AQUIND Interconnector: French network losses

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1 AQUIND's impact on losses in France

AQUIND Interconnector will be a new 2 GW High Voltage Direct Current (HVDC) electricity interconnector between France and GB. The project, commissioning in 2024, will benefit France and GB by facilitating cross-border flows of electricity between wholesale electricity markets. These electricity flows will have an impact of the French and GB electricity networks in the form of possible network constraints and network losses.

Network losses occur in all electricity networks. Power flows through the network result in thermal losses due to the resistance in the network assets. Losses need to be accounted for in supply and demand to ensure the electricity system stays within safe limits and to maintain market equilibrium. Losses occur in all parts of the electricity network, from transformers, to overhead lines and HVDC cables.

ENTSO-E note that whilst some network development may decrease losses "*it should be noted that currently the main driver for transmission projects is the need for transmission over long distances, which may increase losses".* In relation to interconnectors, ENTSO-E also note that *"although new interconnections generally decrease the electrical resistance of the grid and consequently the losses, the additional exchanges, resulting from the increase of the transfer capacities, and the change in generation size can lead to the increase. The precise location of generation units also has a significant effect on the amount of losses, as generation at different nodes leads to different flows*".[1]

This note provides a summary of the impact AQUIND Interconnector could have on network losses in France. This note does not provide any new analysis but summarise studies completed to date, including:

- The analysis completed by RTE, and submitted to CRE, as part of the 2017 AQUIND Interconnector exemption application in July 2017[2]
- RTE's response to AQUIND as part of AQUIND's consultation [redacted] in May 2019[3]
- The AQUIND Interconnector Cost-Benefit Analysis (CBA) completed by AQUIND, and its advisors, in 2018 and 2019
- An independent technical study on the impact of AQUIND on the transmission losses in France, completed by Tractebel in 2019

1.1 Calculating network losses

ENTSO-E sets out a methodology to calculate losses as part of the TYNDP Cost-Benefit Analysis guidance. The methodology considers the volume of losses, measured in GWh, with and without the project in question. System losses are measured in an engineering model, or technical load flow

[1] ENTSO-E CBA methodology 2.0, available here.
[2] "*Information transmitted by RTE to the Energy Regulation Commission within the framework of the examination of AQUIND's exemption application*" – July 2017
[3] [redacted]

model. The change in losses between the model run with and without the specific project isolates the impact of that project on network losses.

Losses occur on all transmission lines, irrespective of whether they are internal (i.e. within a particular country) or cross-border (between countries). However, for additional clarity, it is possible to differentiate and estimate the impact of AQUIND Interconnector on losses across different parts of the network as follows:

- **Losses on AQUIND interconnector**: Electricity flows between France and GB across AQUIND Interconnector will results in thermal losses. In simple terms, if 100MW leaves France, then only 96.235MW will arrive in GB. For AQUIND, the maximum value of these loses is 3.765% of total flows and may be somewhat reduced by technology choices. Except for a small proportion, losses on the interconnector will arise only if electricity is transmitted. Table 1 provides the breakdown of losses on AQUIND Interconnector.
- **Internal network losses**: These are the losses on the French and GB transmission systems. These are the costs associated with thermal losses as power flows through the internal French or GB transmission system. The impact of the interconnector on losses within the national grids occurs when the interconnector is being utilised. Internal network losses also increase when supply of electricity on the internal network increases (and is transmitted to consumption centres) – in other words, internal losses are a general feature of the power system rather than being related only to interconnector flows.
- **Losses on other interconnectors**: A fundamental impact of any new interconnector is that it may impact flows on other cross-border projects. This includes projects on the same border, and connections to other markets. If flows on these projects change as a result of AQUIND, the losses on these lines will also change – lower flows will lead to lower losses and vice versa.

Table 1 Distribution of losses on AQUIND Interconnector

Component	Loss (MW)
Converter Station x 2	20.75
DC Marine Cables	13.2
French DC Cables	1.9
GB DC Cables	1.4
French AC Cables	0.2
GB AC Cables	0.2
Total losses scheme	**75.3 MW**
Loss per pole	**37.65 MW**

In its more recent CBA methodology, ENTSO-E has acknowledged potential double counting in its calculation of network losses in the TYNDP 2018. ENTSO-E noted that the way that demand is calculated in the market modelling, used to calculate Socio-Economic Welfare (SEW), already accounted for some of the impact of losses.[4] This means that the calculation used in the TYNDP 2018

[4] Specifically, ENTSO-E note that "*For the market simulations, demand curves are built to contain grid losses (i.e., using historical time series), which means that parts of the losses are already monetised under the B1 indicator SEW (namely, in the consumer surplus, which takes into account the effect of the change in marginal costs,*

is not an accurate reflection of the cost of losses for AQUIND, or other projects.[5] We therefore conclude that the losses estimates in the TYNDP 2018 are not reliable estimates of the impact of AQUIND on losses in France. We understand that losses in the TYNDP 2020 will be calculated using the updated, and corrected, methodology.

Figure 1 shows the new ENTSO-E CBA 3.0 equation used to calculate losses, avoiding double counting present in the CBA 2.0.

Figure 1 ENTSO-E 3.0 losses equation[6]

$$Delta\ Losses\ (monetized) = \sum_{market\ node\ i} \left(\sum_{time\ step\ h} s'_{h,i} \cdot (p'_{h,i} - p_{h,i}) \right)$$

Key:
The amount of losses, p'h,i (with project) and ph,i (without project) in MWh.
The marginal costs, s'h,i (with project) and sh,i (without project) in €/MWh for a given time step.

Finally, it is important to distinguish between physical estimates of losses (in GWh) and their monetary value (in €). This is because the monetary value of one lost MWh of energy is higher at times of system stress (e.g. peak demand). In the following sections we refer to both physical losses and their monetary value to describe the two facets of AQUIND's impact.

1.2 Comparing estimates

A number of different parties have attempted to calculate AQUIND's impact on network losses in France. The estimates vary as a results of differences in the underlying modelling assumptions. At a high level, high price differentials between GB and France will results in more electricity flows across AQUIND. Higher imports or exports are likely to result in greater power flows across the internal French system, as generation is dispatched to meet demand in GB, which can in turn result in an increase in losses.[7] However, higher AQUIND flows do not always increase internal network losses: for example, in GB, higher imports into the South-East of the country would typically tend to reduce network losses, as there would be less of a need to transport electricity from the North to the demand centres in the South. In the case of France, it is also possible that networks losses could be reduced in some periods, for example when France is importing electricity from GB or Normandy, which has a large surplus of electricity generation comparing to its consumption within the region, exports via the. Interconnector to GB.

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brought about by the project, on the losses part of the demand). This effect needs to be taken into account when monetising the losses from the network simulations." Extract from the 3rd ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects

[5] "*In the TYNDP 2018, ENTSO-E used a new approach to monetize losses associated with each project described in a new Cost Benefit Analysis methodology, discussed with stakeholders and approved by the European Commission. The methodology was followed rigorously and correctly. However, it appeared that the final results were unexpectedly highly impacted for some projects by the difference in granularity of input variables or by projects different sensitivity to climate conditions (same conditions have been applied to all projects). The steps necessary to amend the approach, including amending the methodology, discussing it with stakeholders and implementing it was impossible in the time-frame of the TYNDP 2018 development. This has led to what may be considered as too high monetized losses values that would not occur in reality. ENTSO-E acknowledges these facts and recommends to use the results of losses computation with cautiousness when conducting any sort of financial analysis to estimate the project profitability and feasibility.*" – AQUIND TYNDP 2018 project sheet, available here.

[6] An extract from ENTSO-E's 3rd ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects

[7] The precise impact of AQUIND will depend on the flow pattern with and without AQUIND.

1.2.1 RTE's assessment

In 2017, RTE provided an assessment of the impact of AQUIND on French network losses. RTE provided this analysis to CRE, on request, to support CRE's assessment of the 2017 AQUIND Exemption application.

In its analysis, RTE concluded that AQUIND will reduce the total volume of losses on the French transmission network. Specifically, RTE calculated a reduction in the volume of losses in 2022 and 2027 of 128 GWh and 2 GWh respectively.

As a reference, RTE note that "*in 2016, the annual volume of losses on the RTE network was approximately 11,000 GWh and the purchase price of the losses was approximately €480 M*".

To value these network losses, RTE calculates the cost of losses with and without AQUIND using a methodology which appears to be consistent with the methodology proposed by ENTSO-E in their Cost-Benefit Analysis methodology 2.0.[8] RTE's estimate shows that the cost of losses will increase with AQUIND (by approximately €4m per year in 2022 and zero cost in 2027), whilst the volume of losses actually decreases. We note that since RTE's assessment in 2017, ENTSO-E has corrected its methodology to avoid any double counting, and as such, the monetary value of losses is likely to be lower using the new (corrected) methodology.

Whilst we do not have the data to update RTE's calculations with the new methodology, we anticipate that correcting the calculation would show that the cost of losses in France is negligible as a result of AQUIND.

1.2.2 AQUIND's analysis

To support regulatory engagement with CRE and Ofgem, AQUIND has completed independent analysis to estimate the benefits of the project. This comprehensive study considers the socio-economic value of AQUIND to France, GB and other European countries. As part of the benefit assessment, AQUIND commissioned the engineering consultancy, Tractebel, to complete a specific study of the impact of the project on network losses in France.

Tractebel's analysis followed the methodology set out by ENTSO-E (both the CBA 2.0 and the updated methodology set out in the updated Cost-Benefit guidance, 3.0). Tractebel calculated AQUIND's impact on network losses for each of AQUIND's own scenarios. AQUIND's scenarios provide a comprehensive range of potential market outcomes based on a set of detailed, and bottom-up assumptions about the future electricity capacity mix, demand and commodity prices across Europe.

Tractebel's analysis focuses on the impact of AQUIND on internal network losses in France. The volume and cost of losses across AQUIND Interconnector itself, and across other cross-border interconnectors has already been taken into account in AQUIND's social welfare analysis.

The joint analysis by Tractebel and AQUIND shows that the increase in French network losses, in accordance with the corrected TYNDP methodology, is in the range of approximately €3-7m per year

[8] The Second ENTSO-E's Guideline for Cost-Benefit Analysis is available here: https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/tyndp-documents/Cost%20Benefit%20Analysis/2018-10-11-tyndp-cba-20.pdf

across the three main scenarios. Based on RTE's estimate of total value of 2016 losses of around €480m (see above), this corresponds to a change of less than 2% in monetary terms.

AQUIND has already taken this cost into account in assessment of wider social welfare benefits (the AQUIND Cost-Benefit Analysis). AQUIND total benefit to France in AQUIND's central scenario is expected to be close to €1bn (presented in Net Present Value terms). This includes the cost of losses in France which is approximately €23m over 25 years (in Net Present Value terms).

Table 2 Monetised present value of the variation in grid losses resulting from AQUIND scaled to the utilisation rate[9]

€m NPV @ 4.0%, real 2018	AQUIND Market Scenario	AQUIND Low Commodities	AQUIND High Commodities / Renewables
Variation in losses, France	-€ 23	-€ 29	-€ 52
Variation in losses, GB	-€ 165	-€ 108	-€ 158

1.2.3 TYNDP assessment of network losses

We have already established that the losses calculated by ENTSO-E as part of the TYNDP 2018 are not accurate. We note however, that even if the network losses in France, as a result of AQUIND, were significantly greater, i.e. aligned with the TYNDP 2018, AQUIND would still provide a significant net benefit to France.

The losses estimates in the TYNDP 2018 project total losses for Europe, without providing a breakdown by Member State. ENTSO-E estimate the cost of losses caused by AQUIND across the three ENTSO-E scenarios to rise from €16m in 2025 to an average of approximately €60m per year (based on an assessment for 2030). According to ENTSO-E's CBA methodology, this value also includes losses across the interconnector itself (as well as losses on the European network).

1.3 Conclusion

It is inevitable that AQUIND will have an impact on network losses in France, but our key finding, based on a range of studies summarised in this note, is that this impact is likely to be limited. The analysis undertaken by RTE indicates that the cost of losses in France could be in the region of €4m per year (noting that this analysis is now known to be incorrect). The separate study by AQUIND, and its advisors, arrives at a similar estimate – in the region of €3-7m per year. The AQUIND and RTE analysis does however arrive at a similar outcome although the modelled scenarios are very different.

Taken into account as part of the wider AQUIND CBA, the Net Present Value of losses in either study results in a very small change to the overall benefit assessment from France. Network losses reduce the AQUIND benefit in France by approximately 2% in France in AQUIND's central scenario.

[9] Based on analysis by Baringa and Tractebel for AQUIND.