IEA Bioenergy
Technology Collaboration Programme

Implementation of bioenergy in Belgium - 2021 update

Country Reports

IEA Bioenergy: 10 2021

This report was prepared from the 2021 IEA World Energy Balances and Renewables Information, combined with data and information provided by the IEA Bioenergy Executive Committee and Task members[1]. Reference is also made to FAOstat and Eurostat data as well as data from national statistics. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content. General background on the approach and definitions can be found in the central introductory report for all country reports.

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HIGHLIGHTS

- Renewables made up 8% of *total energy supply* in Belgium in 2019. The renewable energy share in *final energy consumption* was 10%[2]. Around 64% of renewable energy is from biomass.
- Belgium is a small, densely populated country with high energy demand from industry. Primary domestic biomass resources are limited, so an important share of the feedstocks comes from industry residues and waste, as well as imports.
- Electricity production in Belgium is still dominated by nuclear power (50%) and gas (30%). However, a phase-out of nuclear power is prepared in the coming years, which would imply a profound change in power provision. It is anticipated that natural gas will play an increasing role.
- Bioelectricity was the major source of renewable electricity initially. In recent years, the level of bioelectricity has stabilized, while the role of wind and solar power is growing.
- Heat provision in Belgium is still largely dominated by fossil fuels, particularly natural gas and heating oil. Biomass (at 8%) provides the main type of renewable heat.
- Transport fuels are also still dominated by fossil fuels, particularly diesel fuel. Biofuels represent 5 to 6% of transport energy consumption, with a widespread use of B7 as diesel fuel (*containing up to 7% biodiesel by volume*) and E10 as gasoline fuel (*containing up to 10% bioethanol by*

[1] While data for 2020 are starting to become available at national level, it was decided to consider trends up to 2019 for good comparability and benchmarking between the different IEA Bioenergy member countries. Care should also be taken when using 2020 data for analysing trends as these data are distorted by the COVID19 Pandemic.

[2] The difference between the share of renewables in supply and consumption relates to unused heat from power plants, e.g., nuclear plants (which is counted in energy supply, but not in final consumption).

volume).

- Apart from offshore wind and taxation of biofuels for transport, renewables policy is mainly the responsibility of the regions. The main policy support for renewable power has been in the form of obligations connected with green certificates, recently also through calls for tender; for renewable transport fuels the policy framework is mainly based on an obligation system for fuel suppliers.

COUNTRY PROFILE

Population and land use

Belgium is a small country in West Europe. It has a total land area of 30.3 thousand km² and a population of 11.5 million people. This represents a high population density of 381 persons per km².

Belgium has quite favourable geographic and climatic growth conditions. 44% is agricultural land, of which two thirds arable land and one third permanent grassland. Around 25% of the land area is forest land (most in the south of the country). Artificial areas represent an important share in 'other land use', currently occupying about 20 % of the territory (source: EEA).

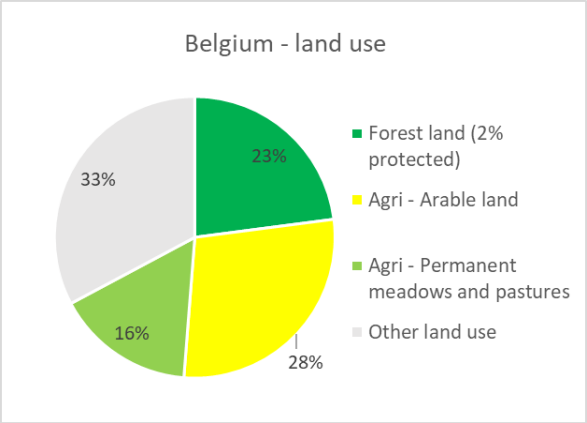

***Figure 1**: Land use in Belgium (2018 figures - Source: FAOstat)*

Final energy consumption

Overall final energy consumption in Belgium (*also including non-energy use of oil, natural gas, and coal in industry*) comes down to 3.5 tonnes of oil equivalent (toe) per capita, which is relatively high compared to the other member countries of IEA Bioenergy. This is mainly due to the heavy industrialisation of the country. Industry represents an important share of 45% of final consumption of energy carriers in Belgium - an important part goes to non-energy uses, e.g., in chemical industries.

Table 1: Distribution of the final consumption of energy carriers by sector in Belgium (2019 figures - Source: IEA (2021) World Energy Balances and Renewables Information)

Final consumption energy carriers	Toe/capita (2019)	% of total	*Median* (toe/capita)*
Industry (energy use)	0.93	27%	*0.67*
Industry (non-energy use)	0.63	18%	*0.21*
Transport	0.77	22%	*0.69*
Residential	0.68	19%	*0.57*
Commercial & public services	0.39	11%	*0.34*
other	0.08	2%	
Total	3.48		*2.34*

** Median of the 25 member countries of IEA Bioenergy*[3]

[3] Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.

NATIONAL POLICY FRAMEWORK IN BELGIUM

TARGETS AND STRATEGIES

Energy policy responsibility in Belgium is divided between the federal government and the three regions (Flanders, Wallonia, and Brussels). Nuclear energy, offshore wind energy, high voltage electricity transmission and transport fuel pricing are federal responsibility. Apart from offshore wind and biofuels for transport, renewables policy is mainly the responsibility of the regions.

Belgium has a national binding target for renewable energy stated in the EU Renewable Energy Directive (2009/28/EC) to account for 13% of gross final energy consumption in 2020. The targeted shares of the three sectors heating/cooling, electricity and transport are shown in the table below. The Belgian integrated NECP (National Energy and Climate Plan 2021-2030) elaborates the targets for 2030.

***Table 2**: renewable energy and climate targets in Belgium**

Sector	Share of renewables in gross final consumption per sector	GHG reduction target
Overall target	13% by 2020 17.4% by 2030	Non-ETS*: -25% by 2020 compared to 1990 -35% by 2030 compared to 2005 2030 GHG target by region: • Flemish Region: -32.6% • Walloon Region: -36.8% • Brussels Region: -39.4%
Heating and cooling	12% by 2020	
Electricity	21% by 2020	
Transport	10% by 2020 13.9% by 2030*	

** 2030 targets mentioned in the Belgian National Energy and Climate Plan 2021-2030 will be reviewed in the frame of the European Fit for 55 package of 2021. (Increased GHG reduction target in EC Fit for 55 proposal: -47% by 2030 instead of 35%)*

The trajectory for non-ETS GHG reductions for the 3 regions, and overall, at Belgian level are provided in the following table.

Table 3: Non-ETS Greenhouse gas reduction trajectories compared to 2005, distributed between the different regions (Source: Belgian NECT 2021-2030 – WAM scenario[4])

	2010	2015	2020	2025	2030
Belgium	-2.7%	-9.9%	-14.9%	-24.3%	-34.4%
Flemish Region	-1.3%	-7.4%	-11.2%	-21.3%	-32.6%
Walloon Region	-5.7%	-13.1%	-20.3%	-28.6%	-36.8%
Brussels Capital Region	0.5%	-16.1%	-20.7%	-30.1%	-39.4%

The NECP provides a trajectory of renewable energy in the different sectors. Mind that these are not formal targets.

Table 4: Renewable energy in final energy consumption of different sectors – WAM[5] scenario (Source: Belgian NECT 2021-2030)

	2005	2010	2015	2020	2025	2030
RES	2.3%	5.7%	7.9%	11.7%	13.7%	17.5%
RES-E	2.4%	7.1%	15.5%	25.1%	27.6%	37.4%
RES-T	0.6%	4.7%	3.8%	11.0%	17.6%	23.7%
RES-H&C	3.4%	6.1%	7.8%	8.0%	9.4%	11.3%

The three regions of Belgium have adopted several policies and measures, including regional climate policy plans and strategies and programmes for low-carbon energy supply. Regions support renewable energy technologies through investment subsidies and green certificates. Additionally, the federal government provides tax incentives.

Parallel to that, investment subsidy schemes exist in all regions in renewable energy projects.

In terms of biofuels, obligatory blending is ruled by the law for the incorporation of biofuels in fossil fuels (at federal level).

A description of renewable energy and climate policies and measures in Belgium is available at the IEA's Policies and Measures Database: https://www.iea.org/policies?country=Belgium

Specific policies related to renewable electricity, renewable heat and transport biofuels will be highlighted in the chapters about the role of bioenergy in different sectors.

[4]National Energy & Climate Plan 2021-2030 https://climate-laws.org/geographies/belgium/policies/national-energy-and-climate-plan-for-belgium
Mind that these targets were set before the European Green Deal that raised the EU wide 2030 GHG reduction target from 40% to 55%.

[5] 'With Additional Measures' scenario

THE CONTRIBUTION OF BIOENERGY IN NATIONAL ENERGY SUPPLY

TOTAL ENERGY SUPPLY

The total energy supply (TES) of Belgium in 2019 amounted to 2,288 PJ and is dominated by fossil fuels (70%). Oil products account for 37% of total energy supply (847 PJ) and natural gas is contributing another 28% (636 PJ). The role of coal is limited to a little over 5% (130 PJ). Nuclear energy in nuclear power stations (which produce 47% of the electricity) represents 20% of total energy supply or 475 PJ. Renewable energy sources have a share of merely 7.8% or 179 PJ. Around 70% of renewable energy supply in 2019 came from biomass (126 PJ), followed by wind energy (35 PJ) and solar energy (16 PJ).

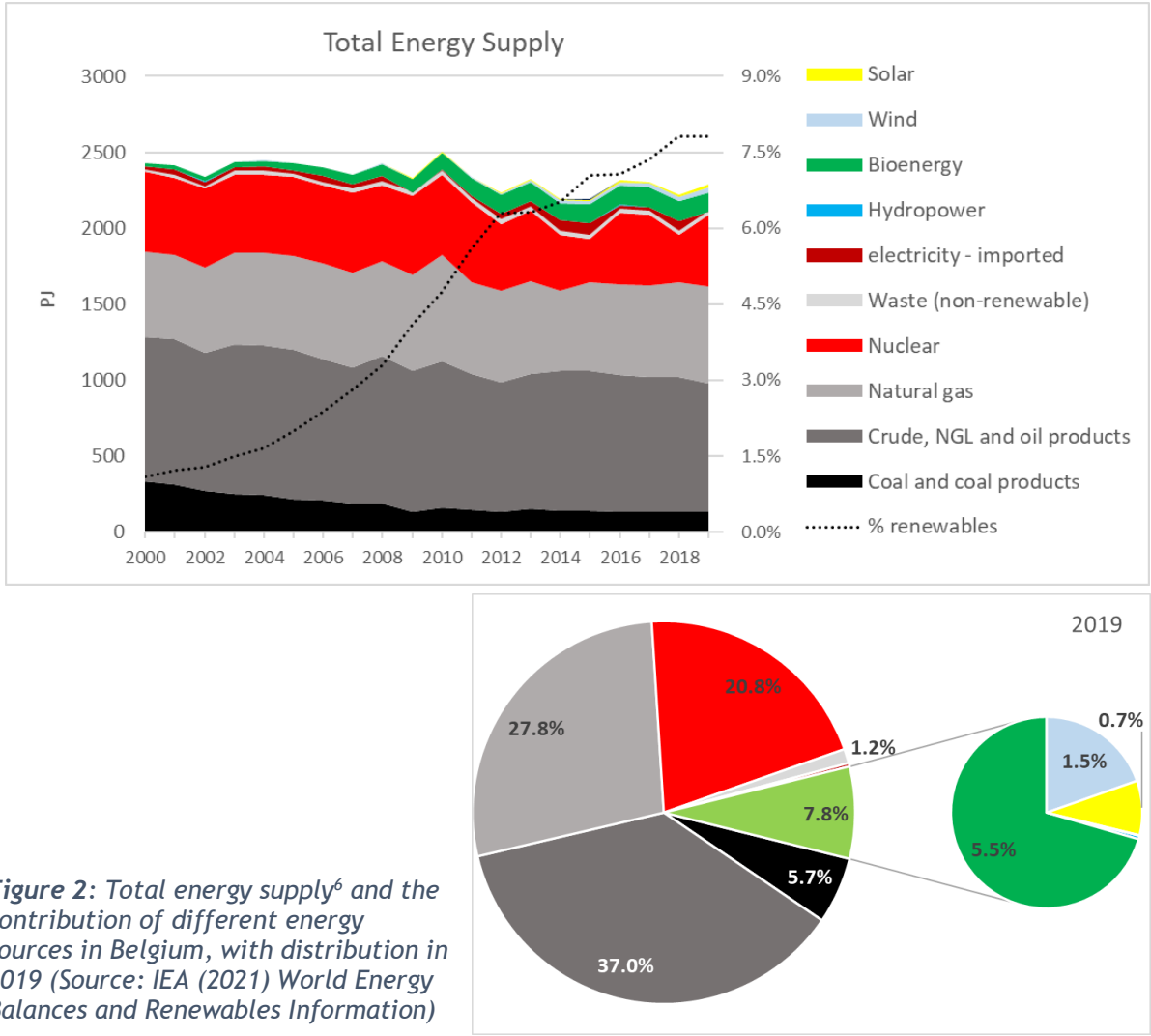

***Figure 2**: Total energy supply[6] and the contribution of different energy sources in Belgium, with distribution in 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Compared to 5 years earlier (2014) the share of oil came down from 42% to 38% of TES. On the other hand, the share of gas increased from 24% to 28% of total energy supply. Coal was fairly stable in the past 10 years around 6% - mind that its share in 2000 was 14%. Production of nuclear energy

[6] Total energy supply refers to the use of resources. In terms of the role in the energy system this distribution overestimates the role of resources producing electricity with a high share of unused waste heat (like nuclear plants).

fluctuated in the past years (with temporary stops of nuclear facilities), and this was compensated by electricity imports from neighbour countries.

Renewable energy supply saw a consistent growth from only 1% of TES in 2000 up 6% in 2012. After 2012 there was still an upward trend, but more stepwise. The overall share of bioenergy in total energy supply was fairly stable around 5.5% after 2012, while solar and wind combined increased from 0.8% to 2.2%.

As is shown in Figure 3, most of the bioenergy consumed in Belgium comes from solid biofuels; their share accounts for two thirds of the total use of bioenergy or 84 PJ. The use of solid biomass is evenly split between the residential sector, industry, and electricity production. The other bioenergy types are biodiesel (16 PJ), energy from the renewable share of municipal waste (16 PJ), biogas (9 PJ) and bioethanol (5 PJ).

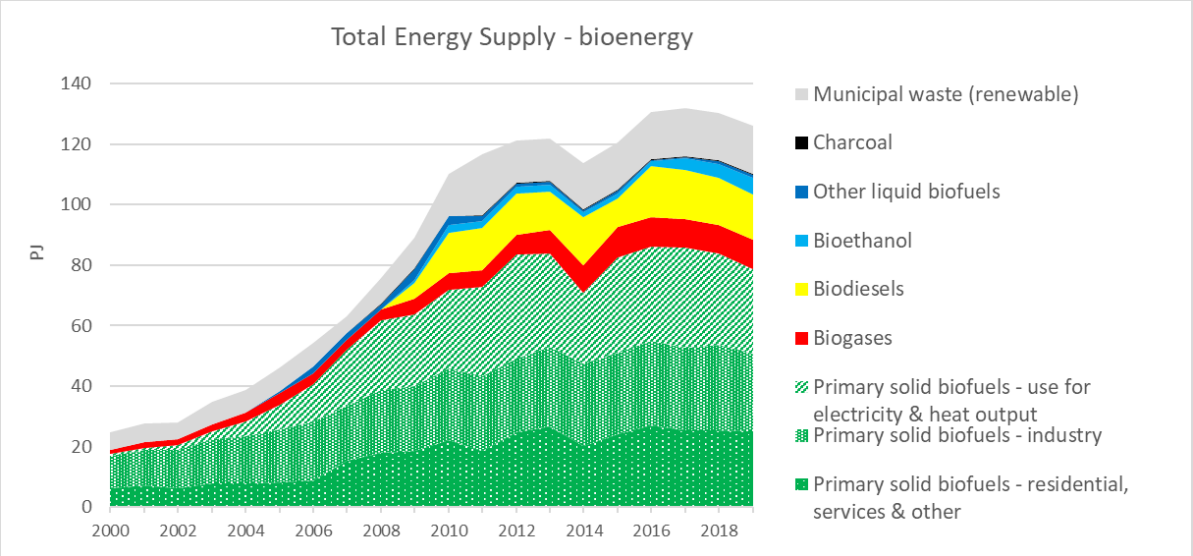

***Figure 3**: Development of total energy supply from bioenergy in Belgium 2000 – 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Evolution of the bioenergy carriers:

- Between 2002 and 2012 there was an important growth in solid biofuels from 20 PJ to 80 PJ, and this stabilised since. In 2014 one important biomass power plant (Rodenhuize) stopped operation for a while, creating a dip in biomass use.
- Biodiesel increased from nearly zero in 2006 to 14 PJ in 2010. Levels have further increased slightly to 15-17 PJ in the past years.
- Bioethanol levels also increased up to 2010, albeit at a lower level of 2 PJ, and stabilized after that. Levels have increased again in the past years up to 5 PJ, due to the introduction of E10 in the transport fuel mix.
- Biogas had a steady increase up to 10 PJ in 2015 and stabilized since.
- Renewable municipal waste increased steadily from 6 PJ in 2000 to 14 PJ in 2010 and has stabilized around 15-16 PJ since.

Table 5 displays the 2019 total bioenergy supply values on a per capita basis. Compared to the other 24 member countries of IEA Bioenergy (expressed per capita), Belgium ranks at the higher end for renewable waste, and in the middle for biogas, liquid biofuels and solid biofuels.

Table 5: Total energy supply per capita in 2019 for different bioenergy carriers

	Supply per capita		Median IEA Bioenergy members
Bioenergy	10.9	GJ/cap	*10.6*
Solid biofuels	6.8	GJ/cap	*7.0*
Renewable MSW	1.4	GJ/cap	*0.8*
Biogas	0.8	GJ/cap	*0.7*
Liquid biofuels	1.8	GJ/cap	*1.5*

Source: IEA (2021) World Energy Balances and Renewables Information

Table 6 indicates the amounts of the different bioenergy carriers compared to some relevant reference points, namely the amount of forest in the country (for solid biomass), the amount of generated MSW (for renewable MSW used for energy), the amount of natural gas consumed in the country (for biogas) and the amount of fossil oil products consumed (for liquid biofuels).

Table 6: Comparison of the supply of different bioenergy carriers in 2019 to specific reference points

	Compared to reference points			Median*
Bioenergy	5.5	%	of total energy supply	*7.2 %*
Solid biofuels	116.2	GJ/ha_forest	compared to the domestic hectares of forest land (excl. protected)	*21.3 GJ/ha_forest*
Renewable MSW	3.38	GJ/ton_MSW	compared to the total generated MSW in the country	*1.4 GJ/ton_MSW*
Biogas	0.015	GJ/GJ_NG	compared to natural gas supply	*0.023 GJ/GJ_NG*
Liquid biofuels	0.025	GJ/GJ_oil	compared to oil products supply	*0.028 GJ/GJ_oil*

Source: energy data from IEA (2021) World Energy Balances and Renewables Information; forest figures from FAOStat; waste figures from World Bank
** Median of the 25 member countries of IEA Bioenergy*[7]

Specific comments in relation to the reference points:

- The amount of solid biofuels compared to the domestic forest area is high (~6 $tons_{dry\ mass}$ of wood per hectare[8]). It should be considered that much of this solid biomass is not sourced domestically. There are considerable wood pellet imports for power production (e.g., from USA, Canada and Germany); wood panel industries also source wood resources in neighbour countries and are using residues from their processes for energy production.
- The use of renewable MSW for energy production is consistent with other European countries with well-developed waste management systems.

[7] Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.
[8] Counted with a typical calorific value of wood (dry mass) of 19 $GJ/ton_{dry\ mass}$

ROLE OF BIOENERGY IN DIFFERENT SECTORS

OVERVIEW

The overall share of renewables in **final energy consumption** among electricity, transportation and heat sectors is a little over 10%, with bioenergy making up almost 7% of the energy share (Table 7). Mind that these figures are somewhat higher than the shares in total energy supply (where unused waste heat, e.g., in nuclear power generation, is also included in the total).

***Table 7**: Role of bioenergy and renewable energy in electricity, transport energy and fuel/heat consumption in 2019*

Sector	Share of bioenergy	Share of renewable energy	Overall consumption
Electricity[9]	5.8%	21.5% *(10.7% wind)*	91 TWh (326 PJ)
Transport energy (final consumption)	5.5%	5.9%	370 PJ
Overall fuel and heat consumption[10]	Direct biomass: 7.7% Biobased heat: 0.3%	8.1%	728 PJ
TOTAL FINAL ENERGY CONSUMPTION	**6.8%**	**10.6%**	**1418 PJ**

Source: IEA (2021) World Energy Balances and Renewables Information

The following paragraphs will consider the evolutions in the different sectors.

[9] Renewable electricity production compared to final consumption. Potential renewable shares of imported electricity are not included.

[10] This includes final consumption of fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry. Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.
Electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported.

ELECTRICITY

The Belgian power production is largely dominated by nuclear energy, representing roughly half of electricity consumption. There have been fluctuations in nuclear power generation in the past decade, which were compensated by electricity imports from neighbour countries (going up to 20% of Belgian electricity consumption in 2014, 2015 and 2018). The federal government has decided to phase out nuclear energy by 2025, so an important change is expected in electricity provision.

Coal power continues its declining trend, and only represents less than 3% of Belgian power production (this was 20% in 2000). On the other hand, natural gas (representing around 25% of power production) is rising again from 20 to 25 TWh in recent years. With the nuclear phase-out by 2025, natural gas is also expected to become more important.

Renewable electricity was mainly dominated by bioelectricity up to 2010. Since then, biobased electricity production has stabilized around 5-6 TWh, representing 6% of electricity consumption, while other sources of renewable power are becoming more important. Particularly wind power has grown from 1 to 10 TWh (10% of electricity consumption) in the past decade; solar power has grown in steps and has now reached 4 TWh (5% of electricity consumption).

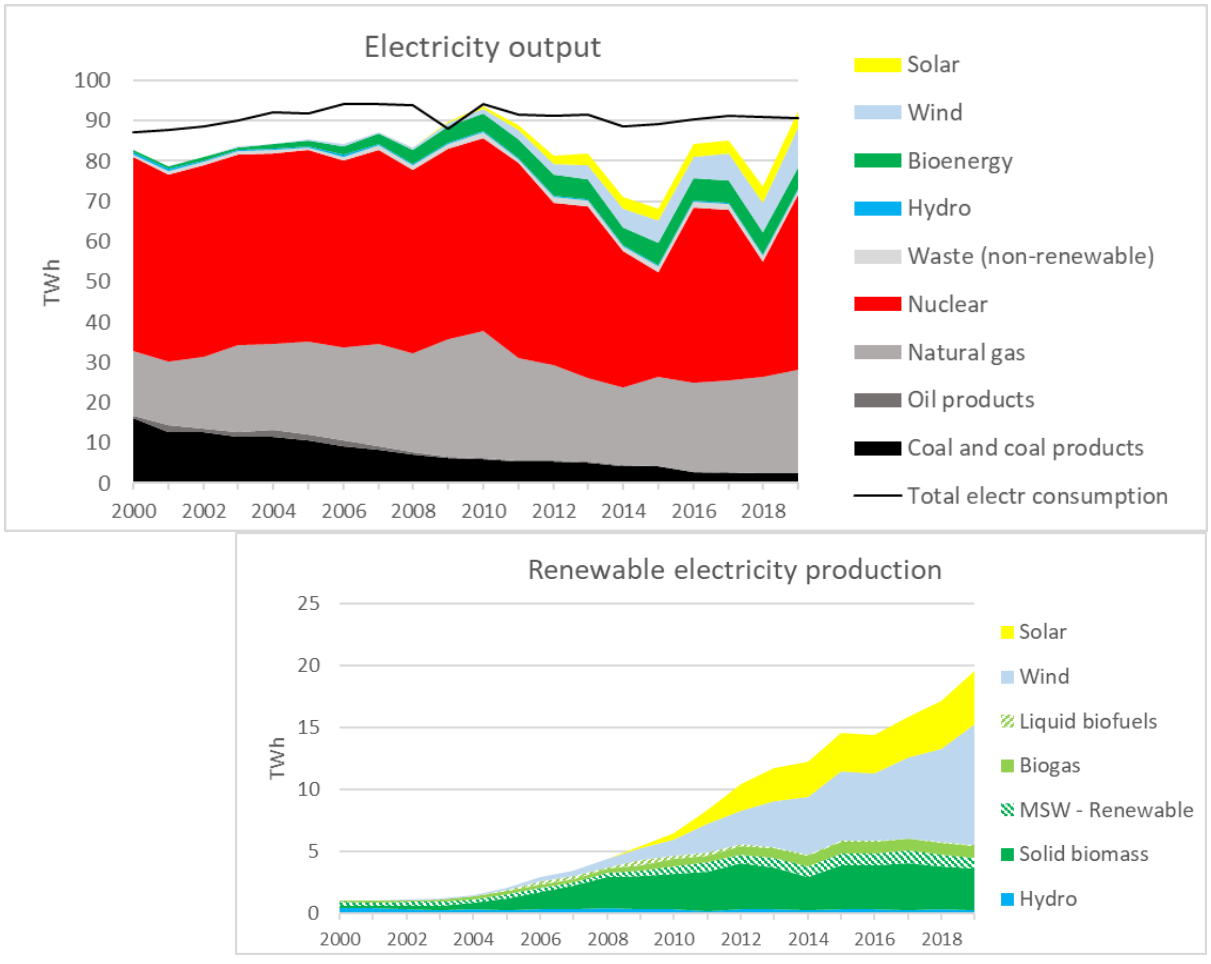

***Figure 4**: Evolution of the electricity mix in Belgium 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Policy framework

In order to foster electricity production from renewable sources, **green certificate schemes** have been established in the three regions. Electricity suppliers need to fulfil yearly quota for green power. If an overshoot of certificates is disturbing the market, grid operators are obliged to buy green certified power at minimum guaranteed prices. Criteria for the attribution of a green certificates and minimum prices are set by the federal government for offshore wind power and ocean power, and by the regional governments for all other kinds of renewable sources, including different types of bioenergy.

- In the Walloon and Brussels Region, green certificates were assigned based on CO_2 savings of power and CHP installations compared to a natural gas reference. For bioenergy installations, fossil energy in the supply chain is accounted for.
- In the Flemish Region, green power certificates are assigned based on the amount of renewable MWh produced. Fossil energy use and electricity use in the biomass supply chain (transport, pretreatment) is subtracted from the amount of certificates.

Recently there is a trend to move to project specific support, which is organized through calls. New green power calls in Flanders are focused on solar PV and wind energy, where projects are ranked according to the requested support against the projected energy production.

Nuclear power currently represents around half of power generation in Belgium but is scheduled to phase out in 2025. To anticipate the phase-out of nuclear power and assure electricity supply security, the Federal Government has launched a Capacity Renumeration Mechanism (CRM) call. This mechanism will grant support from 2021 through annual auctions to units that can supply or save electricity from 2025. Focus is on (flexible) power facilities and battery storage capacity. The first call in October 2021[11] (with a total support of 140 million Euro) selected 40 projects for support, with a total capacity of 4448 MW, of which most relates to the provision of flexibility in existing installations. Two new gas power facilities were also selected for support in this call, with a combined capacity of 1600 MW.

[11] https://www.elia.be/-/media/project/elia/shared/documents/press-releases/2021/20211031_crm-results-of-first-auction-now-available_nl_v2.pdf

HEAT/FUEL

Figure 5 shows the role of different fuels/energy carriers for providing heat in different sectors (industry, residential sector, commercial and public services and other). It also includes heat sold to customers, e.g., through district heating. Fuel use by energy producing industries for transformation and for own use is excluded. Mind that electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported in the IEA database.

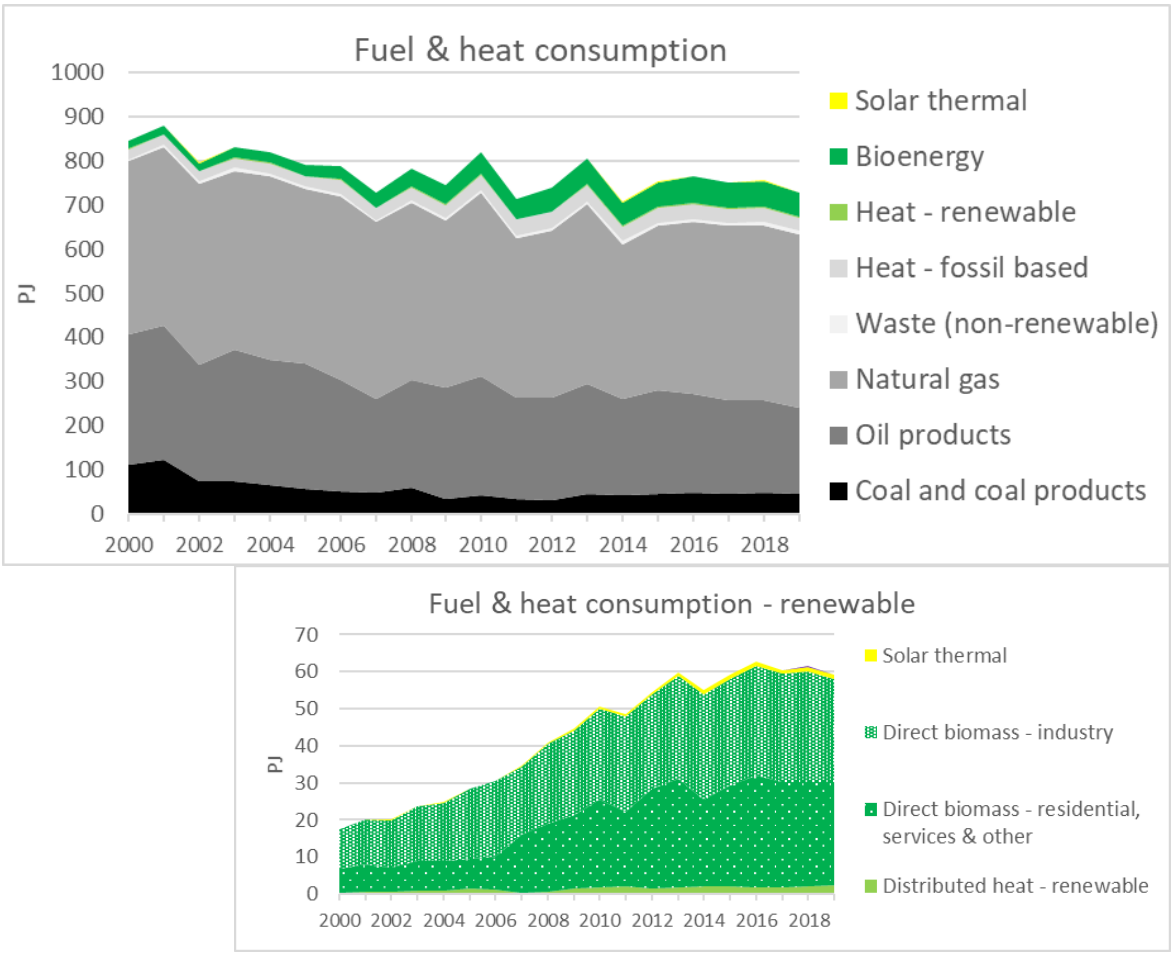

***Figure 5**: Evolution of fuel and heat consumption in Belgium 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

The provision of heat is still largely (90%) based on fossil fuels. Oil-based heat is slightly declining, but consumption of natural gas is fairly stable. Bioenergy reached around 8% of heat/fuel consumption. Mind that some of the bioenergy increase before 2008 is due to an updated accounting of residential wood consumption.

Heat output generated and sold by CHP plants and heat plants represents less than 5% of fuel/heat provided. This distributed heat is mostly produced by natural gas, with an increasing share of residual heat (Figure 6).

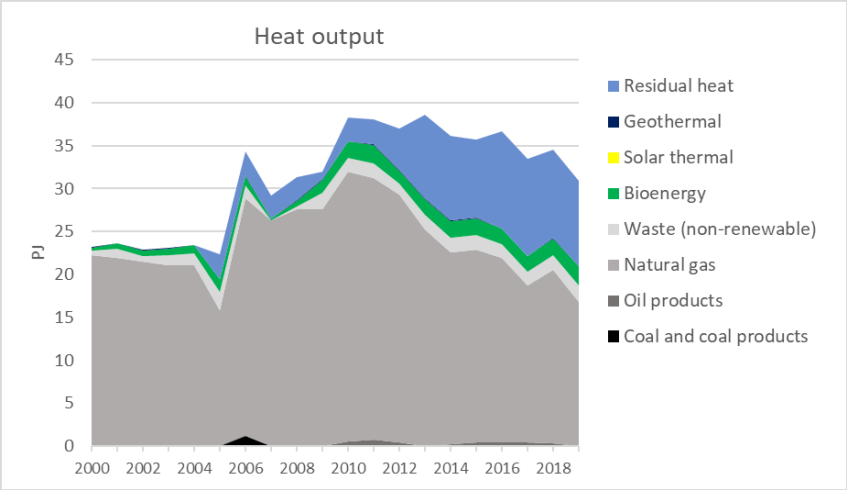

***Figure 6**: Evolution of fuels for heat output in Belgium 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Policy framework

The main relevant policy instruments behind these evolutions are:

- Green certificates in the Walloon and Brussels Region are based on CO_2 savings of power and CHP installations (compared to natural gas reference). This also encompasses CO_2 savings for renewable heat production in CHPs.
- Since 2013 there is a yearly 'Green heat call' in Flanders which is providing support for medium scale facilities. It also includes support for biomethane injection. Nevertheless, there was only room to support a limited number of projects, and in recent years the focus of the call is shifting more towards the valorisation of residual heat instead of renewable heat.
- Energy performance requirements in buildings require low-energy buildings, with a maximum use of renewable energy for the remaining energy requirements.
- Subsidies from Walloon Government to plant 4000 km of hedges and wooded strips for farmers and landowners (and maintaining existing ones) to produce local wood chips and provide local energy supply (boilers, CHP…).
- Wood for residential heating is an important part of the renewable heat in Belgium. Historically this was the case and no changes are expected in the future. In Wallonia, an awareness campaign was launched to promote the proper use of logwood in domestic stoves. In Flanders a Green Deal was negotiated to mitigate negative effects from residential wood combustion, with a focus on air quality effects.

TRANSPORT

Figure 7 shows an overview of the energy used in transport in Belgium, split up by different fuels/energy carriers.

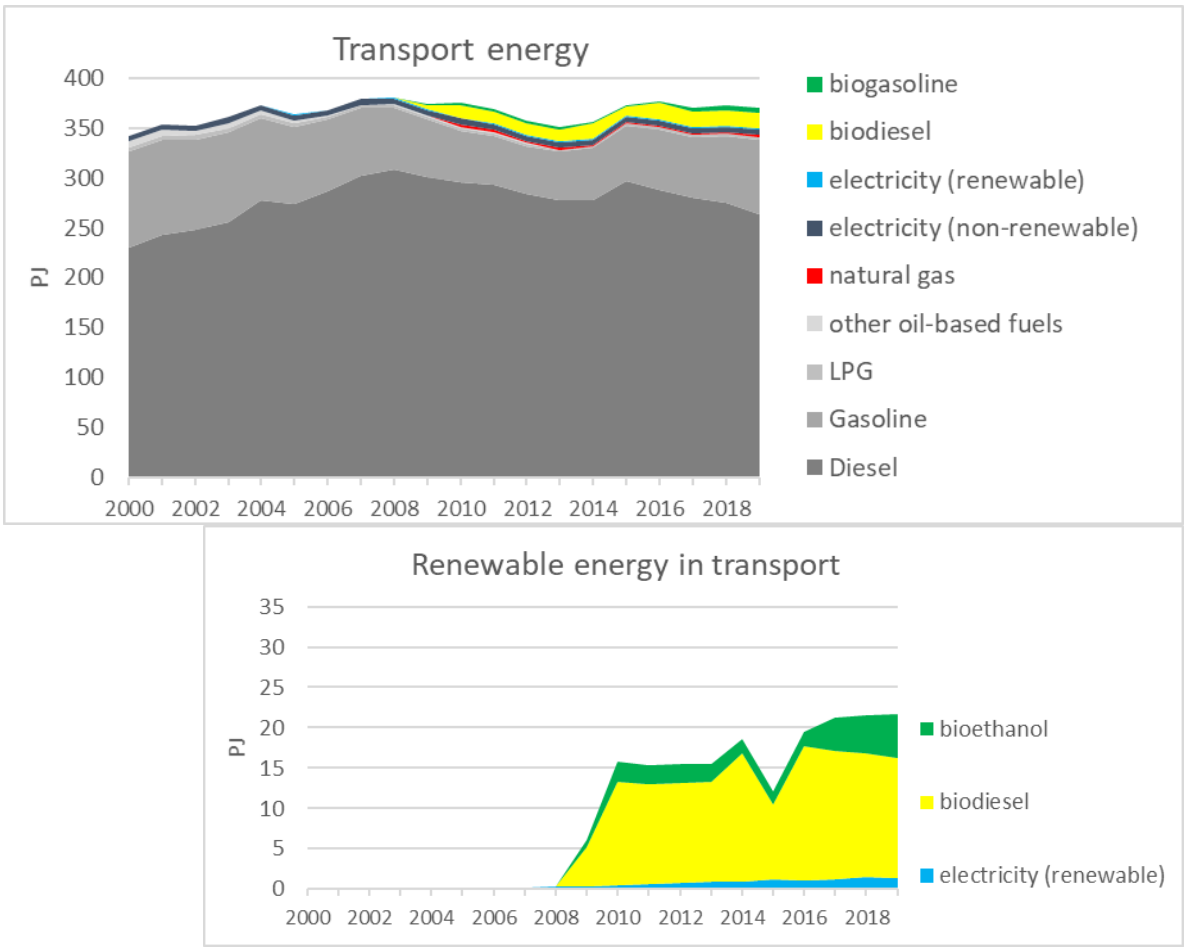

***Figure 7**: Evolution of transport fuels in Belgium 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Diesel represents 75% of transport fuel consumption in Belgium. The role of gasoline has been declining up to 2013 due to the popularity of diesel cars (due to CO_2 based car taxation), but gasoline cars are now regaining some of the market share (with higher taxes on diesel fuel). Up to 2010 there was a strong increase of biofuels; this was predominantly biodiesel considering the dominance of diesel in the fleet. Levels rather stabilized after that around 4% of overall transport energy consumption. In recent years there is an increase of bioethanol use, linked to the general distribution of E10, increasing the role of biofuels to around 5.5% of transport energy consumption.

Electricity represents a share of 1.8% of total transport energy use. This is mostly in rail - the use of electricity in road vehicles is still marginal in 2019 (0.09% of total transport energy use) but can be expected to grow in the coming years.

Policy framework

The main relevant policy instruments behind these evolutions are:

- In 2006 the Belgian government assigned quota to specific biofuel producers (after a public

tender) for certain volumes of biodiesel and bioethanol that could be mixed in transport fuels with tax reduction.

- A Federal law of 22 July 2009 introduced a blending mandate of 4% (by volume), both for biodiesel in diesel and bioethanol in gasoline.
- This law was replaced by the federal law of 17 July 2013 ruling the obligatory incorporation of biofuels in fossil fuels. The obligatory level of biodiesel was increased to 6% (also connected to the new European diesel norm that increased the maximum level of FAME in diesel from 5% to 7%vol).
- E10 is on the Belgian market since 2017 and has overtaken the role of E5 as it is lower taxed.
- A Royal decree of 4 May 2018 introduced an obligation of 8.5% biofuels for 2020 (by energy, including double counting for advanced biofuels).

COMPARISON WITH RENEWABLE ENERGY TARGETS

According to Eurostat[12], the following renewable energy shares in *gross final energy consumption* were reached.

***Table 8**: Share of renewables in different sectors in Belgium, according to Eurostat, and compared to the 2020 target*

%	2005	2010	2015	2019	*2020 target*
Overall share	2.3	5.7	7.9	9.9	*13.0*
In heating & cooling	3.4	6.1	7.8	8.3	*12.0*
In electricity	2.4	7.1	15.5	20.8	*21.0*
In transport	0.6	4.7	3.8	6.8	*10.0*

The electricity sector is close to the 2020 target, but other sectors are quite distant from their target. Belgium will likely rely on statistical transfers from other countries to reach their overall renewable energy target.

Mind that some of these figures can differ from the IEA derived data because of different accounting rules. Particularly in transport the Eurostat shares are higher, which is due to the multiple counting of renewable electricity towards the transport target. The heating & cooling figure in Eurostat also includes heat pumps.

[12] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_335a&lang=en

RESEARCH FOCUS RELATED TO BIOENERGY

Flanders:

In Flanders the bioenergy research has broadened its scope to bio-based value chains, not only making energy but also materials and chemicals from biomass. The following receive important attention in research:

- The Bio Innovation Growth Mega Cluster (BIG-Cluster) is a cross-border 'Smart Specialisation Initiative' aiming at transforming Europe's industrial mega cluster in the Flemish Region, The Netherlands, and the German state of North Rhine-Westphalia into the global leader of biobased innovation growth. The overarching goal is a comprehensive feedstock change with a focus on regionally available biobased and sustainable raw materials, climate protection and safeguarding jobs in the mega region. BIG-Cluster aims at establishing novel value chains within the topics "Aromatics and Fine Chemicals from Woody Biomass", "Chemicals from CO and CO2" and "Aviation fuels from various feedstocks".

- The region of Flanders has at the moment 40 anaerobic co-digestion installations producing biogas. Research is focusing on the use of the digestate after the digestion. Under certain (environmental) restrictions, certified digestate can be returned to the agriculture fields. Research is focusing on separating parts of the wet fraction and converting these fractions into fertilizer and soil improvers, with similar characteristics. A first demonstration at full scale on ammonia stripping will be implemented.

- Significant attention is given to research on the cascading principles in the use of biomass. As a general rule the use of biomass for non-energy applications (materials and chemicals) is favoured over use for bioenergy.

- Flanders Industry Innovation Moonshot: From 2020 to 2040, the Flemish Government will invest an annual 20 million euros in Flanders Industry Innovation Moonshot, totalling 400 million euro. These funds will, through innovative research, focus on the development of breakthrough technologies by 2040 for new climate-friendly processes and products. These innovative products and processes. Biobased chemistry is one of the 4 research trajectories.

- Flanders Biobased Valley is a non-profit organisation supporting the development of biobased activities and resulting economic growth in the region of Flanders. It promotes the development of the biobased economy of the future through collaborative programs, joint initiatives, and synergy creation between the partners in the fields of Research & Development, structural measures and policy, logistics and communication towards the general public.

- Lignin-based bio-refinery to bio-aromatics: Universities like KULeuven, UGent and research institutes like VITO and Bio Base Europe are researching possibilities of using wood-based lignin for the production of bio-aromatics in a bio-refinery concept. A Shared Research Centre 'Biorizon' has been created by TNO (the Netherlands) and VITO (Flanders) in 2013, to co-create technologies for the commercial production of bio-aromatics. Together with industrial partners, Biorizon develops technologies to use residual biomass and recycle streams for the production of bulk and specialty aromatics.

Wallonia

Valbiom is responsible for the development of biomass and biobased value chains and networking of actors in this sector. This structure oversees several missions/projects:

- Develop and structure non-food value chains for agricultural biomass as renewable materials or fuels.

- Study the potential of biomethane in Belgium and, more specifically, evaluate the potential to use biomethane as a substitute for fossil gas by horizons 2030 and 2050. Study led by gas.be at the Federal level.

- Stimulate and structure the development of an economic sector based on the valorisation of technical plant fibres of agricultural origin

- Create a value chain for hedge trimming waste, in the frame of the project “LEADER: Improvement of the ecological function of the hedges by the diversification of their uses".

Research projects in Wallonia:

- H2GREEN: Development of the photoenzymolysis of water based on the use of PSII to lead to the production of H2 (Hydrogenase), NH3 (Nitrogenase) or Carbohydrates (Carboxylase) by recombinant Core-enzymes.

- HYSTACK: The objective of the HyStack project is the development of a test bench allowing the characterization of hydrogen fuel cell stacks in operation for powers up to 10 kW.

- LOOP FC: The goal of the project is to develop from existing EHP products (spreader and two-phase loop) a system that will recover the waste heat from fuel cell stacks for micro-cogeneration systems. In doing so, the two-phase loop and spreader system will standardize the temperature and simultaneously cool the stacks in order to improve overall performance and potentially lifespan thanks to better control of the temperature of the stacks.

- OPTI-AGV: The OPTI-AGV project aims to integrate electrodialysis into the biomethanisation/anaerobic digestion process as a tool of improvement and flexibility in the production of biogas, electricity and biofuel.

- INTERESTS: INTEgrated Renewable Energy power STationS. Integrating local renewable energy production and local consumption. This includes the choice of the renewable energy to introduce and become autonomous as much as possible, the choice of energy storage, with or without hydrogen. Research is done on MOFs. The final aim is to be economically sustainable.

- WallonHY: Improving the efficiency of electrodes in alkaline electrolyser at pilot scale. The second part of the project is to determine the potential of introducing power to hydrogen and power to mobility in Wallonia with the help of techno-economic, legal, and regulatory analyses.

- TTCOGEN: Application for heat and electricity, biogas cogeneration in lean gas engine

- HYDEAI: Hydrogen production, electrolysis improvement

- Boiler development: Applications for heat and electricity, micro-cogeneration for biomethanisation

- COOPILOT BIOMGT: Biochemical (incl. anaerobic digestion), biomethanisation technologies

(micro-cogeneration integration)

- HYFLUX: Hydrogen production, Green H2, water electrolysis, electrodes improvement

A FEDER research program on Energy Efficiency and Sustainable Development (C3E2D) is ongoing until 2023 (http://www.c3e2d.eu/). This program consists of a cluster of research projects related to energy efficiency:

- ENERBIO: The ENERBIO project aims to develop expertise in the Walloon Region in the generation of biofuels (liquid and gaseous) from different biomass sources, and their valorisation in energy systems (e.g., residential cogeneration) and to improve the carbon footprint of particularly energy-intensive processes (e.g., glass melting). One of the objectives is to control the conversion of fermentable, high moisture biomasses, not adapted to thermochemical conversion processes, into basic molecules to produce new types of biofuels.

- ALGOTECH: microalgae production platform for its valorisation in biofuels and high value biochemicals,

- CLEARPOWER and STOCC: electric and thermal energy storage in building components,

- PEPSE: flexible renewable energy management with a semi-virtual test station system.

Several regional and Europeans (Interreg) projects are also ongoing, for example:

- The PERSEPHONE project aims to integrate the anaerobic digestion process in the bioeconomy. Actions:
    - Diversification of biogas infrastructures by integrating renewable hydrogen and refining the digestate.
    - Algae production in the Greater Region to stimulate new markets. -Agronomic trials: the digestate and its fractions in substitution of the chemical fertilisers: impact on the grounds and water quality.
    - Collaboration with companies and services involved in water management and environmental protection to objectify the contributions of the biomethanisation sector to the maintenance of water quality and aquatic environments. -Economic estimate and economic feasibility of the various actions for the biogas sector by 2020-2030.
- NEW-C-LAND and WALLPHY: Production of biomass in marginal lands, phytoextraction and phyto-management: https://www.newcland.eu/en/
- AGRIWASTE VALUE: Development of local supply chains for the valorisation of agri-residues into high-value cosmetics and nutraceuticals : https://www.agriwastevalue.eu/en

Brussels

- TTCogen (2021-2025): Local biomass valorisation through gasification and cogeneration by means of a Homogeneous-Charge Compression-Ignition (HCCI) motor.

RECENT MAJOR BIOENERGY DEVELOPMENTS

In the past years biomethane production and injection in the grid has been initiated, both in Flanders and Wallonia, e.g., in Beerse (2019) and Fleurus (2020), producing biomethane from municipal and agricultural residues (food, animal, park and garden waste).

Engie permanently closed its 80 MW biomass power facility in Les Awirs, Wallonia in August 2020. Unit 4 of Les Awirs was converted to 100% biomass-firing in 2005 and consumed about 400 kt/yr of wood pellets when running on full capacity. Engie is currently considering the possibility of a new gas-fired power plant on the site. Engie still operates a 205 MW biomass-fired plant in Rodenhuize, Flanders. This plant was converted from coal in 2011 and is expected to operate for a few more years. It is not expected that new large scale (>20MW) biomass power plants will be installed in Belgium.

Flanders

Cargill plans to invest in the construction of a new multi wastes and residues based biodiesel plant in Ghent. It will be capable of processing all kinds of feedstocks, including acid oils from vegetable oil refining, liquid residues from industrial processes, and the fat recovered from sewage sludge from local municipalities. The production capacity of the biodiesel plant would be around 115,000 metric tons per year. Construction will commence in October 2020, with the plant due to open in June 2022. The investment for the plant will be around 150 million euros. Cargill already has an operating multi-seed crush plant and a semi-refinery for vegetable oils present on the Bioro site.

ArcelorMittal, Ghent: STEELANOL - production of sustainable, advanced bioethanol through an innovative gas-fermentation process using exhaust gases emitted in the steel. A 165 million euro industrial-scale demonstration plant that will capture waste gases from the blast furnace and biologically convert them into recycled-carbon ethanol. Once complete, the plant is expected to produce up to 80 million litres of recycled-carbon ethanol a year. The project is expected to be completed in 2022. On the same site, ArcelorMittal plant to build a 50-million-euro demonstration plant to convert waste wood into bio-coal, partially replacing the coal currently injected into the blast furnace. In the early stage, the Torero plant will be able to convert up to 60,000 tonnes of waste wood into around 40,000 tonnes of bio-coal every year. This volume will be doubled in a second stage of the project.

Alco Bio Fuel (ABF) is one of Belgium's major biorefineries processing grain (mostly corn/maize) into bio-ethanol, protein-rich animal feed: (DDGS), liquid CO2, and a number of other by-products such as corn oil. They are investing 10 million euros in a second carbon dioxide recovery unit, which will be operational in the spring of 2022, bringing the annual capture of green CO2 to 160,000 tons. The CO2 will be released when ABF processes biomass into ethanol. After capture and treatment, the CO2can be reused in the food and beverage industry, greenhouse horticulture, water purification, refrigerated transport or as a chemical raw material.

Wallonia

In Wanze, BioWanze SA operates one of the most innovative bioethanol production facilities in Europe. With a production capacity of 300,000 m^3 bioethanol, BioWanze is the largest bioethanol producer in Belgium. The plant also produces more than 350,000 tons of liquid animal feed and

55,000 tons of gluten. A biomass power plant uses the husks of the delivered wheat grain to generate a large part of the required thermal and electrical process energy. A further biomass power plant is in the planning stage, to completely reduce fossil fuels input.

LINKS TO SOURCES OF INFORMATION

5th Renewable energy progress report Belgium 2017-2018. Available at: https://ec.europa.eu/energy/topics/renewable-energy/progress-reports_en#5th-progress-report-from-ms-reference-year-2017-2018-

National Energy & Climate Plan 2021-2030. https://economie.fgov.be/nl/themas/energie/energiebeleid/belgische-context/het-nationaal-energie-en; https://economie.fgov.be/fr/themes/energie/politique-energetique/contexte-belge/plan-national-energie-climat

Actieplan voedselverlies en biomassa 2021-2025 (in Dutch) https://www.ovam.be/sites/default/files/atoms/files/VR%2020210423%20Actieplan%20voedselverlies%20en%20biomassa%202021-2025.pdf

VITO (2017): Het potentieel van bio-energie in Vlaanderen in 2030 (in Dutch) https://www.energiesparen.be/sites/default/files/atoms/files/Potentieel_biomassa_2030.pdf

Green Deal huishoudelijke houtverwarming (2018) (in Dutch) https://omgeving.vlaanderen.be/sites/default/files/atoms/files/GDHoutverwarming-document_def.pdf

Panorama de la filière biométhanisation en Wallonie 2020 (in French) https://www.wallonie.be/fr/publications/panorama-de-la-filiere-biomethanisation-en-wallonie-2020

Panorama des filières bois-énergie et agrocombustibles en Wallonie en 2018 (in French) https://energie.wallonie.be/servlet/Repository/panorama-des-filieres-bois-energie-et-agrocombustibles-en-wallonie.pdf?IDR=49095

Des projets témoins en bioénergies (2020) (in French) https://energie.wallonie.be/fr/des-projets-temoins-en-bioenergies.html?IDC=9068&IDD=114555

Circular Wallonia - Stratégie de déploiement de l'économie circulaire (2020) (in French) https://borsus.wallonie.be/files/EC%20Wallonia.pdf