ADEQUACY AND FLEXIBILITY STUDY 2024-2034

Public consultation on the scenario and methodology

This public consultation lasts from 28/10/2022 until 28/11/2022 6 PM

Stakeholders are free to provide their comments on the content of this document as well as on the other documents of the public consultation (Excel file, WG presentation, annexes …) or on the references made to the methodology used in the previous study.

Content

1. Introduction

1.1 Context

Elia organizes a public consultation on the input data and assumptions, as well as on methodology that will be used for the study regarding the adequacy and flexibility needs of the Belgian power system for the 2024-2034 time horizon.

The consultation aims at receiving any comment from market participants on this data and the methodology or any other comment on the provided supporting documents.

The consultation period is set from 28/10/2022 until 28/11/2022, 6PM, is publicly announced on the Elia website and is discussed at an Adequacy Working Group on October 28, 2022.

This public consultation is a voluntary initiative by Elia in order to elaborate a robust study and to collect the valuable input from market parties, both on input data and the methodology. Note that the complete methodology (made of several appendix documents and which builds further on the methodology of the previous study) is also available within this public consultation. It should be noted that only a part of the methodology could be adapted based on stakeholders' feedbacks (some methodological changes require several months/years of work and/or are not always possible in the context of this legally required study).

Elia would like to draw the attention on the fact that this public consultation is taking place in a particular European context, with the ongoing energy crisis and Ukraine war, while having gone through lock-downs in 2020 and 2021 due to COVID-19 pandemic and while climate crisis has also called for action. Important policies/announcements have been made in 2021 and 2022 by European Commission (Fit-For-55 packages, RePowerEU) alongside new national ambitions for some countries. It is also foreseen that each Member State, including Belgium, will update his National Energy and Climate Plan by mid-2023.

While the scenario for this Adequacy & Flexibility study has to be put for consultation during the month of November, in order for the stakeholders to have enough time to react and for Elia to perform and publish the study by June 2023, many uncertainties are still present while writing this document. Elia has nevertheless tried its best to propose a 'Best-Estimate' scenario, based on today's known information. In order to take the latest policies and projections into account but also take into account further developments and/or updates that might still occur in 2022 or beginning of 2023, it is proposed to perform a possible update on several assumptions beginning of 2023 (provided relevant data or assumptions becomes available).

Finally, we recall that while the current methodology on flexibility was already implemented for the first time in the study of 2019 and no fundamental revisions have been implemented since then.

Several opportunities for feedback have been already given to stakeholders (specific workshops on the method towards the first study in 2019, a request for feedback after the publication of the first study) but no fundamental remarks were received until now. At this point, Elia has no information which should justify new modifications to the methodology but it will welcome any remarks received during the consultation based on the methodology.

The input data submitted to this public consultation as well the proposed changes in the methodology itself have been discussed during four 'Comité de Collaboration' meetings that took place prior to the launch of this public consultation (meetings between Elia, FPS Economy, Federal Planning Bureau and CREG). The answers of the public consultation will also be discussed within the same 'Comité de Collaboration'.

In the framework of this new study, several documents are submitted for consultation, some prepared by Elia, others prepared by consultants at the request of Elia:

- Documents prepared by Elia
    - The present document which gives an overview on all input data and assumptions;
    - An Excel file with detailed input data;
    - 9 methodological & assumptions appendixes :
        - Unit Commitment and Economic Dispatch;
        - Adequacy study;
        - Adequacy patch;
        - Climate years;
        - Cross-border exchange capacities;
        - Hourly electricity consumption;
        - Economic viability assessment;
        - Methodology for the assessment on short-term flexibility;
        - Assumptions for the assessment of short-term flexibility.
    - 4 external studies on different aspects of the study :
        - The AFRY study on : « *Update of the peer review of "Cost of capacity for calibration of Belgian CRM* »;
        - The study from N-SIDE on « *Study on the outage parameters of generation units and DC links* » ;
        - The DELTA-EE study on « *Study on the quantification of Belgian residential and tertiary future consumer flexibility* » ;
        - The study from Professor K. Boudt on « *Analysis of hurdle rates for Belgian electricity capacity adequacy and flexibility analysis over the period 2024-2034* ».

    - Separate document focusing the Low Carbon Tender scenario for 2024-25.

All documents are available in the same location.

1.2 Belgian regulatory framework

The legal ground of this study has not evolved since the 2019 study. Article §4bis of the electricity law still reads (in NL and FR):

"§ 4bis. Uiterlijk op 30 juni van iedere tweejaarlijkse periode voert de netbeheerder een analyse uit met betrekking tot de noden van het Belgische elektriciteitssysteem inzake de toereikendheid en de flexibiliteit van het land voor de komende tien jaar.
De basishypotheses en -scenario's alsook de methodologie die gebruikt worden voor deze analyse worden bepaald door de netbeheerder in samenwerking met de Algemene Directie Energie en het Federaal Planbureau en in overleg met de commissie."

§ 4bis. Au plus tard le 30 juin de chaque période biennale, le gestionnaire du réseau réalise une analyse relative aux besoins du système électrique belge en matière d'adéquation et de flexibilité du pays sur un horizon de dix ans. Les hypothèses et scénarios de base, ainsi que la méthodologie utilisés pour cette analyse sont déterminés par le gestionnaire du réseau en collaboration avec la Direction générale de l'Energie et le Bureau fédéral du Plan et en concertation avec la commission.

Prior to this public consultation, there have been four 'Comité de Collaboration' meetings (meetings between Elia, FPS Economy, Federal Planning Bureau and CREG). Throughout these meetings, the elements currently submitted for consultation have been presented and discussed.

Further collaboration and concertation with the aforementioned entities is foreseen throughout the further elaboration of this study.

Concerning the legal reliability standard, Elia has followed the most recent legal basis, being the royal decree of 31 August 2021 on the determination of the Reliability Standard and the approval of the values of the Value of Lost Load and the Cost of a New Entrant, where the reliability standard for Belgium is set at 3 hours.

1.3 European regulatory framework

The Regulation 2019/943 of June 5th 2019 foresees in its article 23 that a methodology should be elaborated for the European resource adequacy assessment to be followed and carried out by ENTSO-E. This methodology has been adopted by ACER on October 2nd 2020. The link with the national adequacy assessments is made through article 24 of Regulation 2019/943, which stipulates that such assessments shall be based on the European methodology.

Under the Electricity Regulation (Regulation 2019/943, article 23), ENTSO-E is thus required to consider, among others, the following aspects:

- An economic viability assessment (EVA) of resource capacities;
- Flow-based (FB) modelling of the power network (when applicable);
- Impact of climate change on adequacy;
- Analysis of additional scenarios, including the presence or absence of CMs;
- Consideration of energy sectoral integration;
- Time horizons of 10 years with annual resolution.

The first application of this adopted European methodology by ENTSO-E was in 2021 with the ERAA2021 report. Furthermore also under the Electricity Regulation (Regulation 2019/943, article 23), the ERAA methodology is to be implemented by ENTSO-E in a stepwise process, following an implementation roadmap starting from the 2021 edition. Currently ENTSO-E is aiming towards a full implementation by end of 2023 or otherwise latest in the ERAA2024 edition[1].

One of the most significant improvements within the implementation roadmap for year 2022 (*ie.* in the ERAA2022 report) is the consideration of a multiyear economic viability assessment for existing and new capacities.

The previous Adequacy & Flexibility study 2021 was largely compliant with the full ERAA methodology. The proposed methodology for the Adequacy & Flexibility study 2023 study is expected to be fully compliant with the ERAA methodology.

1 Implementation Roadmap | European Resource Adequacy Assessment (ERAA) (entsoe.eu) https://www.entsoe.eu/outlooks/eraa/implementation-roadmap/

2. Scenario input data

The goal of this section is to detail the input data that is proposed to be used for this Adequacy & Flexibility study. This data is also part of the dedicated Excel file, also submitted for consultation.

The CENTRAL scenario can be seen as a 'current/stated policies' based on Belgian/European ambitions.

- For Belgium, this is based on the latest information available to Elia. As previously explained, the new Belgian NECP will only be known by mid-2023. Therefore, Elia has made an effort to propose as best as possible a probable evolution of the different scenario components;
- For the European countries, the CENTRAL scenario is based on the European Resource Adequacy Assessment 2022 (ERAA22) that will be published by ENTSO-E end of 2022 as well as on latest national NECPs or new public announcements.

With the **uncertain context**, Elia proposes to **review these assumptions in January/February 2023**, in order to update important changes if necessary but also to take into account the developments that happened in 2022.

2.1 Geographical scope and time horizon

In this study, 28 European countries will be simulated. This is similar to the previous Adequacy & Flexibility study published in 2021, where new countries were added (Lithuania, Latvia, Estonia, Romania, Bulgaria, Greece and Croatia). This enables to simulate the whole Core region (as Core flow-based domains will be used in the simulation) and all EU countries

Note that, although it is required to simulate whole Europe in order to perform a qualitative adequacy study, the adequacy results will be focused on Belgium, as it is the main reason of this study. Other analysis at EU-level could be done but it will not be the main focus of this study.

Figure 1 Geographical perimeter proposed to be simulated in the study

Regarding the time horizon, the study will cover the years from 2024 to 2034 corresponding to Y+1 to Y+10.

While most TSO and ENTSO-E only analyze a limited number of target years, Elia goes further and proposes the following:

- For **each year** of the **10-years horizon**, analysis of the **adequacy situation;**
- For **each two year** of the **10-years horizon**, **detailed analysis** and **sensitivities** for **adequacy**, **economics** and **flexibility** (i.e. 2024, 2026, 2028, 2030, 2032, 2034);

Next to this, Elia also proposes to:

- Perform an **additional adequacy analysis** for the year **2023**, given that 2023-24 will be the next winter after the release of this study in June 2023 and additional insights on this winter might be relevant;
- Perform **additional detailed analysis** for **adequacy** and **economics** for the year **2025**, given that winter 2025-26 will be the first winter without nuclear units in Belgium (the extension of 2 nuclear units as currently foreseen will happen by 2027) and with a CRM in place.

This means that **12 different target years** will be simulated. Given the large amount of time horizons but also the type of analysis, it is important to note that not all sensitivities will be simulated for all time horizons/type of analysis. A choice will be made to have the most relevant sensitivities being computed depending on the time horizon.

Note that each year examined in the study will be run from 1 September to 31 August of the following year. Therefore, the year 2025 will include the entire winter period of 2025-26. This calendar does not prevent to compare the results with other studies which are also straddling the calendar years.

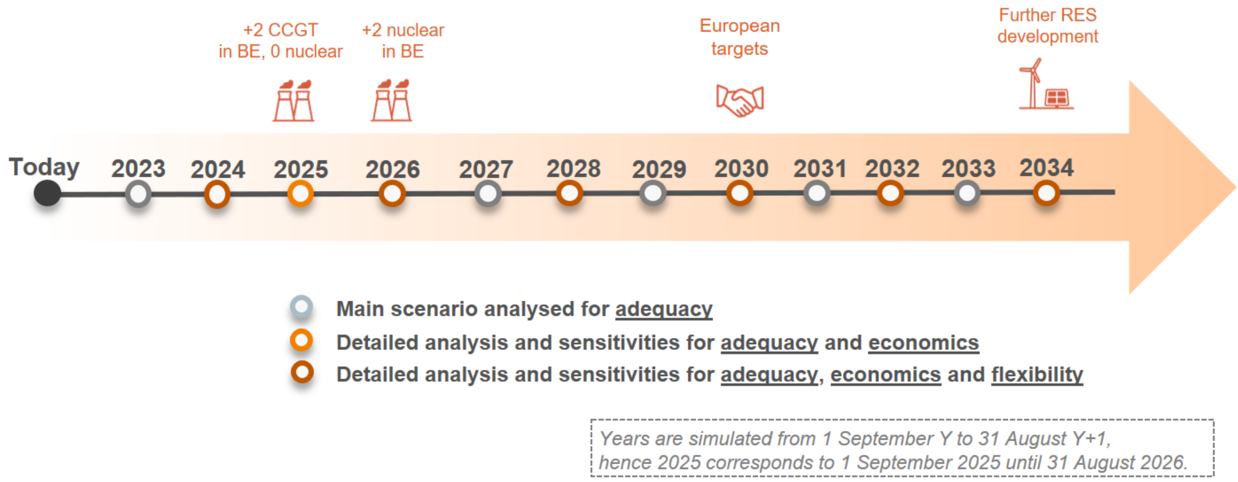


Figure 2: Proposed targets years

2.2 Thermal fleet

The 'CENTRAL' scenario for thermal fleet considers all existing capacities, unless a closure has been officially announced, as well as the foreseen official nuclear phase-out calendar plus the lifetime extension of the two newest nuclear units. It also takes into account new CHP capacities if those are being under construction. Thermal generation in Belgium is made of:

- nuclear power plants;
- combined cycle gas turbine (CCGT) units and open cycle gas turbine (OCGT) units, which are gas-fired power plants;
- turbojets, which can be compared to aircraft motors, using oil as fuel;
- biomass and waste units, using wood and waste as fuel;
- combined heat and power (CHP) units, also called co-generation units, that generate electricity and another by-product such as heat at the same time.

This section is divided in two categories, corresponding to the type of units which are modelled:

- **Individually modelled thermal units**: larger units which have a CIPU (Coordinating Injection of Production Units) contract. Each of the unit is modelled separately in each of the simulations performed;

Profiled thermal units: smaller decentralised units which are usually connected to the distribution grid. These units are aggregated per type in the simulation and associated to a specific production profile.

2.2.1 Individually modelled thermal units

For the CENTRAL scenario, the proposal is to use the following assumptions:

- **Nuclear:**
    - Closure of the following nuclear units as planned in the current official nuclear phase-out calendar being:
        - Doel 3: 1 October 2022;
        - Tihange 2: 1 February 2023;
        - Doel 1: 15 February 2025;
        - Doel 4: 1 July 2025;
        - Tihange 3: 1 September 2025;
        - Tihange 1: 1 October 2025;
        - Doel 2: 1 December 2025.
    - 10-year nuclear extension of Doel 4 & Tihange 3 as of winter 2026-27 and available for the whole time horizon of the study;
    - Those assumptions are summarized on Figure 3.

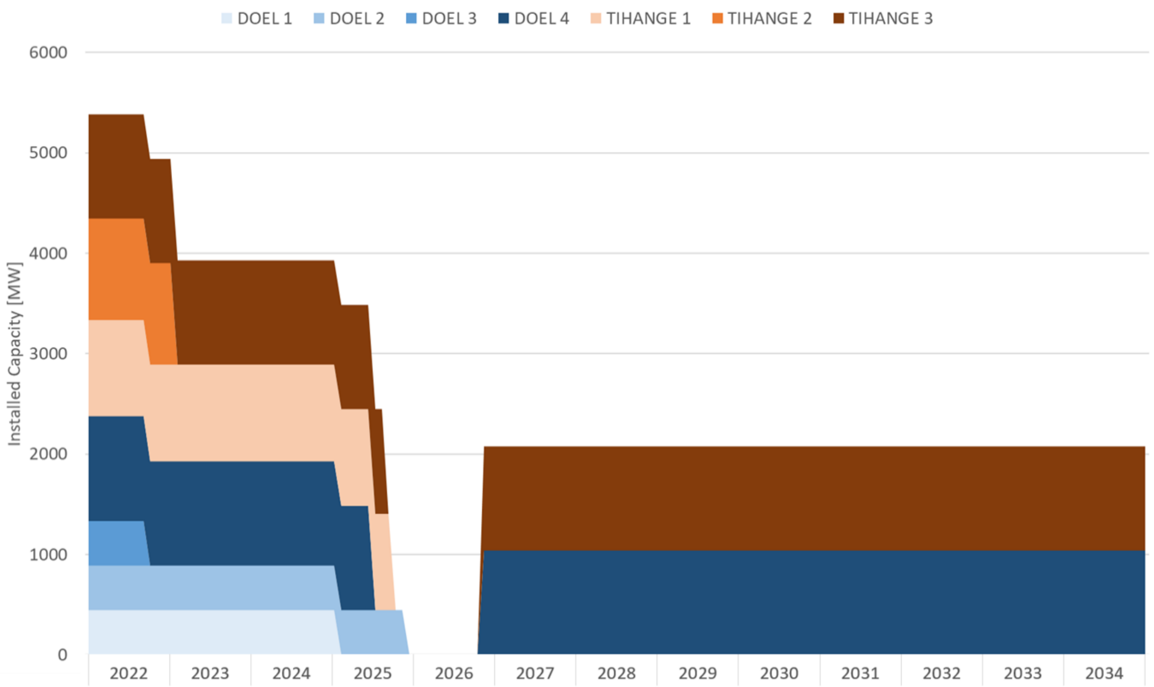


Figure 3: Unit-by-unit installed capacity of the nuclear fleet in MW

- **Gas**
  - Closure of Vilvoorde ST (April 2023) and Vilvoorde GT (October 2025) & Seraing ST (October 2025)[2];
  - 2 new CCGT units (Seraing & Awirs) as of winter 2025-26 (assumed available as from 01/11/2025), contracted in the CRM Y-4 auction for Delivery Period 2025-26 with a 15 years contract;
- **TurboJet**
  - Closure of turbojet Volta (2023);
- **Biomass**
  - Rodenhuize as back-up of Knippegroen as from 24/02/2023.

All the assumptions considered for individually modelled thermal units are presented on Figure 4.

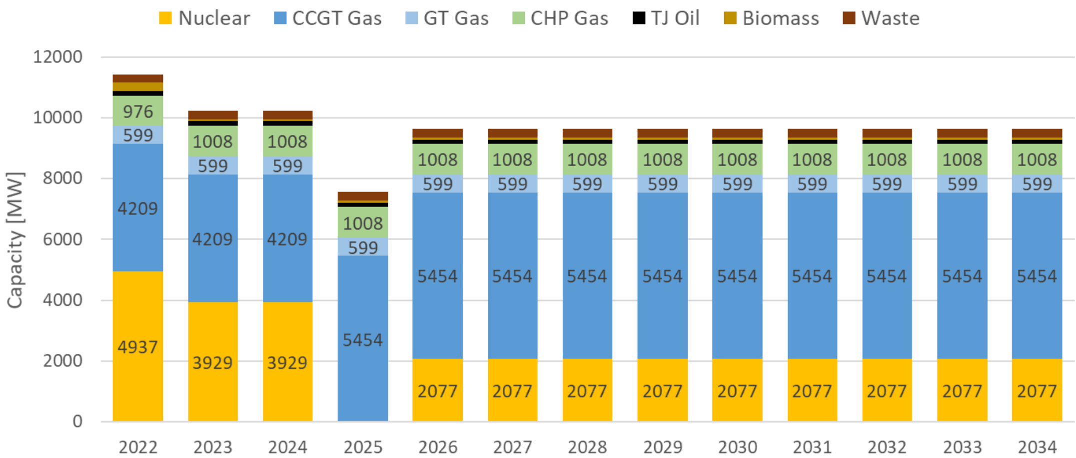


Figure 4: Individually modelled thermal units (capacity assumed at the end of the mentioned year)

Note that, compared to the previous Adequacy & Flexibility study published in 2021, some important assumptions have changed:

- No nuclear extension was considered then while it is now considered based on the current information received from the authorities;
- No additional capacity in the framework of the CRM was considered, as no auction was yet done. The results from the 1st auction for DY25-26 have been thus included and multi-year contracts are considered. The information from the 2nd auction (for DY26-27) will also be integrated once publicly available.

The full list of units is available in the Excel file under the sheet "1.1. Ind. mod. thermal prod".

2 Notifications de mise à l'arrêt ou de réduction structurelle de capacité installée | SPF Economie (fgov.be)

2.2.2 Profiled thermal units

In addition to the individually modelled thermal generation units, smaller units are aggregated into different categories and a generation profile is applied based on historical generation data.
The categories are:

- CHP gas, which is also split between two main categories of assets:
  - Turbines
  - Engines
- Biomass
- Waste

The capacities are based on the information that is available to Elia through the data exchanges with DSOs. The information on the different existing projects and projects assumed to be developed in the next years leads to an increase for gas CHP and biomass profiled units as presented in Figure 5.

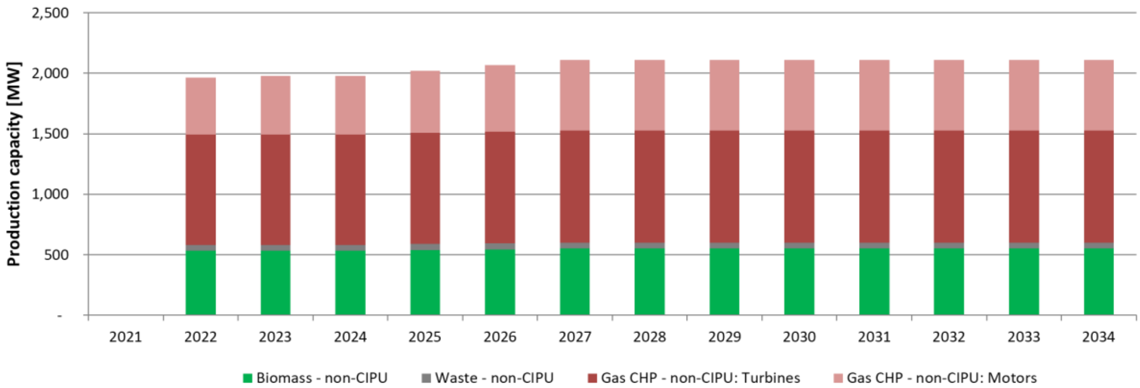


Figure 5: Profiled thermal units (capacity assumed at the end of the mentioned year)

Note that, compared to the previous Adequacy & Flexibility study published in 2021, some important assumptions have changed:

- Increase of the CHP capacity based on the projects available from Elia's internal database (fed by DSO data);
- Split of the gas CHP technology in two categories: motors and turbines, based on the feedback received by Cogen Vlaanderen[3].

Profiled thermal assumptions are available in the Excel file under the sheet "1.2. Renewable and non-CIPU".

[3] https://cdn.nimbu.io/s/uo3nd3c/channelentries/i7qae62/files/WKK_Wegwijzer_2021.pdf?qls9xop

2.3 Renewable energy sources (excluding biomass)

This section is dedicated to renewable energy sources, as presented on Figure 6, and includes trajectory for photovoltaic solar (PV), wind onshore, wind offshore and hydro run-of-river.

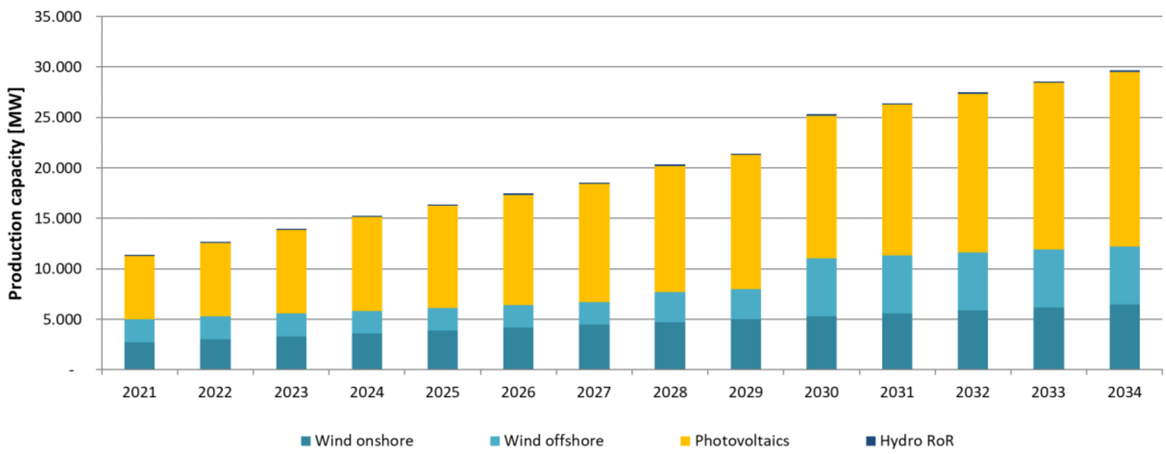


Figure 6: Renewable energy sources (capacity assumed at the end of the mentioned year)

2.3.1 Photovoltaic Solar

An important jump in capacity is expected for 2022. The high demand for PV has led to important delays in supply chains and installations. Therefore, not all the requested capacity in 2022 will be installed in 2022. As assumption, a yearly increase of 1000 MW per year is also assumed for 2023 and 2024. Such assumption should be revised once the detailed numbers of new PV installations for 2022 are known.

After 2024, changes in policies in Wallonia could slow down the installation rate. However, with electricity prices that might stay higher than before and with a significant amount of rooftops still to be covered (incl. social housing, public buildings, etc.), a higher installation rate than previously considered is assumed (800 MW/year). The figures are presented in Figure 7.

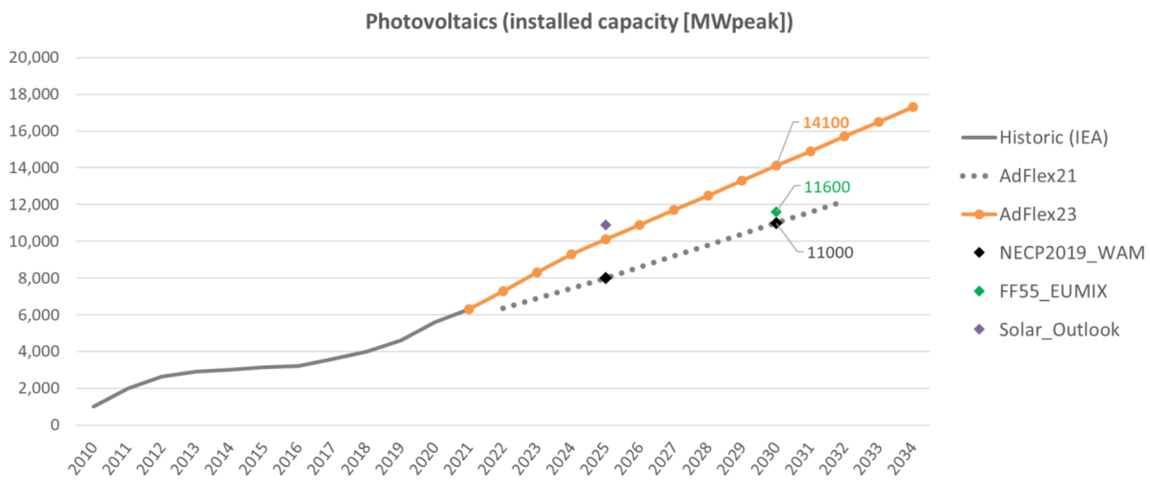


Figure 7: Solar (capacity assumed at the end of the mentioned year)

2.3.2 Onshore wind

In Flanders, the yearly increase has recently been updated from +108 MW to +150 MW for 2022 and 2023[4], while keeping 2500 MW as target for 2030.

In Wallonia, around +70-100 MW is assumed each year from 2022 to 2026[5], with extra potential capacity (380 MW split over 4 years) that might come on top of it.

In Wallonia, the “pax eolienica” will aim to facilitate the installation of onshore wind, which should positively influence the yearly increase.

The figures are presented in Figure 8.

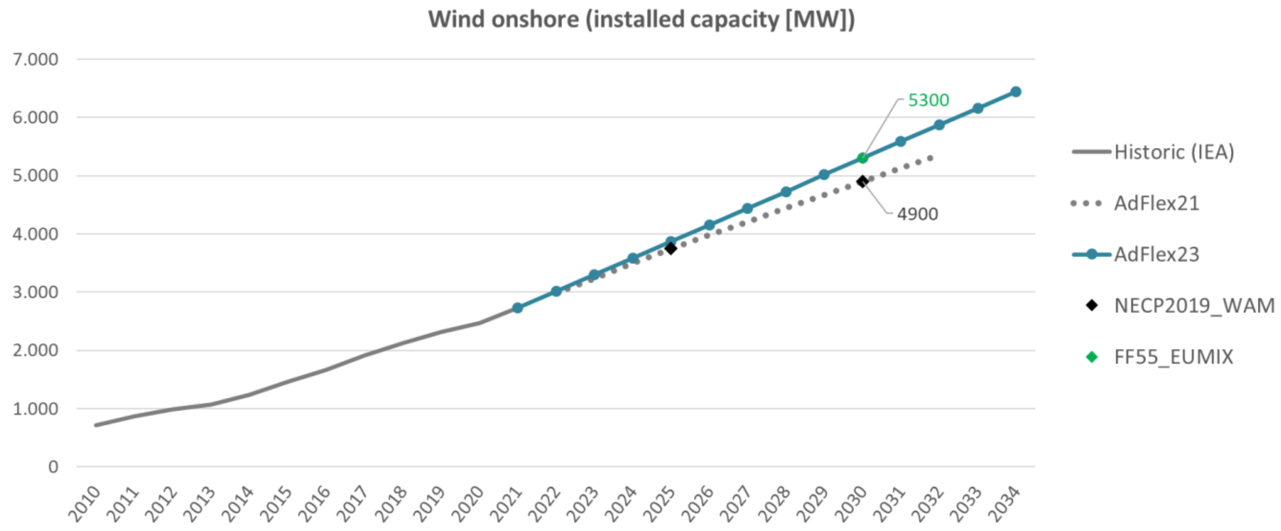


Figure 8: Wind Onshore (capacity assumed at the end of the mentioned year)

2.3.3 Offshore wind

The latest planning of MOG 2 published on the SPF Economie website is used to build the projection. The first 700 MW are expected for Q1/Q2 2028 (not before project Ventilus is completed). The other 2800 MW of MOG2 are expected for 2030 (assuming projects Ventilus and Boucle du Hainaut are completed). The figures are presented in Figure 9.

4 Vlaams Energie- en Klimaatagentschap (VEKA)

5 Service public de Wallonie (SPW)

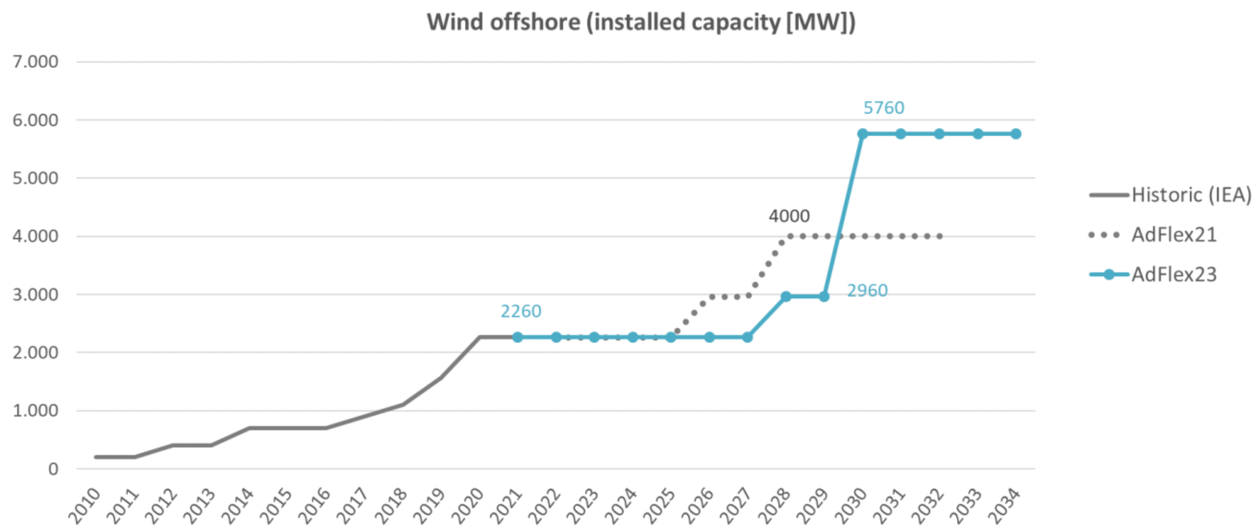


Figure 9: Wind Offshore (capacity assumed at the end of the mentioned year)

Renewable energy sources are available in the Excel file under the sheet "1.2. Renewable and non-CIPU".

2.4 Electricity demand

2.4.1 Total electricity demand

The total electricity demand for Belgium is based on the tool developed by Climact and used in the previous Adequacy & Flexibility study (2021), where the methodology used is described in this report[6]:

This forecast of total electricity demand is build up based on several elements:

- It includes the impact of macro-economic forecasts based on the report published in June 2022 by the Federal Plan Bureau[7];
- It includes the trends in terms of electrification of transport & heating, as presented further in this section;
- It includes the impact of high prices as presented during the WG Adequacy by Climact on 25/08/2022. The impact of high prices are based on the latest forecasts presented in the section "2.6 Economic and technical variables" of this document.

6 https://www.elia.be/-/media/project/elia/elia-site/public-consultations/2020/20200603_total-electricity-demand-forecasting_en.pdf

7 Bureau fédéral du Plan - Publication - Perspectives économiques 2022-2027 – Version de juin 2022

This forecast does not include additional electricity demand which might occur in the industrial sector and/or the growth of new industries (mainly data centers). A range is proposed to capture this additional electrification and is detailed further in this section.

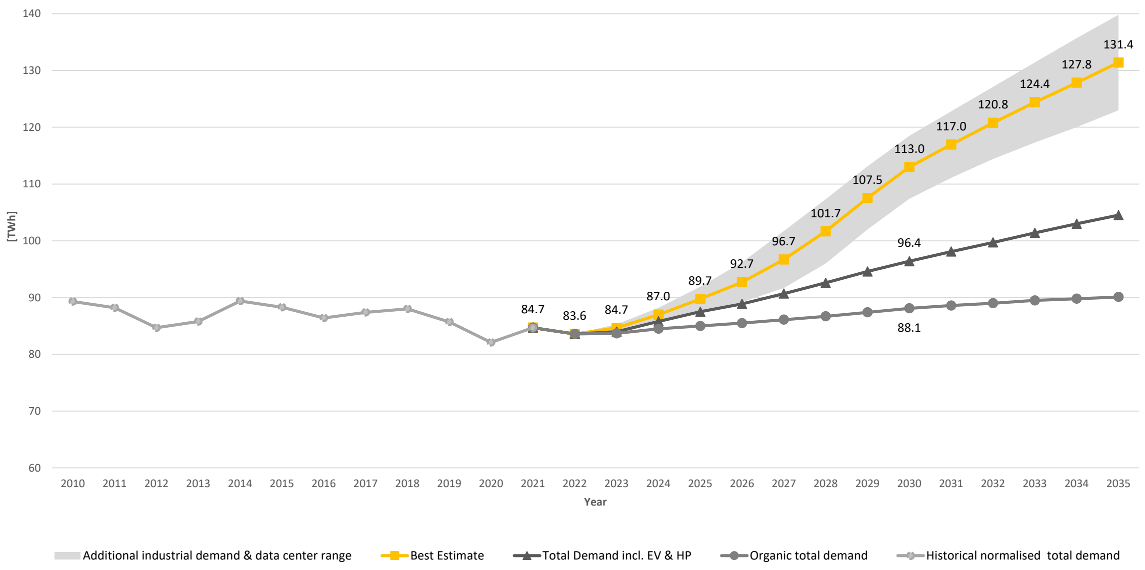


Figure 10 Total annual electricity consumption in Belgium (normalized to 2350 heating degree days, incl.losses, excl. electrolyzer demand and including energy branch consumption)

Figure 11 shows the trajectory as compared to the previous Adequacy and Flexibility 2021 study and other external studies which cover this time horizon.

Sources:

- EC-MIX scenario [8]
- TYNDP2024 & ERAA2023 data collection NT+ scenario guidance range
- EnergyVille-Febeliec – Paths 2050[9]
- Ember – Clean Power pathways [10]

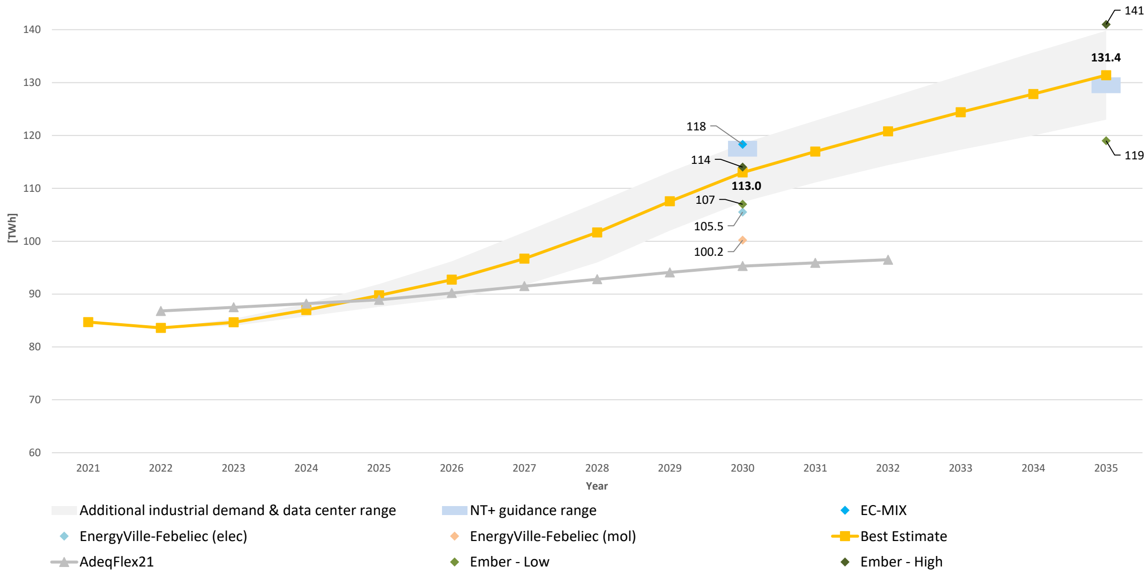


Figure 11 Total annual electricity consumption in Belgium compared to previous Adequacy and Flexibility 2021 and other studies (including grid losses[11], energy branch consumption and excluding electrolyzers)

On 25/08/2022, Climact presented load projections with focus on 2027/28 for the CRM. Since then some improvements have been performed:

- Update of the EV/HP assumptions (refining sub-categories & trajectories, peer review, regionalization etc.);
- Update of the impact of high electricity prices with today's forward prices – including the latest values of the World Energy Outlook (published on 27/10/2022);
- Range of potential additional electrification proposed for industry and data centers.

Electricity demand is presented in the Excel file under the sheet "2.1. Tot. elec. demand".

[8] Policy scenarios for delivering the European Green Deal (europa.eu)

[9] PATHS2050 | Energy outlook (energyville.be)

[10] European Clean Power Pathways Explorer | Ember (ember-climate.org); Low - High range trajectory for the climate objective compliant scenario's

[11] Grid losses are estimated for studies where this is not explicitly included

2.4.2 Electrification of transport

Passenger cars

End 2021 there were around 5.9M passenger cars on the road in Belgium, of which 50k were Battery Electric Vehicles (BEV) and 120k Plug-in Hybrid Electric Vehicles (PHEV), representing a share of around 3% of the total car stock[12]. For the expected evolution towards 2035 it is assumed that passenger car sales will continue the trend of 2020-2022 with reduced sales mainly in the private car segment. Different policies are taken into account which will likely influence the electrification of this segment:

- It is assumed that all passenger car sales will be fully electric by 2035, due to the EU-wide ban on the sale of Internal Combustion Engine (ICE) cars[13].
- For company cars, it is assumed that due to the fiscal measures implemented on the federal level and the Low Emission Zone (LEZ) in the Brussels Capital Region, all sales will be fully electric by 2029 [14] [15].
- In Flanders it is assumed that all car sales are fully electric by 2029 [16].
- In Brussels it is assumed that no more diesel cars are sold from 2030, gasoline from 2035 due to the LEZ[15].
- In Wallonia, no clear targeted policies have been identified. Such that is assumed that 40% of sales will be BEV in 2030 and finally reaching 100% in 2035 as in the other regions.

In Figure 12, the total number of EVs is provided [Mio – Millions of Vehicles] as BEV+1/2 PHEV (as it is assumed that that a PHEV has half of the yearly consumption as compared to a BEV). Also the share [%] of EVs on the total car stock is provided in the Figure. The rapid electrification observed in Figure 12 between 2022 and 2030 is mainly driven by a rapid electrification assumed within the company car segment (around 1.3M units today). The electrification of the private car segment is assumed to happen somewhat slower and to only really accelerate from 2030 onwards.

12 Datadigest 2021 (febiac.be)

13 Fit for 55: MEPs back objective of zero emissions for cars and vans in 2035 | News | European Parliament (europa.eu)

14 Minister Van Peteghem maakt van bedrijfswagens en laadpalen de hefbomen naar een groener wagenpark | Vincent Van Peteghem (belgium.be)

15 Praktisch pagina | Low Emission Zone (lez.brussels)

16 https://energiesparen.be/sites/default/files/atoms/files/VR 2021 0511 DOC.1237-1 Visienota VEKP Bijkomende maatregelen.pdf - "B.2 Uitfasering aankoop fossiele verbrandingsmotoren "

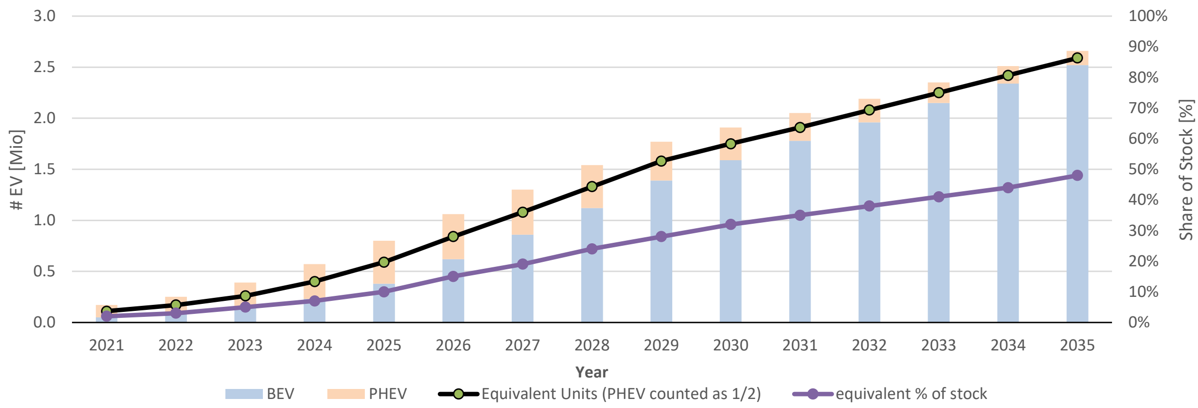


Figure 12 Electrification of passenger cars (assumed at end of year)

Light duty freight (LDV)

End 2021 there were around 850k vans in Belgium, of which less than 1% are electrified. For the expected evolution towards 2035 it is assumed that LDV sales continue on a trend which is slightly below the 10 year average. The main policy taken into account is the EU-wide ban on the sale of ICE which is also applicable for vans[13]. Therefore, it is assumed that all LDV sales will be fully electric by 2035. As such the LDV follow a similar trajectory as passenger cars, but with a more delayed mass uptake, as shown in Figure 13.

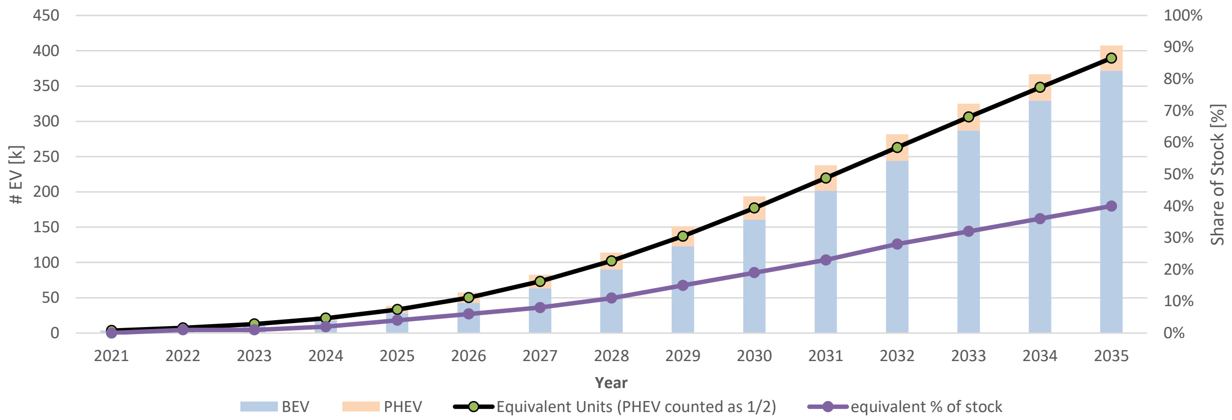


Figure 13 Electrification of LDV vans (assumed at end of year)

Heavy duty freight (HDV)

As shown in Figure 14, end 2021 there were around 150k trucks in Belgium, with practically no electrification. Legislation on the electrification of this segment has not been implemented to this date. The electrification assumed until 2035 is rather conservative, with only 7% of sales being BEV in 2030 and 20% in 2035, leading to only 1% (2030) and 5%

(2035) of BEV share of total stock respectively. There are reasons to assume a stronger uptake since some major truck manufacturers have put different objectives to reach 100% Zero Emissions Vehicles (ZEV) trucks by 2040[17].

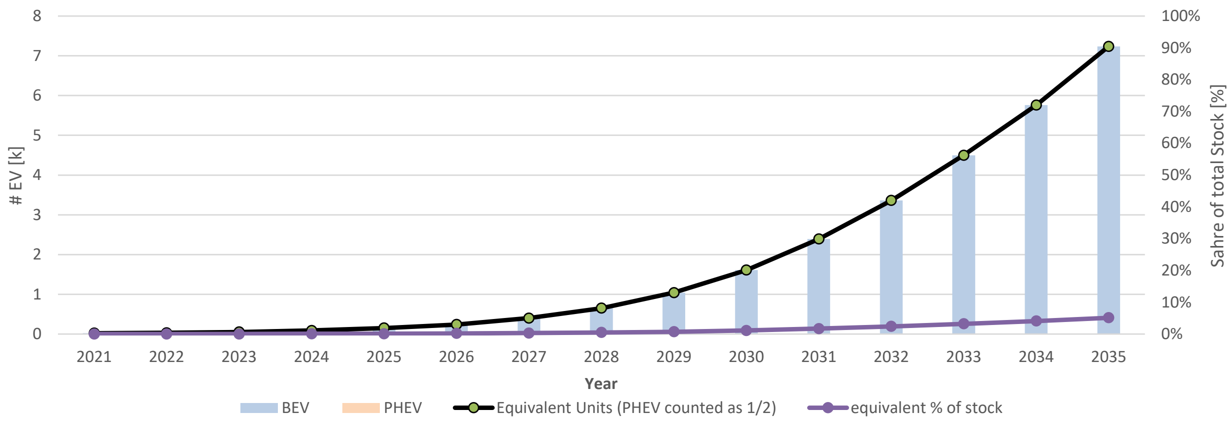


Figure 14 Electrification of HDV trucks (assumed at end of year)

Busses

As shown in Figure 15, end 2021 there were around 15k busses on the road of which around 3% electrified. The electrification of this segment is mainly driven by ambitions communicated by the public bus companies:

- For Flanders, 'De Lijn' has the ambition to reach a 100% electric bus fleet by 2035[18].
- For Brussels, the ambition is to have a 100% electric fleet by 2030[19].

As such an electrification of 30% is assumed for 2030 and 70% in 2035.

[17] **"https://traton.com/en/newsroom/press-releases/press-release-22032021.html** Mercedes-Benz All eActros LongHaul: In Pictures | Trucks.cardekho.com The future of electromobility | Volvo Trucks

[18] E-bussen: De Lijn gaat volop voor groen - De Lijn

[19] 100% elektrische busvloot tegen 2030 - Pascal Smet

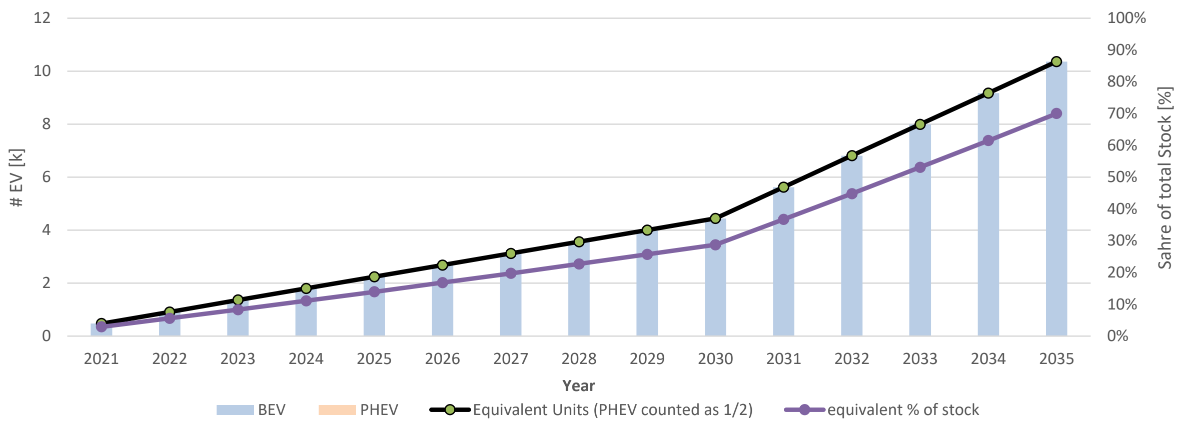


Figure 15 Electrification of busses (assumed at end of year)

2.4.3 Electrification of heating

In this paragraph an overview is given concerning the assumed amount of heat pumps for the residential and tertiary sector. Additional assumptions on the assumed heating demand per building type are included in the Excel accompanying the public consultation (sheet “2.1. Tot. elec. Demand”) .

Residential

The installed stock of heat pumps used as primary heating appliance in dwellings is rather limited up until 2021. Around 90k hydronic[20] heat pumps are currently installed in the residential sector in Belgium with sales increasing from 5k units in 2012 to 17k units in 2021[21]. The most widely installed units are currently Air-Air (AA; reversible) heat pumps with more than 400k units installed end 2021[22]. After discussions with the sector it is assumed that most of these units are primarily used for cooling purposes, where due to their reversible character heating is used as a secondary purpose. It is assumed that for the existing air-air heat pumps,80% of these will be categorized as a secondary heating system (categorized on Figure 16 as “HP as secondary”), contributing less to annual and peak consumption.

The evolution in the number of heat pumps towards 2035 depends on:

- The number of new dwellings per year is assumed to remain constant until 2035, with 55k dwellings being added each year, corresponding to the previous 5 year average[23];
- The renovation rate is assumed to increase from around 0.7% to 1.2% in 2035

Today, full-electric heat pumps are mostly installed in new buildings. For Flanders it is assumed that by 2025 all new buildings will be equipped i) either with a fully electric heat pump (96%) or ii) district heating (4%) due to the phase-out

20 Meaning water is used as heat carrier (Air to Water (AW), Ground to Water (GW))
21 Based on market data from ATTB
22 Based on market data from VEKA, EHPA, EurObserv’ER, Statista and the sectoral organizations ATTB & FRIXIS
23 Bouwvergunningen | Statbel (fgov.be)

of new gas connections in this region[24]. For Wallonia and Brussels no strict obligations are yet in place and it is assumed that 100% heat pump & district heating would be reached in 2035 for new buildings.

For renovations and end-of-lifetime boiler replacements, no one region has currently put in place a strict ban on the usage of fossil gas. Therefore, replacement of heating systems by heat pumps is assumed to remain modest with 23% in 2030, 35% in 2035 for renovations and 18% in 2030, 25% in 2035 for residual end-of-lifetime boiler replacements.

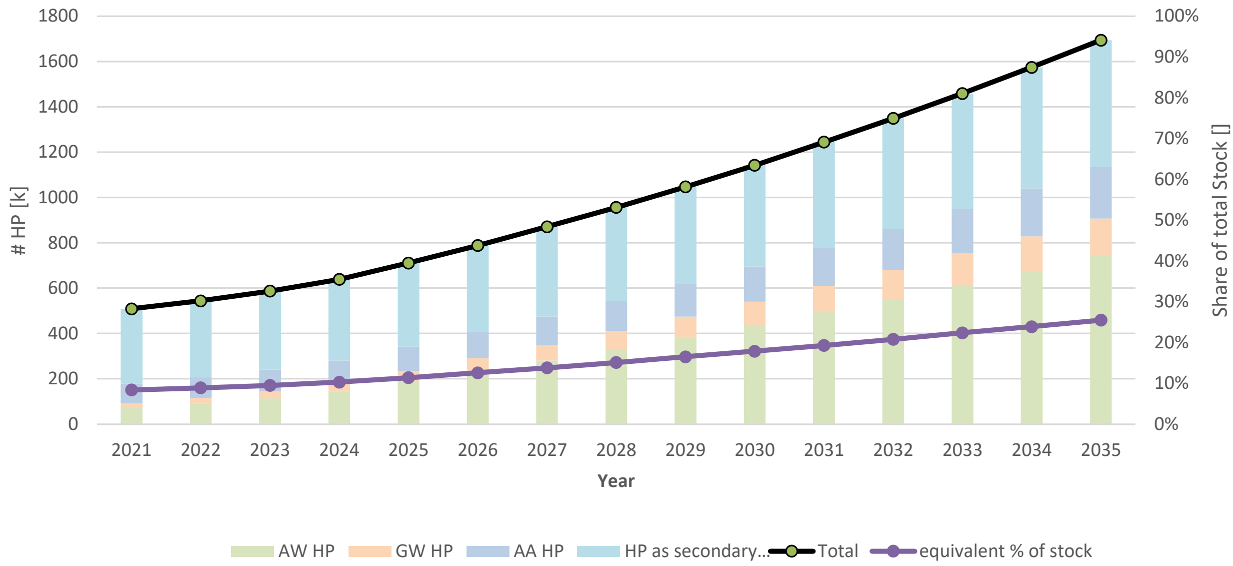


Figure 16 Penetration of heat pumps in the residential sector (assumed at end of year)

Tertiary

The installed stock of heat pumps as primary heating appliance in the tertiary sector is rather limited until 2021. Similarly as in the residential sector the main share are Air-Air (reversible) units for which it is assumed that 80% of these existing units will be categorized as a secondary heating unit.

The evolution in the number of heat pumps towards 2035 depends on:

- The number of new buildings until 2035 is assumed to remain constant until 2035, with 5.8k units being added each year, corresponding to the previous 5 year average[25];
- The renovation rate is assumed to increase from around 0.7% to 1.2% in 2035, similar as in the residential sector.

24 Verplichting elektrische warmtepomp bij nieuwbouw vervroegd naar 2025 - Ode

25 Bouwvergunningen | Statbel (fgov.be)

Compared to the residential sector, a slightly faster uptake of electrification is assumed, with fossil fuels being completely phased-out in new builds by 2030 in all regions (and by 2025 for Flanders as for residential). Additionally, in renovations it is assumed that by 2030 all heating systems are replaced by a heat pump, whereas for end-of-lifetime heating systems (without renovation) the share of heat pumps is assumed at 25% (2030) and 30% (2035).

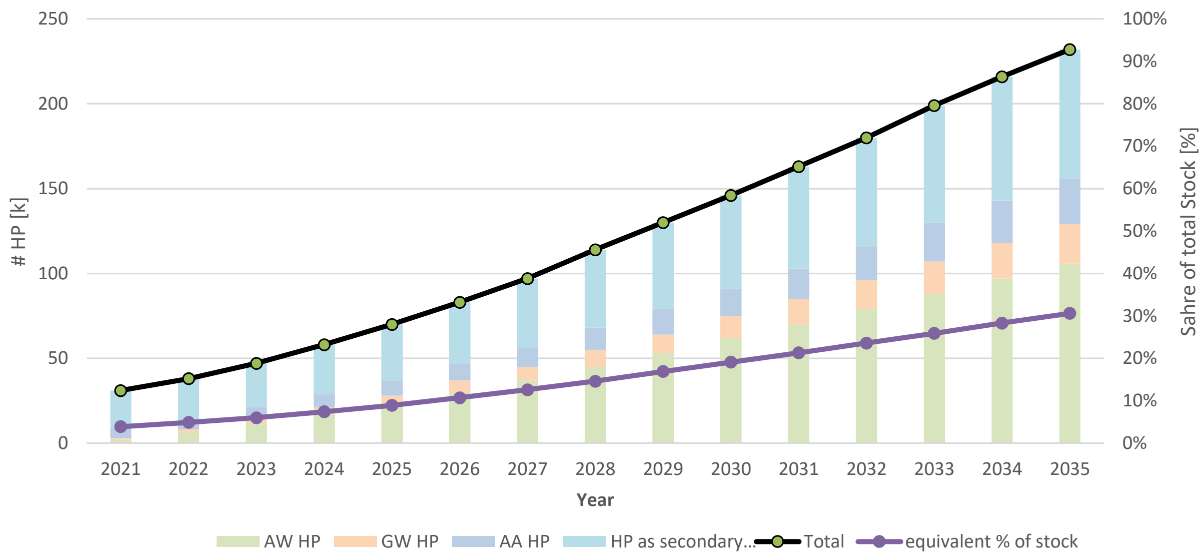


Figure 17 Penetration of heat pumps in tertiary buildings (assumed at end of year)

2.4.4 Electrification of industry and data centers

It must be noted that the forecast of Climact only takes into account the macro-economic impact on industrial electricity demand by assuming the same structural build-up of the industrial sector towards the future. Therefore an increase of electricity demand which is caused by certain industrial processes switching from other energy vectors to electricity and/or due to new projects being planned are not covered in this forecast.

Elia will publish a viewpoint specifically on industry, logistics and data centers on 18/11/2022. This study will include quantified trajectories for industrial demand up to 2050 as well as intermediate values for 2030 & 2040. The forecast for 2030 is based on real-life observed requests from Elia-connected clients and in depth consultation with different industrial companies, sectoral organisations and researchers.

Industry

Since not all communicated projects and requests are considered equally likely, a range is proposed to cover the uncertainty regarding the electrification in the industrial sector as shown in Figure 18. The lower range represents electricity demand increase due to projects that have been confirmed and are categorized as 'very likely' to take place. The higher range represents electricity demand increase due to projects that have been confirmed and requests which are net yet completely certain and categorized as 'potential'.

It must be noted that a significant share of this additional electricity demand is focused on the electrification of heat (industrial heat pumps, electric steam boilers, electric ovens…) & other types of flexible devices. Therefore, not all of this demand will result in additional peak demand and will likely be able to deliver flexibility services.

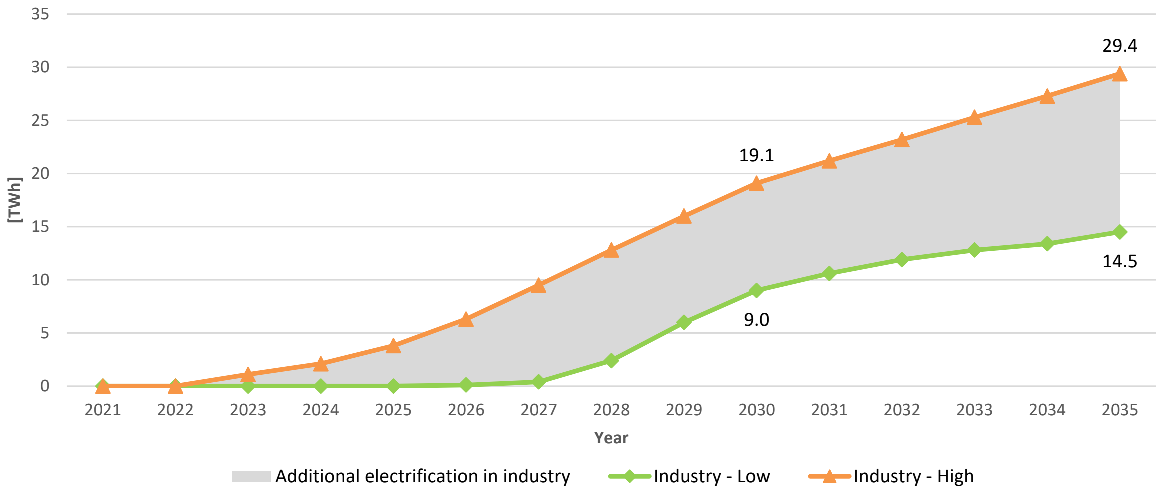


Figure 18 Additional electrification in the industrial sector (on top of organic growth of existing electricity demand)

Data centers

In recent years, data centers have become a significant source of electricity consumption in Belgium, with around 1TWh consumed by 2021. Some key players have communicated their willingness to expand data center operations in Belgium either publicly[26] or bilaterally to Elia. As not all announcements are certain a range is proposed as shown in Figure 19.

[26] Bientôt un nouveau datacenter de Google en Belgique? - Le Soir

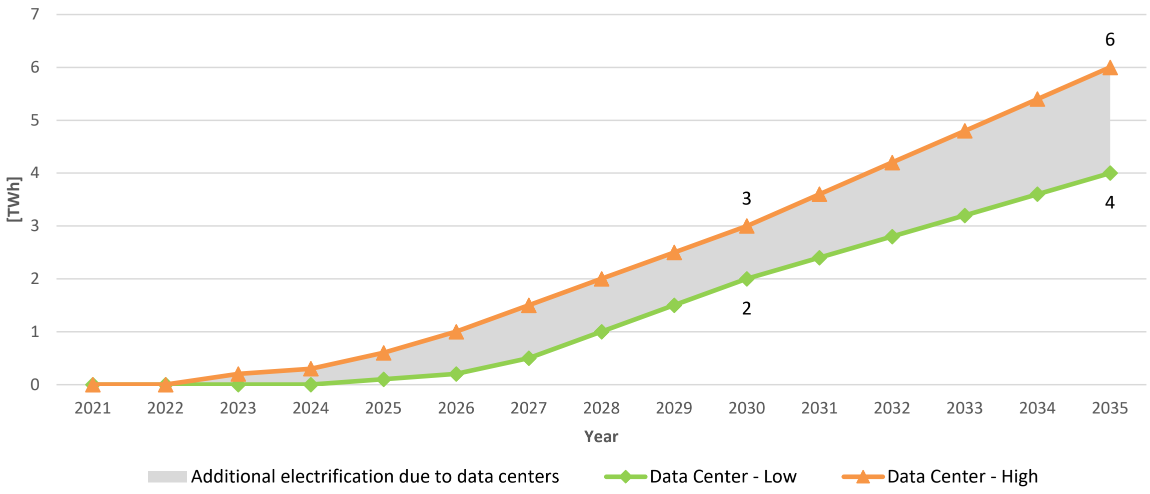


Figure 19 Additional electrification due to new data centers (on top of existing data centers demand)

2.5 Storage and demand response

2.5.1 Pumped-Storage

Pumped-Storage in Belgium consists in 2 sites: Coo and Platte -Taille.

Regarding Coo, the turbining capacity is equal to 1080MW in 2021 and takes into account the reservoir extension of Coo[27] from 2023 to 2025 bringing the overall pumped-storage installed capacity to 1161 MW and a storage reservoir capacity of 5600 MWh.

Regarding Platte -Taille, a turbining capacity of 144 MW and a reservoir volume of 700MWh is considered.

Considering that 500MWh is dedicated to black-start services, the total reservoir volume of pumped-storage available for economical dispatch, after extension, is equal to 5800 MWh.

Pumped-Storage data is presented in the Excel file under the sheet "3.1 Storage".

2.5.2 Large scale batteries

27 https://corporate.engie.be/fr/energy/hydraulique/centrale-daccumulation-par-pompage-de-coo/le-projet-dextension

Large-scale batteries trajectory is presented on Figure 20.

The installed capacity for large-scale batteries is divided in two categories:

- Existing capacity;
- Additional potential if economically viable.

Regarding existing capacities, only the projects “in service” as of today are considered, representing 52MW. As of 2025, this volume also integrates the volume contracted in the framework of the Y-4 auction for Delivery Period 2025-26, leading to a total volume of 226MW.

On top of this existing capacity, additional potential capacity could come by based on projects known today at Elia. These projects will be considered in the scenario if it is proven that they are economically viable without support mechanism. This will be determined via the economic viability assessment (EVA) to be performed in the study..

A significant update has been implemented for the energy content of large-scale batteries compared to previous study. Based on information available on existing and known projects, a 70%/30% split is performed between large-scale batteries projects with respectively a 4h storage capacity and a 2h storage capacity. In the framework of the Adequacy & Flexibility study published in 2021, a single energy content of 2h was considered.

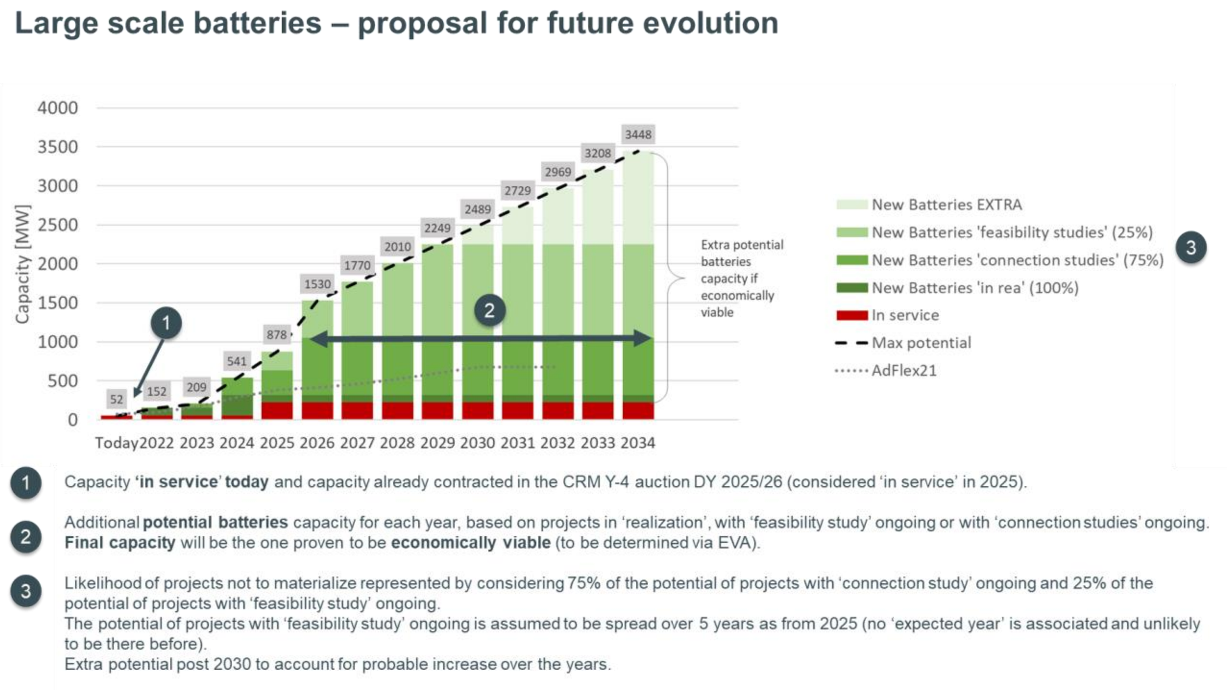


Figure 20: Large-scale storage (capacity assumed at the end of the mentioned year)

Large-scale storage data is presented in the Excel file under the sheet “3.1 Storage”.

2.5.3 Small scale home batteries

Small-scale batteries trajectory is presented on Figure 21.

Small scale home batteries are assumed to be managed behind the meter and are considered for this reason in the "out-of-market" category. The battery profiles depend on the climate years. As it is assumed that battery owners have solar panels installed, the battery profiles are determined by both the consumption of electricity and solar production. The battery is loaded when the ratio between the relative level of solar production of a given hour within a day compared to the relative level of consumption is high and unloaded when this ratio is low. Since the solar and load profiles are determined based on the climate years, it follows that this profile is indirectly determined by the climate years.

The projection assumes battery of 4.5 kW in average with a duration of 2 hours in average (9 kWh). The projections are based on the following reasoning:

- since 2019, subsidies/bonus for home batteries have been put in place in Flanders. Around 19,000 premium were asked in 2021 in Flanders for home batteries;
- the bonus in Flanders foresees a decreasing amount until 2024 (stop in 2025), for maximum 9 kWh: from maximum 2550 EUR in 2021 to maximum 425 EUR in 2024 (amount reviewed each year). Therefore, it is assumed that the number of home batteries in Flanders will continue to increase as in 2020/2021 until 2024, followed by a slower growth rate after that. No other incentive is assumed;
- the installation of home batteries is mainly driven by the installation of PV. In 2021, it seems that 2% the PV installations in Flanders have added a battery capacity of the size of the PV installation, compared to 0,13% in Wallonia. This number is assumed to decrease up to 0,2 % in Flanders after 2024 and the end of the bonus.
- It is important to note that recent announcements from the authorities are indicating that the subsidies in Flanders for 'home batteries' would be stopped earlier than expected. This element is not taken into account in the presented figures (as the information was provided one day before the public consultation).

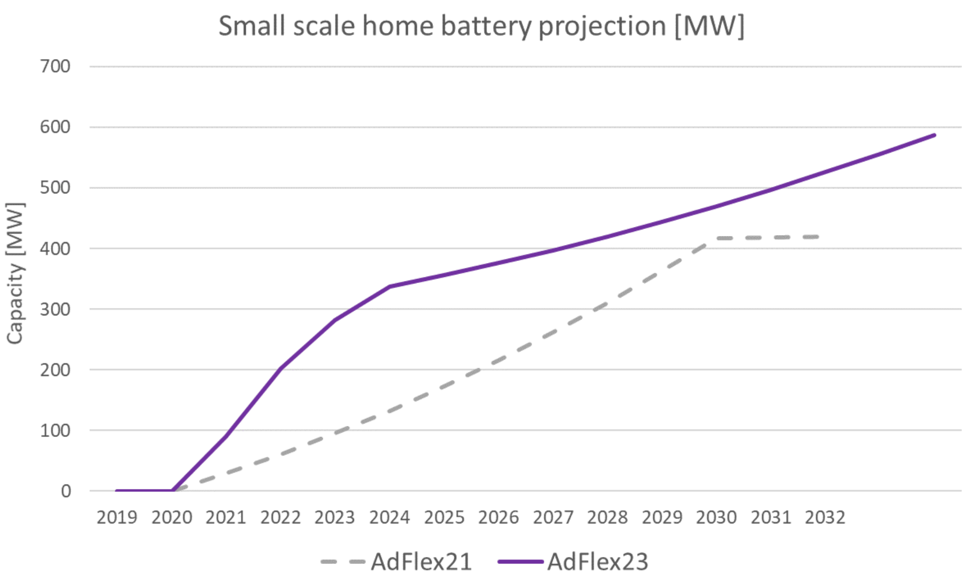


Figure 21: Small-scale storage (capacity assumed at the end of the mentioned year)

Small-scale storage data is presented in the Excel file under the sheet "3.1 Storage".

2.5.4 Demand-Side Response from industry

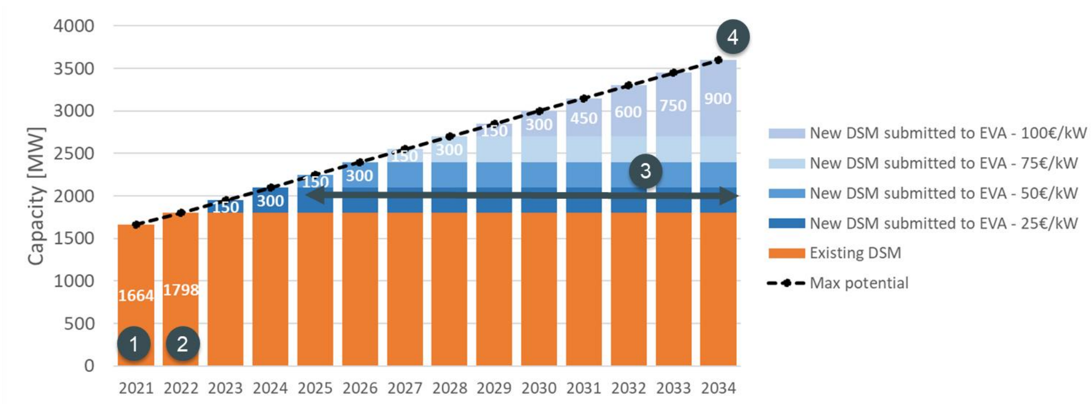
Demand-Side Response (DSR) from industry is presented on Figure 22.

The installed capacity for DSR is divided in two categories:

- Existing capacity;
- Additional potential if economically viable.

Regarding existing capacity, the installed capacity is based on the study performed by E-CUBE consultants[28]. The volume for 2021 is based on the assessment performed on winter 2021-22. For next winter, an extrapolation is performed assuming a growth rate of 8% (highest rate from the E-CUBE study), leading to 1798MW of installed capacity for end of 2022. This volume is proposed to be the baseload capacity for the whole trajectory.

On top of this existing capacity, an additional potential volume can be integrated in the model. This volume will be considered in the scenario if it is proven that they are economically viable without support mechanism. This will be determined via the economic viability assessment (EVA). This additional potential volume is increasing on the time horizon foreseen and is split between different cost ranges, from 25€/kW to 100€/kW by step of 25€/kW. The maximum capacity at the end of the studied time horizon is derived from the estimated maximum potential available in Belgium, corresponding to 25% of the total peak load for Belgium today. Note that such potential is way beyond any study on the potential of DSR[29,30,31].



1. Value for winter 2021-22 from the latest E-cube study.
2. Extrapolation from e-cube study, considering a growth rate of 8% (the highest from historical evolution).
3. Additional potential is submitted to EVA (capacity will be considered if economically viable).
4. Maximum potential is defined as 25% of the total peak load of Belgium today. Such value goes way beyond any study on the potential of DSR (even more that the potential is usually defined on the total load – and not only on the industry one).

Figure 22: Demand-Side Response from existing industry and large clients (capacity assumed at the end of the mentioned year)

28 20220913 meeting (elia.be)
29 Assessment of the theoretical demand response potential in Europe - ScienceDirect
30 https://www.raponline.org/wp-content/uploads/2017/11/rap_sedc_rosenow_thies_fsr_slides_2017_oct.pdf
31 Microsoft PowerPoint - DELTA_Webinar_JRC_final.pptx (delta-h2020.eu)

DSR from industry is presented in the Excel file under the sheet “3.2. DSR industry”.

2.5.5 Demand-Side Response from residential and tertiary sector

The flexibility available from this sector has been assessed through a study carried out by DELTA-EE[32]. The goal of the study was to refine the assumptions of the residential & tertiary flexibility, in order to improve its modelling within the Adequacy and Flexibility study. The DELTA-EE study is also part of this public consultation.

DELTA-EE carried a work in 3 Work Packages (WP). The first one had to scope the relevant technologies able to deliver flexibility in these sectors. The second work package looked at the enablers needed to unlock such flexibility, as well as the load profiles of these flexible assets, given that enablers were in place. Finally, the study had to give a forecast of the flexibility options for each flexible asset.

The study came to the following conclusion:

- Out of all technologies explored, only the Electric Vehicles (EV), Heat Pumps (HP) & Residential batteries will deliver most of the flexibility in the future (indicated in green in Figure 23).

Category	Residential Technologies	Commercial Technologies
Electric Vehicles and Charging points	Passenger Plug in Hybrid (PHEV) Battery Electric Vehicles (BEV) EV charge points: Public charging EV charge points: Home charging	Light commercial electric vehicles EV charge points: Employee EV charge points: Depot
Electric heating loads	Air & ground source heat pumps Hybrid heat pumps	Air & ground source heat pumps Hybrid heat pumps
Cooling Loads	Air conditioning systems	Air conditioning systems Commercial refrigeration
Energy Storage	Home batteries Hot water storage(covered in heating)	Commercial batteries
Misc. loads	Lighting Appliances & white goods	

Figure 23: Technologies judged relevant to deliver flexibility by 2035.

- A framework has also been developed to define the necessary elements needed to unlock flexibility for each asset. These elements are described in Figure 24 below.

32 https://www.elia.be/en/users-group/adequacy-working-group/20221013-meeting

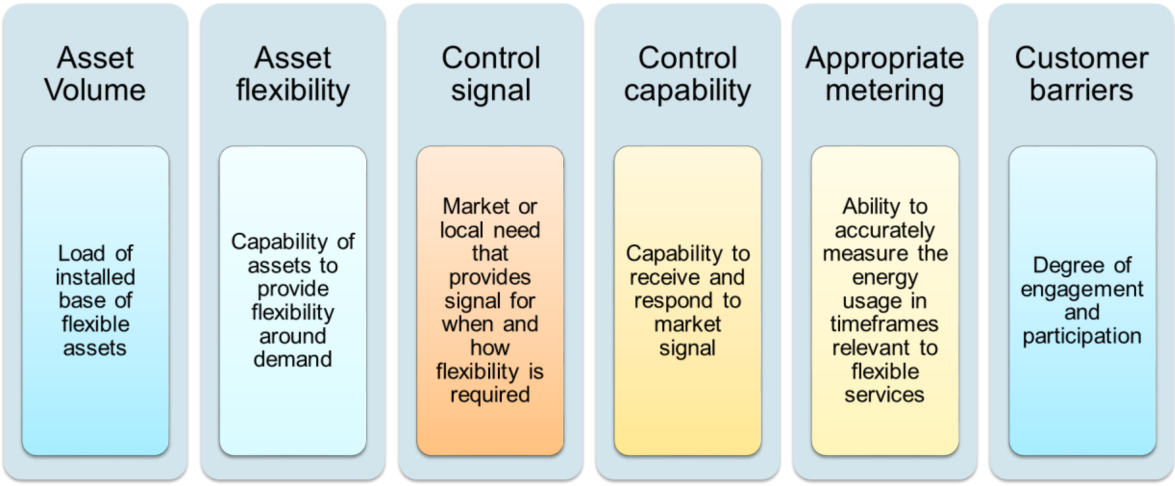


Figure 24: List of enablers necessary to unlock flexibility.

- Based on these enablers, different categories of flexibility options have been defined for each asset. For each of these flexibility options, a different modelling will be applied. The first category is the natural load profile. It corresponds to the way the assets are used now, often contributing to evening peak. Then for each asset, it is considered whether the control signal optimizing the flexibility is local (optimizing the house load) or coming from the market. For the former, an illustrative profile is shared in the Excel of the public consultation, but for the latter, the ANTARES software will optimize the way it is dispatched.

Technology	Profile name	Description	Enablers
Electric Vehicles (EV)	V0	Natural Charging : charges as soon as plugged-in	/
	V1**H**	Smart charging based on local signal (**H**ome)	Smart meter, Smart charger & communication capability, Appropriate tariff
	V1**M**	Smart charging based on **M**arket signal	Smart meter, Smart charger & communication capability, Price signal (e.g.: dynamic tariff)
	V2**H**	Smart management based on local signal (**H**ome)	All V1H enablers, plus: Bi-directional smart charger & EV
	V2**M**	Smart management based on **M**arket signal	All V1M enablers, plus: Bi-directional smart charger & EV
Electric heating loads (Heat pump)	HP0	Natural load	/
	HP-1**H**	Load shifting based on local signal (**H**ome)	Smart meter, Communication capability, Appropriate tariff, (House insulation)
	HP-1**M**	Load shifting based on **M**arket signal	Smart meter, Communication capability, Price signal (e.g. : dynamic tariff), (House insulation)
Residential Batteries	B-2**H**	Load shifting based on local signal (**H**ome)	Smart meter, Communication capability, Appropriate tariff
	B-2**M**	Load shifting based on **M**arket signal	Smart meter, Communication capability, Price signal (e.g. : dynamic tariff)

Figure 25: Categories of flexibility options available per asset.

- Finally, for each flexibility option described in Figure 25, a penetration in the total assets fleet has been derived. See *Figure 26* regarding the penetration of each flexibility option. This forecast considers the effect of market reforms (eg: greater competition amongst aggregators, lower barriers to the market, etc..) not yet implemented in current policies. All underlying assumptions are detailed in the DELTA-EE report.

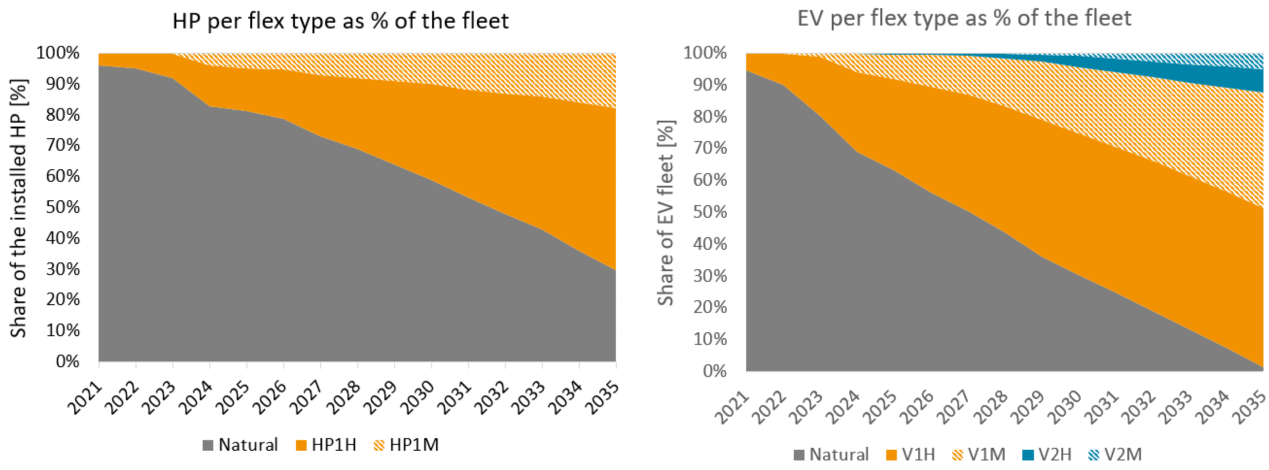


Figure 26: Penetration of flexibility options for HP & EV. The penetration of flexibility grows in the coming years, with greater proportion in House optimization than Market proportion.

DSR from residential & tertiary sector is presented in the Excel file under the sheet "3.3. DSR end-user".

2.6 Economic and technical variables

2.6.1 Fuel and CO2 prices

In this section, the assumptions regarding fuel prices (Natural gas, Coal, Oil) & CO_2 are presented. Prices are published in EUR2022 per MWh, except for the CO_2 where the price displayed is in EUR2022 per ton of CO_2.

The methodology to define Fuel & CO_2 prices differs based on the time horizon studied.

On the short-term, forward prices are available on the market for the different fuels. Note that a difference is made between the United Kingdom & Europe on the short term for natural gas[33] & CO2 prices.

Hence, the market price from the forward contracts are used for natural gas, coal, oil and CO_2 from the EU ETS market until 2025 at least. No forward prices have been found from the UK CO_2 market, so an average was made for 2022 based on historical data[34].

33 UK NBP Natural Gas Calendar Month Futures Quotes - CME Group

34 EU Carbon Price Tracker | Ember (ember-climate.org)

The long-term prices are defined by the World Energy Outlook (WEO[35]) 2022 published by the IEA on 27/10/2022. In the WEO, data are available for 3 scenarios (Stated Policies, Announced Pledges & Net Zero) for the years 2030 and 2050. Out of the three scenarios, Announced Pledges is proposed to be used as the central one.

Methodology:

1 Historical average (for the year 2022)

2 Prices defined by forward contracts, as displayed on relevant source, consulted beginning of October (27/10).

3 Interpolation between last forward price known & long-term price defined in WEO2022.

For all commodities a clear decreasing trend can be noticed. After the energy crisis experienced amidst the invasion of Russia, based on the forwards and the World Energy Outlook, the prices of commodities are expected to come down in the future, except for CO_2 price which are expected to keep increasing in the coming years.

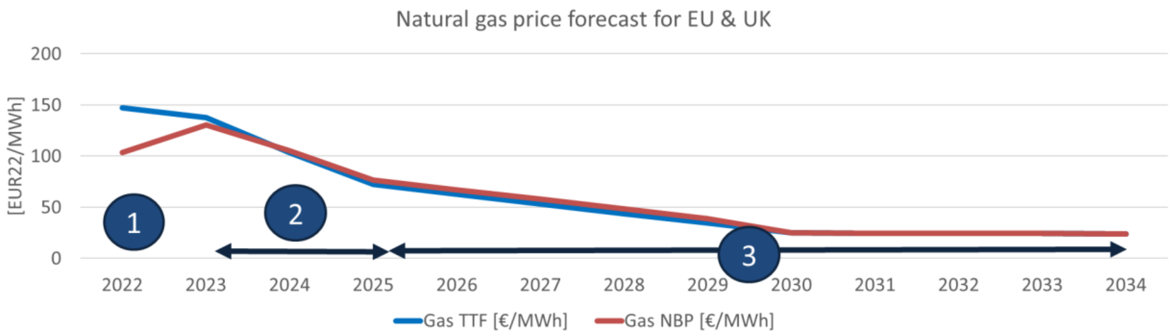


Figure 27: Proposed prices for natural gas for EU & UK.

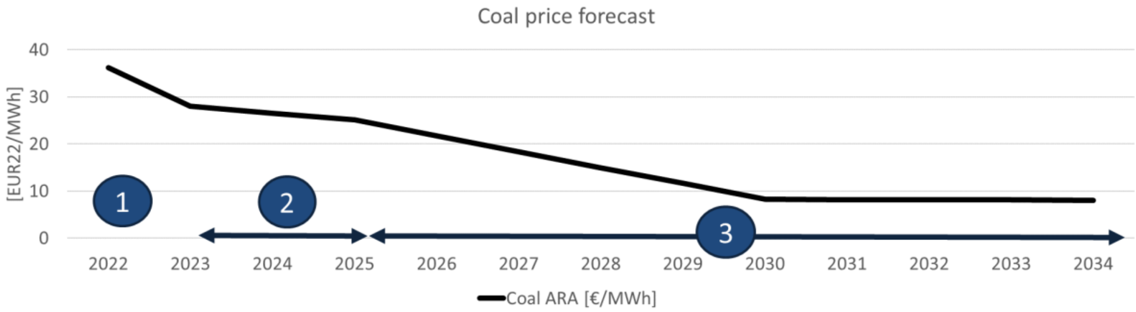


Figure 28: Proposed prices for Coal in the geographic perimeter of the study.

35 https://www.iea.org/reports/world-energy-outlook-2022

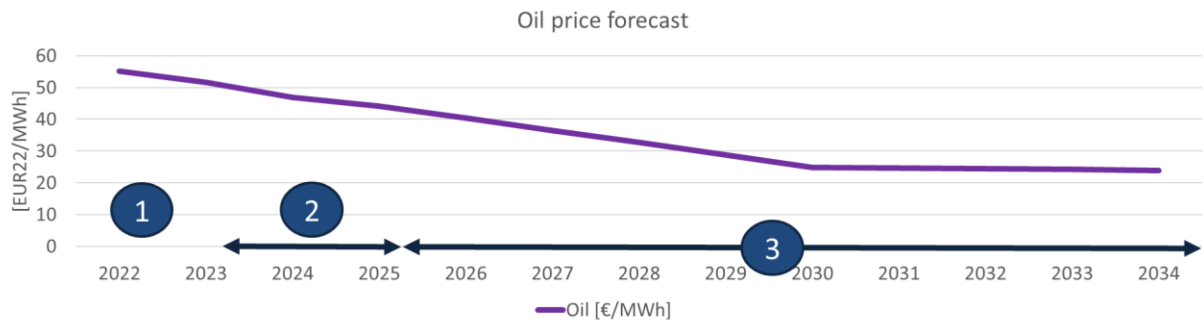


Figure 29: Proposed prices for Oil in the geographic perimeter of the study.

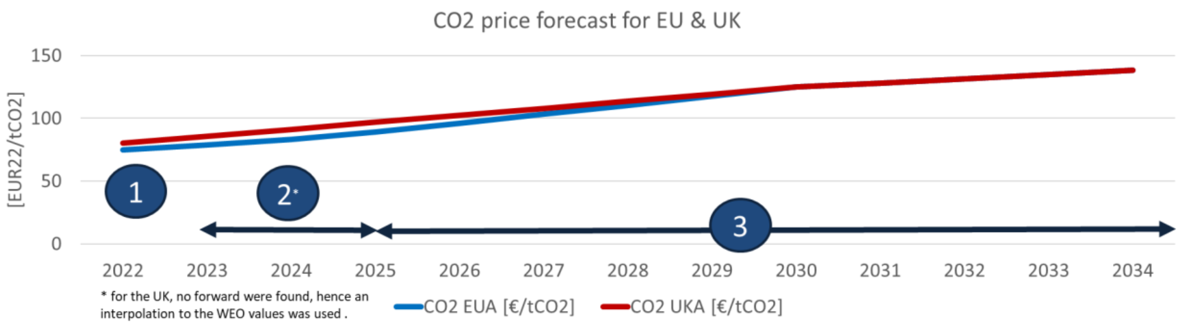


Figure 30: Proposed prices for CO_2 for EU & UK.

2.6.2 Investment costs

All costs are expressed in euros of end 2022. In this way the most recent trends in general and industrial inflation are taken into account. The proposed values are presented in Table 1.

2.6.3 FOM (fixed operation & maintenance costs)

The FOM values are based on the peer-reviewed study done by AFRY, presented in the WG Adequacy of 13/10/2022 and available in this public consultation. An aggregation per type of unit will be taken into account. 4000 running hours will be taken as basis for CCGTs (and 800 running hours for OCGTs) although if the units would run more or less hours, this could be adapted accordingly.

Note that the AFRY-study will also be used as a basis for the upcoming calibration report for the CRM.

CAPEX

In general, the CAPEX of thermal units (including extension costs) of last study (which was expressed in euros of 2019) are proposed but considering an increase of around 25 % based on the information provided by AFRY, due to inflation, equipment & material costs but also increased labor costs.

The proposal for the CAPEX of batteries are based on the ones used for the CRM auction parameters[36], thus including inflation and different costs per year segments between 2022 and 2035. For the RES categories and batteries, an evolution of the investment costs in time is assumed. All consulted sources are available in the Excel.

2.6.4 Hurdle rates

The hurdle rates are based on the study by Professor K. Boudt, which is provided separately within this public consultation.

Table 1 Investment costs and parameters for the different technologies proposed for this study

EUR 2022

Technologies part of the structural block		Applies to	CAPEX [€/kW]			FOM (including major overhauls) [€/kW/y]	Investment economic lifetime [years]	Hurdle rate in EOM (WACC + premium)
			2022-2025	2026-2030	2031-2035	2022-2035	2022-2035	2022-2035
Existing (assumed no extension costs)	CCGT	Existing units <25 years	-			40	-	8.4%
	OCGT		-			25	-	8.4%
	CHP	All existing capacity	-			70	-	8.4%
	Turbojets	All existing capacity	-			35	-	8.4%
	Demand Response	All existing capacity in 2020	-			12	-	8.9-9.6%*
	Pumped Storage	All existing capacity	-			22	-	7.6%
Existing (assuming extension costs needed)	CCGT	Existing units >25 years	120			37	15	9.4%
	OCGT		100			50	15	10.4%
New	Diesels	New capacity	380			20	15	11.4%
	Gas engines	New capacity	500			20	15	11.4%
	CCGT	>800 MW	750			30	20	9.9%
		400 < 800 MW	950			35	20	9.9%
		< 400 MW	1050			35	20	9.9%
	OCGT	>100 MW	500			25	20	11.4%
		<100 MW	600			25	20	11.4%
	CHP	New capacity	1000			70	20	9.9%
	Demand response	New capacity 0 < 300 MW	*All costs included in the FOM*			25	-	8.9-9.6%*
		New capacity 300 < 600 MW				50	-	8.9-9.6%*
		New capacity 600 < 900 MW				75	-	8.9-9.6%*
		New capacity 900 < 1200 MW				100	-	8.9-9.6%*
	Batteries/Storage	Large scale batteries (1h)	400	280	260	15	15	8.4%
		Large scale batteries (2h)	650	460	440	15	15	8.4%
		Large scale batteries (4h)	1000	850	750	15	15	8.4%
	Pumped Storage - new unit	New unit in Coo	1000			22	25	8.4%
Renewables								
RES	Wind onshore	New	1150	1000	900	45	15	7.6%
	Wind offshore	New (after 2 GW)	2650	2000	1850	70	20	7.6%
	PV	New	600	550	500	20	20	7.6%
	Biomass	New	2300	2300	2300	95	20	8.4%

**depending on the activation costs*

All data, sources and inflation figures on which the proposed values are based are further detailed in the Excel file submitted to consultation. The Excel file also includes a comparison with the previous study's values.

Investment costs are presented in the excel sheet under "4.2. Investment costs".

[36] https://www.elia.be/en/public-consultation/20220506_public-consultation-on-crm

2.6.5 Outages

The outage parameters for CCGT, OCGT, CHP, TJ, HVDC links and Pumped Storage units were calculated by N-SIDE in the context of a wider study around outages for Belgian production units. The outage parameters for nuclear units were calculated by Elia in the context of the CRM calibration for delivery year 2027-2028 (details can be found as an annex to the N-SIDE study). 2 The resulting outage metrics are presented in the Table 2 below.

Table 2 - Overview of forced outage parameters

Category	Number of FO per year	Average FO rate [%]	Average duration of FO rate [hours]
Nuclear	1.3*	4.0%* - 20.5%**	199 hours*
CCGT	9.4	5.5%	110 hours
OCGT	9.2	8.2%	221 hours
TJ	3.2	9.8%	130 hours
CHP, waste, biomass	2.9	6.4%	111 hours
Pumped Storage	6.7	6.8%	179 hours
DC links	1.9	6.7%	158 hours

** only considering technical forced outages.*

*** also considering long-lasting forced outages*

Note that the N-SIDE study is also part of this public consultation.

2.7 Assumptions on short-term flexibility study

The assumptions used in the flexibility study are specified in a specific appendix describing the assumptions on the assessment for short-term flexibility study and the Section 4.4 of the Excel with the input data. This concerns the prediction data used, as well as the outage characteristics and the characteristics of technologies towards flexibility

In the adequacy and flexibility study of 2019, Elia made assumptions on technical flexibility characteristics of generation, storage, demand-side and interconnections. Besides the update of the technical characteristics of flexible technologies based on the end-user flexibility study (i.e. electric vehicles, heat pumps and home batteries), no fundamental revisions are foreseen for the upcoming study.

Concerning the assumptions on reserve projections taken into account in the adequacy study (in line with the ERAA methodology), Elia reserves the reserve capacity needs on generation, storage and demand assets, which ensures that Elia can cover its reserve needs - e.g. to cover the unexpected outage of a large unit - even during scarcity periods). Note that in the previous study, aFRR and mFRR projections until 2032 were derived from Elia's MOG 2 study (2020) on the system integration of offshore wind power. Note that new projections will become available in the framework of the offshore integration study (MOG 2 study), for which the results are planned to be presented in early 2023. It is foreseen that these figures will be used in the calculations of this Adequacy and Flexibility study.

Concerning the assumptions on cross-border flexibility, as from 2022, the European balancing energy platforms will facilitate cross-border balancing energy exchange for aFRR and mFRR. Unfortunately, no estimations or projections are available on the expected liquidity on these balancing energy platforms and TSOs depend on a return on experience after implementation. This means that current 'firm' reserve sharing of 250 MW (upward fast flexibility) and 350 MW (downward fast flexibility) and 0 MW of Integrated Gasification Combined Cycle (iGCC; ramping flexibility) are still assumed as the starting point for the analyses. These are complemented with sensitivities, e.g. where the contribution may increase up to 50% and maybe even to 100% of the balancing needs. These assumptions and sensitivities may be calibrated based on available information on the go live of the EU balancing energy platforms on aFRR and mFRR.

2.8 Interconnections

As explained in the annex regarding cross-border exchanges, the exchanges of energy between countries inside Core region are modelled following the flow-based methodology. This methodology is developed and explained in the annex and the input parameters are presented below, in Table 3.

Regarding the bidding zone configuration, ACER Decision No 11-2022 on alternative bidding zone configurations refers to an assessment to be performed within the next Bidding Zone Review study[37], and thus later than the publication of the present study. Hence the bidding zone configuration of the simulated perimeter is the current bidding zone configuration.

Regarding the minRAM targets, the assumptions taken are summarized in Table 4 for the relevant Core borders (adapted from the latest available ACER report on the monitoring of the margin available for cross-zonal electricity trade in the EU[38]).

Regarding the treatment of external flows, Standard Hybrid Coupling (SHC) is assumed until 2024 to model exchanges between Core and non-Core countries. From 2025 onwards, it is assumed that these exchanges will occur following the so-called Advanced Hybrid Coupling (AHC), except for the Channel interconnectors. This is due to the withdrawal of the United Kingdom from the European Union. Since 1 January 2021, the United Kingdom, more appropriately the Great-Britain (-bidding zone), no longer participates to the SDAC / SIDC and in general to the IEM. As mentioned in section 5.1.3 of the Belgian Regulator (CREG) Monitoring Report 2021 [39](“Post-Brexit trading arrangements with the United Kingdom”,
page 53), as a result of Brexit, *“..capacities on the Nemo Link interconnector (between the Belgian and Great Britain bidding zones) are no longer allocated in an implicit manner and instead, market participants trading electricity between both bidding zones, need to follow an explicit allocation process*”.
No allocation constraint is considered for Belgium from 2024 onwards. This is in line with the expected commissioning of capacitor banks according to Elia’s voltage control programs. Regarding the allocation constraint for Poland and Netherlands, (referred as external constraint) data can be found on the Joint Allocation Office[40].

37 Valid at the time of this public consultation.

38 https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Publications%20Annexes/ACER%20Report%20on%20the%20result%20of%20monitoring%20the%20MACZT%20Generic/ACER%20Report%20on%20the%20result%20of%20monitoring%20the%20MACZT%20Derogations.pdf

39 https://www.creg.be/sites/default/files/assets/Publications/Studies/F2355EN.pdf

40 https://www.jao.eu/

Table 3 - Flow-based parameters

Market Parameters	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Flow-based perimeter	CORE											
Bidding zones	As Is											
minRAM	See table below											
Treatment of external flows	Standard Hybrid Coupling (SHC)		Advanced Hybrid Coupling (AHC)									
External & Allocation constraints	No allocation constraint for Belgium from 2024 onwards Dynamic Allocation constraint for PL for all years** External constraint on Core net position of NL (Import: 6500/Export: 6500) until 2023**											
Use of PST in capacity calculation	For Belgium: 1/2 For other: 1/3											
Use of HVDC in flow-based capacity allocation	Only ALEGrO											
Modelling of Channel HVDC (NemoLink, IFAs, BritNed, Noth Sea Link, etc..)	Consideration of 'Explicit Allocation' after Brexit											

** See JAO Publication Tool for monthly statistics on the dynamic allocation constraint for Poland and External constraint of The Netherlands

Table 4 - MinRAM trajectories

Country		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Austria	CORE borders	39	49	60	70	70	70	70	70	70	70	70	70
Belgium*	CORE borders	70	70	70	70	70	70	70	70	70	70	70	70
Netherlands	CORE borders	48	55	63	70	70	70	70	70	70	70	70	70
Germany	CORE borders	41	51	60	70	70	70	70	70	70	70	70	70
France	CORE borders	70	70	70	70	70	70	70	70	70	70	70	70
Slovenia	CORE borders	70	70	70	70	70	70	70	70	70	70	70	70
Kroatia	CORE borders	70	70	70	70	70	70	70	70	70	70	70	70
Romania	CORE borders	48	55	63	70	70	70	70	70	70	70	70	70
Czechia	CORE borders	70	70	70	70	70	70	70	70	70	70	70	70
Slovakia	CORE borders	70	70	70	70	70	70	70	70	70	70	70	70
Poland	CORE borders	50	56	63	70	70	70	70	70	70	70	70	70
Hungary	CORE borders	70	70	70	70	70	70	70	70	70	70	70	70

* with the application of a derogation for Belgium

Finally, the time line for the major internal reinforcements planned for the Belgian grid as well as the timeline for the most relevant planned interconnections are show in Figure 31 and Figure 32 respectively. More details are given in the draft Federal Development Plan (FDP) 2024-2034.

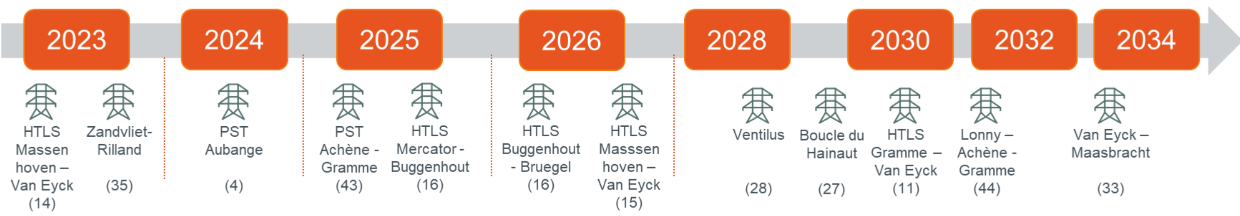


Figure 31 - Internal reinforcements expected to be realized by end of the mentioned year according to draft FDP (full details are available in the draft FDP 2024-2034)

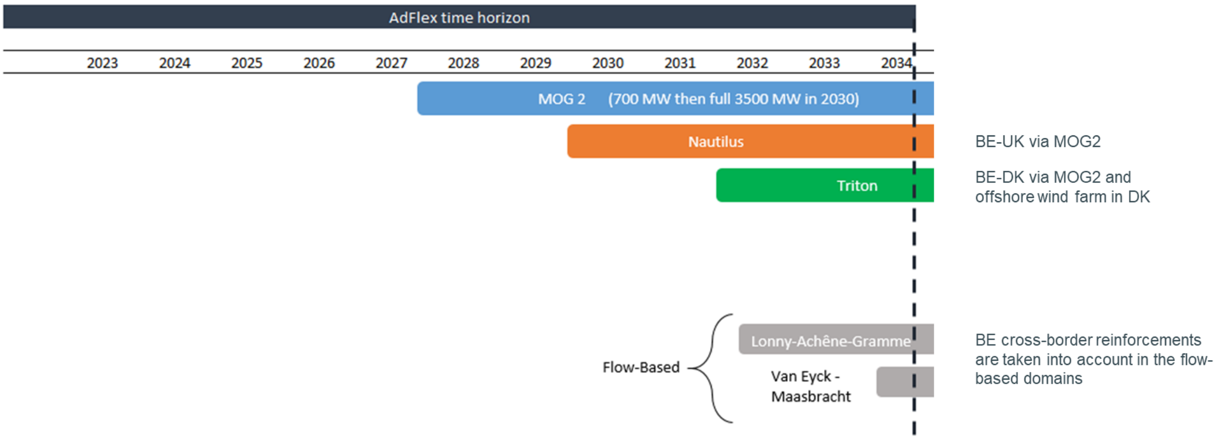


Figure 32 - Interconnections expected to be realized by end of the mentioned year according to the date mentioned in the draft FDP 2024-2034 (full details available in the draft FDP 2024-2034)

2.9 Other EU countries

The assumptions for other EU countries are based on the latest European Resource Adequacy Assessment, the ERAA 2022 by ENTSO-E which should be published by mid-November[41].

This dataset is then updated based on latest policies, announcements and published studies. These sources include the integration of packages published at European level, as the “Fit for 55” and “REPowerEU”, and national studies and governmental announcements.

The following section describes the assumptions taken for neighboring countries and “main” European countries impacting the model.

EU assumptions are presented in the Excel file under the sheet “6.1. Data for other countries”.

41 https://www.entsoe.eu/outlooks/eraa/2022/index.html

2.9.1 France

Regarding France assumptions, 2 main sources are considered on top of the ERAA22 database: the latest announcement from Macron regarding energy in France[42] and the “Futurs Energétiques” published in 2021[43]. The assumptions for France are summarized on Figure 33.

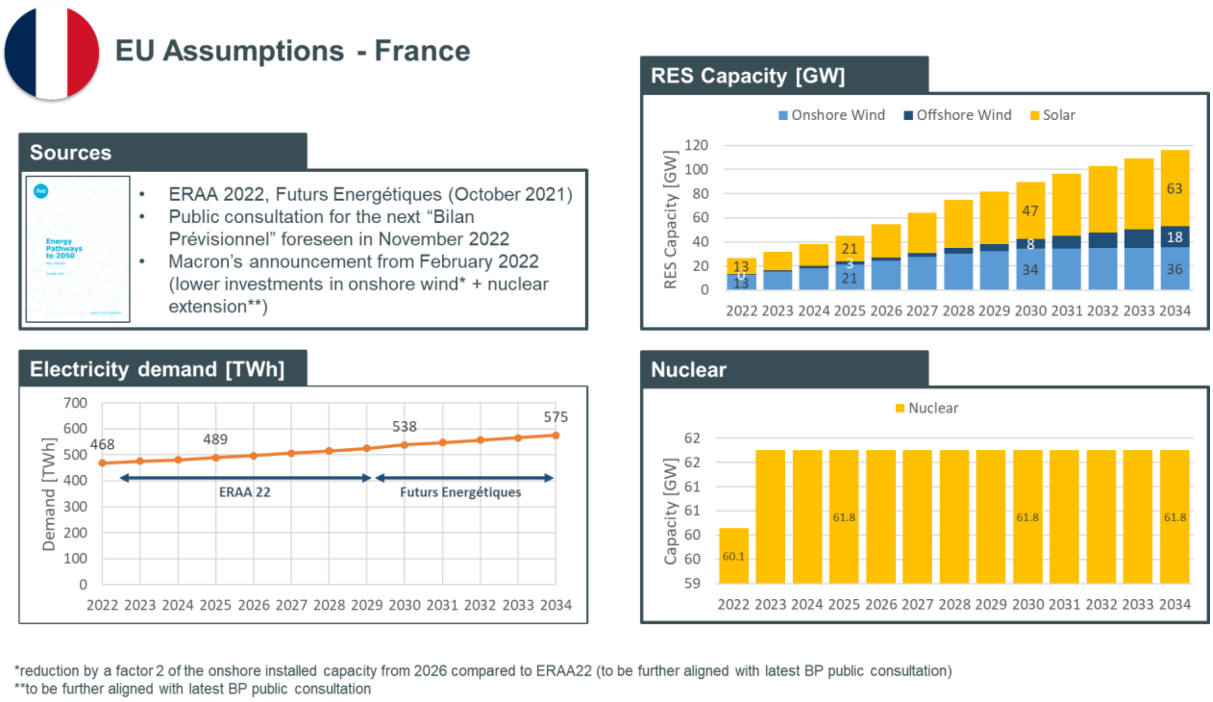


Figure 33: Assumptions for France

[42] https://assets.rte-france.com/prod/public/2021-05/Bilan%20previsionnel%202021%20-%20annexes%20techniques.pdf

[43] Futurs énergétiques 2050 : les scénarios de mix de production à l’étude permettant d’atteindre la neutralité carbone à l’horizon 2050 | RTE (rte-france.com)

2.9.2 Germany

Regarding Germany assumptions, 2 main sources are considered on top of the ERAA22 database: the Easter package[44] from the German government, setting the targets for 2030 for wind onshore, wind offshore and solar, and the NEP2023[45], considering the scenario for 2037. The assumptions for Germany are summarized on Figure 34.

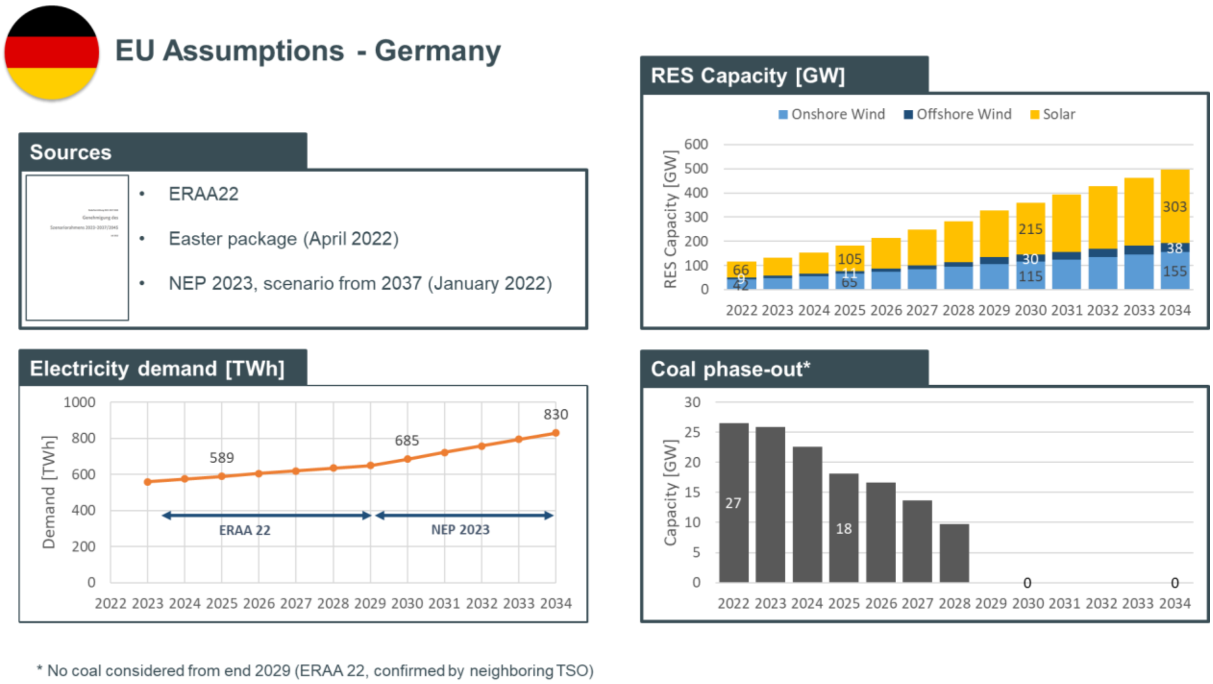


Figure 34: Assumptions for Germany

[44] https://www.bmwk.de/Redaktion/DE/Downloads/Energie/0406_ueberblickspapier_osterpaket.pdf?__blob=publicationFile&v=14
[45] https://www.netzentwicklungsplan.de/de

2.9.3 Netherlands

Regarding Netherlands assumptions, 3 main sources are considered on top of the ERAA22 database: the "Monitoring leveringszekerheid", published by Tennet in 2021[46], the latest announcement from the Dutch government (March 2021)[47] and the update from June 2022[48]. The assumptions for Netherlands are summarized on Figure 35.

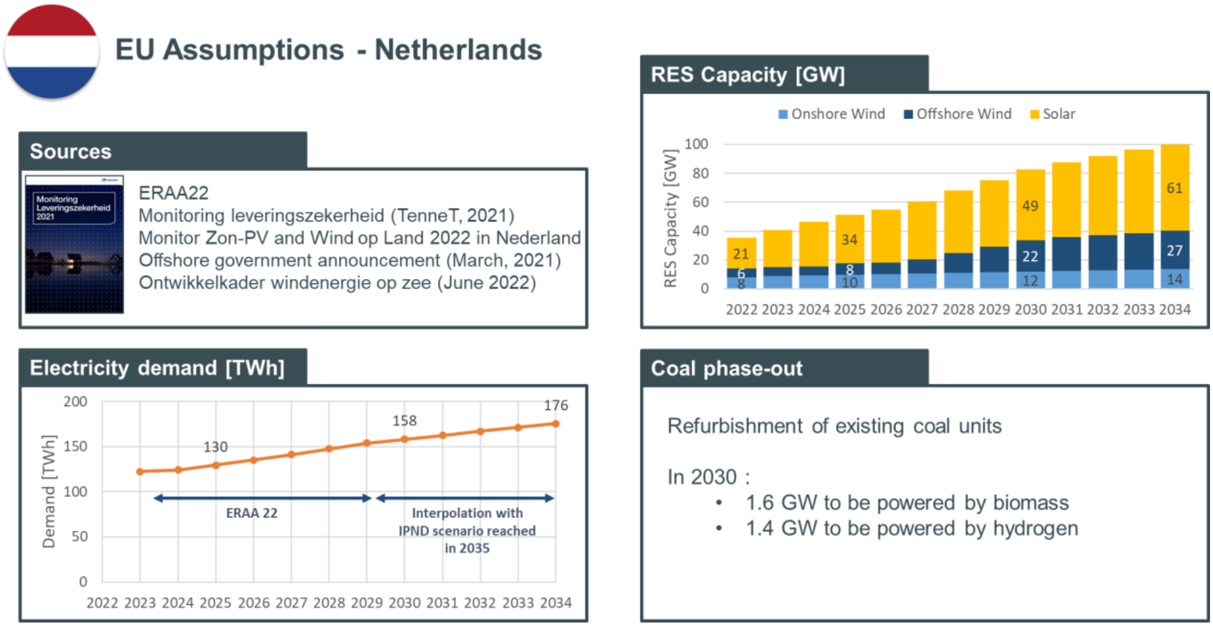


Figure 35: Assumptions for Netherlands

[46] https://www.tennet.eu/fileadmin/user_upload/Company/Publications/Technical_Publications/Dutch/TenneT_Rapport_Monitoring_Leveringszekerheid_2021.pdf
[47] https://windpowernl.com/2022/03/20/dutch-government-to-double-offshore-wind-capacity-to-21-gw-in-2030/
[48] Ontwikkelkader-windenergie-op-zee_juni_2022.pdf (rvo.nl)

2.9.4 United-Kingdom

Regarding United-Kingdom assumptions, one main source is considered on top of the ERAA22 database: the Future Energy Scenarios published in July 2022[49]. Regarding nuclear, a unit-by-unit analysis has been performed based on the most up-to-date information. The assumptions for United-Kingdom are summarized on Figure 36.

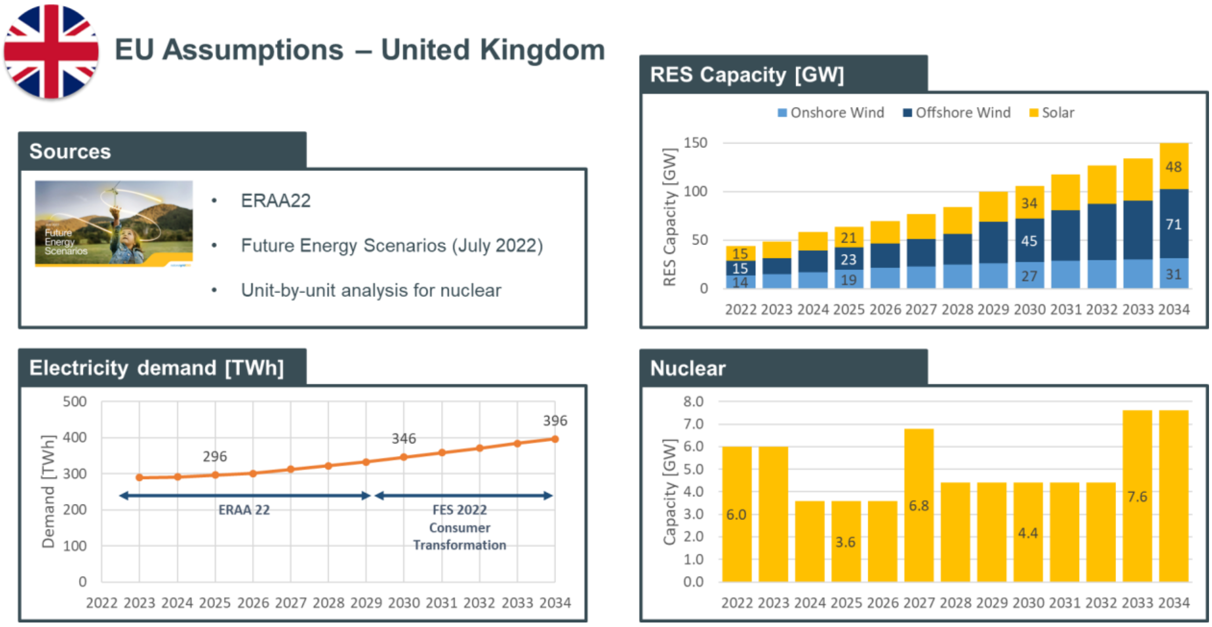


Figure 36: Assumptions for United-Kingdom

[49] Future Energy Scenarios 2022 | National Grid ESO

2.9.5 Spain

Regarding Spain assumptions, different documents[50,51,52,53] are considered on top of the ERAA22 database. The assumptions for Spain are summarized on Figure 37.

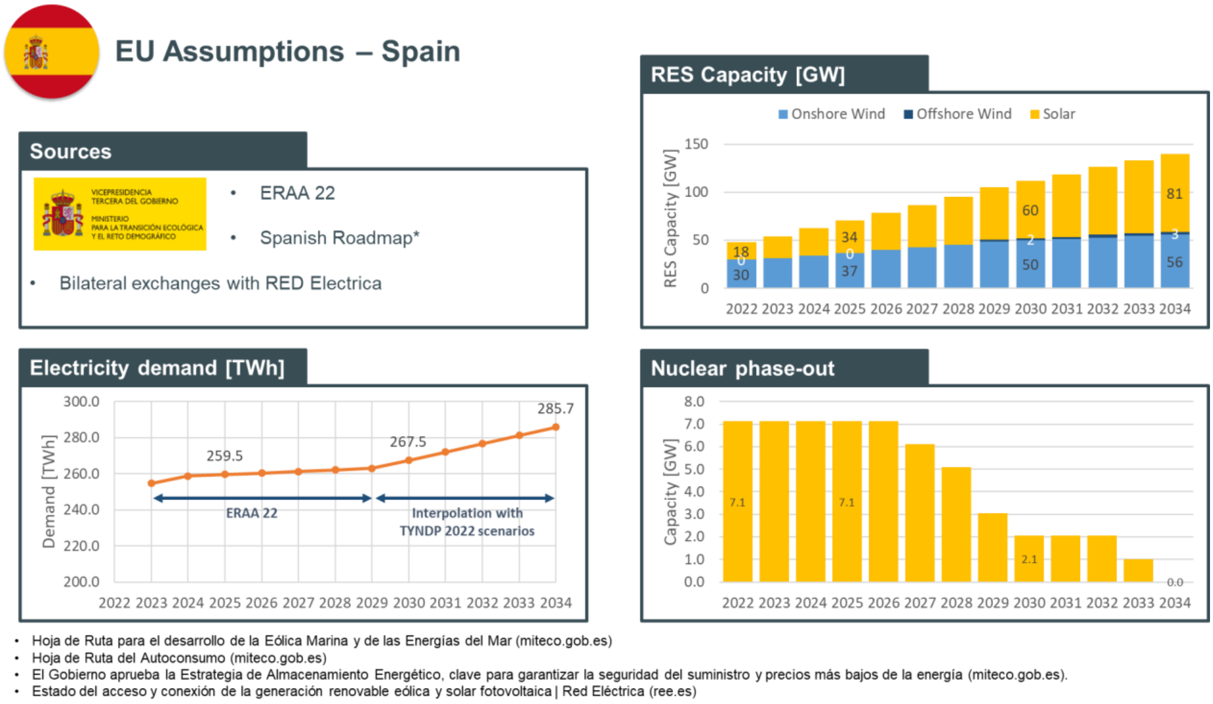


Figure 37: Assumptions for Spain

50 Hoja de Ruta para el desarrollo de la Eólica Marina y de las Energías del Mar (miteco.gob.es)

51 Hoja de Ruta del Autoconsumo (miteco.gob.es)

52 https://www.miteco.gob.es/es/prensa/estrategiaalmacenamiento_tcm30-522655.pdf

53 Estado del acceso y conexión de la generación renovable eólica y solar fotovoltaica | Red Eléctrica (ree.es)

2.9.6 Italy

Regarding Italy assumptions, one main source is considered on top of the ERAA22 database: the “Documento di descrizione degli scenari 2022” from Terna[54]. The assumptions for Italy are summarized on Figure 38.

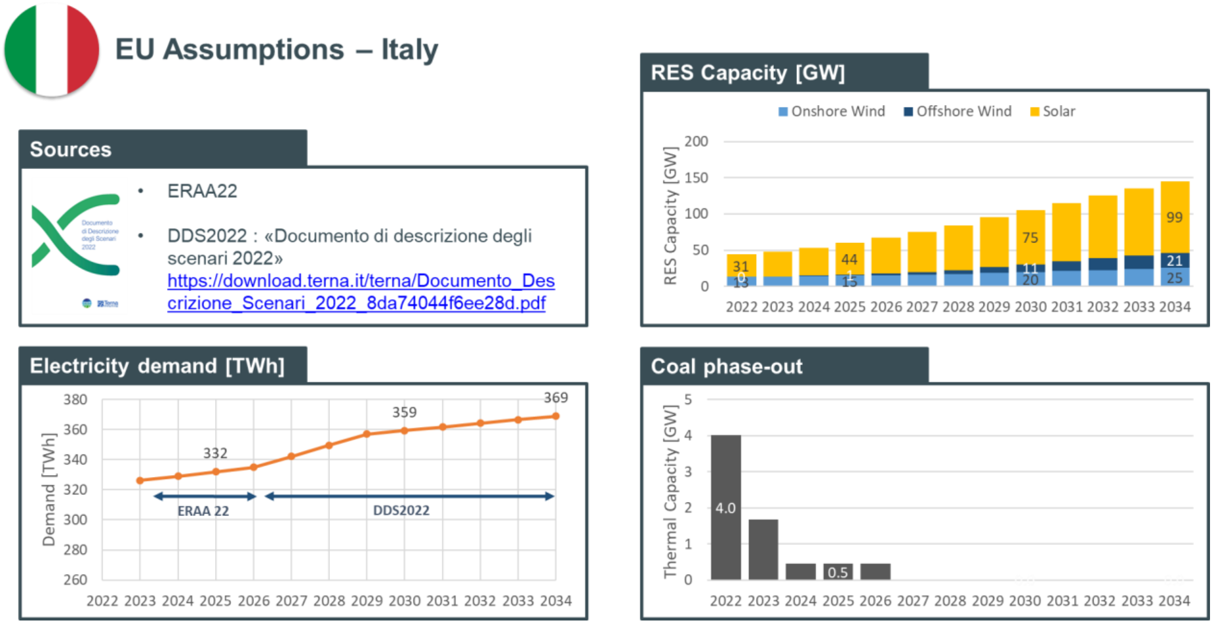


Figure 38: Assumptions for Italy

54 https://download.terna.it/terna/Documento_Descrizione_Scenari_2022_8da74044f6ee28d.pdf

2.9.7 Poland

Regarding Poland assumptions, different sources are considered on top of the ERAA22 database: the Energy Policy for Poland until 2040[55] and different articles related to latest trends[56,57,58,59]. The assumptions for Poland are summarized on Figure 39.

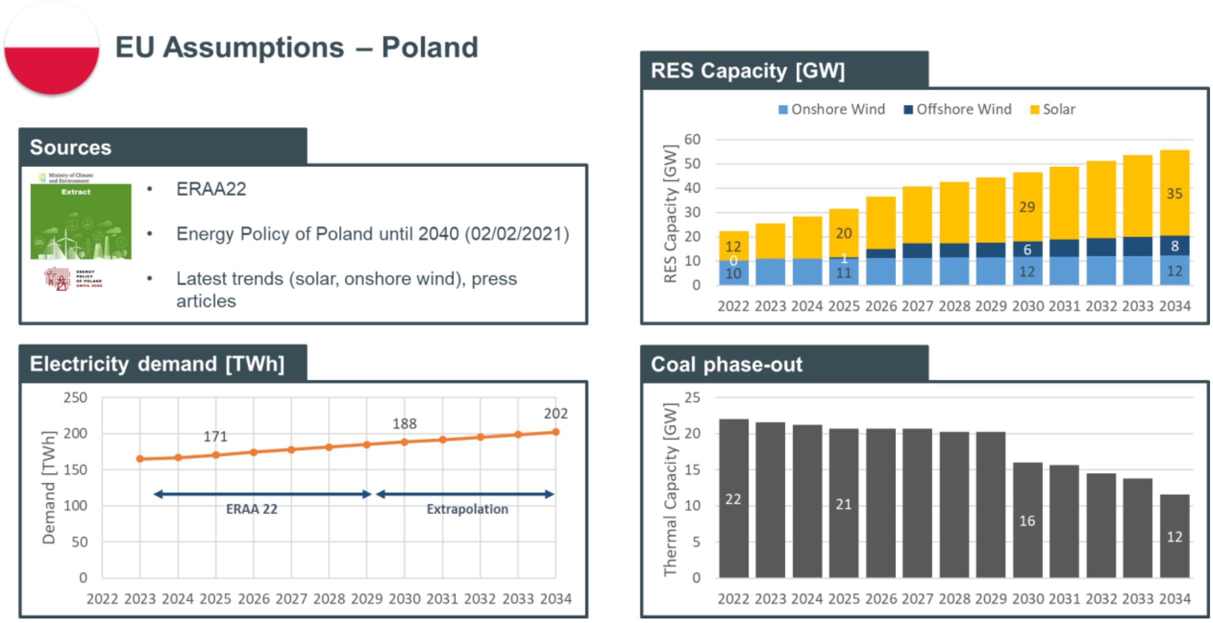


Figure 39: Assumptions for Poland

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55 https://www.gov.pl/web/climate/energy-policy-of-poland-until-2040-epp2040

56 Baltic Sea Countries sign declaration for more cooperation in offshore wind | WindEurope

57 Celebrating 'golden decade,' Poland set to reach 12 GW of PV capacity in 2022 – pv magazine International (pv-magazine.com)

58 Poland could have 28.5 GW of installed solar in 2030 - IEO (renewablesnow.com)

59 Poland may reach 30 GW of solar by 2030 – pv magazine International (pv-magazine.com)

2.9.8 Denmark

Regarding Denmark assumptions, 2 main sources are considered on top of the ERAA22 database: the latest assumptions for Denmark scenario from Energinet[60] and the latest announcements regarding thermal units availability[61]. The assumptions for Denmark are summarized on Figure 40.

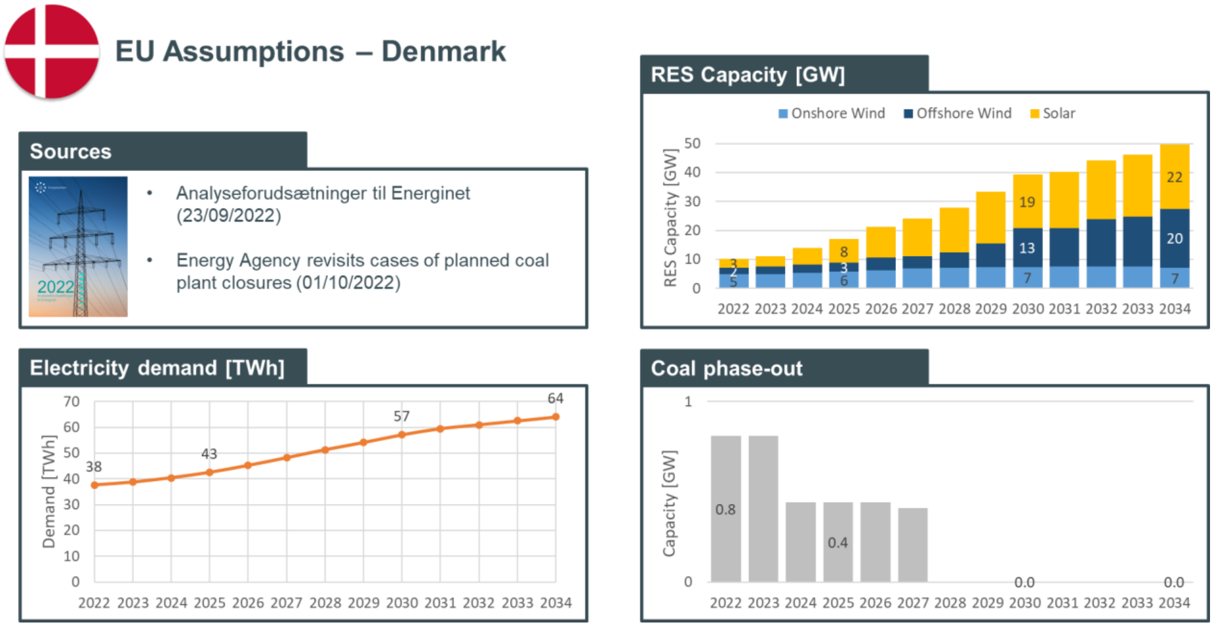

Figure 40: Assumptions for Denmark

[60] Analyseforudsætninger til Energinet | Energistyrelsen (ens.dk)

[61] Energistyrelsen genbesøger sager om planlagt lukning af kulkraftværker | Energistyrelsen (ens.dk)

3 Methodology

The whole methodology is submitted for consultation. It is based on the previous study but also complemented with additional information and proposal for improvements. Those are detailed in the different documents also submitted to public consultation. The main updates on the methodology were also presented during the WG Adequacy of 28/10/2022.

- 9 methodological appendixes :
    - Unit Commitment and Economic Dispatch;
    - Adequacy study;
    - Adequacy patch;
    - Climate years;
    - Cross-border exchange capacities;
    - Hourly electricity consumption;
    - Economic viability assessment;
    - Methodology for the assessment on short-term flexibility;
    - Assumptions for the assessment of short-term flexibility.

- 4 external studies on different aspects of the study :
    - The AFRY study on : « Update of the peer review of “Cost of capacity for calibration of Belgian CRM »;
    - The study from N-SIDE on « Study on the outage parameters of generation units and DC links » ;
    - The DELTA-EE study on « Study on the quantification of Belgian residential and tertiary future consumer flexibility » ;
    - The study from Professor K. Boudt on « Analysis of hurdle rates for Belgian electricity capacity adequacy and flexibility analysis over the period 2024-2034 ».