast errors in day-ahead and the missing features in the input dataset.

The obtained results can be partially explained from a business perspective. The forecasting of the federal losses is tougher than the forecast of the regional losses. The additional difficulty can be attributed to the federal losses' dependency on several day-ahead factors (wind production, load...) but also on factors depending on the outcome of the day-ahead market (mainly cross-border flows). Although the short-term forecasting of the federal losses is complex, an improvement can be observed, i.e. the boxplot is more centered around 0 MW and with lower variance. However, there remain significant tails which can be attributed to several factors (decentralized production, cross border flows, forecast errors...) of which their impact merits further study. Note that in today's approach over the POC period, the federal supply gap is slightly negative. In other words, the procured federal losses are higher than the real federal losses on average. This effect however varies over time and can be seasonal (cf. historical analysis, Elia study report section 2.3).

In order to further detail the federal losses forecasting challenge, the figures 4 and 5 provide an analysis of a specific day with a larger, in comparison to other the other days, mean absolute error. This specific day is the 31th of August 2022. For this day, the forecasted federal losses lead to a clear under-procurement of the federal losses, the supply gap being positive during the entire day. This outcome can be partially explained by the forecast errors of the inputs considered for this day. Figure 4 shows the total load, wind and (limited) solar forecast errors, which contribute to the final forecast error. But as can be seen in Figure 5, the correlation between the supply gap and the cross-border net flow (absolute sum of the export and the import) is significant. Therefore, the inability of this POC to have a complete view of the cross-border flow also limits the reduction of the supply gap of the forecasting method compared to today's approach. It nevertheless illustrates well that researching this further can prove valuable. Note that, as discussed in the benchmarking with other TSOs as done by SIA Partners (cf. Elia study report, section 3), Elia is not the only TSO

that struggles with this feature towards forecasting. Given that Belgium is heavily impacted by cross-border flows (especially relative to its grid size compared to other countries like e.g. France), the effect is likely to be further exacerbated.

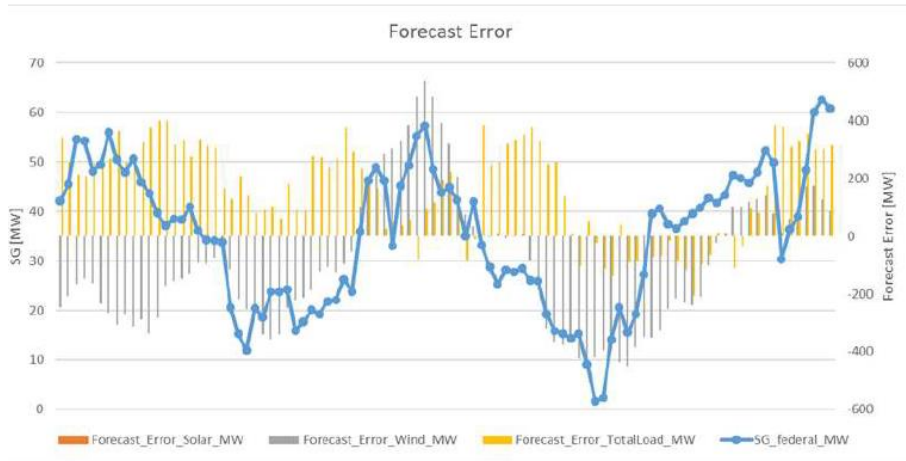


Figure 4: Evolution of the federal supply gap and the forecasts errors of main inputs for 31.08.2022

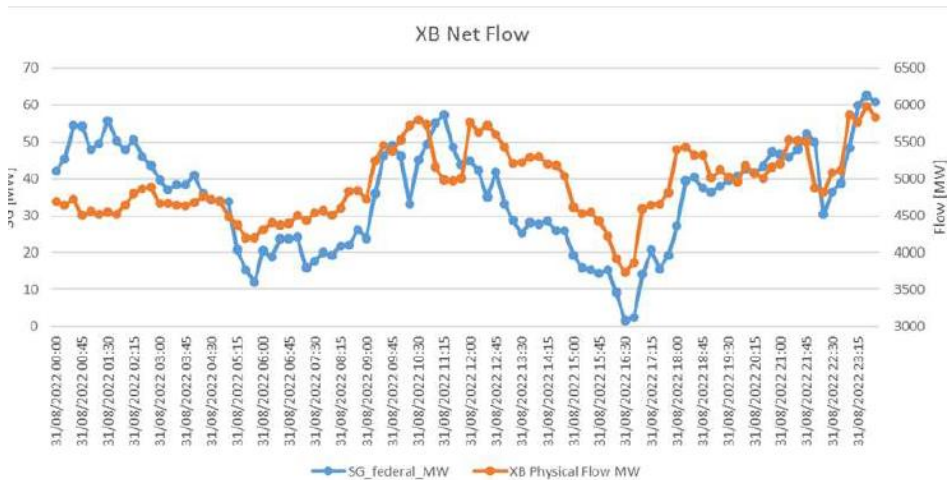


Figure 5: Evolution of the federal supply gap and the XB flow measured on Elia network

2.2.2. Impact analysis

In the previous subsection, the impact of the forecasting method of the supply gap reduction was discussed. The goal of this subsection is to discuss the potential benefit of the compensation approach on the system. The system impact will be firstly discussed based on the distribution of the supply gap and secondly based on the total energy to be compensated via the pool. This total energy to be compensated is obtained by transforming in energy the quarter-hourly value of the supply gap, which is typically expressed in power, and by summing the result over the considered time period.

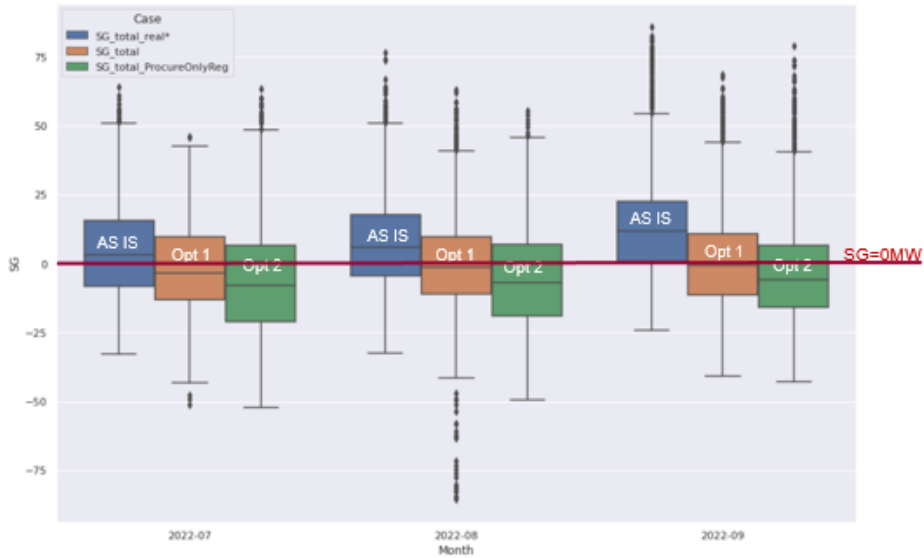


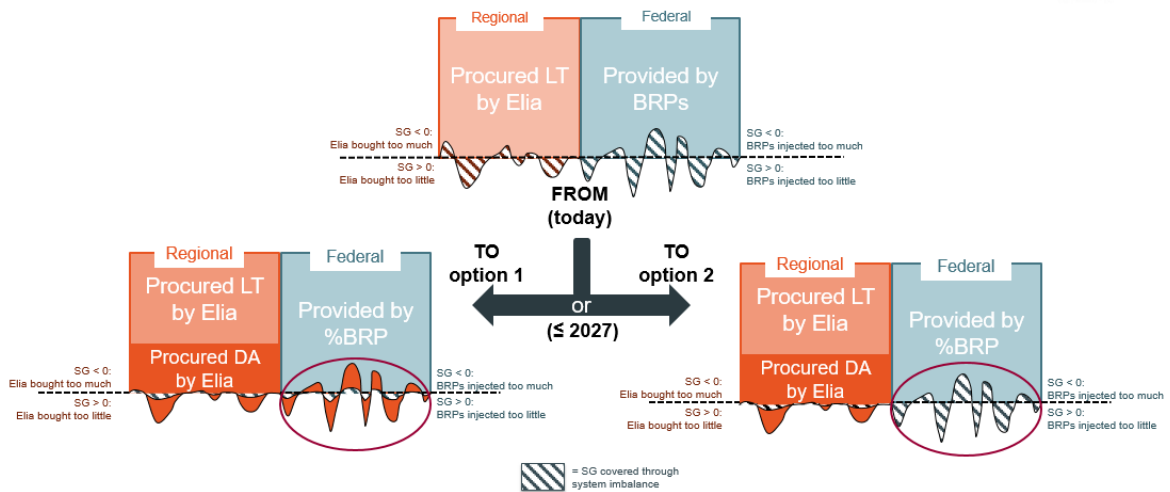
Figure 6: Monthly supply gap in function of the procurement strategy

As shown by the blue boxplots on Figure 6, today's approach has a slight under-procurement for the month of July and a limited higher under-procurement for August and September. In the previous section, we conclude that a short-term forecast can reduce drastically the supply gap for the regional losses and can reduce the supply gap for the federal losses. By procuring the federal and the regional losses via option 1 and option 2, we can respectively obtain the orange boxplots and the green boxplots.

Reminder Option 1 and Option 2:

In Option 1, Elia would procure in the Day-Ahead market the volumes targeting to minimize any gap for both the regional and the federal losses.

In Option 2, Elia would procure in the Day-Ahead market the volumes targeting to minimize any gap for the regional losses. In option 2, Elia stays closer to the contours of the responsibilities and the tariff context.



More detailed information can be found in the Elia study report, section 4.2.

If it would be decided to cover the losses using option 1, the average total supply gap is almost centered on 0 MW. This fact indicates that on average the total losses are well covered with option 1. Therefore, from a volume point of view, the procured losses are almost equal to the measured losses on the network. But from a system point of view, the tails of the boxplot are also important. These tails indicate periods with a negative and positive supply gap. The size of the tail indicates that in rare situations, the supply gap can be higher than 50 MW and although a reduction of the tails can be seen in option 1, a significant variance remains.

If it would be decided to cover the losses using option 2, the average total supply gap is still slightly negative. As discussed in the previous subsection, the quality of the regional losses is high. Therefore, by procuring these losses via a short-term strategy, the regional component of the total supply gap can be highly reduced (average almost zero and reasonable variance). Therefore, it can be supposed for the considered period that the remaining total supply gap can therefore be reduced to the federal supply gap. As shown in the previous section, the federal supply gap obtained with today's approach led to an over-compensation (while knowing that the contribution by BRPs is calibrated on forecasted losses in Y-1 but also accounts for the long-term corrections in view of financial neutrality) on average with significant variance.

Similar analysis can also be performed from an energy point of view. In such analysis, the total supply gap is the sum over the POC period in order to obtain the total supply gap energy (in GWh) over the POC period. With today's procurement approach, the total supply gap energy equals 18,6 GWh. This total supply gap energy has to be procured via the imbalance pool. This energy represents today's losses compensation approach performance from a system point of view.

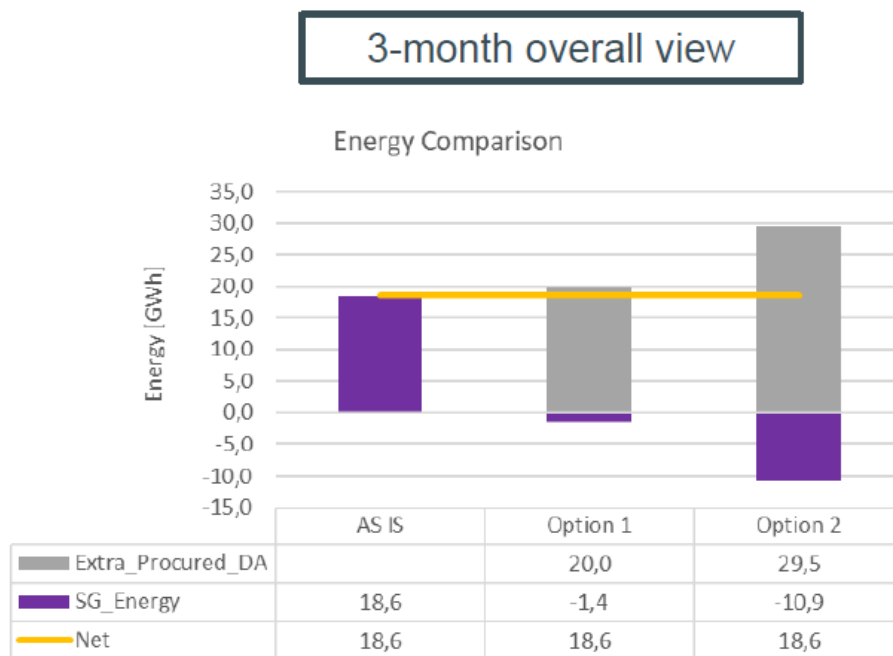


Figure 7: Total supply gap energy and the extra-procurement for each procurement option

If it would be decided to cover the losses using option 1, an extra-procurement of 20 GWh will be required. This extra requirement can be explained by the fact that in today's (AS IS) situation, we are on average in an under-procurement situation. Therefore, this extra procurement is necessary in order to cover the regional losses and the uncovered federal losses. Sometimes, it can happen that for a specific quarter hour, the volume to procure with regards to the regional

losses is opposite to the volume to procure regarding the federal losses. Therefore, the extra volume to procure is reduced, this is one of the main benefits of option 1 compared to option 2. As a result of the extra procurement, the supply gap energy can be reduced from 18,6 to -1,4 GWh. The total supply gap energy is negative which means that we still have a small over-procurement, which is the consequence of a remaining forecast error.

If it would be decided to cover the losses using option 2, an extra-procurement of 29,5 GWh is required. This extra requirement can be explained by the fact that in today's approach, there is an under-procurement trend of the regional losses. This extra procurement is used in order to cover the regional losses only. Compared to option 1, this option does not allow the possibility of netting between the federal, the regional losses and the already procured volume with today's approach. As a result, the volume to procure is higher than for option 1. In addition to this, the resulting supply gap energy, which is mainly driven by the remaining federal supply gap, is equal to -10,9 GWh. Therefore, the supply gap energy can only be reduced from 18,6 to - 10,9 GWh. The total supply gap is negative which means that we still have an over-procurement.

From a total supply gap energy point of view, option 1 can lead to a higher reduction with a lower extra procurement needed compared to option 2. The main reason is the possibility of netting between the federal, the regional losses and the already procured volume with today's approach. The netting possibilities were particularly high during the POC period, there is an under-compensation of the regional losses in average and an over-compensation of the federal losses in average. These netting possibilities will not necessarily be that high for the other months of the year.

2.3. Key take aways – lessons learned

The Proof-Of-Concept shows that on one hand, forecasting of regional losses is feasible with a limited, and deemed acceptable, forecast error. On the other hand, it shows that the forecast of federal losses is also feasible, but the methodology currently leaves the question on whether the outcome is already sufficiently good to progress with the current model, considering the number of possible improvements that can be done. A clear conclusion for the latter is the need for more study work, allowing a study over a longer period, incorporating the impact of seasonal effects, and the integration of more complex data, particularly related to the cross-border context, in order to assess its value and the effects on the forecast.

The result of these federal forecasting values goes hand in hand with the insights gained from the SIA international benchmarking conducted with regards to the first June report. Hereby other TSO's, such as Swissgrid and Amprion, also struggled in a similar manner with the optimization of their forecast. A clear difficulty factor here continues to be the integration of the cross-border interactions.

Notwithstanding the recommendation to further investigate federal losses forecasting and taking into account the POC's 3-month duration limited the representativeness of the results, the POC, and more precisely option 1 of the POC, already reveals a possible solid contribution to reduce the supply gap. And although option 2 offers a principles advantage in simply better covering the regional losses, the noise created by the 'unhandled' federal supply gap makes for a less beneficial approach.

In terms of impact, the POC results not only indicate a better coverage of the losses but also indicate that more volumes will be bought by Elia to closer cover the regional losses compared to today. The resulting smaller supply gap is beneficial in the context of the real-time imbalance of the zone and the imbalance pricing. Assuming that from a system perspective it is deemed better to avoid impact on the imbalance where possible, the overall effect seems positive.

The decision to go for option 1 or 2 is not an Elia decision as such, as it touches closely to the roles and responsibilities and how costs are potentially transferred from one role to another (or not). In Elia's view, this is particularly something on which the viewpoint of CREG matters and that needs to be settled in the context of the implementation (cf. infra).

As, based on the above findings, the results of the POC is deemed sufficiently 'promising', Elia looks into the creation of an implementation plan as required by the incentive. This is done in the next section.

3. Implementation plan

The implementation plan looks into the different aspects which would need to be in place to support the rolling out of the different possible pathways as identified in the study and the POC. Therefore, both option 1 and option 2 will be taken into account.

3.1. Introduction

Following the analysis and the key take aways of the POC as well as taking into account the insights from the study report published in June, Elia concludes that there is a possibility to make a solid contribution to the reduction of the supply gap using a short-term forecasting and procurement approach. With regards to the obligation in kind to be taken over or not by Elia, referral is made to the insights from the June report. The arguments put forward have not changed as a consequence of the POC results.

In order to implement the identified improvement on the shorter-term (≤ 2027), the final design is yet to be chosen. The assessment following the study and the POC, regarding both options are taken into account. Option 1, although still open for improvement e.g. in terms of including cross border flow effects in the forecasting, seems to provide the most interesting way forward from a system-perspective. Whilst option 2, which struggles with more remaining “noise” and limited positive effects towards the overall system as a consequence of not tackling the federal supply gap, remains a principles advantage as it simply provides a better coverage of the losses with a stricter respect for the currently stipulated roles and responsibilities.

Which design option to take is clearly a choice yet to be made in the upcoming months, both options would follow very similar implementation tracks. Although there are differences to account for, on the short term they do not define the critical path.

3.2. Continued improvement of the forecasting model

As can be concluded out of section 2.2 of this study, this POC, which had the mere purpose of testing a concept, can still greatly benefit from continuous improvement. On a first point, the short duration of the POC can be used as a source for improvement as the short period that the data was analyzed did not provide the model with sufficient exposure to seasonality effects and may for instance not capture sufficiently evolving flow patterns and variable energy mixes. In addition to this, a longer testing period will also benefit the machine learning model which is being used to analyze the data.

As a second point, the forecasting errors especially at federal level are expected to benefit from the inclusion of cross-border related data coming from the capacity calculation phase in the day ahead market coupling. This is a shorter term priority for the model's evolution.

In any case, cf. above, it remains always crucial to follow-up on the model's performance as the grid, the energy mix, flow patterns,... are evolving over time and new trends, sometimes happening over a short period of time (e.g. nuclear phase-out, new offshore wave) may impact the training needs for the model in order to maintain a representative training set for a sufficient long duration.

3.3.IT implementation

The IT framework consists of the creation of a robust IT architecture, which should provide the ability to procure the losses in the day-ahead market on a daily basis based on a forecast occurring at D-1 in the morning. The current implementation realized for the POC targeted solely the validation of the feasibility of an idea or methodology, lacked a technical approach aimed at creating a robust and sustainable execution of the full process.

The implementation plan nevertheless builds on these learnings, e.g. in terms of data accessibility and quality, but now also aims for the use of a robust architecture and approach which can support the tool to run on a 7 on 7 basis. This should enable the tool to facilitate a close follow-up, alerting, link with a front office for the purchasing, but also provide Elia with the necessary back-up solutions when needed.

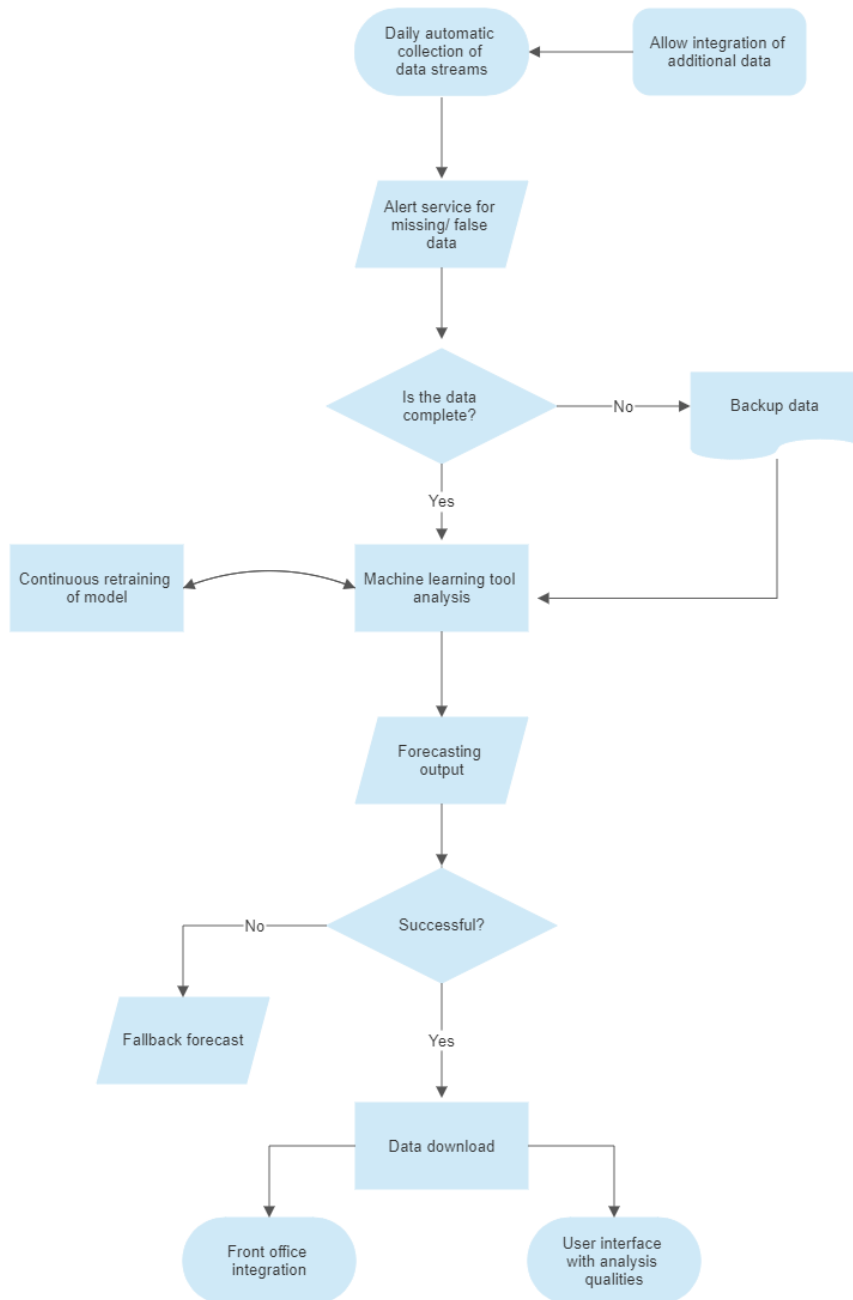


Figure 8: Grid losses tool architecture

The set-up of the tool would consist of the integration of forecasting data, as described in section 2.1.2, into a trained artificial intelligence (AI) model which would enable the creation of day ahead losses forecasts. In order to keep up with evolutions that require a continued follow-up the machine learning model will need a regular updating and re-training in order to sustain and improve forecasting quality.

An estimated time to the technical go-live would be 12 months (see also timeline in 3.7). In terms of resource availability and the need to integrate such development in the already crowded overall development agenda related to ancillary services and market evolutions, it is expected that such IT implementation activities can only take off as from 2024 onwards. Such implementation was so far not foreseen in any implementation roadmap and calls for flexibility on Elia side to be integrated as such. Given the 12 month lead time, an earliest go-live can be expected in Q1 2025. This of course assumes that the other implementation tasks can be successfully completed in parallel.

3.4. Legal & regulatory framework

For the potential addition of the federal grid losses to the Elia procurement, Elia considers that at least for the short to mid-term (≤ 2027), changing the compensation in kind by BRP's to a procurement by Elia is not possible nor recommendable. At least a multi-year advance notice is needed in order to prepare an implementation approach guided by a clear and stable framework and the identified boundary conditions are to be evaluated positively by the relevant entities.

For the potential mid-term evolution towards short-term (DA) procurement, the (legal and regulatory) framework needs to be supportive. This is further addressed in this section.

3.4.1. Legal framework

In order to assess the legal framework regarding the possible evolution towards a short-term approach, Elia looked at the possible hindrances and the level of comfort that is provided by both regional, national and EU legislation.

In general, based on an initial legal analysis, Elia perceives the current legal framework as not blocking for an evolution towards short-term procurement by Elia. Elia bases itself hereby on the articles regarding the procurement of the losses, which can be found in the Flemish 'Energiedecreet'², Walloon 'Décret énergie'³ and Brussels regional laws 'Ordonnantie'⁴. These articles refer mainly to the transparent, non-discriminatory and market conform basis of the procurement approach. This is echoed in the 'electricity law', which stipulates a similar obligation for the TSO's. The stipulations remain high-level and do not particularly detail an approach to be followed, neither does it seem to act as a roadblock.

As a consequence, Elia sees the legal framework as sufficiently supportive – or at least as 'not blocking' - towards the implementation of a short term procurement approach. Nevertheless, being formulated rather high-level and little to no indications on the governance or any 'rules of engagement' if Elia would act on, for instance, DA markets operated by NEMOs, there is a need to further complement this with the necessary guidance. This should not only clarify how Elia

² Artikel 4.1.6 van het decreet van 08/05/2009 behoudende algemene bepalingen betreffende het energiebeleid ("Het Energiedecreet"). [Decreet houdende algemene bepalingen betreffende het energiebeleid \[citeeropschrift: "het Energiedecreet"\] \(vlaanderen.be\)](#)

³ Artikel 11 van het decreet van 01/05/2001 betreffende de organisatie van de gewestelijke elektriciteitsmarkt. [LOI - WET \(fgov.be\)](#)

⁴ Artikel 5 van de ordonnantie van 19 Juli 2001 betreffende de organisatie van de elektriciteitsmarkt in het Brussels Hoofdstedelijk Gewest. [LOI - WET \(fgov.be\)](#)

could act on the market, while not becoming a true market actor or trader, but also provide the necessary comfort in terms of acceptability of the costs made by Elia. Several of the elements for which further guidance is deemed useful are discussed in section 3.5 dealing with the ‘purchasing approach’. As these aspects clearly require a strong involvement of the CREG and given that in the past the tariff file framework served as a place to describe several aspects of the regional losses compensation approach, the next section on the regulatory framework picks this up as a useful pathway.

Finally, at European level, no hindrances were found. However, it can be concluded that both the Council⁵ and the European Parliament (EP)⁶ are more and more looking into the matter in the context of potential upcoming legislation. Based on Elia’s own assessment, the approach proposed seems sufficiently in line with those evolutions. In essence, the evaluations seem to rather target energy efficiency and losses reduction, while in the context of this report and incentive the compensation of the remaining losses is dealt with.

3.4.2. Regulatory framework

Today, in the context of the tariff file, the budget and the way how Elia approaches the procurement of the (regional) losses is dealt with as Elia justifies to CREG how it plans to fulfill its roles on this in a tariff period allowing CREG to also approve the budget. Especially in absence of a further structured governance defined by legislation, this has proven to be a workable approach in the past. Of course, CREG also receives all cost details ex post, e.g. in approving the “soldes tarifaires” after each year allowing it to control Elia’s activities.

This approach of working via the tariff file followed in the past could also provide a basis to describe further how Elia could engage in the future into a short-term procurement approach. In view of the planning ahead, a new tariff file for the period 2024-27 is coming up and in fact provides a good opportunity. How far things should be detailed in the tariff file between CREG and Elia and whether this suffices in providing the necessary clarity and comfort in terms of ‘rules of engagements’ and resulting costs is yet to be further discussed between CREG and Elia.

Also the choice in terms of design (option1 or option2, cf. above) may find its answer in the tariff context as the distinguishing element relates to which roles (BRP or access holder) are considered, as well as any further effects such choice have (e.g. option1 is likely to reduce the amounts to be considered from a LT perspective in setting a next percentage for compensation in kind by BRPs).

Keeping market parties in the loop - a request also casted by market parties in the 17/11 workshop held by Elia - through the working groups of the Elia Users’ Group, can offer a pragmatic solution in absence of further legally set governance.

3.5. Purchasing approach

In order to realize either design options 1 and 2, and hereby procure volumes on the short term, Elia would be required to be active on the day-ahead spot market (and perhaps intraday at a later stage when deemed providing additional added value). As mentioned above, providing clarity and comfort to Elia and the market parties on the ‘rules of engagement’ for such short-term procurement is key.

⁵ Interinstitutional File 2021/0203 (COD). 27th June 2022. Proposal for a directive of the European parliament and of the council on energy efficiency. Retrieved from [pdf \(europa.eu\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0558R(01)-EN).

⁶ COM/2021/558 final/2. 14th July 2021. Proposal for a directive of the European Parliament And of The Council on energy efficiency. Retrieved from [EUR-Lex - 52021PC0558R\(01\) - EN - EUR-Lex \(europa.eu\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0558R(01)-EN).

Indeed, when Elia would be taking active positions in the market, a number of concrete questions for implementation pop up. This was also something that did not go unnoticed to the market parties whilst presenting the topic during the workshop of the WG Balancing on the 17th of November.

	Suggested approach
Target volume?	Mimize Supply Gap (Total – Option 1, or Regional only – Option 2)
Price?	At any price, at all times. No price-setter, losses have to be covered.
Buy and/or sell?	Buy ‘only’ (reducing risk of ‘long’ position by means of prudent LT position)
Which NEMO?	Limit transaction costs, e.g. linked to the fact that 50HzT is already active on DA market

Table 2: Possible purchasing approach Elia

When looking into the possibility to optimize the procurement of the regional supply gap in the day ahead market, a simple purchasing approach has been put forward by Elia, cf. the table above:

- Hereby the procured volume would have the target to minimize the supply gap, while at this stage leaving open the question on whether design option 1 or 2 is followed (cf. above).
- Compared to the current situation where Elia still relies heavily on forwards contracts, complimented by seasonal contracts, Elia would reconsider its LT volumes to procure and most likely (slightly) reduce those long-term procured volumes to avoid to arrive in day-ahead with a ‘long’ position. In view of limiting the impact towards the market, Elia believes that ‘only buying’ on the spot market is the most prudent approach. Avoiding a ‘long’ position and hence a need to sell(-back) on the DA fits such approach. As Elia would forecast and procure on the short term, the amount of forward contract procured could hence be decreased and the peak hours could be gapped better by short term day ahead procurement what would eventually optimize the supply gap.
- Given that the need to cover the losses is a continuous system need, covering the volumes as forecasted at all times seems the most logic approach in view of the system. Any non-covered volumes would anyhow affect the imbalance of the zone, an effect which is generally to be minimized.
- Avoiding becoming a true market actor or trader, Elia considers that it is best to avoid that Elia would be a price-setter in the market and should be rather a price-taker. The considered volumes to be bought on the day ahead market are also believed to remain sufficiently small compared to the volume traded on those markets, making the price-taking approach also more realistic. This implies that when participating to the day-ahead price Elia would not make price orders, but rather buy the volume ‘at any price’.

Elia will have to choose via which NEMO it would act on the DA market. While this should not impact the pricing, minimizing transaction costs and synergies with other activities in Elia may drive this choice. For instance, within the Elia Group the 50HzT branch already operates a front office acting on the day ahead market.

3.6. Multiple BRP’s active on a single access point

As already referred to in the June report (cf. section 4.2.3⁷), Elia performed a study around the feasibility of designating multiple BRP’s on a single access point and analyzed a subsequent netting of the losses on this point. This study received positive feedback from the participating market parties and an accompanying implementation plan has been

⁷ [Balancing incentive study on the estimation and the compensation of the grid losses \(elia.be\)](https://www.elia.be/en/balancing-incentive-study-on-the-estimation-and-the-compensation-of-the-grid-losses)

performed and presented. As the implementation of such new rules and split of losses will provide an impact on the calculation of federal losses, which is deemed beneficial by the concerned market parties, the planned implementation of the new multiple BRP's scheme is of influence to the implementation plan presented in this report.

The implementation planning with regards to this multiple BRP approach is still in line with what was presented to the market parties in the WG Balancing on 08/12/2021. The estimation of an implementation by beginning 2024 is thereby still valid. One dependency which might influence the overall timing would be the needed modifications to the BRP contract and the access contracts.

3.7. Indicative timeline

An indicative timeline summarizes the different tasks, as discussed above, and the time frame of the individual parts. Elia envisions to commence working on the IT development by the beginning of 2024, but will continue to study the data inputs and the modelling throughout 2023. Next to this a further legal/regulatory preparation will need to take place in 2023, e.g. in the context of the tariff file as suggested above, in order to allow for a go-live period early 2025.

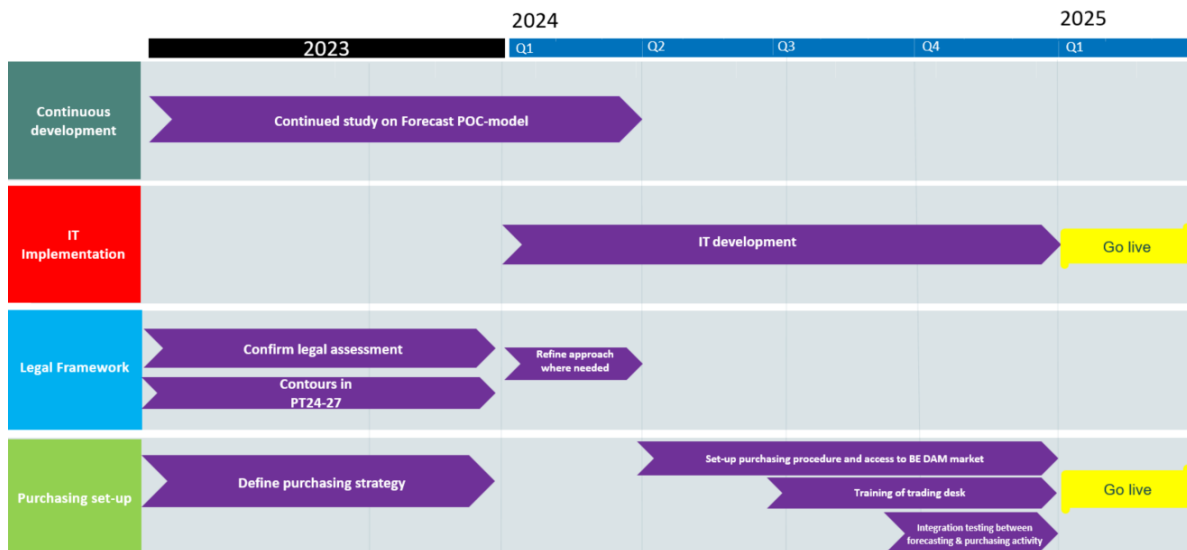


Figure 9: Timeline implementation plan

4. Impact

In terms of impact, the POC has provided Elia with a clear indication that a short-term forecasting approach and a subsequent procurement can help provide a better coverage on the losses. Therefore, this new strategy would fine-tune the compensation approach and limit the amount of possible over- and under-compensation.

Next to expected better losses coverage resulting in a lower supply gap and, hence, lower reliance on the imbalance mechanism to cover for this supply gap, compared to the existing practice the short-term day-ahead procurement by Elia would however lead to a higher amount of volumes procured (with the amount differing between the option 1 or option 2 design). This is a direct consequence of shifting volumes from the supply gap and more implicit compensation through the imbalance mechanism to the explicit compensation in the context of the losses. This also results in an increase of the direct cost made by Elia related to losses compensation. Of course, from a system perspective, it is only a shift of cost, not an increase. Even more, there are indirect benefits related to the reduction of the supply gap in terms of not limiting the interference on the imbalance mechanism and real-time prices, cf. Elia's June report for a further discussion.

Also, as already discussed above, the impact of option 1 and 2 is different. Next to a different system impact in terms of changing supply gap, there is also a difference in how the different roles, notably BRPs and access holders, are affected. Option 1 also targets the federal supply gap in the current context of compensation in kind by BRPs. This is expected to reduce the 'mismatch' by the compensation of the BRPs and the actual federal losses and thereby has the clear potential to also reduce the (positive or negative) amounts that need to be transferred to next years to ensure a long-term financial neutrality towards BRPs (cf. Elia's June report) and thereby impacts the percentages defined for next years. This however also implies a transfer of these costs to the 'regular Elia tariffs' for the compensation of losses charged on access holders. The specifics of such transfer need to be further concretely addressed if such option is chosen.

Furthermore, while a clear and well-balanced framework on how Elia could act on the market for procuring volumes to cover the losses are clearly needed, such approach would result in Elia becoming more active on the market. Elia deems however that, this effect is not impacting the overall market functioning, especially in case of application of the proposed contours described in section 3.5 on purchasing approach.

With regards to Elia taking over the compensation in kind by the BRPs, Elia refers to its June report where different impacts have already been discussed. The findings from the POC do not result in updated insights on this matter.

5. Conclusion

The conclusions of this study are guided by the two research questions (see section 1) as proposed by the CREG as part of the incentive. In order to provide the CREG with a holistic and substantiated answer, Elia looked into the, short and long term, feasibility and impact of the implementation of the suggested approaches as such. The results of the POC were an essential testing ground for the practicality and the impacts of the different set-ups. For the sake of completeness, Elia included a multi-optional approach (option 1 and 2).

In terms of digestion of the POC and taking into account its limitations in terms of operating model and limited test period, both the effect on the supply gap as the overall system impact were taken as important validators for the different approaches.

- Hereby, the - predominantly more difficult to forecast - federal losses show to have a dependency on a wide range of variables. And although the forecasting developed in the POC saw some clear and promising improvements, the overall results vary and suggest that the forecast could benefit from a larger studying time and continued effort to integrate further and more complex data.
- In comparison, the regional losses saw a clear improvement in coverage through the POC's forecast, leading to a reduction in supply with a limited remaining forecasting error.

As the results from the forecasting sufficiently support the development of a short term procurement approach, both the system impact of an approach where Elia targets the minimization of the supply gap of both the regional and federal losses (option 1) as an approach where Elia solely targets the minimization of the regional supply gap (option 2) were analyzed. Although option 1 showed an overall more solid contribution to reduce the supply gap, and thereby also reduce the impact on the imbalance mechanism, both options were taken up into an implementation approach as also other factors are at play such as the overall governance framework on the losses compensation.

The implementation of such approach based on short-term procurement by Elia clearly shows the need for a sufficient framework providing clear rules and comfort for Elia on how to participate, with either design option 1 or 2, on the Day-Ahead market (and potentially at a later stage in intraday) and how those costs are then treated. This requires further interaction between Elia and CREG, e.g. in the context of the upcoming tariff file 2024-27.

The implementation also requires an important IT development to be realized. This is currently estimated at 12 months, assuming that the design and framework have been sufficiently clarified. Taking into account resource availability, this IT implementation can only start as from 2024 onwards. An earliest go-live can then be expected by Q1 2025. The POC results also indicate room for further improving the machine learning model, next to being an continuous task (also when fully up and running) there are clear study fields identified to seek improvement before a go-live (e.g. the integration of data related to cross-border flows).

Overall, Elia deems that the POC was successful and delivers a promising outcome to build on and, together with the analyses done in the June report, it confirms that there is a clear potential to move forward on the short term procurement. The implementation plan sketches such way forward. With respect to a potential evolution of the federal losses compensation in kind by BRPs Elia refers to its findings in the June report, but reminds that the case of multiple BRPs on a single access point is foreseen to be picked up on the shorter term.

Annex

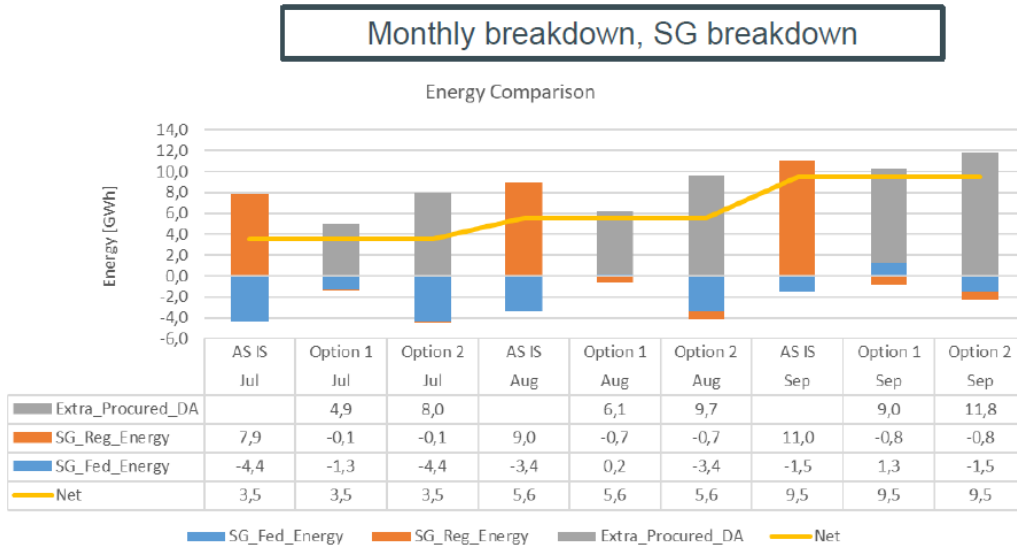


Figure 10: Supply gap impact; as is-Option 1-Option 2