Total Electricity Demand Forecasting

Methodology description for short-term projection of total electricity demand for Belgium in the framework of the strategic reserve volume evaluation

Disclaimer

This work has been performed by **Climact** and is commissioned by **Elia.** It describes an add-on to the Belgian Calculator (BECalc) developed in 2019 and 2020 by Climact for the **Federal Public Service Health, Food Chain Safety and Environment.**

The report details the methodology to obtain a short-term scenario using BECalc. The results shown in section 3 are illustrative ones based on available macro-economic forecasts. Those will be updated with new projections for the public consultation to be held in August 2020 (notably to take the COVID-19 crisis into account). Hence they should be seen as an example and not as a proposed scenario for the Strategic Reserve volume determination exercise. The final scenario will be submitted to public consultation in August 2020.

Climact: Michel Cornet, Maïté Jonas, Simon Lalieu, Marion Latiers, Benoît Martin, Vincent Matton, Julien Pestiaux
Elia : Rafael Feito-Kiczak, Bilal Hahati

Table of Contents

ACRONYMS

AV	Added Value
BECalc	The Belgian Calculator
BEV	Battery Electric Vehicle
BFP	Bureau Fédéral du Plan
EC	European Commission
EV	Electric Vehicle
GHG	Greenhouse gases
GDP	Gross Domestic Product
LEV	Low-emissions Vehicle
NBB	National Bank of Belgium
NECP	National Energy and Climate Plan
PHEV	Plug-in Hybrid Vehicle
WAM	With additional measures
WEM	With existing measures
ZEV	Zero-emission Vehicle

Executive Summary

In accordance with the Belgian Electricity Act, Elia must submit a probabilistic analysis of Belgium's security of supply for the following winter by 15 November of each year. This requires, among other inputs, to determine how the total electricity demand will evolve in the short term (Year +1 to Year +3), accounting for the latest projections.

In this framework, Elia has been working with Climact to develop a methodology for short-term projection on total electricity demand for Belgium. The present document describes the short-term projection methodology developed by Climact within the BECalc tool to account for short-term macroeconomic trends and evaluate their impact on the electricity consumption in Belgium. A first illustrative scenario is shown in the end of the document to support the description of the methodology. However, this does not correspond to the proposed scenario that will be submitted to public consultation in August 2020 as new macroeconomic projections are expected to be issued before then (which will take into account latest public forecasts such as the expected impact of the COVID crisis).

1 Context of the study

In the framework of the strategic reserve volume evaluation study and based on the remarks received by stakeholders in the previous public consultations, Elia initiated with Climact a project to improve the current approach to forecast the total electricity demand for Belgium. The main goals of this project are:

- Refine the current approach to better understand the main drivers behind the evolution of total electricity demand for Belgium;
- Better integrate policy changes in this demand forecasting process (e.g. macro-economic trends, electric vehicle penetration, etc.);
- Use an tool with transparent methodology and assumptions.

The present document provides a description of the new methodology developed by Climact and integrated in the BECalc tool for short-term projections of the total electricity demand for Belgium.

1.1 Overview of BECalc

The goal of this section is to give the reader a general understanding of the original model used as a starting point for the development of a short-term total electricity demand methodology, what it covers and how it works. The interested reader will find more details about the model on the project website[1].

The Belgian Calculator (BECalc) is a simulation tool that models the energy use in the various economy sectors in Belgium. It has been developed by Climact for the Federal Public Service Health, Food Chain Safety and Environment to support the development of the Belgian long-term strategy to reach Paris agreement objectives by 2050 (1). Its main features are the following:

- BECalc is a multi-energy model that allows to compute the energy use due to the activity in the different considered sectors: transport, industry, residential and tertiary buildings, agriculture, land-use and energy production;
- The goal of the tool is to determine how energy use is going to evolve up to 2050 depending on future technological and behavioural/societal evolutions;
- These evolutions are represented by levers specific to each sector, e.g. the electrification of vehicles for the transport sector or the switch from fossil fuels to biomass in building heating systems. These levers are thus the main parameters driving the evolution of energy consumption and in each sector. A lever can take several different values representing different levels of decarbonization ambition. For example, the fuel switch lever in the building sector can be set to a low value, leaving the fuel mix of heating bodies unchanged, or a very high value where there is a strong uptake of gaseous and liquid biomass;
- It aims at modelling interactions between various sectors, e.g. between transport and industry: if the road passenger transport demand increases more vehicles need to be produced by the industry sector (in Belgium or abroad);
- The model is sequential and does not perform any kind of cost optimization.

These features are summarized on Figure 1. On this figure, only a subset of the possible model outputs is represented since Elia only uses the tool to compute electricity consumption projections.

[1] The model will be made publicly available in the course of the summer 2020 on www.climat.be/2050

1.2 Needed developments for short-term projections

The aim of short-term projections is to determine the expected electricity consumption in Belgium from Y+1 to Y+3, accounting for latest available macroeconomic forecasts. This result can be used then as an input for the 'Strategic reserve volume determination'. Originally, the BECalc model does not explicitly account for macroeconomic evolutions. Then, as mentioned above, it is a simulation tool that computes the outcome of a given pathway, without attaching any specific likelihood to it. Hence, the short-term methodology presented here should address these two shortcomings to build a scenario for the expected electricity consumption from Y+1 to Y+3.

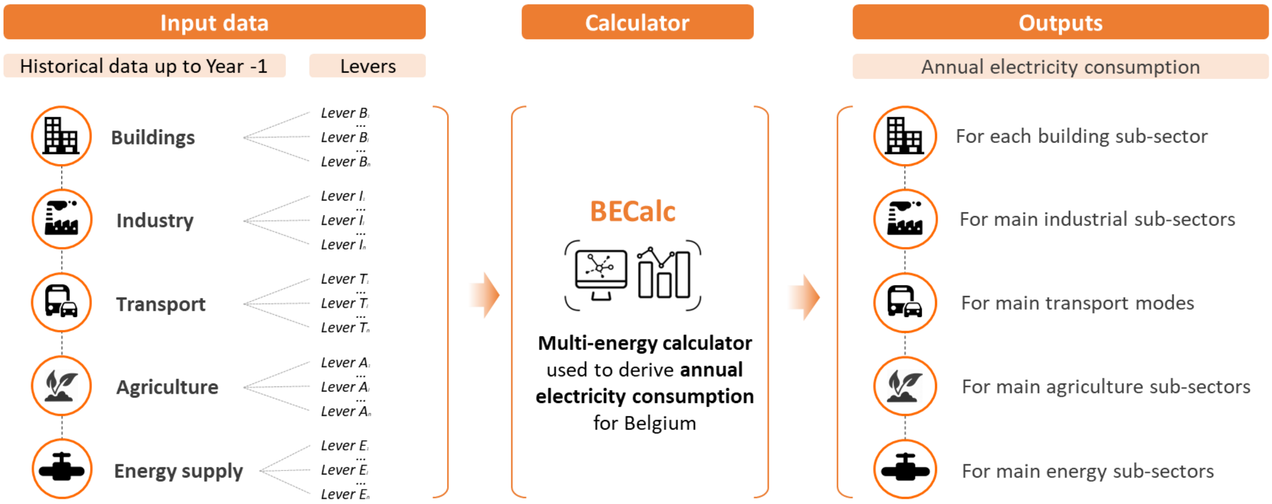


Figure 1: BECalc structure for Elia

Source: Climact

2 Short-term methodology

2.1 Review of the influence of macroeconomic variations on electricity consumption

The first step in developing this short-term methodology is to understand which macroeconomic indicators significantly impact the energy consumption in general and, in particular, electricity. First, several existing energy models that account for a selection of macroeconomic parameters are reviewed.

The first considered model is the GEM-E3 model used by the EC (2). It is a general equilibrium model that determines macroeconomic indicators, accounting for the links with the energy system and the environment. The model computes the *equilibrium prices of goods, services, labour and capital that simultaneously clear all markets under the Walras law and determines the optimum balance for energy demand/supply and emission/abatement* (3). Its outputs include GDP per sector, environmental policies, energy prices and taxes and techno-economic features of energy supply technologies. As shown on Figure 2, the GEM-E3 model can be linked with the PRIMES model (4). This is the model used by the EC to construct its energy and emissions scenarios, notably in the framework of the 2050 energy and emissions strategy (5). When both models are linked, they allow to *perform closed-loop energy-economy equilibrium analysis* (4).

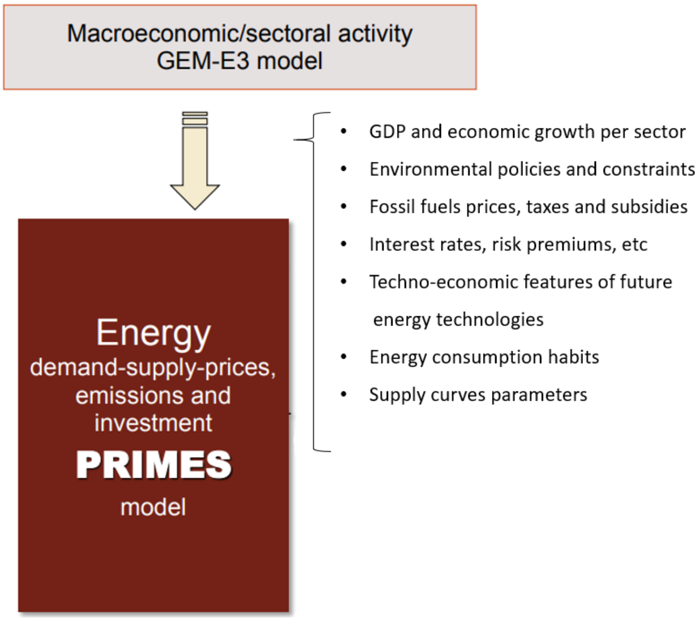


Figure 2: Link between GEM-E3 and PRIMES models.
Adapted from (4) and (3)

The second model reviewed is RTE in-house model, developed to assess the evolution of electricity consumption in France. This tool accounts for the following macroeconomic indicators to build electricity demand projections: the added value per sector, the amount of tertiary jobs, the population and household size. By defining various trajectories for these socio-economic indicators, RTE constructs various scenarios for the evolution of electricity consumption (Figure 3) (6).

	2016	2035			
		Trajectoire basse	Trajectoire intermédiaire 2	Trajectoire intermédiaire 3	Trajectoire haute
Population (millions)	64,5	66,5	69,1	69,1	72,1
Nombre de ménages (millions)	28,4	31,5	32,7	32,7	34,2
PIB (TCAM 2016-2035)		+1,0%	+1,5%	+1,5%	+1,9%
Production tertiaire (TCAM 2016-2035)		+1,1%	+1,6%	+1,6%	+2,0%
Production industrielle (TCAM 2016-2035)		-0,1%	+0,5%	+0,5%	+1,0%

Figure 3: Socio-economic indicators trajectories used by RTE
Source: RTE (6)

The third model considered is IHS Markit, previously used by Elia for its total electricity demand forecasting exercise. It accounts for the added value per sector, the amount of tertiary jobs and the average household income (7). However, there is no further detail about the data sources nor the way these indicators are integrated in their in-house model.

Besides the models discussed above, a literature review has been carried out to identify how macro-economic evolutions can influence the electricity consumption in the considered sectors.

A survey focusing on the socio-technical factors influencing residential energy consumption in Belgium is carried out in (8). The authors perform a thorough review of studies related to this topic to find out that the disposable income and the household size are the two socio-economic indicators that are systematically correlated with household electricity consumption. They also highlight a trend towards a larger living surface per capita, a reduction of the household size (i.e.

number of inhabitants in a same household) and a growing number of appliances per household. The link between household income and electricity consumption is also pointed out in (9).

In (10), the authors perform an analysis of the evolution of various sectors energy intensity in Belgium as a result of energy efficiency policies. They also make the link with the following macro-economic indicators: the GDP in the industry, in the tertiary sector and the level of private consumption. The study shows that the evolution of the tertiary sector in terms of the number of jobs or added value follows a similar trend, which means both indicators can be used interchangeably. It also shows that there is a shift from highly energy-intensive sectors, i.e. manufacturing industries to less energy-intensive tertiary activity sectors, as the share of manufacturing industries in the GDP is steadily decreasing.

2.2 Choice of macroeconomic variables and links with BECalc variables

As illustrated above on Figure 1, five demand sectors are considered for electricity consumption: industry, transport, buildings, agriculture and energy supply. Two types of electricity uses are modelled in the energy supply sector. The first corresponds to distribution and transmission losses, for which Elia figures are used. These include forecasts for future additional losses due to the increase of exchanges flows foreseen with neighbouring countries. The second corresponds to the electricity used in refineries to produce fossil fuels from crude oil.

This methodology focuses on the three first sectors of this list as they either represent the majority of the current electricity consumption (buildings and industry) or are expected to see a significant increase in their electricity consumption in the future (transport, with an increasing share of electric vehicles in the car fleet).

The BECalc model variables can be broadly divided into “activity” variables and “technology” variables, which can be defined as follows:

- Activity variables: represent the **level of consumption of goods and services**. This includes for example the transport demand (expressed in passenger-kilometers (pkm)), the food consumption (calories) or the individual housing surface (m^2 per capita);
- Technology variables: determine **the way this demand for goods and services is addressed**. This includes for example the modal split for passenger transport and the vehicle fleet technology split (%), the fuel mix of residential heating bodies fuel mix (%) or the share of various processes in industry sectors (%).

First, the key activity variables for each sector are considered for the short-term methodology:

- Industry:
  - material production level by subsector;
- Transport:
  - the individual passenger transport demand;
  - the freight transport demand;
- Buildings
  - Residential buildings: individual surface appliance ownership and use;
  - Tertiary buildings: total surface.

Then, two technology variables that have a significant impact on the electricity consumption are also taken into account:

- Buildings: renovation rate and depth that will impact the energy consumption for heating and cooling;
- Transport: share of low- (PHEV) and zero-emission (BEV) vehicles in the vehicle fleet, that will increase the electricity consumption of the transport sector.

Considering these BECalc variables and macro-economic indicators reviewed in the previous sections, the following links are proposed between them (Table 1).

Macroeconomic variable	Unit	BECalc activity variables	Unit
Disposable income	[€]	Passenger transport demand	[pkm/cap/year]
		Appliances own	[number/household]
		Appliance use	[hour/year]
		Living space per person	[m²/cap]
Tertiary sector added value	[M€]	Tertiary buildings area	[1000m²]
Industrial subsectors added value	[M€]	Freight transport demand	[tkm/year]
		Material production	[kt/year]
Energy/environment policies	[/]	Renovation depth in buildings	[%]
		renovation rate in buildings	[%/year]
		Technology share of LEV and ZEV in new vehicle sales	[%]

Table 1: Proposed link between BECalc variables and macro-economic variables
Source: Climact analysis

2.3 Integration of the short-term methodology in the existing BECalc architecture

As mentioned in the beginning of this document, the BECalc model is sequential. Figure 4 shows how the various modules are articulated. On this figure, the newly created 'macro-economic' module is indicated in blue. This module determines the link between chosen macro-economic indicators and BECalc variables. Its outputs are the projections for BECalc variables indicated in Table 1. These projections will replace the original inputs of the model (levers) that normally define them.

2.4 Sources for macro-economic indicators and assessment of the link with BECalc variables

The considered macroeconomic indicators and their sources are detailed in the following subsections. A summary table of the different sources and their update frequency is given in section of this report. It should be noted that these projections have been made prior to the COVID crisis and do not account for its effect. An update of these projections is foreseen (August 2020) with data originating from the BFP accounting for the COVID crisis.

2.4.1 Establishing the link between two variables with a linear regression

To establish a link between a macroeconomic variable and a BECalc variable, a linear regression analysis is perfomed between their historical values as illustrated on Figure 5. The parameters of the linear regression are then used to build a projection of the BECalc variable based on the available projection for the considered macroeconomic indicator.

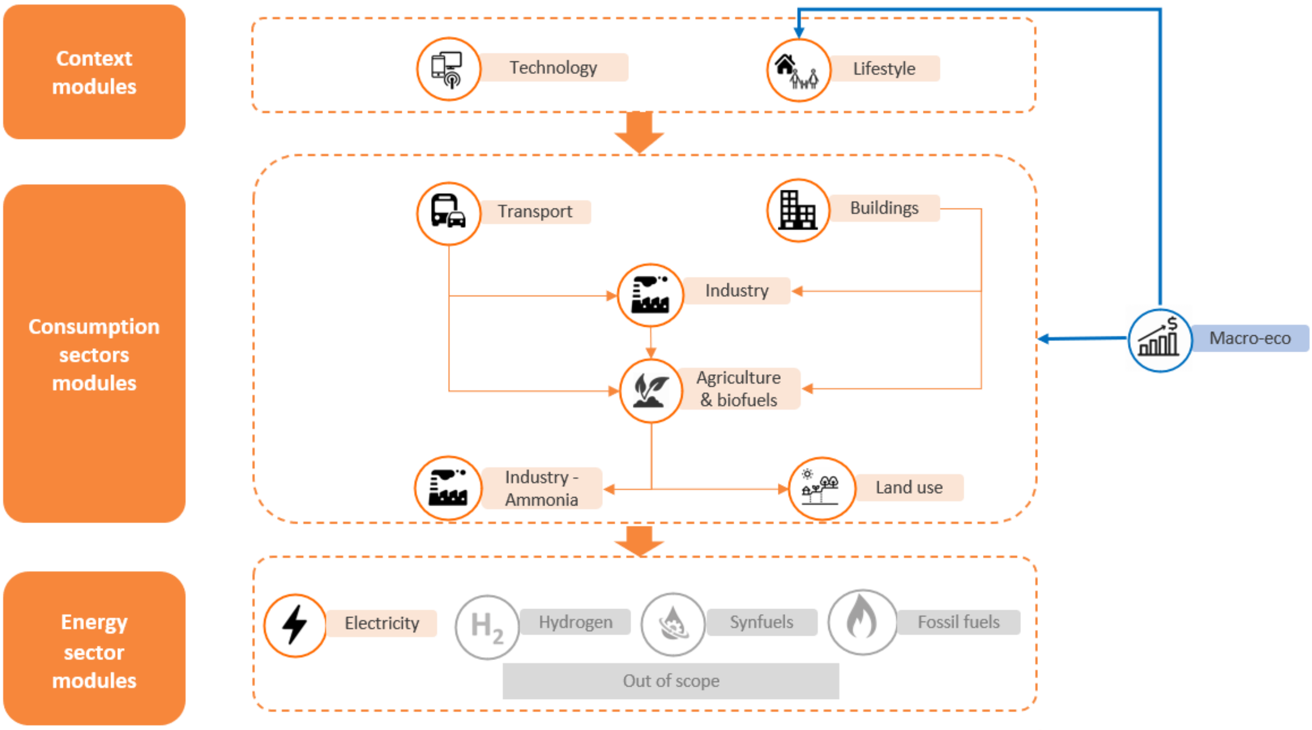


Figure 4: Integration of the short-term, macro-economic methodology in the BECalc architecture
Source: Climact (BECalc)

2.4.2 Disposable income

The disposable income data comes from the regional household income accounts published by the NBB (11). Historical data are available up to 2017. Projections are given by the NBB from 2018 to 2023 in (12) (last update in December 2019). Both historical data and projections are displayed on Figure 6. It can be observed that the forecasts are in line with the general increasing trend observed in the past.

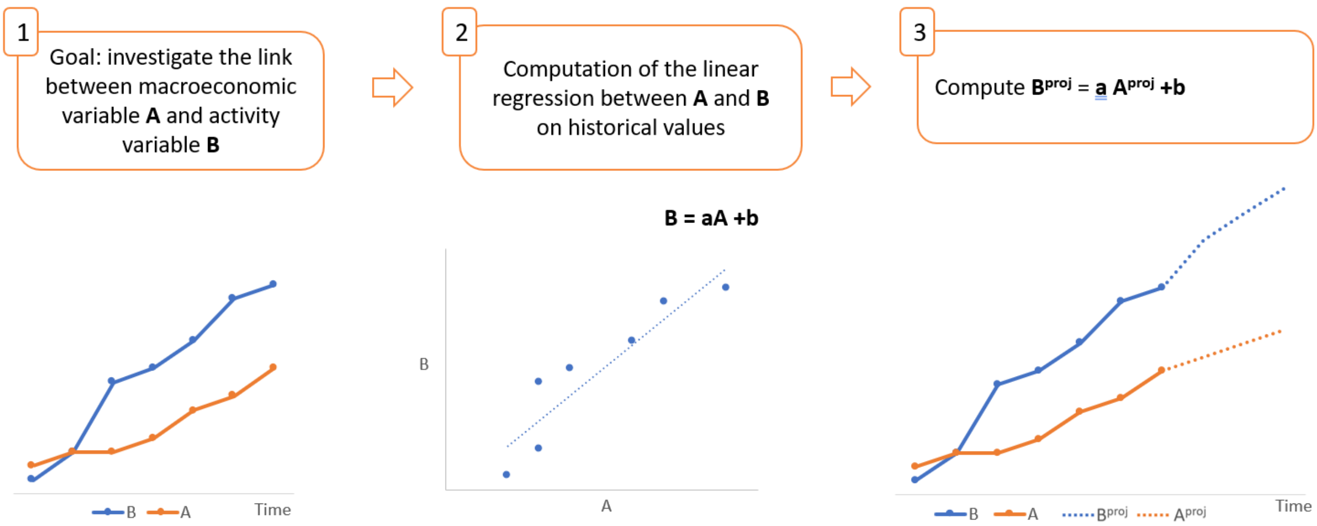


Figure 5: Linear regression method to assess the link between two variables
Source: Climact

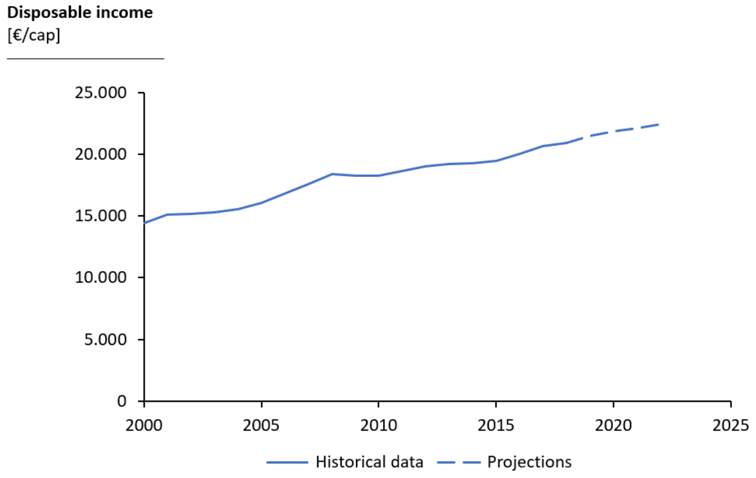
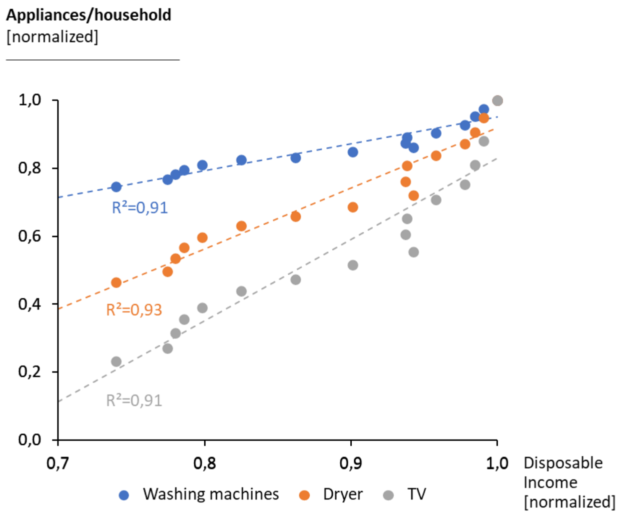


Figure 6: Disposable income (in real prices)
Sources: Historical data: NBB (11) Projections: NBB (12)

To compute projections of the BECalc variables related to the disposable income, a linear regression analysis is performed between these variables and the disposable income. On Figure 7, these linear regressions are shown for a subset of considered variables (left). The Pearson correlation coefficient is above 0.9 for all considered variables, which indicates a good level of correlation.

Based on regression parameters and disposable income projections, the projections for BECalc variables can be computed (Figure 7, right). With an increasing disposable income and a positive correlation with BECalc variables (here the appliance ownership for the example), the appliance ownership per household is projected to increase as well, which is in line with trends observed in the past.



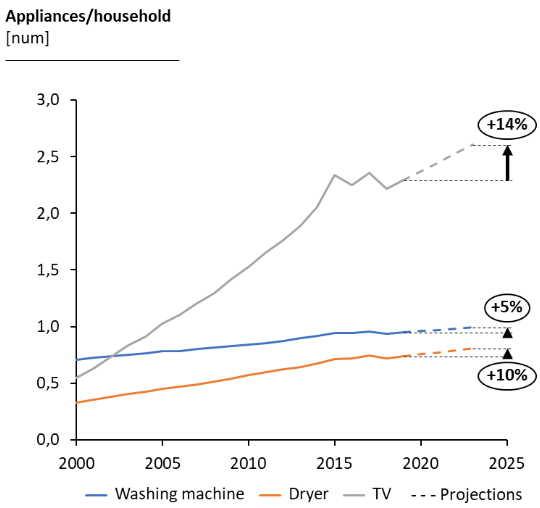


Figure 7: Regression between disposable income and appliances ownership (left) and projections (right)
Sources: Left: BECalc (Climact) and NBB, Right: BECalc (Climact) and BFP

2.4.3 Tertiary added value

The added value for the different economy sectors originates from the detailed national accounts (major components by branch and by sector) published by the NBB (11). The projections are given by the BFP (13)[2]. Given that the sector nomenclatures differ between BFP, NBB.stat and BECalc, they need to be matched. The matching is shown in Table 2 how the matching is made between these different categories.

BFP		NBB.stat (NACE A38)	BECalc
Projections		Historical values	
3. Industries manufacturières	a. Biens intermédiaires	BB	lime
		CE,CF	chemicals
		CG	glass, ceramic, cement
		CH	steel, aluminium, non-ferrous
	b. Biens d'équipement	CI,CJ,CK,CL	other-industries
	c. Biens de consommation	CA	food
		CB	other-industries
		CC	wood, paper
		CM	other-industries
5. Services marchands	a. Transports et communication	HH,JB	tertiary/transport
	b. Commerces et Horeca	GG,II	tertiary
	c. Crédit et assurances	KK	tertiary
	d. Santé et action sociale	QA,QB	tertiary
	e. Autres services marchands	RR,SS,JA,JC,LL,MA,MB,MC,NN	tertiary
6. Services non-marchands	a. Administration publique et enseignement	OO,PP	tertiary
	b. Services domestiques	TT	tertiary

Table 2: matching between sector definitions in BFP, NBB.stat and BECalc nomenclature
Sources: NBB, BFP, Climact analysis

Both historical data and projections for the tertiary sector (market and non-market) are displayed on Figure 8. It can be observed that the forecasts are in line with the general increasing trend observed in the past.

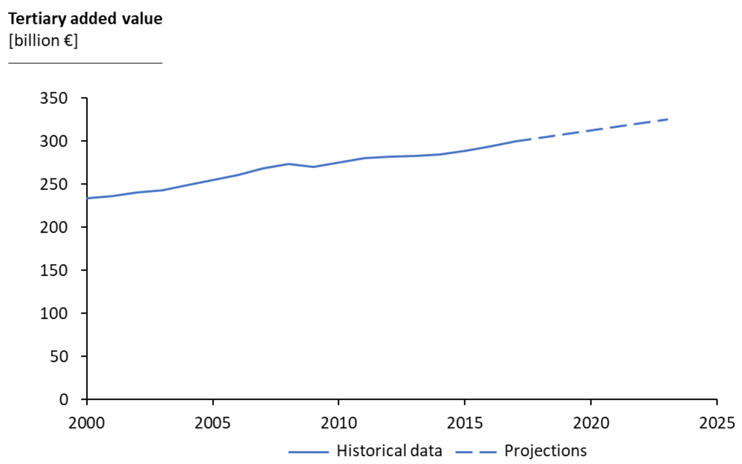
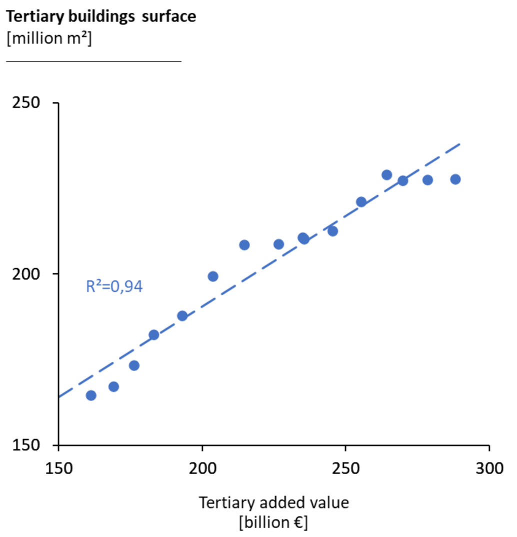


Figure 8: tertiary sector (market and non-market) added value in volumes.
Sources: Historical data: NBB (12) Projections: BFP (14)

[2] The version from June 2019 was used rather than the last version from March 2020 as this last issue did not include detailed projections by sector. The projections from June 2019 are based on NBB.stat figures from October 2018 (not the last version either), which include data up to 2017. The next BFP projections update foreseen for June 2020 will be based on last NBB.stat figures.

The linear regression between the tertiary AV and the tertiary buildings surface is shown on Figure 9 (left). A positive correlation between these two variables can be observed, with a Pearson correlation coefficient of 0.94, indicating a good level of linear correlation between them. On the right-hand side of Figure 9, projections of the tertiary buildings surface are made for 2020-2023. As seen on this figure, the projections are in line with the past trend for this BECalc variable and lead to an 8% increase of the tertiary buildings surface between 2019 and 2023.



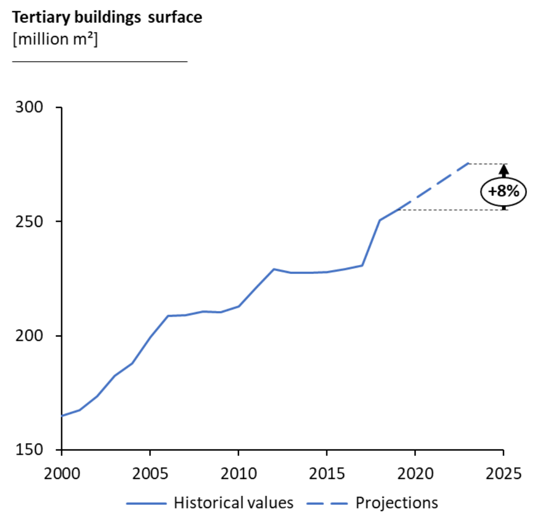


Figure 9: Regression between tertiary AV and tertiary buildings surface (left) and projections (right)
Sources: Left: BECalc (Climact) and NBB, Right: BECalc (Climact) and BFP

2.4.4 Industry added value

Sources for historical values and projections are the same as for the tertiary sector (see above for more details). These data and their projections are displayed on Figure 10. The general trend through all industry sectors is for growth. However, as it is the case above, these projections are anterior to the COVID crisis and do not account for it.

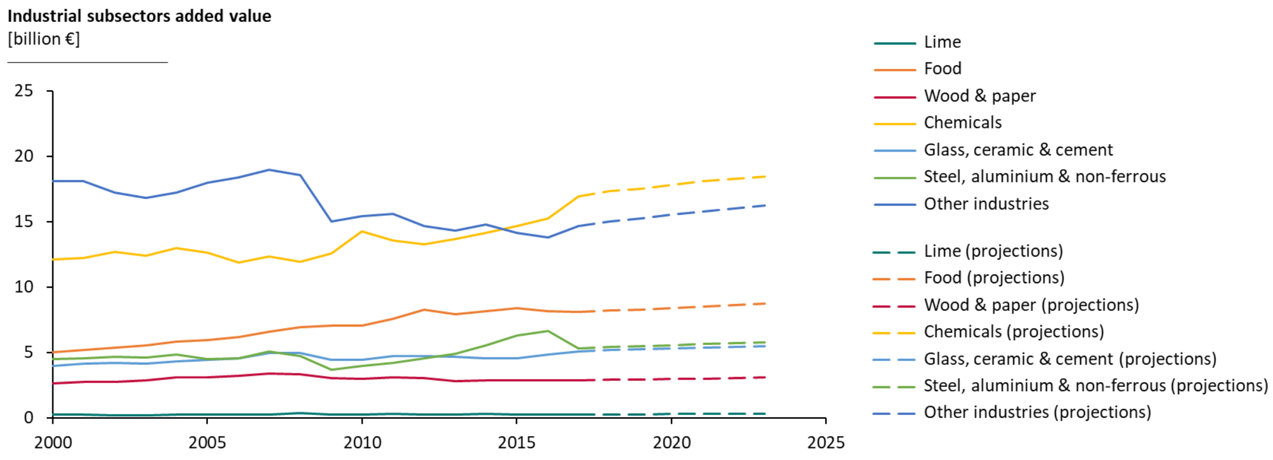


Figure 10: industry sectors added value in volumes.
Sources: Historical data: NBB (11) Projections: BFP (13)

The linear regression between industry sectors AV and physical output is shown on Figure 11. For sectors displayed on this figure, the correlation is negative. This means that the AV of these sectors is increasing while their material production quantity is decreasing. This trend may seem counterintuitive at first sight. Nonetheless, it can be explained by two elements. The first one is that there is a shift toward higher added-value products in these sectors, e.g. products requiring less material and exhibiting better performances. In this case, the added value of manufacturing sectors can increase even though their output, measured in kiloton is stagnating or decreasing. The second element to consider is the evolution towards a more circular and functional economy. In this paradigm, products last longer, have a higher recycling rate (hence less primary material production is needed) and require less material for the same function. Lastly, similar negative correlations for these sectors AV and production can be found in the IDEES database used by the EC (14).

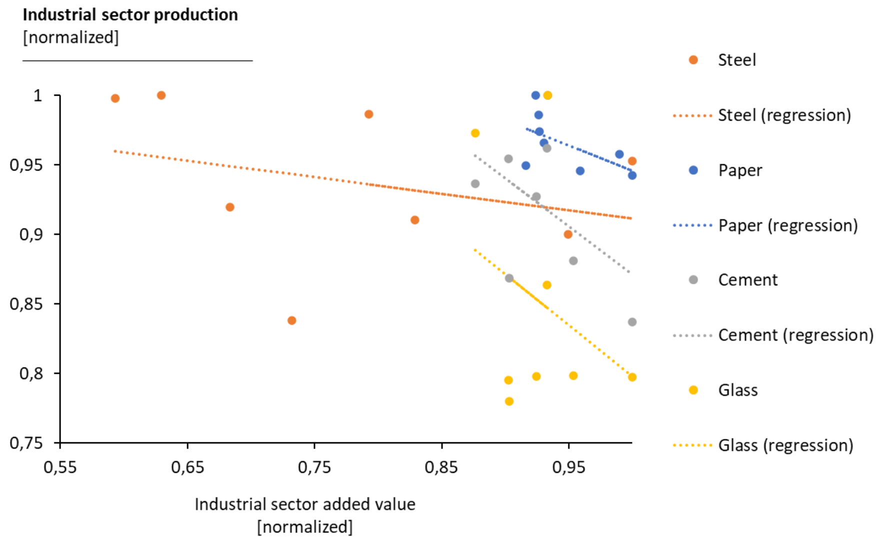


Figure 11: Link between AV and production for 4 industry sectors
Sources: BECalc (Climact) and NBB

Apart from the elements discussed above, the regression between AV and production could be improved for some sectors where historical production data are either missing or incomplete, which is shown on Figure 12.

Data completeness	
Aluminium	Yellow
Cement	Green
Ceramic	Green
Chemicals: ammonia	Green
Chemicals: chlorine	Yellow
Chemicals: olefin	Orange
Chemicals: other	Orange
Food	Orange
Glass	Green
Lime	Green
Non-ferrous	Orange
Other industries	Green
Paper	Green
Steel	Green
Wood	Orange

Figure 12: completeness of historical data for industry production levels. Legend: Green: complete time series, Yellow: Partially complete time series, Orange: Single data point for base year
Source: BECalc (Climact)

Bearing this in mind, the projections for industrial production from 2020 to 2023 based on AV projections are displayed on Figure 13. There is a general stagnation in the production levels. Once again, the AV projections do not account for the COVID crisis, which is expected to affect them downwards.

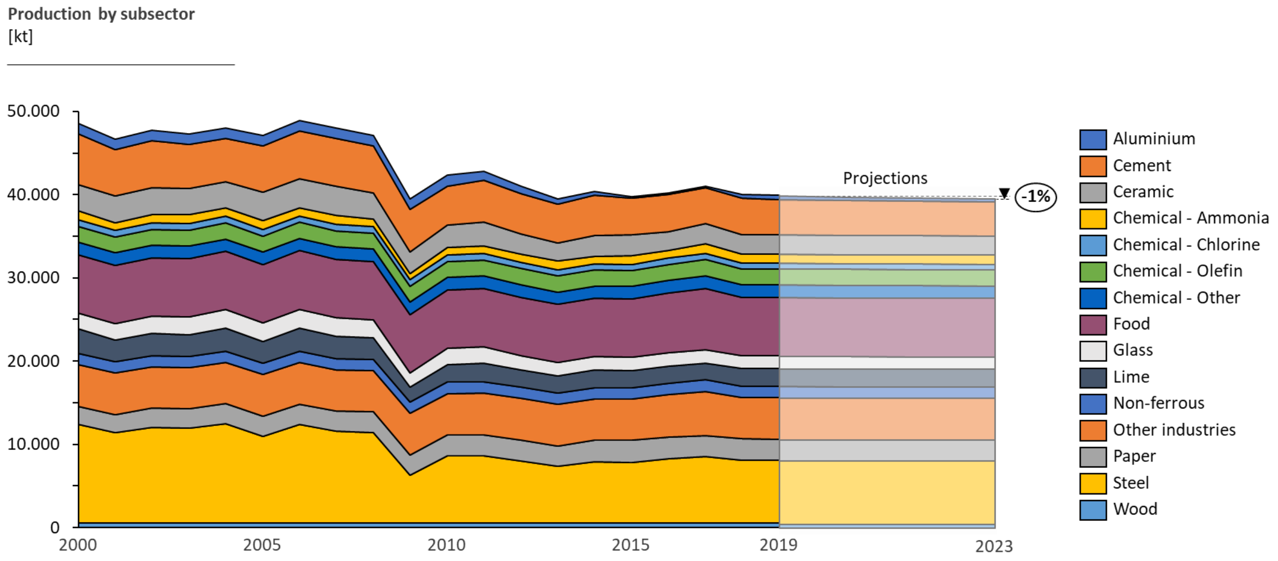
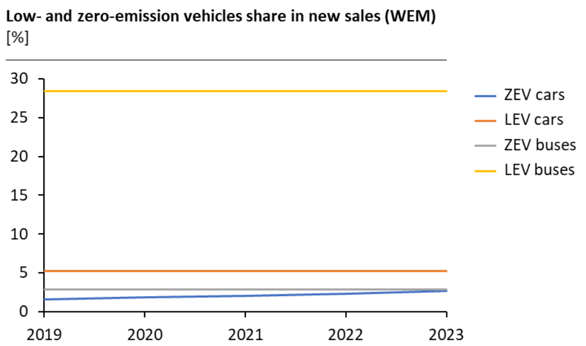


Figure 13: projections of industry sectors production from 2020 to 2023
Source: Historical and projections: BECalc (Climact)

2.4.5 Policies

As indicated above, the considered policies relate to the uptake of LEV and ZEV in the vehicle fleet and to the renovation of the building stock. For the first category, the WEM scenario of the NECP (15) is used to evaluate the corresponding uptake of alternative powertrains, e.g. BEV and PHEV, which will impact the electricity consumption of the transport sector. The results for cars and buses is shown on Figure 14 (left). On the right side, the renovation rate of various types of tertiary buildings are displayed. These figures are based on an ongoing work on regional renovation strategies in Flanders and Wallonia.



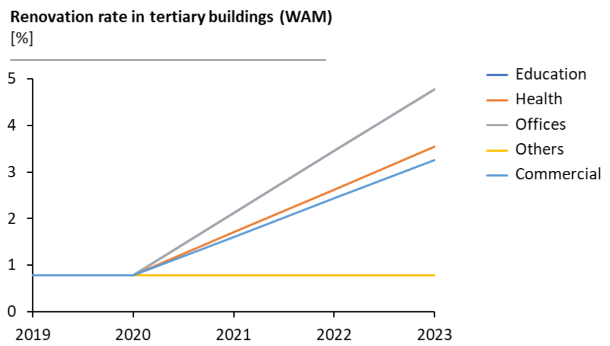


Figure 14: Illustration of expected outcomes of selected policies
Sources: NECP (15), Climact analysis based on ongoing work for regional renovation strategies in Wallonia and Flanders

2.5 Backtesting of the methodology on years 2016-2017

The backtesting of the short-term methodology consists of testing the quality of its results. This is done by applying this methodology on past years, where the total electricity demand is already known and can be compared with the obtained results. More precisely, the following approach is followed:

1. 2015 is chosen as the base year and projections are performed for 2016 and 2017. The reason for this is that historical data for the considered macro-economic indicators is only available up to 2017;.
2. The values of BECalc variables related to macro-economic indicators are projected for years 2016 and 2017 based on the linear regression established between these BECalc variables and macro-economic indicators values prior to 2015.
3. Other BECalc variables not affected by the short-term methodology are set to their known historical values for 2016 and 2017.
4. The resulting total electricity demand for 2016 and 2017 is compared to Elia Total Load figures for these years.

The backtesting results are shown on Figure 15. It can be seen that the short-term methodology results for 2016 and 2017 are very close to Elia Total Load figures, with differences inferior to 1%. It should be noted a similar difference also exists for the year 2015, for which the original BECalc model, without short-term methodology, is used.

The BECalc model is calibrated on Eurostat energy balances, which are constructed in a bottom-up fashion: the energy consumption figures for different end-uses (steel industry, residential sector, transport sector, etc) and vectors (electricity, fossil fuels, etc) are taken together to compute the overall energy consumption.

Elia Total Load, on the other side, is a high-level measurement accounting for the power offtakes and injections on Elia network and an evaluation of losses. The slight difference between Eurostat and Elia figures can thus be explained by the difference in the way they are determined.

Finally, it should be noted that the total electricity consumption is normally calibrated against Elia Total Load (excluding Twinerg and Sotel loads in Luxemburg) for a regular run of the model. For the backtesting, this calibration on Elia figures has been removed to observe the differences between with the model outputs.

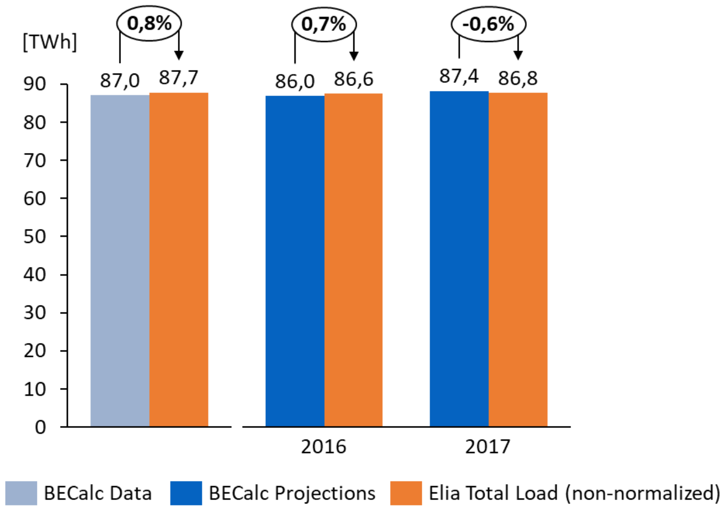


Figure 15: Comparison of Elia Total Load with BECalc results
Sources: Elia (16) and BECalc (Climact)

3 Illustrative results for years 2021-2023

DISCLAIMER

This section shows a first scenario obtained with the short-term macroeconomic methodology. It is called an illustrative scenario as the macroeconomic data sources should be updated before the public consultation on data (August 2020) with new projections accounting from Federal Plan Bureau for the COVID crisis. Hence the results hereunder should be seen as an example and not as a final scenario for the Strategic Reserve exercise.

3.1 Scenario construction

The process for the scenario construction is illustrated on Figure 16. The year 2019 is the base year for projections. Hence, all figures up to 2019 are historical data. Then, from 2019 on, projections are performed for the various model variables. The first set of variables illustrated on top of Figure 16 corresponds to those that are projected using the short-term macro-economic methodology. The projections for such variables are performed using the available macro-economic indicators projections and the results of linear regressions detailed in previous sections.

Then, for the rest of BECalc variables, the original projection method based on levers is applied. These levers are set on their 'business-as-usual' level to represent a short-term evolution in line with recent trends.

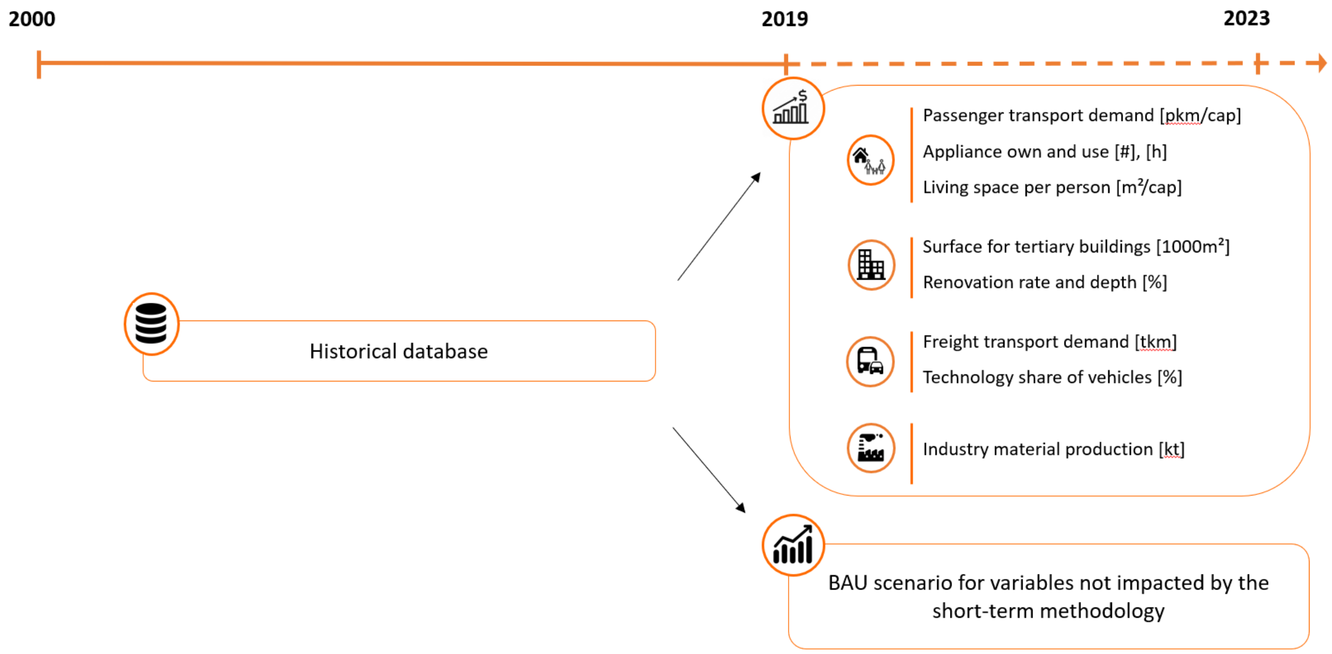


Figure 16: illustration of the scenario construction
Source: Climact

3.2 Total electricity demand

What is the "total electricity demand"?
Total electrical consumption takes account of all the loads on the Elia grid, as well as on the distribution system (including losses). Given the lack of quarter- hourly measurements for distribution systems, this load is estimated by combining calculations, measurements and extrapolations.
What are the differences compared to Elia's consumption (more generally known as 'Elia grid load')?
The Elia grid load covers all offtake as seen from the perspective of the Elia grid. It is indirectly calculated based on the injections of electrical energy into the Elia grid, which includes the measured net generation of (local) power stations that inject power into the grid at a voltage of at least 30 kV, and the balance of imports and exports. Generation facilities that are connected to distribution systems at voltages under 30 kV are only included if a net injection onto the Elia grid is measured. The energy needed to pump water into the reservoirs of the pumped-storage power stations connected to the Elia grid is deducted from the total. Decentralised generation that injects power into the distribution networks at a voltage under 30 kV is therefore not fully included in the Elia grid load. The significance of this segment has steadily increased in recent years. Elia therefore decided to complement its publication with a forecast of Belgium's total electrical load. Elia's grid comprises networks with voltages of at least 30 kV in Belgium plus the Sotel/Twinerg grid in southern Luxembourg.
What is published on Elia's website?
Two load indicators are published on Elia's website: the Elia grid load and the total load. The published Elia grid load and total load [ELI-12] includes the load of the Sotel/Twinerg grid (which is not the case for the total load calculated in this study).

The results for the total electricity demand in the illustrative scenario are shown on Figure 17. A 2.5 TWh increase of electricity consumption can be observed between 2019 and 2023. This increase is mostly due to an increasing electricity consumption in the buildings sector, both in residential and tertiary buildings. Transmission losses are assumed to increase by 0.5 TWh between 2019 and 2023[3] due to the increase of exchanges flows foreseen with neighbouring countries. A very slight increase of 0.1 TWh can also be observed in the transport sector, while the consumption is stagnating in the industry and agriculture sectors. These results are commented in the next sections.

[3] These figures are the result of Elia computations

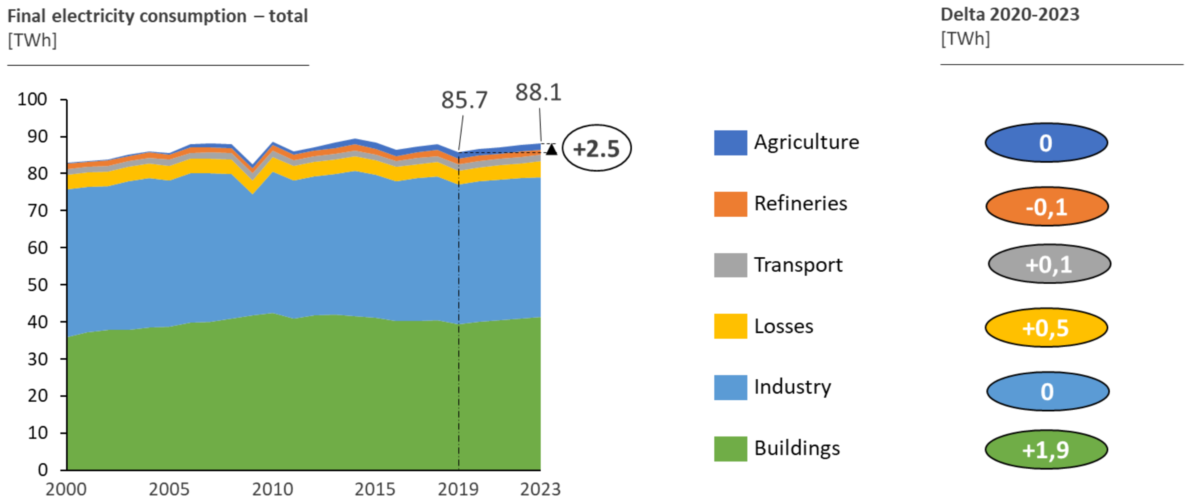


Figure 17: Total electricity demand in the illustrative scenario.
Source: BECalc (Climact)

3.3 Focus on residential and tertiary buildings electricity demand

The electricity consumption of the buildings sector is divided into residential buildings and tertiary buildings consumption.

The evolution of tertiary buildings electricity consumption by end use is shown on Figure 18.

There is a 1.1 TWh increase throughout all end-uses between 2019 and 2023, which represents a 5% increase. This increase is distributed over the various end-uses. The driver behind this increased consumption is the 8% growth of tertiary buildings surface in the same period (see Figure 9). However, the electricity consumption increases slower than the tertiary buildings area due to the renovation of a part of the building stock and a slight increase in energy efficiency for all end-uses during this period.

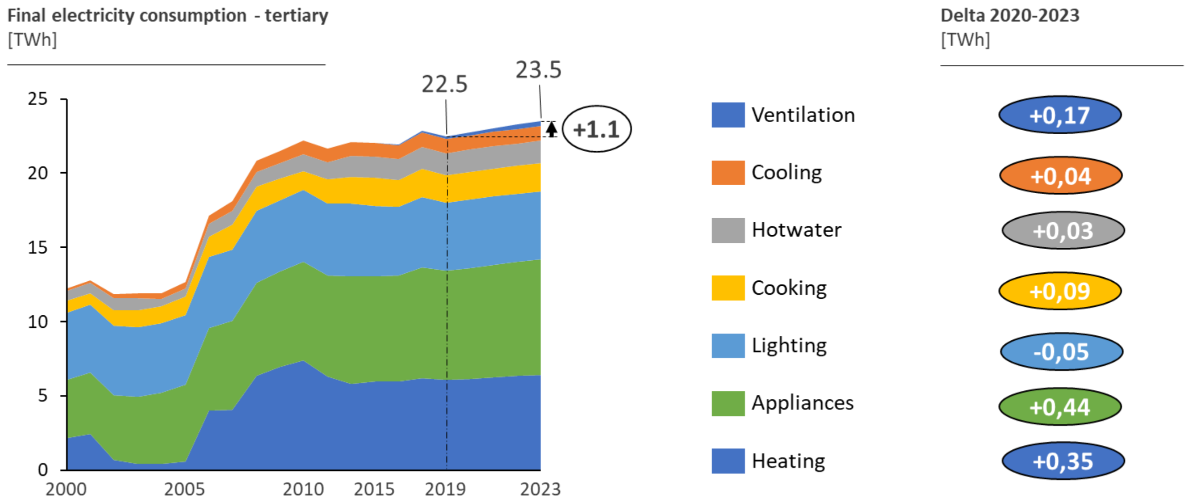


Figure 18: Evolution of the electricity consumption in tertiary buildings by end-use
Source: BECalc (Climact)

The electricity demand of residential buildings sees a similar 5% increase from 2019 to 2023 (Figure 19). However, unlike tertiary buildings, this increase is not distributed among all end-uses but is mainly due to an increased consumption from appliances and ventilation.

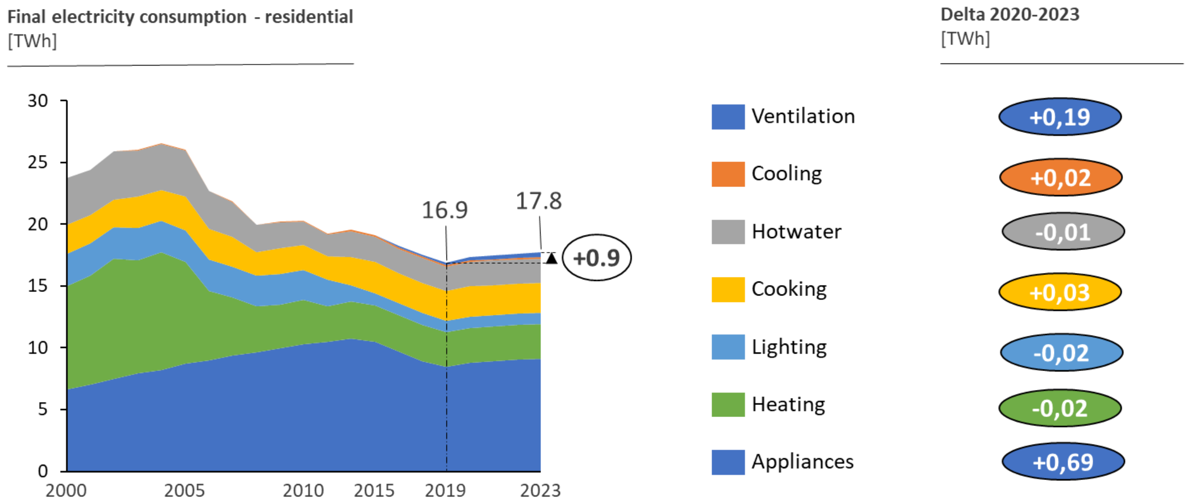


Figure 19: Evolution of the electricity consumption in tertiary buildings by end-use

Source: BECalc (Climact)

This can be explained by the way appliances and ventilation electricity consumption is computed in BECalc (see Figure 20). For a specific type of appliance, the electricity consumption is computed as the product of the number of households, the number of appliances per household, the duration of use of an appliance over the year and the average power of the considered appliances. The three first variables are on the rise between 2019 and 2023: the households number is growing with the population and the appliances per household and their duration of use is also increasing due to the growing income projection (see Figures 6 and 7). The average power of appliances is decreasing thanks to efficiency improvements.

As can be seen on Figure 20, the rise of the three first variables in the short-term outreach the energy efficiency improvement. However, in the medium-term, the trend is reversed and the foreseen efficiency improvements outreach the increasing amount and duration of use of appliances.

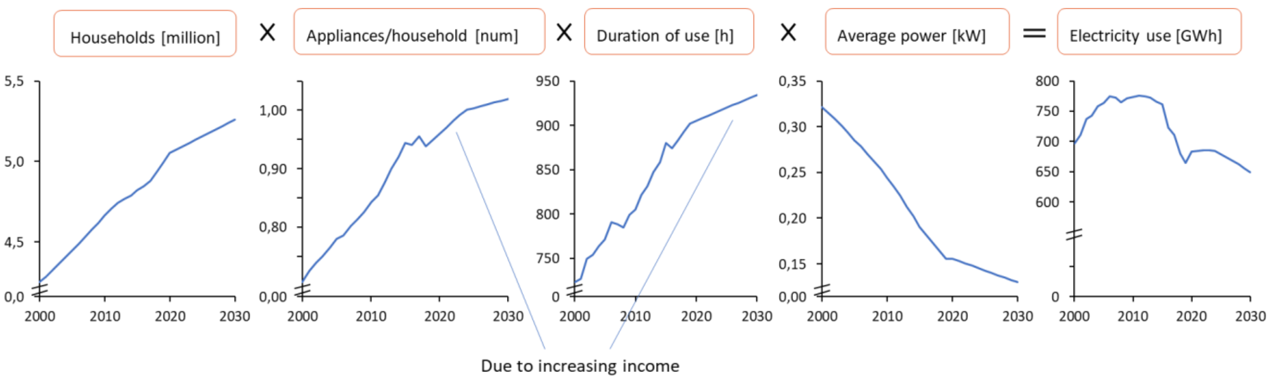


Figure 20: Computation sequence for appliances electricity consumption in residential buildings (illustrative figures for washing machines)

Source: BECalc (Climact)

3.4 Focus on industrial electricity demand

The evolution of electricity consumption in the industry is shown on Figure 21. The general trend is a stagnation of the total industrial electricity consumption, with small variations in the various subsectors. This is in line with the projections of industrial production on Figure 13.

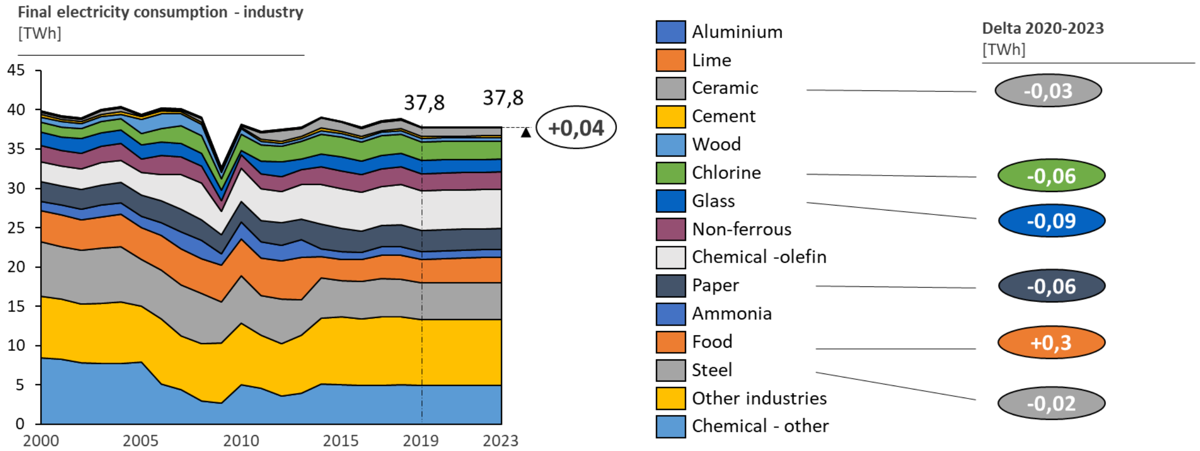


Figure 21: Evolution of the electricity consumption in the industry subsectors
Source: BECalc (Climact)

3.5 Focus on transport electricity demand

The electricity consumption in the transport sector sees a 0.12 TWh increase between 2019 and 2023. This is a result of the electrification of road vehicles, mainly private cars. The electrification scenario considered here corresponds to moderate electrification rates of road vehicles (see Figure 14) in the WEM scenario. A slight decrease of trains electricity consumption can be observed on Figure 22. It can be explained by a stagnation of the train transport demand in the WEM scenario, coupled with energy efficiency improvements during that period.

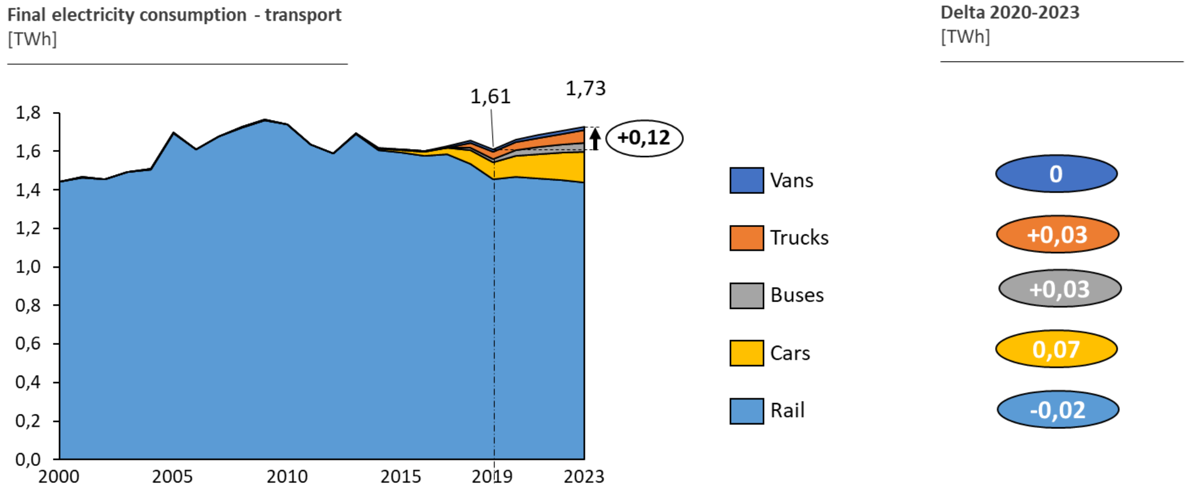


Figure 22: Evolution of the electricity consumption in the transport sector by mode
Source: BECalc (Climact)

4 Appendix

4.1 Macro-economic data sources

Indicator	Unit	Historical source	Projection source	Projections update frequency	Next update
Disposable income	€/cap (nominal)	1995-2017, NBB.stat	NBB, Economic Review, December, 2019	6 months	June 2020
Added value	M€ (volume)	1995-2017, NBB.stat	BFP, Perspectives économiques 2019-2024, June 2019	6 months	June 2020

5 Table of figures

6 References

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