# Grid constraints backbone Antwerp & Liège region

*Focus on period 2025-2030*

- This note summarizes an expert view analysis with the aim of identifying the main constraints regarding transmission infrastructure linked to a hypothetical prolongation of existing nuclear capacity in Belgium, focusing on the period 2025-2030. The purpose of this note is to provide the teams in charge of the negotiations with Engie with the best possible information regarding grid constraints, without knowledge of the options potentially considered to date. Where needed, specific grid studies could further refine and quantify the insights from this expert view.
- The most important reason for these constraints is linked to compliance with EU Regulation 2019/943 of June 5th, 2019. This regulation strictly limits the allowed restriction on cross-border electricity exchanges due to flows and congestions internal to a Bidding Zone.
- As from winter 2025 – 2026, 1 GW nuclear injection can be integrated both on the site of Doel and Tihange. This covers either the lifetime extension of 1 GW nuclear capacity at Doel (Doel 4) and of 1 GW nuclear capacity at Tihange (Tihange 3) or any other temporary measures that would lead to a maximum of 1 GW of injection at each site.
- Combining nuclear capacities of more than 1 GW respectively at Doel or Tihange generates significant network constraints. These can only be structurally solved by amending the market rules stemming from EU Regulation 2019/943, which seems highly hypothetical, or by additional investments in grid infrastructure.
- The required grid infrastructure investments entail a complex combination of transmission line upgrades to be executed. The planning and timing of these works has already been optimized in order to maximally reduce delays.
    - At Tihange, these works are currently planned to be completed by 2030-2032.
    - At Doel, not all required works are currently foreseen. Best estimate and subject to further feasibility studies, if planned today, would be that the last required works are completed in 2035-2038.
- Although the situation at both sites seems similar, the site of Tihange offers additional modulation options due to the combined presence of nuclear capacities and new CCGTs (Les Awirs and Leval, selected in the 2021 Y-4 CRM auction). Temporary measures resulting in more than 1 GW of nuclear injection at the Tihange site would therefore require firm modulation agreements with the operators under certain market conditions. As an order of magnitude, the combined injection of the nuclear units at Tihange, the new CCGT and existing OCGTs at Leval, the new CCGT at Les Awirs, and the pump storage unit at COO needs to be restricted to ca. 4.5 GW. All injection above will need to be reduced by the operators in 6 à 10% of the time.
- Furthermore, additional injection in the Liège region will complexify the planned key upgrade of the transmission axis Liège-Limburg. During the long-duration grid outages required to perform this upgrade, combined injection in the Liège region will have to be further reduced to about 3.2 GW.

# Introduction

This note provides an expert view analysis with the aim of identifying the main constraints regarding transmission infrastructure linked to a potential prolongation of existing nuclear capacity in Belgium.

Where needed, specific grid studies could further refine and quantify the insights from this expert view. Prior to performing such detailed grid studies, the hypotheses to be taken should be detailed and agreed upon by all relevant stakeholders.

This analysis is strictly limited to conditions related to the transmission system, without considering other potential constraints related to nuclear safety, economics, legal, regulatory, etc.

# Why do transmission grid constraints exist in the first place?

One could question why limitations related to the transmission system exist for the nuclear generation units at Doel and Tihange, while those units have been operating in the electrical system for years already.

Before diving into the concrete drivers for such grid constraints, it is worth reminding that the power system is a continuously evolving system, with infrastructure being built, renewed and decommissioned, and generation, demand and storage facilities connecting to the system as well as leaving the system every year. Likewise, also EU regulation and national laws are evolving, and can have a significant impact on the design of the power system. Notably for the situation around the backbone and the nuclear units, exactly these EU regulation changes have a major impact.

The connection process of third parties to the highest-voltage transmission system is governed by the "Gedragscode elektriciteit". In short, this process ensures that when new connections to the system are being analysed by the TSO, all existing grid user's connections, as well as capacity reserved for future grid users are taken into account. Vice versa, when grid users announce the closure of their generation units (through an article 4bis), or when decisions by the authorities force by law the closure of specific technologies (such as the  nuclear exit), the related capacities on the transmission system that are freed up can and will be assigned to other uses in order to ensure an efficient usage of transmission infrastructure.

## *EU Regulation: the key driver for grid limitations in the regions around Doel and Tihange*

The first, and most important constraint is defined by article 16 from EU Regulation 2019/943, also known as the Clean Energy Package. In summary, it states that bottlenecks in the country-internal transmission grid cannot structurally constrain cross-border trade, and at least 70% of the thermal capacity of grid elements needs to be reserved for cross-border market exchanges. This rule therefore indirectly restricts the number of grid users that can be connected to the backbone grid, as those generate flows competing with these cross-border flows. Secondly, ACER has defined rules restricting the inclusion of internal grid elements in the market coupling algorithm, further reducing the grid capacity that can be assigned to local generation and demand on the backbone grid. Derogations to this regulation are only allowed until 2025.

Important to note is that today and in the past, with all nuclear units in the Belgian grid in operation, this regulation already creates issues for the high-voltage grid around the Doel substation since its introduction. Given that the nuclear phase-out was planned to be completed in 2025, these issues were foreseen to disappear as from 2026. This matched well with the implementation trajectory of this EU Regulation, which was equally allowed until 2025.

Three potential solutions exist for grid issues related to this regulation:

a) building additional internal grid infrastructure to create more transmission capacity, or

b) splitting the bidding zone, effectively moving congestions to the borders, or

c) simply accepting the costs linked to redispatching generation when congestions effectively occur.

It is however important to keep in mind that the latter redispatching costs can become very high very quickly (assuming that the redispatch means would at least be available when needed, which is a question in itself). In Belgium they are today limited to a few million Euros; for Germany however these already reached billions of Euros. The desirability of leaning upon this third option for the Belgian consumer is therefore highly questionable.

The reinforcement of the entire Belgian backbone to HTLS conductors is planned and being executed, as described in the Federal Development Plan. These works however take time as the different axes have to be tackled sequentially due to long outage periods being required, and the Belgian backbone not being able to sustain multiple axes being unavailable at the same time.

Splitting the Belgian bidding zone is subject of a political choice, with important consequences for Belgian consumers, given that different electricity wholesale prices over the Belgian territory would be the result of splitting the bidding zone.

*Upgrading a transmission line to HTLS: what does it entail?*

Depending on the conductor type chosen, equipping an existing transmission line with HTLS conductors can lead to doubling the thermal capacity at relatively limited cost. Given the large benefit for a limited cost, an upgrade of the entire Belgian backbone to this new type of conductors has been planned, and is currently ongoing. Elia was one of the European frontrunners in installing this new technology in the electricity transmission grid, which has since been followed by multiple other TSOs.

Contrary to what could be understood at a first glance, upgrading an existing transmission line to HTLS conductors entails much more than “only” replacing the conductors themselves. Without being exhaustive, the following actions are to be conducted: typically, the existing pylons cannot support the additional weight of the new conductors. A detailed analysis of the existing pylons, and the options on how to reinforce each of those is therefore required. Generally this means that a permitting process is needed as well, as the silhouette of the line is affected. Last but not least, upgrading a line typically requires very long periods of unavailability in order to perform the works.

Given that these grid elements are crucial in the Belgian transmission system, planning such works while avoiding impact on consumers and avoid creating a significant risk for the system is very complex, and executing the upgrade of multiple axes in parallel is outright impossible.

## In the Antwerp and Liège region, what is competing for grid capacity with the nuclear units?

**In the Liège region**, the capacity on the internal grid that ought to be freed up by the decommissioned nuclear units in 2025 is partly reassigned to the two new combined cycle gas turbines at Les Awirs and at Leval that were contracted in the 2021 Y-4 auction for the Belgian CRM.

Secondly, a reinforcement of the French-Belgian eastern interconnector (Lonny-Achêne-Gramme phase 2), foreseen to be completed by 2030-2032, will also use the capacity on the internal backbone in the Liège region. Prior to completing this reinforcement however, the internal backbone between Liège and the border with The Netherlands already needs to be reinforced (the Gramme-Van Eyck HTLS project, completion planned for 2030-2032).

**In the Antwerp region**, the freed up capacity thanks to the decommissioning of the Doel units is partly reassigned to the reinforcement of the Dutch-Belgian western interconnector (Zandvliet-Rilland). This

reinforcement is well underway, with the majority of the investments on the Belgian side already being completed, and final commissioning expected for 2023.

Main drivers for this project were both increasing price convergence between Belgium and the North of Europe, bringing significant welfare for the Belgian society, as well as improving Belgian Security of Supply through increasing the importing capacity on the north border. Cancelling or postponing this project would therefore lead to stranded grid assets, and could lead to more generation capacity being required in Belgium to fulfill the reliability standard.

**In both regions**, more and more grid connection studies for large-scale storage projects are being ordered by investors. Generally those projects are not in the final stages yet, but according to the aforementioned legal grid connection process, once a technical agreement on the grid connection is agreed upon by the ordering party and the TSO, those projects are awarded with a capacity reservation as well, creating additional restrictions on any potential nuclear prolongations.

## Prolonging 1 GW of nuclear capacity at Tihange and/or Doel

After the announcement has been made of a potential lifetime extension of Doel 4 and Tihange 3, Elia has looked into the capability of the transmission system to accept this power injection. Finally, it has been concluded that a continued injection of 1 GW at both the sites of Tihange and Doel is acceptable from a grid point of view.

This also means that, in case a gap in the operation of Doel 4 and/or Tihange 3 occurs due to works having to be executed in order to prepare their lifetime extension, during this time period other temporary measures leading to a 1 GW injection at either site would be acceptable for the transmission system as well. If we assume that both Doel 4 and Tihange 3 will be out for winter 2025-26, and both will be back online in winter 2026-27, other temporary measures leading to 1 GW of injection at both sites would be acceptable only for winter 2025-26.

An overlap between aforementioned temporary measures and the injection of Doel 4 and/or Tihange 3 would lead to important issues on the transmission system. Apart from limiting the cross-border flows on the backbone, which would be non-compliant with EU Regulation, only reinforcing the backbone grid could lift these constraints. The required grid infrastructure investments entail a complex combination of transmission line upgrades to be executed, of which an overview is given in the next section.

Specifically for the site of Tihange it is to be noted that the new CCGTs at Les Awirs and Leval that were contracted in the 2021 Y-4 CRM auction are incompatible with overlapping measures resulting in more than 1 GW of nuclear injection at the Tihange site. Postponing (or forcing not to run simultaneously with nuclear injection) one of those new CCGT units would lift this incompatibility.

*High-level quantification of the required limitations to generation in the Liège region.*

Before the completion of the HTLS upgrade Gramme-Van Eyck, as a first estimate, the grid could accommodate a maximum of 3.3 GW of combined injection from the Engie perimeter injecting directly or indirectly into the Gramme substation when the grid is fully available[1]. This includes the new CCGT at Les Awirs (Rimière), the COO pump-storage unit and all nucleair injection in Tihange (Gramme). Everything above will require to be reduced between 6 and 10% of the time in order to ensure a secure grid operation.

In order to perform the HTLS upgrade Gramme-Van Eyck, important outages are however required. Three periods of roughly 6 months consecutive outage of one of the circuits between Gramme and Van Eyck will be needed to replace the conductors. These outages are planned outside of the winter periods to avoid impact on Belgian Security of Supply. According to the current planning (subject to changes[2]), these 6 month periods are foreseen in 2027, 2028 and 2029. During these outage periods, the combined injection from the Engie perimeter has to be further limited to a maximum of 2 GW[3] (exact number to be confirmed through detailed grid studies).

As the abovementioned works are planned outside winter periods, the stricter limitations should not coincide with potential scarcity periods in Belgium. Additionally, even the 3.3 GW constraint can probably be relaxed in potential scarcity situations, given that the grid constraints are generally linked to large cross-border flows from France to Belgium and beyond, which are quite improbable in a scarcity situation where France requires massive imports.

[1] If also the EDF Luminus perimeter is included (both the new CCGT and the two existing OCGTs at Leval), this limit increases to ca. 4.5 GW.

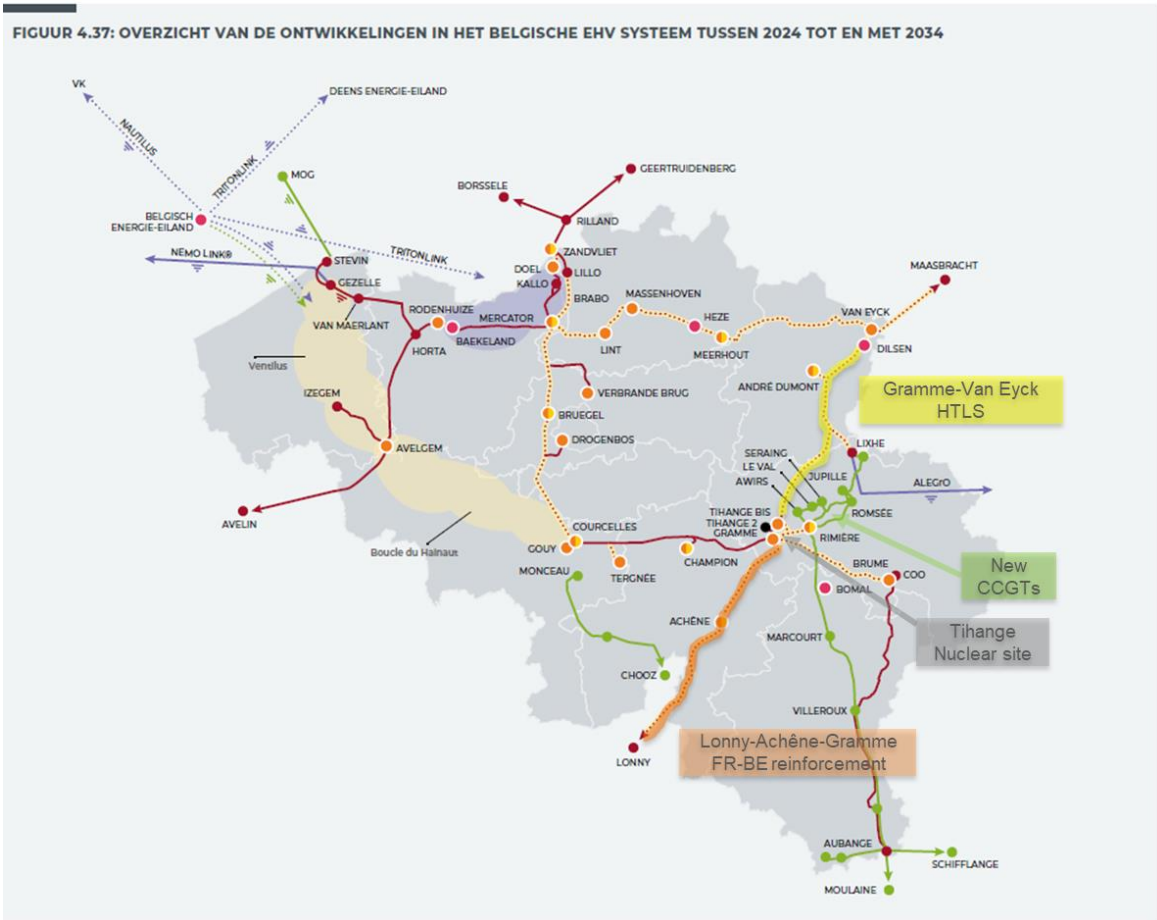
[2] This planning is subject to change, linked to the permitting process, works planning, international coordination, etc.

[3] If also the EDF Luminus perimeter is included (both the new CCGT and the two existing OCGTs at Leval), this limit increases to ca. 3.2 GW.

# Overview of required grid infrastructure investments

*Impacting the Tihange site*

- The Gramme-Van Eyck axis of the 380kV backbone will have its HTLS upgrade completed in the period 2030-2032;
- A reinforcement of the eastern French-Belgian border (Lonny-Achêne-Gramme, phase 2) is planned to be completed in the period 2030-2032.




*Overview of (planned) generation units in the Liège region*

In the Liège region, a significant number of generation units is or will be concentrated:

- All nuclear units at the site of Tihange (ca. 3 x 1000 MW);
- The new CCGT at Les Awirs (ca. 900 MW) as from 2025;
- The new CCGT at Leval (ca. 900 MW) as from 2025;
- The existing gas turbines at Leval (2 x 150 MW)
- The existing steam turbine at Leval, to be decommissioned before the connection of the new CCGT (170 MW)
- The pump-storage facility at COO (ca. 1200 MW combined, including the ongoing extension works)

*Impacting the Doel site*

- A reinforcement of the western Dutch-Belgian border (Zandvliet-Rilland) is ongoing and planned to be completed in 2023;
- The first reinforcement of the backbone around the Antwerp harbor (the Brabo project) is ongoing and planned to be completed by 2025;
- The Mercator-Bruegel axis of the 380kV backbone has its HTLS upgrade currently ongoing;
- The Mercator-Massenhoven axis of the 380kV backbone will have its HTLS upgrade completed in the period 2030-2032;
- HTLS upgrades of the Doel-Zandvliet (2 circuits, spanning the river Scheldt) and Doel-Mercator (4 circuits) axes are currently not planned yet. A best estimate, subject to further feasibility studies would be that those projects, if planned today, could be completed by 2035-2038;
- The Triton-Link project, currently being studied with a target commissioning date around 2032, is foreseen to be connected in the Ghent-Antwerp region.

FIGUUR 4.37: OVERZICHT VAN DE ONTWIKKELINGEN IN HET BELGISCHE EHV SYSTEEM TUSSEN 2024 TOT EN MET 2034