Flanders' energy dilemma: review of the challenges and opportunities of energy storage

K. Hameeuw, M. van den Broek

Department of Flow, Heat and Combustion Mechanics, Ghent University - UGent, Sint-Pietersnieuwstraat 41, Gent, 9000, Belgium. Kris.Hameeuw@UGent.be, Martijn.vandenBroek@UGent.be

Abstract:

Lacking meaningful amounts of traditional resources, Flanders is a prime example of a highly dependent society when fossil (and nuclear) fuels are the sole source of energy supply. Recent attempts to convert to renewable energy sources have had mixed rates of success. Subsidizing schemes resulted in a high percentage of houses being equipped with photovoltaic installations and initiated off-shore wind energy projects. However, recent figures exposed the high total cost of such initiatives. At the same time, failing nuclear reactors revealed the region's vulnerable dependence on aging production units in a centralized energy system. Since some of those units face definite closure, extensive investments to revise the remaining facilities and ensure continuity of operation would be necessary to avoid power outage for the coming decades. Despite initial enthusiasm and a shared sense of urgency, the challenges Flanders is facing on the path towards renewable energy threaten both public acceptance and political determination to continue. Our study aims to outline existing frameworks, identify bottlenecks and the recommendations to overcome them, in terms of technology, legislation as well as government incentives. At present, the activities of so-called ESCOs are for example hindered by an unclear regulatory framework. Furthermore, we will describe the current efforts to introduce a combined implementation of fuel cells and hydrogen storage. Their ability to act as a buffer allows to avoid energy shortage problems due to both insufficient power supply at peak demand from conventional centralized energy distribution, as well as the inherent non-constant energy supply generated by renewable energy sources. Flanders may serve as a textbook example for numerous other regions in Europe and around the world.

Keywords:
Energy Policy, Energy planning, Fuel cells, Energy storage, Social issues, Sustainability.

1. Introduction

As a densely populated and heavily industrialized region in Europe, Flanders faces different challenges in terms of energy production and needs. Within the European framework, it also has to comply with targets and goals set for Green House Gas (GHG) reductions, Energy Efficiency (EE) and renewable energy resources (RES). This paper aims to review the actual Energy Policy in Flanders and discuss its most prominent challenges and opportunities in the context of the transition towards RES and the consequent transformation of the energy system. Because Flanders is part of the federal state of Belgium, we begin with a brief introduction to the Belgian political structure and its possible implication on energy policies.

2. Flanders energy landscape

2.1. Political structure and responsibilities

As a region of Belgium, Flanders is embedded in a federal structure. Responsibilities and the different aspects of energy policy are divided between the regions (Flanders, Brussels and the Walloon Region) and the federal government. The federal government's main responsibilities are the high-voltage network, central energy production, security of supply, nuclear energy and nuclear waste. The regions are responsible for the low-voltage network, EE, social energy policies and RES.

For the region of Flanders, energy policy is mainly addressed by two ministries. The Ministry of Budget, Finance and Energy deals with executive matters and the actual implementation and execution policy. The Ministry of Economy, Science and Innovation is responsible for innovation and research projects, but also for the transfer and validation of new technologies.

2.2. Energy production, resources and demand

Today Belgium has an installed Net Generation Capacity (NGC) of approximately 17 000 MW [1]. About 6000MW is produced by two major nuclear facilities; the remaining fossil capacity is generated by aging power plants (gas, coal and peak production plants). Rather recently, renewable sources were added to the mix: major offshore wind projects were initiated and a large amount of photovoltaic (PV)-units have been installed, both residential as well as in industrial 'farms' [1]. Table 1 shows the present and expected installed capacity split per energy source in 2010, 2030 and 2050 for the actual system and three different policy scenarios that are outlined in appendix A.

Installed capacity, REF and policy scenarios, 2010, 2030 and 2050
GW

	2010	2030				2050			
		REF	GHG40	GHG40EE	GHG40EERES30	REF	GHG40	GHG40EE	GHG40EERES30
Nuclear	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydro	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Wind	0.9	7.6	8.2	7.6	9.2	12.5	14.9	13.7	15.3
Solar	0.9	4.8	4.8	4.8	4.8	9.2	10.0	7.7	6.4
Biomass & waste	1.1	1.5	1.5	1.5	2.0	2.4	3.0	2.9	3.5
Geothermal	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
Coal	1.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0
Natural gas	5.8	11.8	11.1	11.4	10.6	14.6	15.2	11.7	10.6
Other	1.1	1.1	1.0	1.0	1.1	0.6	0.5	0.5	0.5
Total	17.0	27.2	27.0	26.8	28.1	39.5	43.9	36.7	36.6

Source: PRIMES.
Note: 'Other' stands for petroleum products and derived gases.

After closure of its coal mines, Flanders no longer has fossil fuel resources available. Some projects are initiated towards the exploration of shale gas, but these are still in a very early phase and face substantial political and public resistance.

Traditionally, the region has a large number of very energy-intensive industries, mainly (petro-) chemical in the Antwerp region and food industry (frozen vegetables) in the south-west of Flanders. Moreover, the residential sector is consuming a lot of energy as well due to a large amount of old buildings [2].

3. Challenges for conventional and renewable energy

3.1. Security of supply

Considering a peak load (PL) of about 13 000 MW [3], the Remaining Capacity (RC), defined as the difference between NGC and PL, may seem abundant. However, certain facilities are alternately unavailable due to maintenance, technical problems or economic reasons. The so called Unavailable Capacity (UC) in Belgium is rather high, so that Reliable Available Capacity (RAC), the difference between NGC and UC, can become critical. Security of supply requires that sufficient RAC should be left on the power system to cover any unexpected load variation and unplanned outages in normal (average) conditions. A RAC of about 5 to 15 percent of RC should be sufficient to avoid shortage of supply [4]. When the interconnection capacity is relatively high, a spare margin of about 5% may be sufficient. Otherwise, 10 to 15% of reliable and controllable spare capacity should be available, ruling out weather-dependent RES as part of such spare capacity. The interconnection capacity for Belgium is limited, so that a margin of at least 10% is preferable.

3.2. Nuclear phase out and RAC evolution

Belgium opted for a nuclear phase out by 2025: nuclear facilities will be closed down between 2015 and 2025. As such, about 6000MW of controllable production capacity will disappear. However, three of the nuclear reactors were already taken offline recently due to unexpected problems [4]. The remaining conventional production facilities are also relatively old and cannot be expected to continue to run indefinitely. Thus, not only nuclear plants will close down in the coming years. Moreover, some gas power plants were closed down because of market conditions. Renewable Energy Sources (RES) are obviously intermittent by nature.

In the period between 2015 and 2019, spare capacity in Belgium will fluctuate between -10 and -30% when no new investments in controllable capacity such as gas- or biomass plants are added [4]. After 2020, the spare margin plunges to -40% in 2024 as compared to peak demand, which comes down to a lack of capacity of about 5300 MW. Security of supply is thus a main factor of concern.

3.3. Renewable energy certificates

In early 2000, the Flemish government launched an initiative to promote installation of renewable energy capacity in terms of PV installations. Energy produced by these installations is subsidized with so-called renewable energy certificates (RECs). Those certificates were initially valued at 450 euro for a period of 20 years at a rate of 1 certificate per 1000 kWh electricity produced. This fixed price was assured by the administrators of the distribution network, who are obligated to buy the certificates and sell them on the energy market. Due to the huge success of the scheme, a significant oversupply in certificates was generated and prices plunged. Combined with the political decision to freeze the energy price over the last three years, the REC scheme has already generated a deficit of about 1.2 billion euro. The Social Economical Council of Flanders (SERV) calculated that this deficit may climb to 12 billion euro in the coming years if no adequate changes are made [5].

Despite initial enthusiasm, RECs now face a lot of criticism and threaten public support for and acceptance of renewable energy sources in general [4].

4. Government planning and policies

Since new governments were installed at all different levels in month 2014, several new initiatives and decisions were outlined in governmental policy notes [6-8]. In an attempt to understand where Flanders will be heading in terms of energy matters, we will present a short review.

4.1. Federal level

The main goal of the federal government is to assure energy security of supply by means of a so-called 'winter action plan'. The three fundaments of this plan are 1) demand guidance -by individual agreements with big industrial players, 2) enhanced import from abroad -though interconnectivity capacity clearly puts an upper limit, and 3) use of strategic reserves when necessary.

Regarding production capacity, two concrete actions are defined. Firstly, keep the nuclear reactors Doel 1 and Doel 2 operational until 2025, as far as safety will allow it. Secondly, install a substation 'power outlet' in the North Sea to facilitate easy access to the mainland power network for the different -planned and existing- off shore wind projects.

Furthermore, the intention is expressed to `facilitate market dynamics’, 'aiming for a technology-impartial transition to sustainable energy supply' and 'think about storage', without further clarification or planning.

4.2. Regional level

For the Flemish regional government, the policy note of interest is that of the Ministry of Budget, Finance and Energy, because this is the department that deals with executive matters and the actual implementation and execution.

The policy note of the Flemish Energy Agency (VEA) [6] puts the main focus on 'energy efficiency' and accompanying administrative measures. The existing renovation subsidies will be evaluated to determine whether 1) they are still efficient in stimulating people to take action, and 2) the focus needs to be redirected towards different parts of the renovation process. Furthermore, VEA plans to initiate a 'renovation pact' [6, 7] and aims to improve energy efficiency of new buildings. The industry will be stimulated to take action with new 'Industry Energy Agreements' and obligatory energy audits. Last but not least, VEA aims to transform the system of RECs towards investment support in an attempt to avoid further accumulation of deficits and make the system more transparent and cost-efficient.

4.3. Political challenges

Since different political levels are involved and responsible for different aspects of the energy supply chain, as discussed previously, Flanders faces a number of additional challenges [9].

First, even in ideal circumstances, such scattered responsibilities do not facilitate the development of a common strategy and implementation plan. Second, Flanders is embedded in the European Union, which implies another administrative level and a number of targets that have to be met. Responsibilities -who has to do what- to comply with those European targets are not always clear and could be defined more transparently. Third, this fragmentation causes a profusion of regulations and a rather heavy and unclear set of administrative hurdles and requirements for private companies that are, or want to become, active in the energy sector [9].

Last but not least, the financial crisis still has a severe impact on the European economic situation and makes budget availability and priority setting more difficult than ever, especially given the historical Belgian budget government deficits [4].

5. Opportunities

5.1. Innovation and research

Flanders is involved in a number of high profile ongoing Innovation and Research projects. For the purpose of this paper, we choose to focus on hydrogen projects. In terms of hydrogen and hydrogen related technology, most of the initiatives are supervised by the WaterstofNet consortium [10], a joint initiative of Flanders and the South Holland region.

WaterstofNet is involved in the follow-up of the 1MW Proton Exchange Membrane (PEM) fuel cell power plant installed at the Solvay Chlorine production facility in the Port of Antwerp region, the biggest fuel cell of its type worldwide [11].

The consortium also supervises the most elaborate combined hydrogen installation in Belgium, the Netherlands and Luxemburg. It is installed at the main site of Belgian retail group Colruyt and consists of a PV farm, an electrolyser that produces hydrogen from demineralized water, and a fuel cell that converts the hydrogen back to electricity when the PV system does not produce enough power. Additionally, the hydrogen is used to fuel forklift trucks that operate in the storage facility. They are powered either by a fuel cell or a combustion engine running on hydrogen [12].

Flemish bus manufacturer Van Hool has the leading role in HighVLOcity [13], a European consortium that studies the viability of hydrogen-powered public transport. Together with the public transport company De Lijn, trials are being run in Flanders as well as in major cities around Europe. The aim of the project is to accelerate the introduction of hydrogen buses in daily service in Europe's major cities.

As shown by the examples above, Flanders is an important stakeholder as far as innovation and R&D are concerned.

5.2. Implementations

Contrary to other regions in the world, mainly Japan and the United States of America, where several projects and pilot projects are running [14], Flanders is lacking initiatives that implement existing hydrogen technology for everyday use. To ease the transition towards an energy system that fully relies on Renewable Energy Sources (RES), it is important that practical projects are being implemented. When public buildings, e.g. new government buildings, hospitals or schools, are being refurbished or planned, the authorities could use those projects as opportunities to implement existing hydrogen technology and get acquainted with its benefits. These could be equipped with stationary fuel cells to act as emergency back-up systems or even supply everyday heat and electricity. These examples could lead to ease the introduction in the private sector [15].

Even if hydrogen technology might still suffer from being too many 'unknowns', or having a difficult 'image', very basic initiatives could be taken to introduce owners of PV-installations to the concept of energy storage. An information campaign, preferably combined for both professional and individuals, could for example highlight the benefits of an electric water heating and storage system to obtain 'free' sanitary hot water when excess energy from PV-systems is available. Boiler systems have a very high efficiency of 85% to 95% for the conversion of energy. Such basic ways of 'intelligent energy consumption' could reduce the impact of residential intermittent energy sources on the current net, while at the same time substantially improve the gain for the owners.

6. Discussion

Although both policy notes do contain concrete and necessary measures, it is fair to say that a cohesive plan of action and a clear vision are still lacking [4,16]. Especially the document compiled by the new Federal administration requires further elaboration of concrete initiatives that need to be taken and agreed upon. Many actors in the field share the opinion that the sense of urgency justified by the number and seriousness of the challenges that Flanders is facing is not adequately reflected in the federal policy notes [1,4,5].

However, plenty of interesting initiatives exist and with the appropriate adjustment, Flanders has numerous opportunities to bridge the gaps and get on top of those challenges [1,9,16].

6.1. Different scenarios

In 2011, the Belgian ministers in charge of energy commissioned three main Belgian institutes, the Federal Planning Bureau (*Federaal Planbureau*, FPB), the *Vlaams Instituut voor Technologisch Onderzoek* (VITO) and the *Institut de Conseil et d'Etudes en Développement Durable* (ICEDD), to draft an elaborate report on the challenges and opportunities of a next generation energy system [1]. This report shows that it is feasible for Belgium to completely transform to an energy system solely based on RES by 2050, if the right measures are introduced and action is taken on all levels [1]. Moreover, the implementation of this strategy would create unmatched economical possibilities and create between 20000 and 60000 jobs according to the predictions. The earlier such measures are taken, the more profitable the outcome will be in all aspects.

The FPB made a further detailed benchmark study [3] to establish a baseline in terms of costs and consequences if Flanders would continue towards 2050 “under current trends and adopted policies in the field of climate, energy and transport while integrating the 2020 Climate/Energy binding objectives”. This study clearly shows that by doing so, not only will Flanders fail to meet European targets, but it will incur a huge monetary impact, for example in terms of an additional 10 billion euro to be spent on importing fossil fuels in 2050 –as referenced to 2010 [3]. To replace the phased out nuclear plants and renew fossil production facilities, investments in new production capacity are needed for a total of 62 billion euro to secure the energy supply. The impact of disutility and avoided greenhouse gas damage costs are not included in this estimate. Nonetheless, dependency on import of energy would raise by 10% [3].

Recently, the FPB completed a follow-up study outlining three different possible scenarios (GHG40, GHG40EE and GHG40EERES30) and calculating costs and benefits with respect to the baseline reference scenario (REF) [2]. Appendix A gives a brief description of the different scenarios and their underlying assumptions [2]. Tables 2 and 3 summarize the main results. The most profitable scenario in terms of GHG reduction and RES share, GHG40EERES30, requires an additional 7 billion euro of investment expenditure over a 40 years' time span, whereas the total energy system cost as share of GDP is estimated 3% higher than the REF [2].

Summary of key results, REF and policy scenarios, 2030

	REF	GHG40	GHG40EE	GHG40EERES30
Primary energy consumption (Mtoe)	42.2	40.1	37.6	37.6
Final energy demand (Mtoe)	34.7	33.0	30.2	30.4
GHG emissions non-ETS (% difference to 2005)	-15.1	-24.5	-32.2	-30.6
RES share in GFEC (%)	16.8	18.0	18.4	23.4
Import dependency (%)	88.2	87.7	87.6	85.7
Total energy system cost (% of GDP)	15.9	16.2	17.0	17.0
Fossil fuel trade balance (% of GDP)	-4.1	-3.9	-3.7	-3.5
Total GHG emissions (Mt CO_2-eq.)	118.0	106.5	103.0	101.4
Carbon intensity power sector (tCO_2/GWh)	176	162	168	144
Average cost of electricity generation (€'10/MWh)	108.0	108.5	104.2	105.4
RES share in net electricity generation (%)	46.3	50.8	47.5	55.0
Investment expenditure in power plants(*) (billion €'10)	31	32	31	36

Note: GHG=Greenhouse Gas; RES=Renewable Energy Sources; GFEC=Gross Final Energy Consumption; ETS=Emission Trading Scheme.
(*) points to the fact that the indicated values do not represent yearly values, but denote the total investments required for the period 2010-2030.

Summary of key results, REF and policy scenarios, 2050

	REF	GHG40	GHG40EE	GHG40EERES30
Primary energy consumption (Mtoe)	45.6	38.2	32.4	32.2
Final energy demand (Mtoe)	37.9	30.4	26.0	26.0
GHG emissions non-ETS (% difference to 2005)	-13.4	-68.1	-70.6	-71.1
RES share in GFEC (%)	19.2	40.6	38.8	45.2
Import dependency (%)	85.7	80.5	81.1	79.0
Total energy system cost (% of GDP)	13.4	15.9	16.5	16.4
Fossil fuel trade balance (% of GDP)	-3.4	-2.0	-1.7	-1.6
Total GHG emissions (Mt CO_2-eq.)	121.3	49.1	51.1	51.4
Carbon intensity power sector (tCO_2/GWh)	131	73	125	101
Average cost of electricity generation (€'10/MWh)	100.2	119.0	96.3	95.3
RES share in net electricity generation (%)	54.0	53.7	57.8	64.5
Investment expenditure in power plants(*) (billion €'10)	31	46	31	33

Note: GHG=Greenhouse Gas; RES=Renewable Energy Sources; GFEC=Gross Final Energy Consumption; ETS=Emission Trading Scheme.
(*) points to the fact that the indicated values do not represent yearly values, but denote the total investments required for the period 2030-2050.

6.2. Coordination

The strategy towards a full RES energy supply requires an elaborate and common effort. The Belgian federal structure however divides the responsibilities. RES, a responsibility of the regional governments, will gradually replace traditional production of energy and secure energy supply, both federal responsibilities. It is clear that a lot of know-how is present at different levels and for different stages of development, but a combined approach is essential to be able to implement and execute an effective strategy.

Moreover, strengthening existing collaboration, not only between different governments, but between all actors, in both execution and R&D domains could serve to instill the aforementioned common sense of urgency. An example of how such project could be handled is the region of ”Pays de la Loire” in France [17].

6.3. Importance of storage

The review of the Belgian policies demonstrates that initiatives concerning energy storage are lacking, both federally and regionally. A recent report of the Fuel Cell Hydrogen – Joint Undertaking (FCH-JU) [18] however stresses the major importance of an appropriate storage strategy as one of the key ingredients for a successful RES based energy system. Flanders is a densely populated area with a merely inexhaustible amount of possible 'energy supplying buildings', whereas climatological conditions imply highly fluctuating wind and solar energy intensity. Given the past initiatives for the introduction of PV systems, Flanders could serve as a prime region to implement the technically most interesting combination of PV energy and storage.

6.4. Facilitating ESCOs

Energy Supplying Companies (ESCOs) can be an important catalyst to introduce new RES technologies in industry and SMEs where they may be considered unfamiliar, involving too much risk or too cumbersome to implement. Facilitating the market for ESCOs is mentioned in both the regional and federal policy notes. A clear vision and set of initiatives still needs to be established, both on federal and regional level, to establish the so called 'right climate' for ESCOs.

Again, neighbouring regions could be a source of inspiration to avoid having to reinvent working concepts. The Utrecht region for example launched a campaign to make an inventory of the energy efficiency of all buildings and make a priority listing based on costs and potential savings per building [17]. Such summary turned out to be a very helpful tool for ESCOs wanting to work efficiently in the residential market. It allows them to identify potential clusters of projects. When different owners could be contracted simultaneously, both renovation costs and potential savings could be optimised, making Return on Investment (ROI) times substantially shorter and thus also enhancing future gains.

7. Conclusions

In this paper we outlined the energy landscape and political structure that make out the context of RES technology implementation in Flanders. The existing challenges and bottlenecks were identified and recent initiatives to explore the feasibility of renewable energy sources and hydrogen storage in Flanders are reviewed.

Different studies clearly stipulate the overall feasibility and benefits of a RES transition, and presents policies and measures to achieve those. As such, they provide further valuable input to decide on appropriate legislation as well as on concrete incentives to be installed.

The most recent policy notes only partially incorporate these recommendations, mostly in terms of energy efficiency targets. Despite the very valuable initiatives in the R&D domain, it seems that additional measures and concrete initiatives remain to be taken to overcome the existing bottlenecks and realise a smooth transition of Flanders’ energy system.

References

[1] Devogelaer D., Duerinck J., Gusbin D., Marenne Y., Nijs W., Orsini M., Pairon M., Towards 100% renewable energy in Belgium by 2050; the Federal Planning Bureau (FPB), the Institut de Conseil et d'Etudes en DÈveloppement Durable (ICEDD) and the Vlaams Instituut voor Technologisch Onderzoek (VITO), April 2013.

[2] Devogelaer, D., and Gusbin, D., 2030 Climate and Energy Framework for Belgium; Impact assessment of a selection of policy scenarios up to 2050; April 2015.

[3] Devogelaer, D., and Gusbin, D., Het Belgische energiesysteem in 2050: Waar naartoe?; Beschrijving van een Referentiescenario voor België; Oct 2014.

[4] Albrecht J., 2014-2019: Diagnose en prioriteiten: Energy Security First!, Itinera Institute, March 2014.

[5] SERV, Subdoelstellingen groene stroom 2013-2020: Context en implicaties van het VEA-voorstel en alternatieven, Brussel, May 2013.

[6] Turtelboom A., Beleidsnota 2014-2019 Energie, Oct 2014.

[7] Delvaux B., addendum Beleidsnota 2014-2019 Energie, Feb 2015.

[8] YERA, De energieplannen van de regeringen, een samenvatting, 2014.

[9] Boogmans D. et al., Aanbevelingen voor Groene Energie in Vlaanderen, Eindrapport iRG Groene Energie, Oct 2012.

[10] WaterstofNet – Available at:< http://www.waterstofnet.eu >

[11] Solvay fuel cell plant project website – Available at:< http://www.waterstofnet.eu/toepassingen/electriciteitsproductie.html>

[12] Colruyt mobile hydrogen fuel station – Available at <http://www.waterstofnet.eu/h2-productie/verplaatsbaar-waterstoftankstation-vlaanderen.html

[13] High VLO City project website – Available at: < http://highvlocity.eu>

[14] Fuel Cell and Hydrogen Energy Connection, Feb 2015.

[15] Gosselin, K., First Apartments In Old Hartford Bank Building To Be Ready In April – Available at: < http://www.courant.com/real-estate/hc-777-main-street-apartments-hartford-20150109-story.html >

[16] Boogmans D. et al., Aanbevelingen voor eco-innovatie in Vlaanderen, Eindrapport Innovatieregiegroep Eco-innovatie, Nov 2012

[17] Rifkin J., The third industrial revolution: how lateral power is transforming the economy and the world. MacMillen; 2011.

[18] Lymperopoulos, N., et al., Commercialisation of Energy Storage in Europe, Fuel Cells and Hydrogen Joint Undertaking (FCH JU) – Available at:< http://www.fch-ju.eu >

Appendix A

The policy scenarios are set in enabling conditions – they do achieve GHG emission reductions in line with the European Roadmaps in a 2050 perspective [18].

a. GHG40

General description: This scenario presents a medium ambition in terms of GHG emission reduction that meets in 2030 a 40% GHG reduction, and in 2050 a 80% GHG reduction compared to 1990 levels. It is based on the assumption of equalisation of marginal abatement cost of GHG emissions across the economy driven by increasing carbon prices and simulated carbon values. This represents a least cost approach to reduce GHG emissions economy-wide without yet defining the additional policies through which this would be achieved (in the non-ETS sector). In addition, as of 2035, more stringent CO2 standards for passenger cars apply to simulate electrification. Carbon pricing incentivises fuel shifts and GHG emission reductions, it also has a pull effect on RES penetration and increase of energy efficiency.

GHG policies: GHG policies lead to the achievement of the 40% and 80% reduction targets in respectively 2030 and 2050 through equalisation of increasing carbon prices and values.

EE policies: There are no additional EE policies compared to the Reference scenario. In the long term, the EEVs are higher than in the Reference scenario to reflect the energy efficiency effect of the carbon value. Stringent CO2 standards for passenger cars are implemented: 95 gCO2/km in 2030 and 25 gCO2/km in 2050.

RES policies: There is no pre-set RES target and consequently no dedicated policy in support of RES (in addition to the Reference scenario). The increased EU RES share of 26.5% is mostly achieved in the ETS sectors.

b. GHG40EE

General description: This scenario presents a medium ambition in terms of GHG emission reduction and is mainly driven by explicit ambitious energy efficiency policies that ensure progress by addressing market imperfections and failures. Beyond concrete EE policies, carbon pricing continues to incentivise fuel shifts, energy savings and non-energy related emission reductions.

GHG policies: The achievement of the 40% reduction target in 2030 is realised. There is an equalisation of the overall cumulative GHG emissions up to 2050 to projections of the GHG40 scenario with overall ETS emissions approximating cumulative ETS emissions of GHG40. This implies a tightening of the linear reduction factor to -2.4% applied to all ETS sectors from 2021 on.

EE policies: These policies are ambitious and go beyond the enabling conditions. The key elements are:

- Measures speeding up the buildings renovation rate which attains on average (2020-2050) 1.69% (in REF, the average renovation rate is 1.18%)
- Energy management systems introduced gradually over time
- Extended and more ambitious energy efficiency obligations
- The measures above are most strongly driven by EVs to trigger energy savings. For Belgium, the EV ranges from 288 €/toe in 2020 to 716 €/toe in 2030 further increasing to 1955 €/toe in 2050
- The efficiency standards for products driven by Eco-design Regulations are continuously tightened, broadened and extended to not yet regulated products to cover all energy product categories represented in the model
- Additional support for smart grids and efficiency standards for power networks
- Wide deployment of CHP and district heating/cooling

– Stringent CO_2 standards for passenger cars: 70 gCO_2/km in 2030 and 25 gCO_2/km in 2050

– Other additional transport related measures as reflected in the White Paper on Transport.

RES policies: There is no pre-set RES target and consequently no dedicated policy in support of RES (in addition to the Reference scenario), increased EU RES share of 26.4% is mostly achieved in the ETS sectors. EE policies contribute to higher shares of RES as they reduce total energy consumption.

c. GHG40EERES30

General description: This scenario presents a medium ambition in terms of GHG emission reductions and is mainly driven by explicit ambitious energy efficiency policies and pre-set RES target that ensure progress by addressing market imperfections and failures. Beyond concrete EE policies, carbon pricing continues to incentivise fuel shifts, energy savings and non-energy related emission reductions.

GHG policies: The achievement of the 40% reduction target in 2030 is realised. There is an equalisation of the overall cumulative GHG emissions up to 2050 to projections of the GHG40 scenario with overall ETS emissions approximating cumulative ETS emissions of GHG40.

EE policies: They are ambitious (identical to those in GHG40EE, including CO_2 standards for passenger cars).

RES policies: There is a pre-set EU RES target of 30% and in modelling, RES values are applied in order to represent the policies necessary to achieve this target. For Belgium, the RES values rise from 28 €/MWh in 2020 to 42 €/MWh in 2030 and decline to 29 €/MWh in 2050. EE policies contribute to higher shares of RES as they reduce total energy consumption.