STUDY

Black Start service availability analysis

Evolution of the available assets over the period 2025-2030 to provide the Black Start service.

Conform art 8. §1 20° of electricity Act of 29 April 1999

Non-Confidential

Content

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

1. Executive summary

The Black Start service is an essential service to allow Elia to restore the system in case of a Black-out. In order to do so, Elia acquires five Black Start Providing Groups via a competitive dialogue tendering procedure. Typically, these assets are equally distributed across the five different Black Start zones. However, in case there is no Black Start Providing Group available in a certain Black Start zone, Black Start Providing Groups in adjacent zones can be selected. Currently the tendering procedure for the period 2027-2029/2038 is ongoing. So, the RSP contracts will be awarded until at least 2029 included.

Table 1 shows the evolution of the availability of assets in each of the 5 zones with the potential to deliver the Black Start service in the coming years. Both assets with and without a need for investment to deliver the Black Start Service are included. Overall, the assets are relatively evenly distributed across the different Black Start service zones, certainly towards 2030.

Thanks to the introduction of large-scale batteries, an increase in potential Black Start Providing Groups can be seen starting from 2025. However, this does not necessarily mean that this will result in additional competition. Indeed, this is subject to the evolution of the installation rate of these batteries. If more or less batteries are installed, the number of assets that can deliver the Black Start service can increase or decrease. In addition, it is important to note that the theoretical capacity of batteries to deliver the Black Start Service still needs to be confirmed in practice. In any case, every candidate to deliver the Black Start Service is subject to a dedicated analysis to confirm their practical capacity to deliver the Black Start Service. In addition, similar to pumped storage, battery storage is likely to come with high opportunity costs.

Table 1: Total capacity with the potential to deliver the Black Start service for the five Black Start Zones (North-East, North-West, South-East, South-West and 380kV)

Total	2025	2026	2027	2028	2029	2030
NE	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
NW	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SE	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SW	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
380kV	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

2. Introduction

2.1 Structure of the document

This study consists of three chapters. The first chapter is the executive summary, describing the main conclusions of the study. This is followed by the introduction. It consists of 3 parts: a description of the structure of this document, the relevant legislative framework and an overview of the Black Start service.

In chapter 3, the availability analysis is presented. This chapter details the data that is used for the availability analysis and continues with the results per technology type. Based on these results, the conclusion is drawn in the final section of this chapter.

2.2 Legislative framework

.

This availability analysis is created in accordance with art 8. §1 20° of the Electricity Act[1] of 29 April 1999. Conform the Electricity Act, every 3 years, Elia, as Belgian Transmission System Operator, has to create and provide to the CREG, as Federal Regulator, and the minister a report on the availability non-frequency related ancillary services for a period of 5 years. This study also needs to be published on the website of Elia. .

> *" Art. 8.§ 1.20° Bezorgen aan de minister en aan de commissie uiterlijk op 1 april van elke driejaarlijkse periode die volgt op de inwerkingtreding van deze wet, een studie over de beschikbaarheid voor een periode van vijf jaar, van de middelen waarmee de niet-frequentie gerelateerde ondersteunende diensten kunnen worden gedekt. Hij publiceert die studie op zijn website.] "*

Section 3 of this document will as such contain this information. In the published version, some elements will be redacted for confidentiality reasons

[1] Electricity Act = Electricity Act of 29 April 1999 on the organisation of the electricity market (published in the Belgian Official Gazette on 8 January 2012) and its amendments (Justel databank).

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

2.3 Black Start service – restoration of the system

In case of a blackout in Belgium, Elia has prepared a restoration plan[2] to restore the system in a phased approach, with parallel restoration in multiple zones, and by relying on top-down assistance from neighboring countries or on bottom-up re-energization from contracted black start units depending on the situation. This section explains the current restoration approach in more detail for information purposes only. The relevant documentation can be found on the website of Elia.

2.3.1 Three phases in the restoration plan

After a blackout, Elia aims to gradually build up the system and re-energize at least 90% of the connection points towards the clients within 24 hours. To achieve this, a step-by-step approach is passed through before returning to a normal state with load and market restoration. Figure 1 illustrates the three high-level phases of the restoration process.:

- A diagnosis of the situation (Phase 1 Diagnosis)
- Activation of the re-energization procedures either top-down or bottom-up (Phase 2 Creation of a backbone and restoration of high priority significant grid users)
- Phase of TSO controlled dispatch of generation and load (Phase 3 restoration of the load)

[2] **Emergency situations**

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

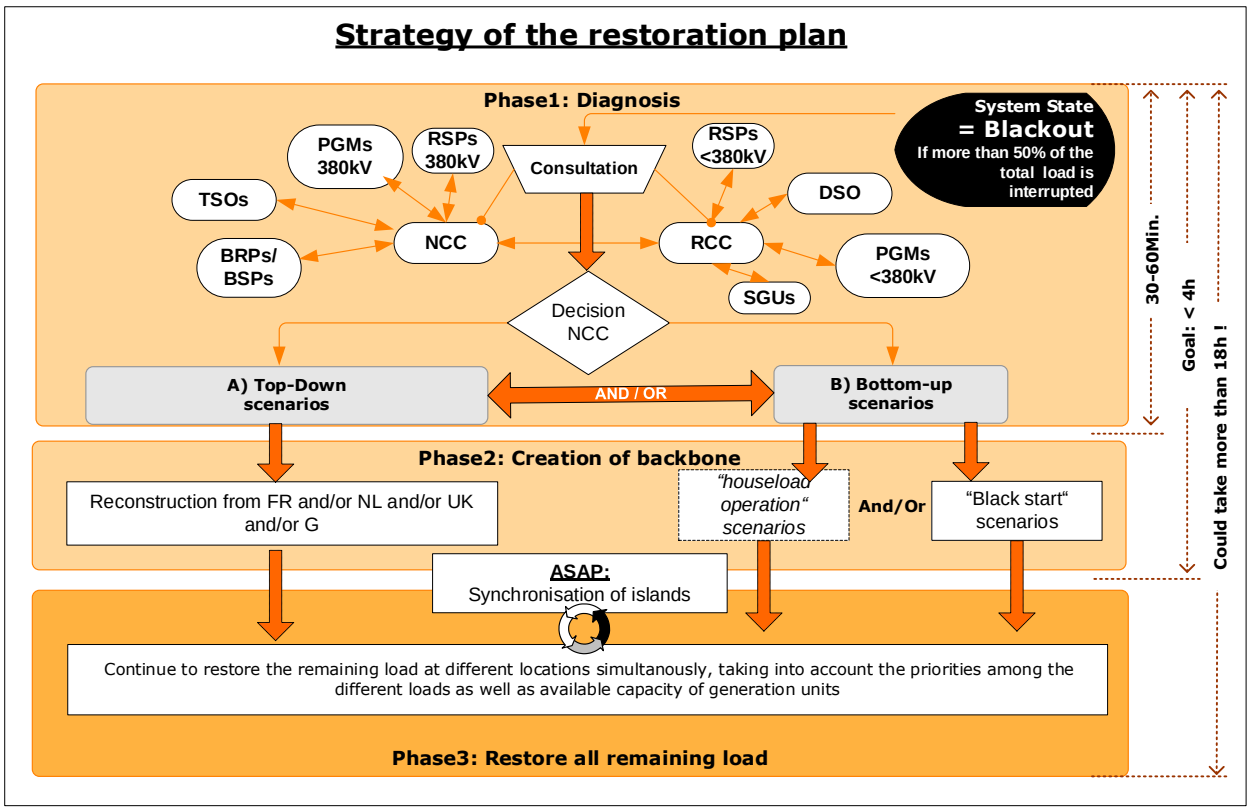


Figure 1: Phases in the restoration plan

2.3.1.1 Phase 1: Diagnosis of the situation

After a blackout, there is first the diagnosis phase. The system engineers in the control center of Elia evaluate the extent of the blackout and the impact on generation assets and grid elements. This phase involves communication with producers, national and regional control centres, neighbouring TSOs, DSOs, etc. Based on this diagnosis, NCC of Elia decides on the procedure to follow (top-down restoration from neighbouring countries in collaboration with other TSOs and/or bottom-up restoration using the restoration means available in the own system, when neighbouring countries are also in an emergency or blackout state and cannot provide support to Elia). Elia assumes that this phase lasts approximately 30 to 60 minutes. Although full diagnosis may take an hour, Elia would be able to send the instructions for restarting black start units after 30 minutes.

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

2.3.1.2 Phase 2: Creation of a backbone and restoration of high priority significant grid users

The second phase is the start of system restoration. The aim is to build electrical islands to re-energize critical loads within the target times. In addition, Elia will as quickly as possible re-energize the majority of the 380kV grid (including border substations) and a cranking path to non-black start units, which can further assist in system restoration. Once stable electrical islands are formed, the interconnection of the islands with the backbone can start.

Phase 2 therefore includes the start-up of the system where Elia enters in a phase of TSO controlled dispatch arrangement during which ELIA instructs, in close collaboration with other system operators, consumers and generators (with and without black start services) to follow a certain set point of active and reactive power, injected to or consumed from the grid.

2.3.1.3 Phase 3: Restoration of the load

Before reaching the normal state again, Elia continues to dispatch generation and load to:

- Synchronize with neighbouring grids
- Restore N-1 security
- Re-energize remaining connection points, including coordination with DSOs for restoration of lower voltage networks

The synchronization of the electrical islands and with the neighboring countries can be performed only at substations having automatic synchronization devices. This is the case for some 380 kV substations and on some 150/380 kV or 220/380 kV transformers. For a successful synchronization, both sub-networks must have the same frequency (which is impacted by the balance between production and load) and voltage angle, meaning that just after the interconnection the flow on the tie-line will be close to zero. This is also valid for cross-border interconnections.

2.3.2 Combined zonal-backbone restoration

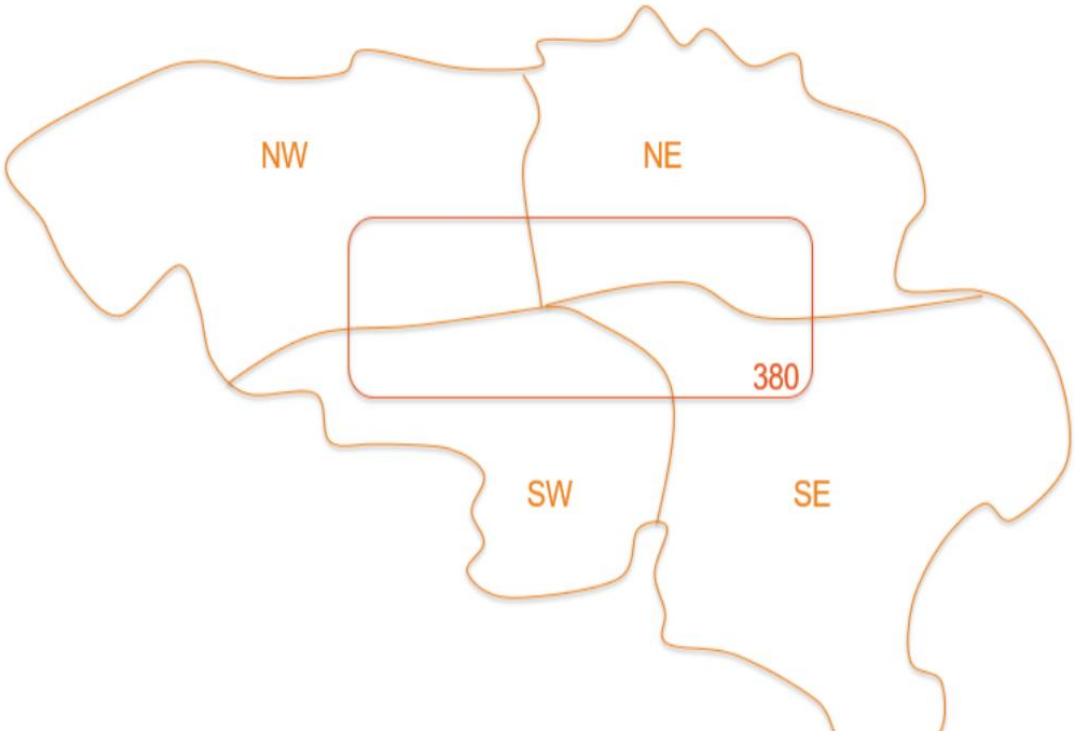
For execution of the restoration plan Elia has currently split the grid in five zones: four regional zones (North West, North East, South West, and South East) plus the 380kV backbone. This allows re-energization procedures to be started up in parallel, as managed by different national and regional control centres. These zones are defined in the restoration plan.

This means that potential Black Start Providing Groups (BSPGs) are selected to deliver the Black Start service for the zone where they are connected (in case the BSPG is connected to the 380kV backbone, they will be considered to be in the 380kV zone). Only if during the procurement procedures, a Black Start Zone does not have an offered BSPG, can the BSPG from an adjacent zone be considered to deliver the Black Start service for the zone without a BSPG.

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium



2.3.3 Black Start ancillary service

The electricity law foresees that Elia organizes a competitive process or a public tendering for the procurement of the ancillary service, to which providers can voluntarily participate. Currently a tender is ongoing to contract the BSPGs until at least 2029 including. The technical requirements for the services are included in the Terms & Conditions for the Black Start service (T&C RSP) and transparently communicated in the call for tender.

The price paid for the service is set during the tendering procedure and reflects the installation (if needed) and maintenance of the black start equipment, procedures, and training of personnel, and is indexed annually. Elia pays the provider for each day that the production unit is available to provide the service (therefore not on days with forced or planned unavailability). There is also a remuneration reduction if the unavailability of the plant is larger than the acceptable margin described in the contract. Finally, the Black Start Capability is tested as well and the RSP is remunerated for every successful test.

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

3. Availability analysis

3.1 Context

As mentioned in Section 2.2 Elia has an obligation to provide an availability analysis. In this analysis, all assets that are able to deliver the Black start services need to be identified. The analysis must cover the coming 5 years (2026 - 2030). In this analysis, all assets that could potentially comply with the requirements of the current Black Start contract are included. This means that assets that don't have a Blackstarter[3] at this time can still be included, given that the tender framework allows for investments to be included in their offer.

3.2 Data

For the availability analysis, Elia used 2 resources:

1. Public consultation on the installed capacity for the adequacy and flexibility study of 2025
2. Internal database of the study requests

Based on these 2 sources, the following information will be extracted for the next 5 years:

1. Existing and future installed capacity
2. Technology

Both resources will be used for different purposes. The main purpose of the adequacy and flexibility study is to determine the level of the evolution of the installed conventional active power capacity in Belgium. These are the typical units that are used for the restoration of the power system.

However, there is an additional asset-type that can potentially deliver the Black Start service: Large-scale batteries. Given that the specific projects are confidential and thus not announced in the adequacy and flexibility study of Elia, a different information resource needed to be used. This is the internal database on study requests. However, it is important to note that this database does not necessarily accurately reflect the future installed capacity. Not all projects that are in study phase will also be realized in the end. Therefore, a filter has been applied to only take TSO connected projects in EDS phase into account, on top of the already realized capacity. These values are than weighted based on the estimations in the adequacy and flexibility study However, given the uncertainty, this also means that it is likely that the amount of assets and their location will deviate from the assumptions taken in this study.

[3] A Technical Unit that can start up without power from the grid and that can start up the supporting services of a larger production unit.

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

3.2.1 Adequacy and flexibility[4]

The results section repeats the relevant information included in the public consultation of the adequacy and flexibility report.

The scenario proposed for the AdeqFlex'25 study takes into account several references (see Figure 2). The AdeqFlex'25 study develops a scenario called the CENTRAL scenario which is built following the current commitment and announced policies of Belgium and other countries.

In particular for Belgium, it should be noted that the scenario is aligned with the updated draft Federal Energy and Climate Plan published in November 2023[5] or with more recent governmental announcement (e.g. 'Nieuwe Vlaamse Regeerakkoord' Sep. 2024)[6].

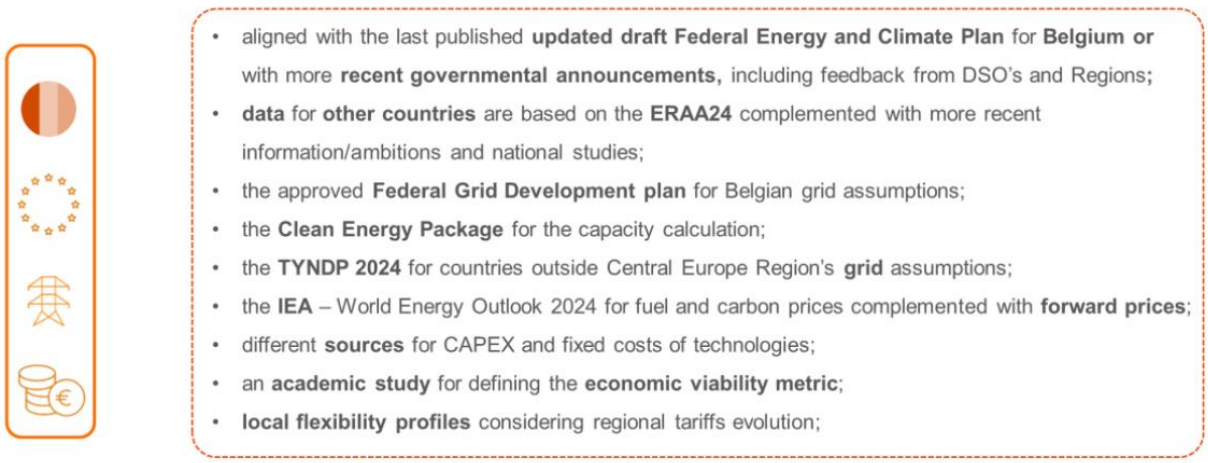


Figure 2: Main references used for the CENTRAL scenario

3.2.2 Internal database

The internal database of Elia includes all EOS (Etude d'Orientation / OrientatieStudie) and EDS (Etude Détaillée / DetailStudie) requests, on top of the already installed capacity. A filter on was used to give the most realistic view possible on the future installed capacity. However, given the uncertainty of this information, certainly on the longer term, the conclusions of this analysis are to be viewed in their correct context.

[4] https://www.elia.be/en/public-consultation/20241104_public-consultation-on-the-methodology-the-basis-data-and-scenarios
[5] https://www.nationalenergyclimateplan.be/en
[6] https://www.vlaanderen.be/nieuwsberichten/nieuwe-vlaamse-regering-en-vlaams-regeerakkoord-2024-2029

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

3.3 Results

As mentioned in the previous section, the results will be based on a combination of the information gathered from the adequacy and flexibility study and the internal database.

The most important requirement used to determine if an asset is able to deliver the Black Start service is the absorption of reactive power. As per the T&C, a minimum of 20MVAr needs to be absorbed during the restoration process. This is the most restrictive criterium.

As mentioned previously, the presence of a Blackstarter on-site is not used as a criterium, given that the current T&C allow for the inclusion of an investment cost in the offer. The same goes for the large-scale batteries. Both assets with grid following and grid forming inverters[7] will be considered.

3.3.1.1 Thermal capacity - Gas-fired units

Given that only gas-fired power plants in the thermal fleet present a real capacity for a system restart, this section will focus on this asset-type.
Figure 3 shows the evolution of the Belgian thermal capacity. A large part of the existing thermal nuclear generation is phased out and will be in part replaced by new CCGTs.

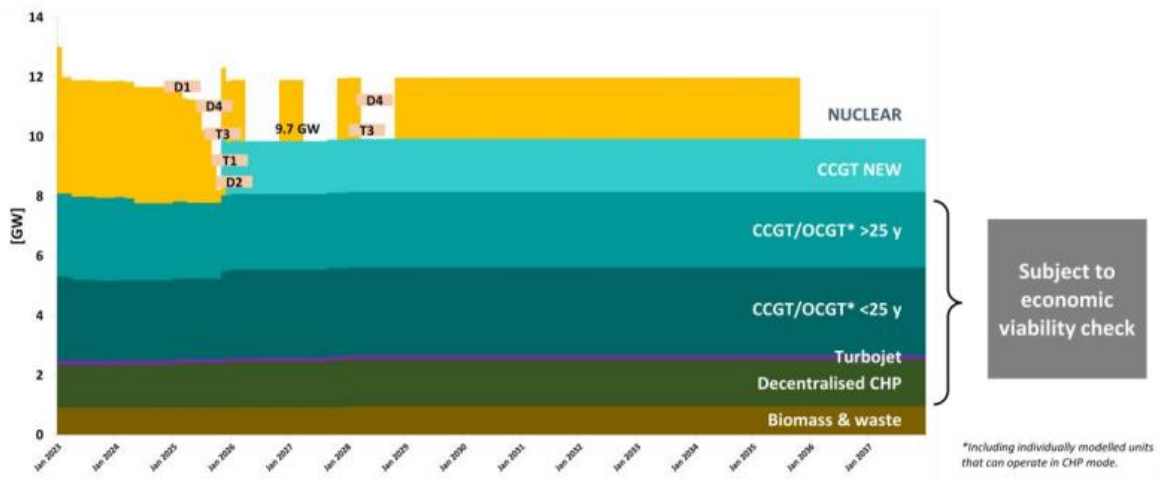


Figure 3: Proposed thermal capacity evolution in Belgium

[7] Grid forming transformers are a requirement for BESS to be able to repower the grid in case of a Black-out.

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

The CENTRAL scenario considered the following assumptions:

- 2 new CCGT units (Seraing 885 MW and Flémalle 890 MW) contracted in the CRM Y-4 auction for Delivery Period 2025-26 with a 15 year contract, are assumed available as from 01/11/2025;
- Vilvoorde GT (255 MW) is considered as available as from the 1st of November 2025, following the information published on NordPool[8];
- Vilvoorde ST (105 MW) and Zwijndrecht Lanxess ST (15 MW) are considered as decommissioned in 2023 and Sappi Lanaken (43 MW), Fluxys Zeebrugge (40MW), and Seraing ST (170 MW) are considered as decommissioned in 2024 (Art. 4 bis)[9], therefore not considered for the time horizon of this study.
- Rodenhuize is considered as a backup unit to Zelzate Knippegroen for burning steel gas when Knippegroen is unavailable;
- A repowering of Zandvliet Power is considered as of November 2024.
- The steam turbines of combined cycle gas fired power plants are not considered because the boiler and steam conditions cannot be fulfilled within the required start-up time. Moreover, fast active power/frequency control according to the restored load in the black-started island is not possible with a steam turbine in a combined cycle power plant.

[redacted]

Table 2: Thermal capacity with the potential to deliver the Black Start service for the five Black Start Zones (North-East, North-West, South-East, South-West and 380kV)

Thermal capacity	2025	2026	2027	2028	2029	2030
NE	[redacted]					
NW	[redacted]					
SE	[redacted]					
SW	[redacted]					
380kV	[redacted]					

[8] https://umm.nordpoolgroup.com/#/messages/937ab00f-4cd1-4aca-9c2d-0ef05594fd28/2
[9] https://economie.fgov.be/fr/themes/energie/securite-dapprovisionnement/electricite/mecanismes-de-capacite/reserve-strategique/notifications-de-mise-larret

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

3.3.2 Renewable energy sources (non-thermal)

Complementing the conventional thermal capacity is the renewable power generation (non-thermal). In this subsection of asset-types, there is one potential contributor: Run-of-river hydroelectricity. The other renewable asset-types (solar PV, onshore wind and offshore wind) are not able to have a continuous availability, which is required for the Black Start Service. [redacted]

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

3.3.3 Storage

3.3.3.1 Hydro-electric/pumped storage

Existing pumped-storage in Belgium consists in 2 sites: Coo and Platte -Taille. Regarding Coo, the ongoing extension to bring the overall pumped-storage installed capacity to 1161 MW and a storage reservoir capacity of 5600 MWh is taken into account for all time horizons, as summarised on Figure 8-1. Regarding Platte -Taille, a turbining capacity of 144 MW and a reservoir volume of 700MWh is considered.

Figure 4: Proposed pumped storage capacity in Belgium

Table 3: Pumped storage capacity with the potential to deliver the Black Start service for the five Black Start Zones (North-East, North-West, South-East, South-West and 380kV)

Pumped storage	2025	2026	2027	2028	2029	2030
NE						
NW						
SE						
SW						
380kV						

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

3.3.3.2 (Large-scale) battery capacity

Large-scale batteries are batteries which are usually directly connected to a DSO or TSO grid.

- In service capacity based on
  - total expected existing capacity at the end of 2024 and;
  - capacity already contracted in a CRM auction volume, including the 2024 auction results.
- Additional potential capacity based on
  - all the projects in the 'realisation phase';
  - percentages of the projects in 'connection study' and 'feasibility study' phase;
  - extra additional potential, considering an extrapolation of the installation rate.

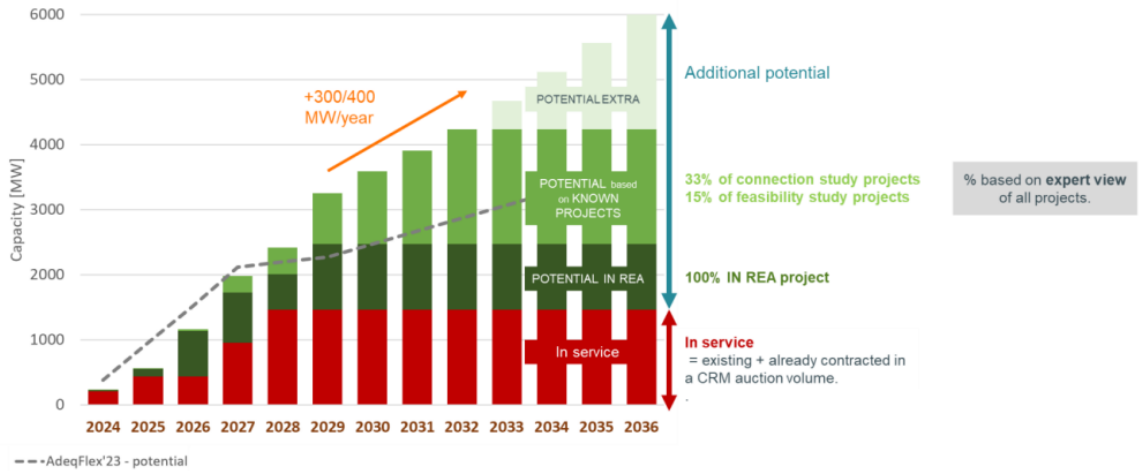


Figure 5: Proposed evolution of the large-scale battery capacity in Belgium

Both categories are considered in this availability analysis for the Black Start service. The evolution of the availability of large-scale batteries for the Black Start service can be found in Table 4. The main filter to determine the black start capability of these batteries is their potential to absorb reactive power. As mentioned, a minimum of 20MVAr needs to be absorbed following the T&C. In order to approximate this, Elia determined a minimum active power capacity of 60MW.

Table 4: Large-scale battery capacity with the potential to deliver the Black Start service for the five Black Start Zones (North-East, North-West, South-East, South-West and 380kV)

Total	2025	2026	2027	2028	2029	2030
NE						
NW						
SE						
SW						
380kV						

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium

3.4 Conclusions

Thanks to the introduction of large-scale batteries, the number of assets that can deliver the Black Start service will increase in the coming years. However, in order to be able to deliver the Black Start service using batteries, a grid forming invertor is required. In addition, the usage of batteries also comes with an important cost. Of course, a case-by-case analysis is still required to assure the operational feasibility of performing a Black Start with a BESS.

The conclusions of this study are also subject to the evolution of the installation rate of the batteries. In case there are more or less batteries are installed, the number of assets that can deliver the Black Start service can increase or decrease.

Overall, the assets are relatively evenly distributed across the different Black Start service zones, certainly towards 2030.

Table 5: Total capacity with the potential to deliver the Black Start service for the five Black Start Zones (North-East, North-West, South-East, South-West and 380kV)

Total	2025	2026	2027	2028	2029	2030
NE	[redacted]					
NW	[redacted]					
SE	[redacted]					
SW	[redacted]					
380kV	[redacted]					

Contact

Project spokesperson
Carsten Bakker | Carsten.bakker@elia.be

Elia System Operator SA/NV
Boulevard de l'Empereur 20 | Keizerslaan 20 | 1000 Brussels | Belgium