Review of 'Bevoorradingszekerheidsstudie voor België: Nood aan strategische reserve voor de winter 2016-2017 (November 2015)'

FINAL VERSION, DECEMBER 9th, 2015

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ABSTRACT

The recommendations by Elia concerning the need for Strategic Reserve are based on a very comprehensive and convincing approach. The flow-based methodology (ANTARES) brings a great value added compared to 'island'-approaches and reflects current best practices.

The modelling results by Elia have been assessed by adapting an existing model at Ghent University. The latter is not presented as an alternative model to assess security of supply issues. The basic goal was to find out whether or not a much less sophisticated model can replicate the results of Elia. Based on similar assumptions on peak load and generation capacity, both models yield very similar average and P95 LOLEs (in the reference case). The need for Strategic Reserves (SR) is comparable although slighter lower with the model of Ghent University. The results show that Belgium critically depends on imports for its security of supply.

The rather good comparability of results from both modelling approaches confirms that the approach by Elia provides a sound basis for policy recommendations concerning the need for Strategic Reserves in the winter of 2016/2017.

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To ensure security of electricity supply, TSO Elia estimates every year the need for Strategic Reserve assets for the coming winters. Elia published the results of its probabilistic analysis on November 15th, 2015. The used adequacy criteria were LOLE < 3 h and LOLE P95 < 20 h.

This review of the report by Elia contains three components;

1. Modelling the need for Strategic Reserves for the winter of 2016/2017;
2. LOLE for the 2016/2017 winter;
3. Conclusions

Part 1 – Modelling the need for Strategic Reserves for the winter of 2016/2017

In this section, we assess the very comprehensive modelling approach by Elia. We argue that the modelling efforts of Elia build upon excellent expertise, state-of-the-art modelling tools and the best data available. In particular, we note that the assessment for the winter of 2016/2017 did benefit from several comments and improvements since the report for the winter of 2015/2016. Moreover, we found the assumptions used to build the reference scenario realistic and adequate for the purpose.

An existing model at Ghent University has been adapted in a basic effort to replicate the results by Elia. In this section, the differences between both models are briefly discussed. However, we do not present the model at Ghent University as an alternative model to assess security of supply issues. The basic goal was to find out whether or not a much less sophisticated model can replicate the quantitative results of Elia.

Estimations of LOLE and energy not served (ENS) depend on the expected electricity demand in the winter of 2016/17, the availability of generation assets, weather patterns, the impact of market response mechanisms and the ability to import electricity. The interaction between economic activity and the weather determines the demand for electricity while generation from intermittent renewable capacity equally depends on the weather. In the following paragraphs, we discuss Elia's approach to modelling each of these elements and how the Ghent model differs.

Electricity demand

Electricity demand in the Elia model is based on predicted growth for electricity demand, corrected for weather forecasts during the winter months. For predictions regarding the baseline demand, Elia uses predictions produced by IHS CERA (p.43), which indicate a slight increase in demand in the next years. The evolution of peak load is however more variable than the evolution of total demand (see Figure 48). Elia uses weather data for 40 winters (1973-2013) as well as estimates of the thermo-sensibility of electricity consumption to simulate the distribution of predicted consumption for the 2016/17 winter. We can expect that the most extreme weather events are considered in the probabilistic analysis by Elia. The model at Ghent University is based on only three weather years, including the winter of 2011/2012.[2] An assessment based on 40 years of weather data is clearly superior.

Based on 40 years of historical weather data, Elia predicts an average peak demand of 13 750 MW for the 2016/2017 winter (and a P95 peak demand of 14 250 MW, see Figure 47 on page 47). Based on the evolution of peak load since 2002, this approach seems adequate. In an effort to replicate the assumptions of Elia, electricity demand data have been manipulated in the model at Ghent University[3] to ensure that the average peak load in the winter of 2016/2017 for all model runs is identical to the average peak load in the approach by Elia. Hence both approaches assess the ability to meet a peak demand that is <u>on average</u> identical.

[2] The cold spell in the winter of 2011/2012 was rather intense compared to the average Belgian winter in the last 25 years (see Figures 16 and 17 in the Elia report).

[3] The model at Ghent University is based on electricity demand data for the period from 2005 until 2014.

Generation capacity

The Elia report contains all relevant information on the assets to generate electricity in Belgium. Given the increasing importance of wind and solar output, it becomes very important to model the contribution of renewable capacities. Information on installed renewable capacity is combined with the 40-year weather data to generate a distribution of electricity generation from wind and solar panels (section 3.1.2.).

The variability of the availability of the thermal generation assets is explicitly discussed on the pages 22-23 and in section 2.1.2. Details about the availability of nuclear power plants are included in section 3.1.4. The baseline scenario integrates the extension of Doel 1 and Doel 2 which has recently been confirmed. The outlook on the increasing renewable generation capacity up to 2020 could be rather optimistic as mentioned on page 31 (section 3.1.1).

Market response

The possible contribution of market response mechanisms is described and quantified in section 3.2.4. Based on a survey by Pöyry, three sources of flexibility have been distinguished: contract-based, price-based and voluntary responses. In total, a potential market response of 826 MW has been identified. This response is nevertheless constrained in terms of the number of activations and their duration. Elia's model integrates these constraints and optimizes against them (p. 51). These constraints are not taken into account in the Ghent model, which may bias our results towards decreasing the predicted need for the strategic reserve.

Predicting market response is tricky. The current prediction relies on a survey of key market operators. In the model, Elia assumes that 100% of this demand response potential is available in critical moments (p.51). One could argue that this is an optimistic assumption. At the same time, this new market of demand-side mechanisms is still evolving, and an even higher potential to move electricity demand could be available in the next years. For longer cold spells in the winter of 2016/2017, the assumption of 100% availability is less likely to hold. Furthermore, RTE foresees a market response of 3,2 GW in France for the winter of 2016/2017 and this large capacity is also considered to be always available (without a limitation on the activation of demand response in France). Given the strong correlation of average temperatures in France and Belgium, both countries count on 4 GW market response irrespective of the length of the cold spells.

Imports

Elia's model includes 19 countries and uses the market simulation tool ANTARES developed by RTE. ANTARES is used in several European projects. Elia validated data and hypotheses on assets in neighboring countries through bilateral contacts with the other TSOs.

Because of recent projects (like BRABO I), the maximal import capacity for Belgium amounts to 4 500 MW for the 2016/2017 winter. The technical import capacity is significantly larger: 3 750 MW on the Dutch border and 3 900 MW on the French border. To assess the availability of import capacity in the 2016/2017 winter, Elia used the flow-based methodology. With flow-based, the market circumstances in the neighboring countries and the resulting physical flows determine the capacity to import electricity in Belgium. The relevant domains in flow-based approaches need to be verified in advance. The Belgian grid has been significantly reinforced since the winter of 2014/2015 and the 'remedial actions' to construct the relevant domain have been coordinated and approved by the other TSOs. However, Elia mentions in its report that there are no guarantees that these remedial actions will be accepted by the other TSOs at times when Belgium needs to import electricity (p.64).

When Belgium and France both face a structural deficit and need to import electricity, the capacity to import will be allocated in ANTARES to maximize welfare over both countries. Otherwise there would be a risk that one country can fully meet its import needs while the other country cannot import electricity despite a structural deficit. The latter outcome should be avoided by an 'adequacy patch' to ensure that a country can always import a certain amount of electricity. The 'adequacy patch' does not guarantee at all that each country can import without any constraint (p.65). Figure 68 (p.69) shows the levels of electricity import at times with a structural deficit; for 43% of the hours with a deficit, Belgium can import 4 500 MW. For the remaining 57% of the hours with a deficit, Belgium can import less than 4 500 MW but more than 1 150 MW. For 80% of the time, Belgium can import 2 000 MW. Without this 'adequacy patch' the capacity to import could be much lower under specific circumstances, leading to much higher needs for Strategic Reserves. The effectiveness of this type of 'adequacy patch' is an important assumption and we explore the sensitivity of the results to it in part 2. As this mechanism builds upon experiences among TSOs, we can expect that the patch most likely will produce the intended outcomes.

Since the model at Ghent University is limited to generation assets in Belgium, the availability of import capacity is modelled based upon Figure 68 in the Elia report, i.e. a maximal import capacity of 4 500 MW for 43% of the time with a structural deficit and an import capacity between 1 150 MW and 4 500 MW during the remaining 57% of the time. Randomizing the import capacity at times with a high need to import is a crude approach but unavoidable in a model that is not coupled to neighboring countries.

Table 1 summarizes available capacities to meet electricity demand in the 2016/2017 winter. The model at Ghent University makes use of exactly the same inputs – e.g. see Table 2 in section 3.1.8 - but its scope is limited to Belgium. Table 1 shows that firm generation capacity exceeds 10 500 MW – irrespective of the availability – while the sum of market response and import capacity exceeds 5 300 MW. Installed wind capacity amounts to close to 2 500 MW. This basic overview suggests that the results of any security assessment will be very sensitive to the ability to import electricity as well as to the available of thermal capacity.[4]

Table 1 – Winter 2016/2017; assumptions on peak demand and available capacities

Average peak demand in 2016:	**13 750 MW**
Nuclear (with D1D2)	*3 912 MW*
Gas	*3 366 MW*
Biomass + CHP	*3 196 MW*
Turbojet	*130 MW*
Firm capacity	*10 558 MW*
Demand response	826 MW
Firm capacity + demand/market response	*11 384 MW*
Import capacity	4 500 MW
Wind capacity	2 429 MW

[4] Figure 19 in the Elia reports shows an average availability of thermal capacity around 8 300 MW.

Part 2 - LOLE for the 2016/2017 winter

The models are used to generate predictions about the average number of hours during which the electricity demand will not be covered by the available capacities including market response and imports (LOLE) and the average number of hours where demand cannot be covered for exceptional hours (LOLE95). When the LOLE and LOLE95 are higher than 3 hours and 20 hours respectively, capacity is added in the models by tranches of 100 MW until the 3 hours and 20 hours benchmarks are met. This corresponds to the recommended size of the strategic reserve.[5]

In Table 2 we compare our results to the results in the Elia report. The calculation of the average LOLE yields very similar results; 6 h compared to 7 h. For the P95 LOLE, the difference between both calculations amounts to 10 h. This difference is most likely due to the modelling of available import capacity, the variation in available capacity and the missing of extreme weather events in the approach of Ghent University. The difference in the modelled Strategic Reserve (MW) to lower the average LOLE and P95 LOLE to the benchmark levels – 3 h and 20 h – is 200 MW.

Table 2 – Comparison between the predictions of the Elia and Ghent model (baseline assumptions); average and P95 LOLE

		Elia	Ghent University
LOLE (h)	Average	6	7
	P95	37	28
Strategic Reserve (MW)	Average	700	500
	P95	1 000	800

Elia's model predicts that the strategic reserve will be activated on average once per year for a duration of 6 hours. For exceptional years (95-percentile), the model predicts 5 activations and a total of 37 hours of operation.

Sensitivity analysis

We already hinted to the fact that we find the assumptions used by Elia for its baseline model fully adequate given the circumstances and the purpose of the modelling exercise. Assumptions remain assumptions however, and it is useful to understand the sensitivity of the results to them.

In its report Elia presents a very interesting and comprehensive section on the sensitivity of the results in the reference scenario. We noted above that predicting the effective size of the demand response was a tricky exercise. In one of the sensitivity exercises, Elia assumes (p. 74) that no demand response is available. This is an extremely conservative assumption and it is interesting to see that its impact in terms of LOLE is limited (7 h instead of 6 h for the average LOLE – see Figure 75 in the Elia report). Its impact on the size of the Strategic Reserve is bigger, moving it from 1 000 MW to 1 200 MW (P95 LOLE). Given that the true effective size of demand response is likely to be closer to 826 MW than to 0 MW, this is reassuring that Elia's result do not overly depend on its assumption about the size of demand response.

Modelling imports is another sensitive part of the model, for which Elia provides several sensitivity exercises. The baseline model already uses the N-1 assumption for interconnections (which

[5] Given that the model is adjusted by tranches of 100 MW (and not by e.g. 20 or 50 MW), the result may slightly overstate the size of the required reserve. This is marginal however.

corresponds to international standards when performing this type of analysis). Interestingly, the loss of an additional interconnection or net element almost doubles the value of the LOLE but implies only a 100 MW increase of the Strategic Reserve (P95 – see Figure 88).

Given the importance of the ability to import electricity, the model at Ghent University has also been used to calculate LOLEs without imports. The results of this sensitivity assessment by Elia are presented in section 4.6 of the Elia report. Not surprisingly, LOLEs respond strongly to this assumption. Table 3 shows that the Ghent University model finds significantly lower LOLEs; 2 077 h versus 2 673 h for the average LOLE and 2 477 h versus 2 944 h for the P95 LOLE. Part of the difference in results can be attributed to limited weather data in the model of Ghent University, leading to an overestimation of PV and wind output in the winter months. The gap between LOLE and P95 LOLE is 'only' 271 h with the Elia model while this gap is 400 h with the model of Ghent University.

Table 3 – Results; average and P95 LOLE without the ability to import

		Elia	Ghent University
LOLE (h)	Average	2 673 (74% of winter)	2 077 (58% of winter)
	P95	2 944 (81% of winter)	2 477 (69% of winter)

The results by Elia suggest that without import, Belgium will face structural deficit for 74 to 81% of the time in the 2016/2017 winter. The Ghent University model concludes that 58 to 69% of the time in winter Belgium needs to import electricity (average LOLE).

Finally, we use the model at Ghent University to assess the sensitivity of the results of the reference scenario to a lower minimal capacity to import electricity. Specifically, we assume that the minimal import capacity is not 1 150 MW but only 750 MW. The latter outcome implies that the 'adequacy patch' did not deliver the expected capacity to import electricity. Elia does not provide a similar sensitivity assessment. Table 4 shows a strong increases in the LOLE. The P95 LOLE implies a Strategic Reserves of 1 000 MW.

Table 4 – Sensitivity: 750 MW import lower bound

		Ghent University	Strategic Reserve
LOLE (h)	Average	29 h	800 MW
	P95	80 h	1 000 MW

Part 3 – Conclusions

The recommendations by Elia concerning the need for Strategic Reserve are based on a very comprehensive and convincing approach. The results show that Belgium critically depends on imports for its security of supply. This is not necessarily problematic since we do live in a world of interconnected grids and markets. Modelling the actual ability to import is particularly difficulty as it depends on the market situation in neighboring countries. The flow-based methodology (ANTARES) brings a great value added compared to 'island'-approaches and reflects current best practices.

The modelling results by Elia have been assessed by adapting an existing model at Ghent University. The latter is not presented as an alternative model to assess security of supply issues. The basic goal was to find out whether or not a much less sophisticated model can replicate the results of Elia. Based on similar assumptions on peak load and generation capacity, both models yield very similar average and P95 LOLEs (in the reference case). The need for Strategic Reserves (SR) is comparable although slighter lower with the model of Ghent University.

The rather good comparability of results from both modelling approaches confirms that the approach by Elia provides a sound basis for policy recommendations concerning the need for Strategic Reserves in the winter of 2016/2017.

Predicting the future is a difficult exercise and methodologies and data are likely to continue to improve. On that front, it would be useful to also carry out an ex-post evaluation of the predictions and see how the market actually played out and the Strategic Reserve was used. Future assessment exercises by Elia could integrate this type of analysis.