IEA Bioenergy
Technology Collaboration Programme

Implementation of bioenergy in the European Union - 2024 update

Country Reports

IEA Bioenergy: 12 2024

This report was prepared based on data from the 2024 IEA World Energy Balances and Renewables Information[1], combined with data and information provided by the IEA Bioenergy Executive Committee and Task members. Reference is also made to FAOstat and Eurostat data. All individual reports were reviewed by the 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 18% of *total energy supply* in the EU27[2] in 2022. The renewable energy share in *final energy consumption* was 22%[3], of which 60% from biomass.
- Energy supply in the EU still relies for around 70% on fossil fuels, particularly oil and gas. In terms of fossil fuels, the European Union has a high import dependency (95% for oil, 88% for gas and 53% for coal), making its energy production and economy quite vulnerable.
- In contrast to fossil fuels, for bioenergy carriers and waste (used for energy) net import dependency is below 5%. In fact, production of bioenergy carriers and waste in the EU is at similar level as the combined production of crude oil, natural gas and coal in the EU. In several European countries bioenergy has made a major contribution to energy security.
- Solid biofuels (for residential use, industry use, and for transformation to power and/or heat) represent almost 70% of bioenergy supply, but liquid biofuels, biogas and renewable waste also play a substantial role.
- Electricity production in the EU can be divided in three parts: fossil-based power at 38%, nuclear

[1] www.iea.org/statistics

[2] In 2020 the United Kingdom withdrew from the EU, bringing the number of member states back from 28 to 27. All data in the document (also data from before 2020) refer to the total of the current 27 countries of the EU.

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

power at 22% and renewable power at 39% in 2022. Fossil power is largely based on natural gas, but also coal still has an important share in power production.

- Renewable power consists of a stable amount of hydropower, a slightly growing amount of biomass-based electricity (producing 6% of EU power, often in CHP mode) and fast increasing shares of wind and solar power.

- Heat production and transport energy are still dominated by fossil fuels. Bioenergy/biofuels are the main sources of renewable energy in these sectors.

- Fuel/heat consumption (excl. electric heating) in the EU is still for almost 70% based on fossil fuels (particularly gas), with 18% direct use of biomass for heat in the residential sector and in industries. Distributed heat represents 12% of heat provision, of which almost one third is based on biomass.

- Diesel fuels represent two thirds of transport energy in the EU, hence there is an important role for biodiesels. Between 2004 and 2010 there was a strong increase of biofuels up to a combined level of 5% (by energy) of transport energy. However, these levels stalled between 2010 and 2016 - due to uncertainties regarding indirect land use change (iLUC) restrictions - while fossil fuel consumption in transport increased further. In recent years growth of biofuels has resumed again.

- On average, biodiesel (FAME and HVO together) represented 7.2% by energy of diesel consumption in 2022, with most countries offering B7 (up to 7% biodiesel by volume) as standard diesel fuel. Bioethanol on average represented 4.7% by energy of gasoline consumption. Several countries offer E10 (up to 10% ethanol by volume) as gasoline fuel; other countries still only offer E5. Almost 40% of biofuels consumed in the EU27 in 2022 are qualified as ‘advanced biofuels’, meaning that they are produced from residues and waste (particularly used oils for biodiesel).

- The different uses of biogas represented around 4-5% of total gas consumption in the past decade. In recent years, levels of biogas are increasing; the main growth is now in biomethane production for injection in the natural gas grid. This is also triggered by the European strategy to move away from Russian gas imports.

CONTENTS

PROFILE

Population and land use

The European Union (EU) is a political and economic union of European member states. In 2022, the EU had 27 member states; in the further text, we will often refer to the current European Union as EU27. The EU27 has a total land area of 4.0 million km² and a population of 447 million people, which represents an average population density of 111 persons per km². Climate conditions are diverse, from temperate maritime in the southwest, Mediterranean in the south, continental climates in central Europe and boreal climates in the north.

Around 40% of the land area in the EU are woodlands, of which about one third planted forests and two thirds naturally regenerating forest. Agricultural land represents a similar share of 40%, of which one third are permanent grasslands, and a bit less than two thirds are cropland; a small part are permanent crops (such as orchards, vineyards, olive plantations).

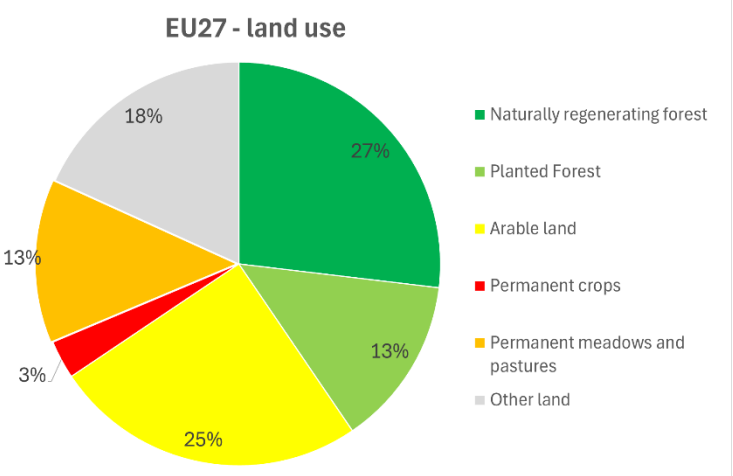

***Figure 1**: Land use in the EU27 (2022 figures - Source: Eurostat)*

Final energy consumption

Overall final energy consumption in the EU27 (*also including non-energy use of oil, natural gas, and coal in industry*) equates 2.16 tonnes of oil equivalent (toe) per capita. Industry, transport, and residential/services each represent around one third.

***Table 1**: Distribution of the final consumption of energy carriers by sector in the EU27 (2022 figures - data source: IEA (2024) World Energy Balances and Renewables Information)*

Final consumption energy carriers	Toe/capita (2022)	% of total	*Median* (toe/capita)*
Industry (energy use)	0.51	24%	*0.71*
Industry (non-energy use)	0.17	8%	*0.18*
Transport	0.62	29%	*0.66*
Residential	0.52	24%	*0.50*
Commercial & public services	0.26	12%	*0.32*
other	0.08	4%	*0.08*
Total	2.16		*2.50*

** Median of the 23 member countries of IEA Bioenergy*[4]

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

THE CONTRIBUTION OF BIOENERGY IN ENERGY SUPPLY

TOTAL ENERGY SUPPLY

The total energy supply (TES) of the EU27 in 2022 amounted to 54.6 exajoules (EJ). It is still for around 70% dominated by fossil fuels, particularly oil and gas, which represented 34% (21.9 EJ) and 23% (16.8 EJ) of total energy supply, respectively in 2022. Coal represented around 12% of TES (6.8 EJ), similar as nuclear energy at 12% of TES (6.6 EJ). Renewable energy sources had a share of 18% or 9.8 EJ. More than 60% of renewable energy supply in 2022 came from biomass (6.1 EJ), followed by wind energy (1.5 EJ), hydropower (1.0 EJ), solar energy (0.9 EJ) and geothermal energy (0.3 EJ).

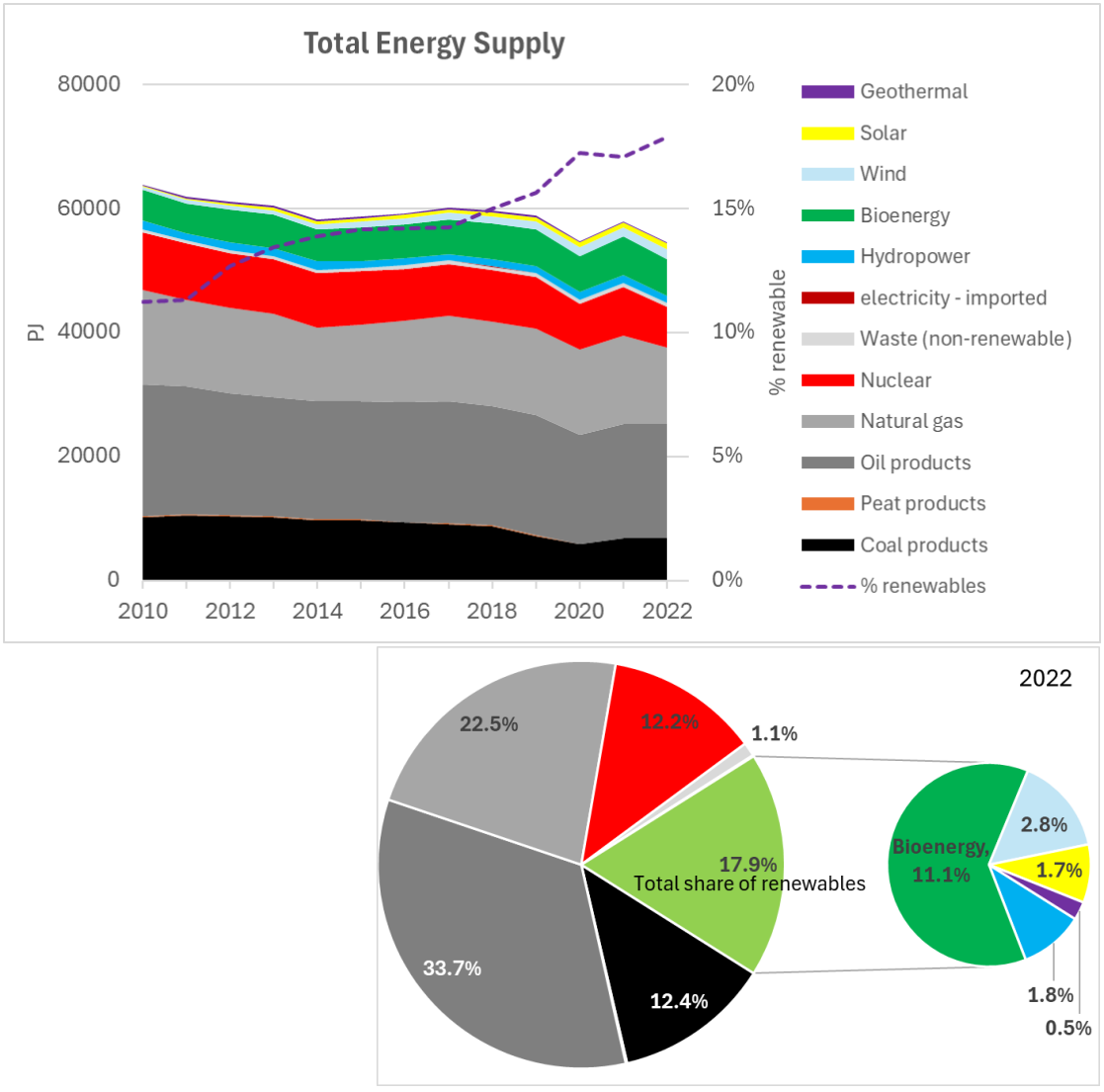

***Figure 2**: Total energy supply[5] and the contribution of different energy sources in the EU27, with distribution in 2022 (data source: IEA (2024) World Energy Balances and Renewables Information)*

[5] Total energy supply represents all the energy required to supply end users in the country. Some of these energy sources are used directly while most are transformed into fuels or electricity for final consumption. 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, coal or natural gas plants).

Overall, total energy supply declined between 2006 and 2014 from 66 EJ to 58 EJ, and more or less stabilized around 59 EJ between 2014 and 2019. In the Covid year 2020 there was a substantial drop compared to 2019, followed by a slight recovery in 2021, and a drop to 2020 levels again in 2022 due to the energy crisis triggered by the invasion of Russia in Ukraine.

- **Oil** supply steadily declined between 2005 and 2013 from 24 EJ to 19 EJ, followed by a stabilisation at that level between 2013 and 2019. In the Covid year 2020 – with a major reduction in transport movements - there was a 9% drop in oil consumption to 17.6 EJ. Levels have gone back to 18.4 EJ in recent years.
- **Natural gas** saw some decline from 15 EJ to 12 EJ in the 2005-2014 timeframe. However, by 2019, levels had increased again up to 14 EJ. After a slight dip in demand in the Covid year 2020, in 2021 levels returned to 14 EJ. In 2022 there was a 13% drop in natural gas supply compared to 2021, which can be linked to the Russian invasion in Ukraine, leading to price spikes of natural gas and measures to reduce Europe's reliance on Russian gas.
- **Coal** used to be relatively stable around 12 EJ up to 2007, but has consistently declined since afterwards, down to 6.8 EJ in 2022 (with a temporary drop to 5.9 EJ in 2020).
- **Nuclear** energy declined slightly from 10 EJ in the early 2000s to 8 EJ in 2021. In 2022 there was a drop to 6.6 EJ. This was mainly related to a temporary shutdown of several French nuclear power plants (France produces more than half of the European nuclear energy), but there were also some permanent closures of nuclear plants in other member states.
- The share of **renewable energy** in TES increased from 7% in 2005 to 14% in 2014. Levels of renewable energy stabilized somewhat between 2014 and 2017. Since 2017 there has a clear acceleration in renewable energy, particularly in wind and solar energy, but there was also growth in bioenergy.

EVOLUTION OF BIOENERGY IN TOTAL ENERGY SUPPLY

Figure 3 shows the evolution of the different bioenergy carriers. Overall use of bioenergy has continued to grow in the past decade, from 4.9 EJ in 2010 to more than 6 EJ in 2022. Solid biofuels remain dominant reaching 4.2 EJ in 2022, or almost 70% of bioenergy supply. 13% of bioenergy comes from liquid biofuels (0.8 EJ), 11% from biogas (0.7 EJ) and 7% from the renewable share of waste (0.44 EJ).

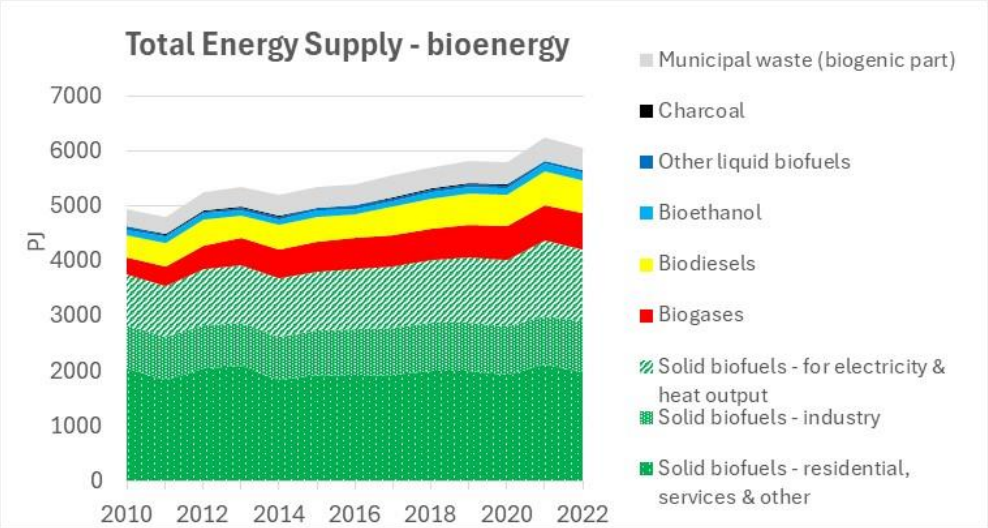

Figure 3: Development of total energy supply from bioenergy in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

Evolution of the bioenergy carriers:

- The use of solid biomass in residential applications has been fairly stable in the past decade around 2.0 EJ. The use of solid biomass in industries slightly increased in the same period from 0.79 to 0.91 EJ. The main growth of solid biofuels was in energy plants (producing electricity and/or heat), steadily increasing from 0.93 EJ in 2010 to 1.37 EJ in 2021. In 2022 there was a slight drop as the increase in energy prices, as well as the ban on Russian pellet imports to the EU, also increased pellet prices.
- Liquid biofuels saw a strong growth between 2004 and 2010 from 0.1 EJ to 0.6 EJ. However, between 2010 and 2016 growth has stalled, likely related to uncertainties on how indirect land use change (iLUC) would be handled in legislation. Since 2017 (after the publishment of the ILUC directive), growth has picked up again up to 0.8 EJ in 2022. Liquid biofuels will be further discussed in the chapter on transport.
- Biogas had a strong growth between 2006 to 2013 from 0.13 to 0.50 EJ, with most biogas produced in Germany. Since 2014 there has still been growth, but at lower pace, reaching 0.67 EJ in 2022. Biogas and biomethane will be further discussed in a dedicated chapter.
- Renewable energy from MSW grew steadily from 0.15 EJ in the early 2000s to 0.40 EJ in 2017. Levels have stagnated around that level after 2017.

ENERGY DEPENDENCY

The following graphs show the difference between domestic production and domestic use of different energy carriers of all EU members together. Based on the difference between these figures, we can deduct the energy import dependency of the EU27.

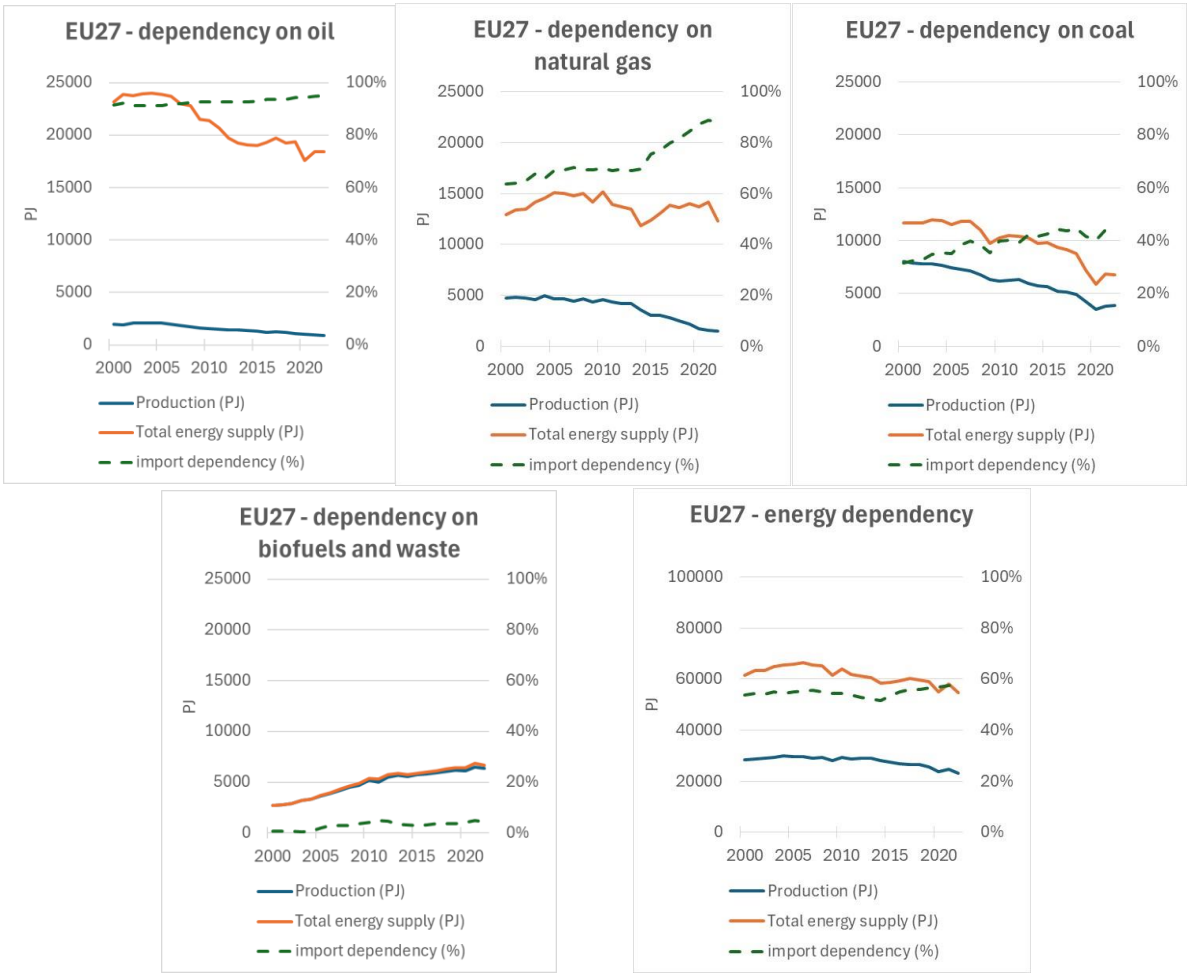

Figure 4: Evolution of energy import dependency for different energy carriers in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

In terms fossil fuels, the European Union has a high import dependency, which makes its energy production and economy quite vulnerable. For its oil, gas and coal supply the EU is for respectively 95%, 88%, and 53% dependent on imports from outside the EU. Particularly for natural gas, there has been a problematic evolution since 2014, with slight increases in gas supply but declining production in the EU, leading to a growing reliance on Russian gas imports.

In contrast to fossil fuels, for bioenergy carriers and waste net import dependency is below 5%. In fact, overall domestic production of bioenergy carriers and waste (for energy) counted for 6.4 EJ in the EU in 2022, while total domestic production of oil, coal and gas together counted for 6.3 EJ. In several European countries bioenergy has made a major contribution to energy security.

With nuclear energy, most bioenergy, as well as other types of renewable energy (hydropower, solar, wind, geothermal energy) being produced domestically, this leads to an overall energy import dependency of 58% in the EU27.

When looking at the different bioenergy carriers, in 2022 there were net imports of 104 PJ solid biofuels (2.5% of solid biofuel consumption in the EU), 43 PJ bioethanol (30% of consumption in the EU) and 99 PJ biodiesel (16% of consumption in the EU). Mind that some of the biofuel production in the EU depends on imported feedstocks from outside the EU (e.g. corn imported from North America or used cooking oil imported from Asia).

POLICY FRAMEWORK IN THE EUROPEAN UNION

TARGETS AND STRATEGIES

Promotion of modern bioenergy, together with other renewable energy sources, started with the Renewable Electricity Directive (*Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market*[6]) and the Biofuels Directive (*Directive 2003/30/EC on the Promotion of the use of biofuels and other renewable fuels for transport*[7]). Both directives had a high focus on renewable energy produced from biomass. The strong influence of policy framework on renewable electricity, including bioenergy supply, can be observed in the Energy Balances of the 15 Member States[8] that were constituting the European Union at the time.

The **Renewable Energy Directive** (*Directive 2009/28/EC*[9] *of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC*), also call 'RED I' established a European framework for the European Member States for the promotion of renewable energy, setting mandatory national renewable energy targets for achieving an overall 20% share of renewable energy in the EU final energy consumption by 2020, with a sub-target for the transport sector of 10% renewables. RED I introduced sustainability criteria, which had to be met to have bioenergy counted towards the national and Union's mandated targets. This was to achieve a more coherent approach between energy and environmental policies. It started from requirements for transport biofuels and bioliquids and announced that "the requirements for a sustainability scheme for energy uses of biomass, other than bioliquids and biofuels, should be analysed by the Commission in 2009, taking into account the need for biomass resources to be managed in a sustainable manner". Sustainability criteria were comprised of both minimum greenhouse gas emission savings from biofuels as well as sustainable sourcing of biomass or land use restrictions.

In 2018, as part of the 'Clean energy for all Europeans' package, the Renewable Energy Directive was updated in Directive (EU) 2018/2001[10] or RED II. This directive, which had to be transposed into national law by EU countries by June 2021, established a new binding renewable energy target for the EU of at least 32% of gross final energy consumption by 2030, along with an increased target of 14% for the share of renewable fuels in transport by 2030. It included limits on crop-based biofuels at 7% and a specific target for advanced biofuels (minimum share of 3.5%). The sustainability criteria for biofuels were further strengthened and extended to solid and gaseous biomass fuel.

[6] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0077&from=en
[7] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0030&from=en
[8] BE, DK, DE, GR, ES, FR, IE, IT, LU, NL, AT, PT, FI, SE, UK
[9] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (europa.eu)
[10] Directive - 2018/2001 - EN - EUR-Lex (europa.eu)

In 2020 the European Commission adopted the Green Deal[11], which aims to make the European Union climate neutral by 2050. In April 2021 European Parliament and Council agreed on an intermediate target of 55% GHG reduction by 2030. For the achievement of the 2030 target, the European Commission adopted a set of policy proposals in July 2021 under the "**Fit-for-55" Package**.

In response to the hardships and global energy market disruption caused by Russia's invasion of Ukraine, the European Commission is implementing its **REPowerEU** Plan to phase out Russian fossil fuel imports. Launched in May 2022, REPowerEU is helping the EU to save energy, diversify energy supplies and produce clean energy. Within REPowerEU, biomethane got under a spotlight with the aim of increasing the EU's biomethane production, either as biogas or its upgraded version, to reach 35 billion cubic metres (bcm) per year by 2030 and the estimated investment need for the period amounts to €37 billion[12]. Energy and climate targets become intertwined as under the Regulation on the Governance of the Energy Union and Climate Action, the EU has adopted integrated rules to ensure planning, monitoring and reporting of progress towards its 2030 climate and energy targets and its international commitments under the Paris Agreement.[13] Biomass, together with its ecosystems, extraction and end-use, become multifunctional with numerous targets across different policy domains, creating high demand and pressure on the biomass supply chains.

In November 2023, a next revision of the Renewable Energy Directive (Directive EU/2023/2413 or **RED III**) entered into force, as part of the Fit-for-55 Package. It sets an overall renewable energy target of at least 42.5% binding at EU level by 2030 - but aiming for 45%.

With a view to achieving the increased target for greenhouse gas emissions savings set by the European Climate Law (Regulation (EU) 2021/1119), the level of renewable energy supplied to all transport modes in the Union is to be increased. Allowing the Member States to choose between a transport target expressed as a greenhouse gas intensity reduction target (at least 14.5% by 2030) or as a share of the consumption of renewable energy (at least 29%[14] by 2030) provides the Member States with an appropriate degree of flexibility to design their policies to decarbonise transport. Furthermore, introducing a combined energy-based target for advanced biofuels and biogas, including a minimum share for renewable fuels of non-biological origin, would ensure an increased use of the renewable fuels with smallest environmental impact in transport modes that are difficult to electrify such as maritime transport and aviation.[15]

Biofuels consumption is expanded from road to maritime and aviation transport. FuelEU Maritime sets maximum limits for the yearly average greenhouse gas (GHG) intensity of the energy used by ships above 5,000 gross tonnage calling at European ports, regardless of their flag. Targets will ensure that the GHG intensity of fuels used in the sector will gradually decrease over time, starting with a 2% decrease by 2025 and reaching up to an 80% reduction by 2050[16]. ReFuelEU Aviation[17] promotes the increased use of sustainable aviation fuels (SAF) as the single most powerful tool to decrease aviation CO_2 emissions. SAF includes synthetic aviation fuels, advanced and other aviation

[11] EUR-Lex - 52019DC0640 - EN - EUR-Lex (europa.eu)

[12] Biomethane - European Commission (europa.eu)

[13] 2030 climate targets - European Commission (europa.eu)

[14] Including multiple counting mechanisms for different types of renewable fuels and renewable electricity

[15] Directive - EU - 2023/2413 - EN - Renewable Energy Directive - EUR-Lex (europa.eu)

[16] Decarbonising maritime transport – FuelEU Maritime - European Commission (europa.eu)

[17] ReFuelEU Aviation - European Commission (europa.eu)

biofuels, as well as recycled carbon aviation-fuels. These blended aviation fuels are fully compatible with the current technology and certified to reach a SAF blend of up to 50%. Research and innovation are being devoted to increasing the maximum blending rate to 100% to untap the full potential of SAF. The targets are 2% and 50% of share of SAF in EU airports from 2025 and 2050, respectively, and 1.2% and 35% share of synthetic aviation fuels in all EU airports from 2030 and 2050, respectively. The definition of SAF is set out in Article 3(7) of the ReFuelEU Aviation Regulation[18]. It covers drop-in aviation fuels compliant with the sustainability criteria of the Renewable Energy Directive (RED).

RED III brings stringent criteria for biomass sourcing (e.g. no-go areas, protection of especially biodiverse and carbon-rich habitats, such as primary and old-growth forests, highly biodiverse forests, grasslands, peat lands and heathlands, high iLUC crops) and achieved GHG emission savings to be counted against the Union target if biomass is used for electricity, heating and cooling. RED III also lowers the thresholds for installations on solid biomass fuels to fall under the sustainability criteria: from 20 MW to 7,5 MW installed thermal input. Member States are severely limited for granting new support or renew any support for the production of electricity from forest biomass in electricity-only installations.

In line with the principle of the cascading use of biomass, woody biomass should be used according to its highest economic and environmental added value in the following order of priorities: wood-based products, extending the service life of wood-based products, re-use, recycling, bioenergy and disposal. Where no other use for woody biomass is economically viable or environmentally appropriate, energy recovery helps to reduce energy generation from non-renewable sources.

For the transport sector, a Union database for biofuels (UDB) is set up, starting from November 2024, to enable the tracing of liquid and gaseous renewable fuels and recycled carbon fuels.

***Table 2**: renewable energy and climate targets in the EU27.*

Sector	Share of renewables in gross final consumption per sector	GHG reduction target compared to base year 1990
Overall target	42.5% (45%) by 2030	-20% by 2020 -55% by 2030 -100% by 2050
Transport	29%[19] by 2020	-14.5% by 2030

The update of the **EC Bioeconomy Strategy and Action Plan** is foreseen for 2024, aiming at finding the best use of biomass to achieve climate targets. The main orientation of the EU future energy

[18] SAF are defined as: Synthetic aviation fuels from renewable hydrogen and captured carbon (in the meaning of Article 2(36) of RED and limited to liquid drop-in fuels only); Advanced biofuels from waste and residues notably (produced from feedstock listed in Part A of Annex IX, in the meaning of Article 2(34) of RED); Biofuels produced from oils and fats notably (such as from feedstock listed in Part B of Annex IX, in the meaning of Article 2(33) of RED); and Recycled carbon aviation fuels in the meaning of Article 2(33) of RED.

[19] Transport target is consisted of several subtargets by transport sector and type of renewable fuel. For details, please check: https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/biofuels_en

policy is enabling framework for renewables through simplifying permitting processes[20] and ensuring faster commercialisation of innovation in clean technologies (Strategic Technologies for Europe Platform[21]).

ROLE OF BIOENERGY IN DIFFERENT SECTORS

OVERVIEW

The overall 2022 share of renewables in **final energy consumption[22]** among electricity, transportation and heat sectors was 22%, with bioenergy making up 13% of the energy share (**Table 3**). Mind that these figures are slightly higher than the shares in total energy supply (where unused waste heat, e.g., in fossil and nuclear power production, is also included).

***Table 3**: Role of bioenergy and renewable energy in electricity, transport energy and fuel/heat consumption, as well as total final energy consumption in 2022*

Sector	Share of bioenergy	Share of renewable energy	Overall consumption
Electricity[23]	5.9%	38.5% *(15.1% wind; 9.9% hydro)*	2791 TWh (10.05 EJ)
Transport energy (final consumption)	6.1%	6.9%	11.67 EJ
Overall fuel and heat consumption[24]	Direct biomass: 17.8% Biobased heat: 3.8%	22.6%	17.39 EJ
TOTAL FINAL ENERGY CONSUMPTION*	**13.1%**	**21.9%**	**38.9 EJ**

Based on own calculations. Source of the data: IEA (2024) World Energy Balances and Renewables Information

Electricity represents 26% of final energy consumption, transport fuels (excl. electricity) represent 29% and other fuels/heat (excl. electricity) 45%. This shows the importance of fuels and heat production.

[20] Enabling framework for renewables (europa.eu)

[21] Strategic Technologies for Europe Platform - European Union (STEP) (europa.eu)

[22] Final energy consumption excludes non-energy use of coal, oil products and natural gas.

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

[24] 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.

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

ELECTRICITY

Electricity consumption in the EU27 has been relatively stable around 2900 TWh and can be divided into three parts: (1) fossil power - in 2022 at 38% of power production; (2) nuclear power - in 2022 at 22%; and (3) renewable power - in 2022 at 39%.

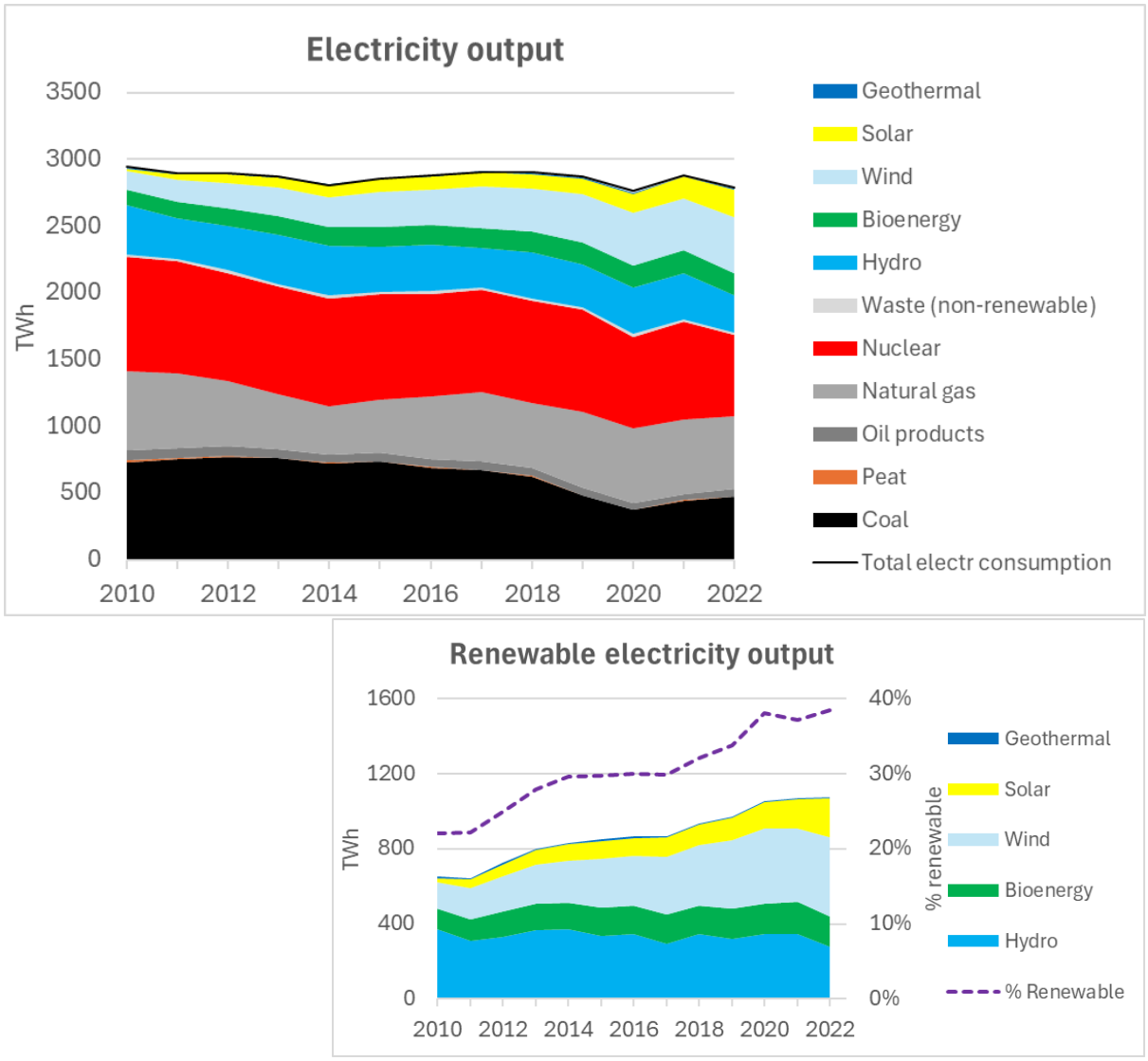

Figure 5: Evolution of the electricity mix in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

Fossil power has declined in the past decade, with mainly coal power going down. **Coal** power represented 25% of power production in 2010 (at 735 TWh) and up to 2015 levels were relatively stable around 750 TWh. After 2015 levels have dropped substantially to less than 500 TWh in 2019. After a drop in the Covid year 2020, there has been a slight revival of coal power in recent years. **Natural gas** power peaked at 21% of power generation in 2008 (at 615 TWh), but its share declined to 13% in 2014 (producing 360 TWh). However, natural gas power recovered again by 2019 up to a level of 570 TWh, representing 19-20% of power production in recent years, thereby compensating

for some of the reduction in coal power (and increasing Europe's dependency on Russian gas). **Oil** power only represented a maximum of 6% of power production in the EU in the early 2000s; this has dropped to 2% in recent years, mainly serving as back-up power.

Nuclear power has been and still is one of the important sources of electricity in the EU. In the early 2000s nuclear power represented one third (33%) of power production in the EU27, at around 900 TWh. Levels have dropped slightly to 29% in 2010 (850 TWh) and further to 25% in 2021 (730 TWh) due to the closure of some nuclear power plants in Europe (in countries that decided to phase out nuclear energy). In 2022, there was a 17% drop in nuclear power compared to 2021, which was largely due to reactor maintenance and repairs in France, which is the largest producer of nuclear power in the EU (producing half of EU nuclear power). Nevertheless, preliminary data for 2023 confirm the lower level of nuclear power, likely because of further closures of nuclear power plants in several countries.

Renewable electricity increased steadily from 15% of power production in the early 2000s to around 30% in 2014, with some stabilisation around this level in the period 2014-2017. Since 2018, levels have started to increase again up to 39% in 2022. Preliminary data show that there is a further increase to 44% in 2023. **Hydropower** used to be the dominating type of renewable power and has been fairly stable in the past decades – apart from some fluctuations due to dry winters – at around 350 TWh, typically around 12% of power production. The main growth in renewable power has been in **wind energy**, steadily increasing from 60 TWh in 2004 up to 420 TWh in 2022, which represents 15% of power production in the EU – preliminary data for 2023 show a further increase to 480 TWh (17.5% of EU electricity production). **Solar** power had a strong increase between 2008 and 2013, from 8 TWh to 80 TWh. In the years after, growth was more moderate to 118 TWh in 2019. Meanwhile, there has been a strong growth again, up to 206 TWh in 2022, 7.5% of EU electricity production - preliminary data for 2023 show a further increase to 245 TWh (9% of EU electricity production). **Biomass**-based electricity represented 6% of electricity production in the EU27 in the past few years, peaking at 170 TWh in 2021. As shown in **Figure 6**, bio-electricity can be split between solid biomass, biogas and renewable MSW. Solid biomass represents half of bio-electricity, biogas one third and electricity from the renewable share of MSW around 10%.

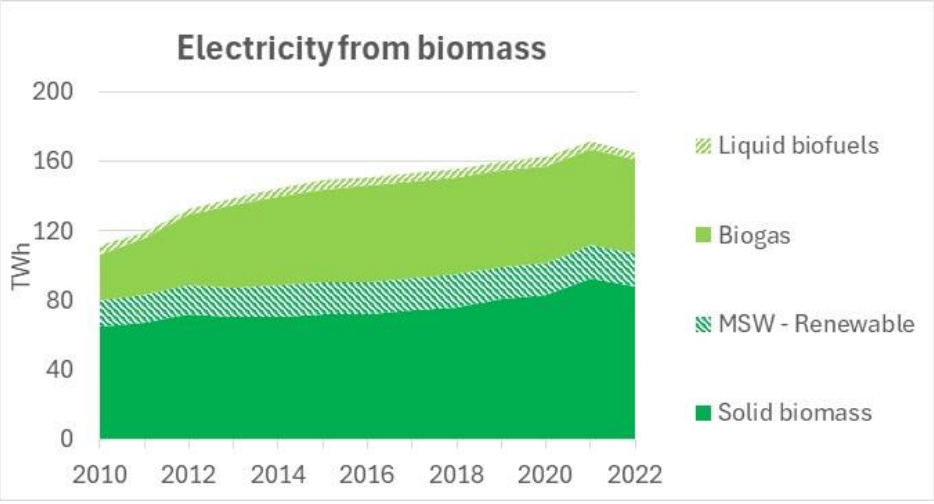

Figure 6: Evolution of electricity from biomass in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

Figure 7 shows the distinction between electricity produced in electricity-only plants and combined heat and power (CHP) plants for different types of energy carriers. Several EU countries have a good

tradition in CHP, while for others this is less the case. Overall, all nuclear power, 52% of gas power and 63% of coal power is produced in electricity-only plants, meaning that heat is condensed away. This also explains the difference between the contribution of nuclear energy to total energy supply (6.65 EJ – 12% of TES), compared to its contribution to final consumption via the produced electricity (2.19 PJ – 5.6% of final energy consumption).

On the other hand, 75% of biomass-based electricity is produced in CHP plants, which also produce useful heat.

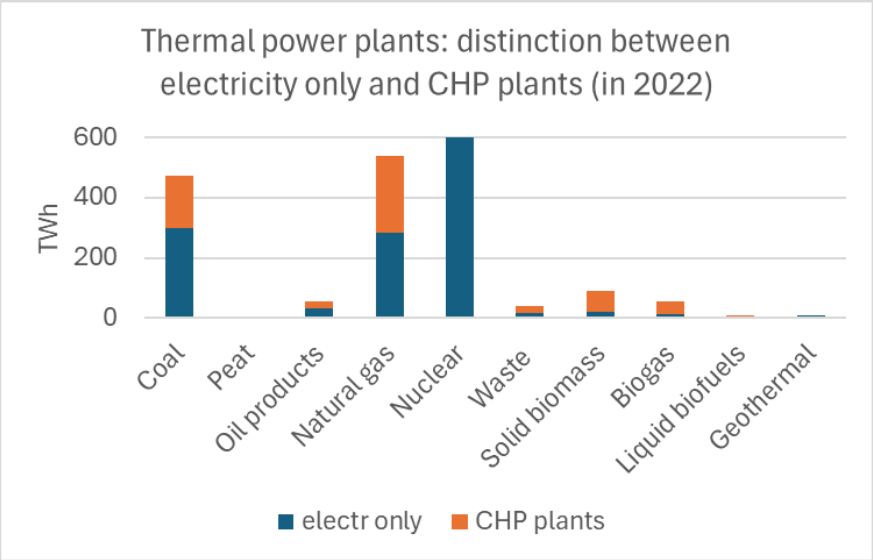

***Figure 7**: Electricity produced from electricity only vs CHP plants in the EU27 in 2022 (data source: IEA (2024) World Energy Balances and Renewables Information)*

Policy framework

The main relevant EU-level regulations impacting these evolutions are:

- Renewable Electricity Directive -Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market: indicative targets for the Member states
- Renewable Energy Directive (RED) - 2009/28/EC: overall target to reach 20% renewables by 2020, with Member states dependent targets.
- Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (RED II): overall target to reach 32% renewables by 2030.
- Amended by Directive EU/2023/2413 (RED III) in November 2023: renewable energy target of at least 42.5% binding at EU level by 2030 - but aiming for 45%.
- Effort Sharing Regulation (ESR) - 406/2009/EC & (EU) 2018/842: sets national targets for emission reductions from road transport, heating of buildings, agriculture, small industrial installations, and waste management (non-ETS)
- EU Emissions Trading System (EU ETS): The overall volume of greenhouse gases that can be emitted by power plants, industry factories and aviation sector covered by the EU ETS is limited by a 'cap' on the number of emission allowances. Within the cap, companies receive or buy emission allowances, which they can trade as needed. The cap decreases every year.

- Energy Efficiency Directive (EED) - 2012/27/EU: mandates energy efficiency improvements within the European Union. (*impact on electricity consumption*)

HEAT/FUEL

Figure 8 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[25].

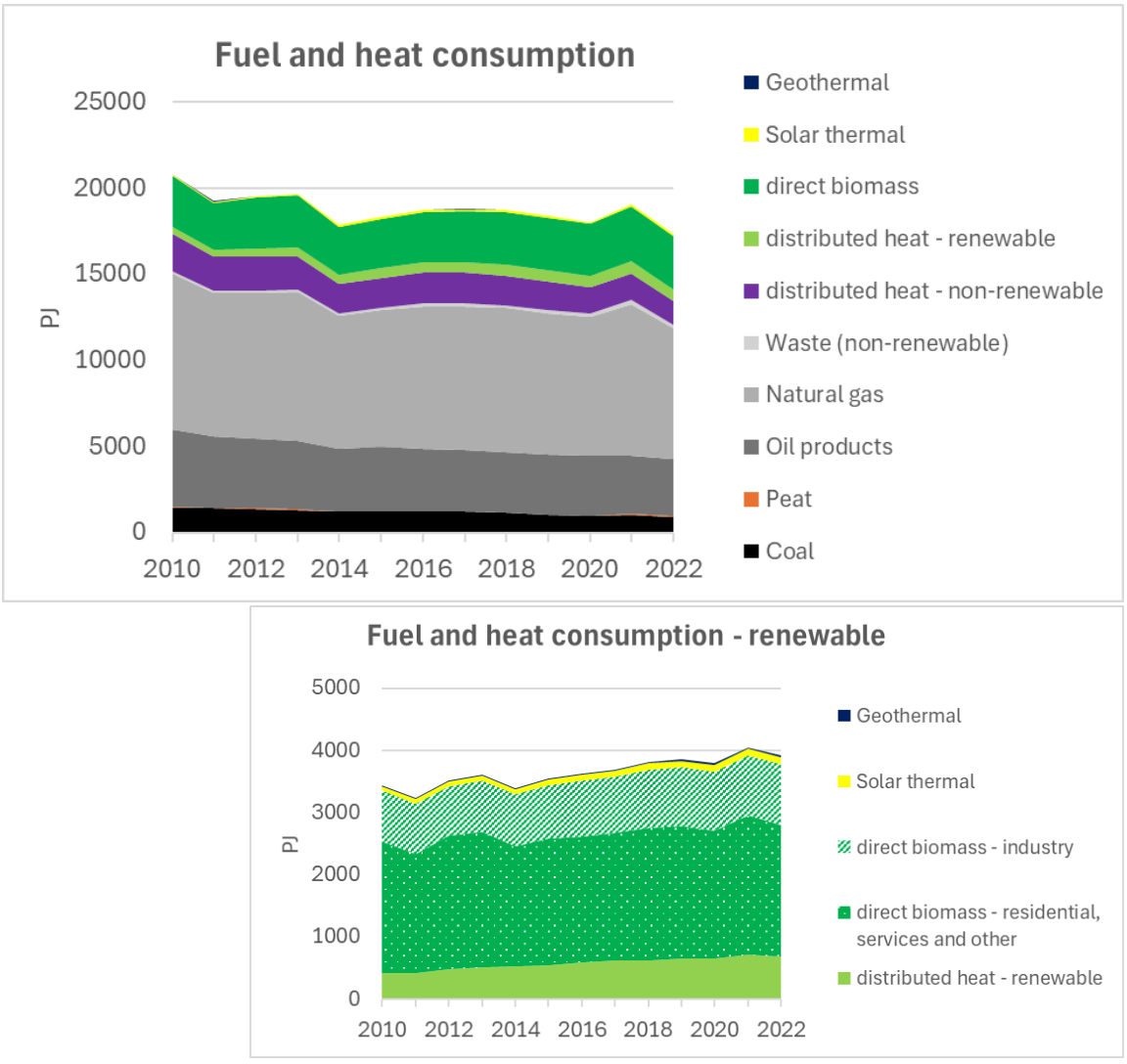

Figure 8: Evolution of fuel and heat consumption in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

The overall consumption of fuel/heat in the EU27 slightly declined up to 2014 and stabilized around 18-19 EJ in recent years. In 2022, there was a significant drop, mostly through lower natural gas consumption. This can be linked to the spike in natural gas prices in 2022, triggered by the Russian invasion in Ukraine.

[25] According to Eurostat, the contribution of heat pumps for heating in the EU27 in heating and cooling was around 700 PJ in 2022.

In 2022, the provision of fuel/heat was still for almost 70% based on fossil fuels, with natural gas being the main energy source (44%). The direct use of biomass as heating fuel represented 18% (3.1 EJ) in 2022 and is the main type of renewable in this sector.

Heat output generated and sold by CHP plants and heat plants (e.g. through district heating) represented around 12% of fuel/heat provided in the EU27 in 2022. Levels vary a lot between EU member states, with certain countries (like Denmark, Sweden or Austria) more focused on distributed heat. Overall, levels of heat sales in the EU27 have slightly reduced in the past decade. Heat output is on average still for almost 60% fossil based, with a dominant role for natural gas, but also still an important role for coal. The use of biomass for distributed heat production increased over the years and now represents one third % of heat output.

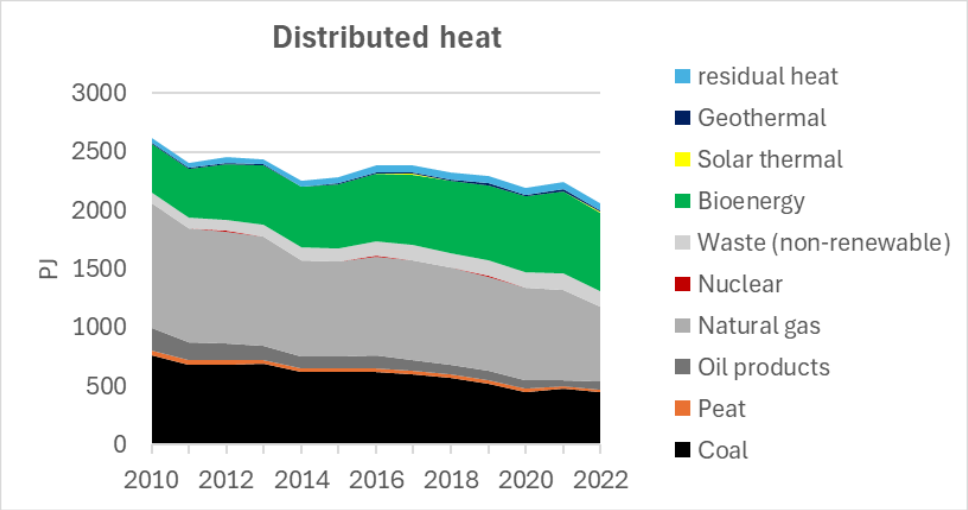

***Figure 9**: Evolution of fuels for heat output in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)*

Policy framework

The main relevant EU-level regulations impacting these evolutions are:

- Renewable Energy Directive (RED) - 2009/28/EC: overall target to reach 20% renewables by 2020
- Combined Heat and Power (CHP) Directive - 2004/8/EC: creating a framework for the promotion and development of high efficiency cogeneration.
- Effort Sharing Regulation (ESR): sets national targets for emission reductions from road transport, heating of buildings, agriculture, small industrial installations and waste management (non-ETS)
- EU Emissions Trading System (EU-ETS): relevant for energy consumption in large industries
- Energy Efficiency Directive - 2012/27/EU: mandates energy efficiency improvements within the European Union.
- Energy Performance of Buildings Directive (EPBD) - 2002/91/EC: required that the MS strengthen their building regulations and introduce energy performance certification of buildings. The recast EPBD (2010/31/EU) broadened its focus on Nearly Zero-energy buildings.
- Amended Renewable Energy Directive EU/2023/2413 (RED III) from November 2023: renewable energy target of at least 42.5% binding at EU level by 2030 - but aiming for 45%.

TRANSPORT

Figure 10 shows an overview of the energy used in transport in the EU27, split up by different fuels/energy carriers.

Diesel fuel is the dominating transport fuel in the EU, at a combined level of fossil diesel and biodiesel of 67.5% of overall transport energy consumption in 2022. Gasoline (including bioethanol) represented 25.3%. Aviation fuels[26] represented 2.1%, LPG 2.0% and natural gas 1.2%.

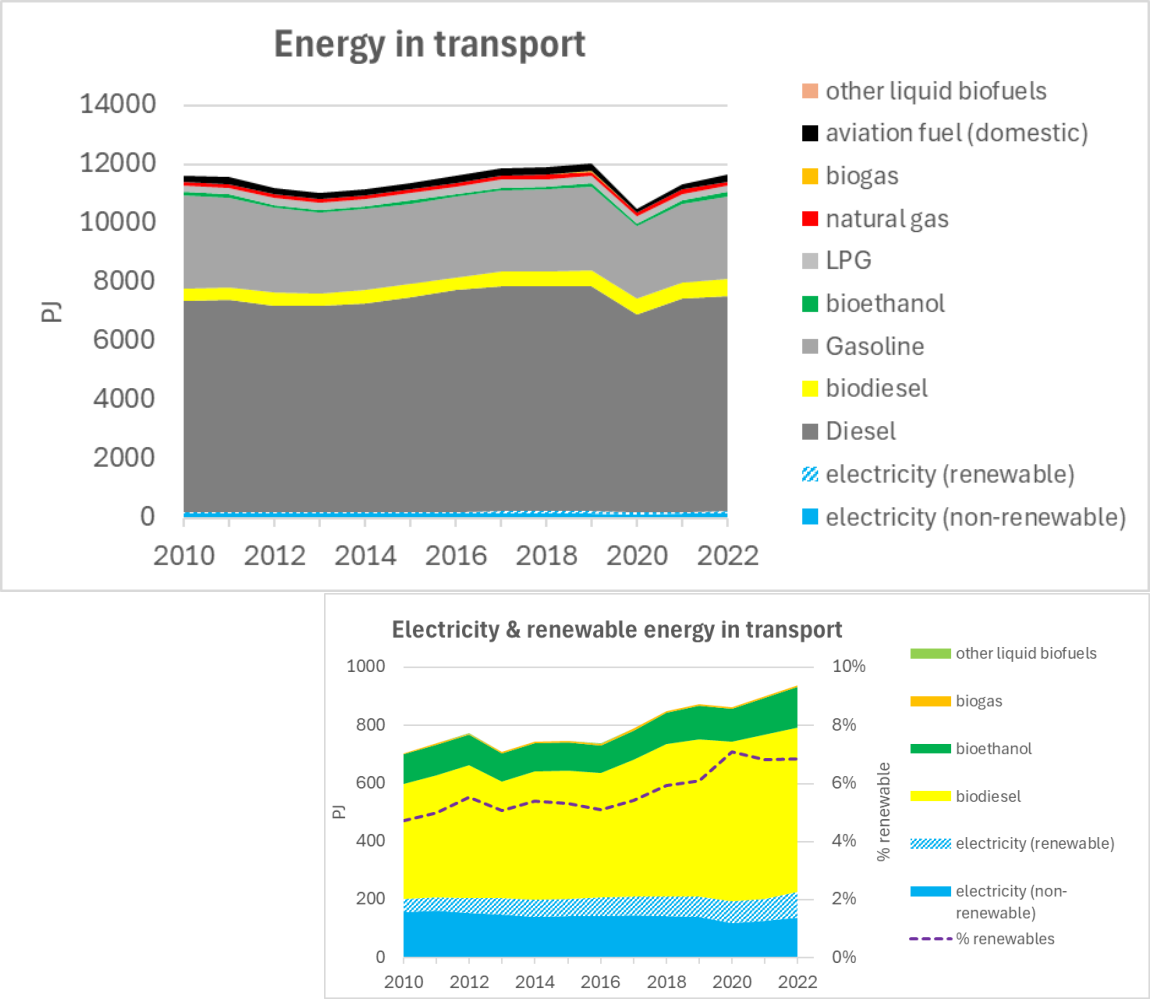

***Figure 10**: Evolution of transport fuels in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)*

In the early 2000s there was already some consumption of biodiesel, particularly in Germany and France. Between 2004 and 2010 there was a strong increase of biofuels up to a combined level of 5% (by energy) of transport energy in 2011 (see 2021 Country Reports[27]). However, these levels stalled up to 2016, likely in relation to uncertainties regarding iLUC restrictions. Since 2017 (after publication of the iLUC Directive) growth has resumed. On average, biodiesel (FAME and HVO together) represented 7.2% by energy of diesel consumption in 2022. Most EU countries have B7

[26] This is limited to aviation fuels for domestic flights within countries (as this is the sum of IEA data for the separate EU countries). It does not include flights between European countries.

[27] 2021 Report for the EU28 (including UK) available at: https://www.ieabioenergy.com/wp-content/uploads/2021/11/CountryReport2021_EU28_final.pdf

(diesel with up to 7% by volume biodiesel) as their standard diesel fuel. In several countries, there is also additional blending of HVO. Bioethanol on average represented 4.7% by energy of gasoline consumption. Several countries offer E10 as gasoline fuel (gasoline with up to 10% ethanol); other countries still only offer E5. Some countries also support E85 in flexfuel vehicles, but these levels are limited at EU scale.

Almost 40% of biofuels consumed in the EU27 in 2022 are qualified as 'advanced biofuels', meaning that they are produced from residues and waste (particularly used oils for biodiesel). These can be double counted towards the renewable energy targets in transport.

Electricity (which is almost 40% renewable on average) represented a share of 1.9% of total transport energy use in 2022. Most of that (~1.6%) is through rail, at relatively stable level. The use of electricity in road vehicles is rising but still limited in 2022 (at 0.32% of total transport energy use).

Policy framework

The main relevant EU-level regulations behind the evolutions in transport are:

- Biofuels Directive - 2003/30/EC: Reference values for Member States: 2% share of biofuels in transport fuels in 2005, 5.75% in 2010.
- Energy taxation directive - 2003/96/EC: Possibility of tax reduction for biofuels, without overcompensation.
- Renewable Energy Directive (RED) - 2009/28/EC: Specific target of 10% renewable energy in transport by 2020 (with multiple counting of advanced biofuels and renewable electricity)
- Amended Fuel Quality Directive (FQD) - 2009/30/EC: By 2020 fuel suppliers should reduce the greenhouse gas intensity of their fuel (CO2eq per MJ fuel) by 6% compared to 2010
- iLUC Directive (EU)2015/1513, amending the RED and FQD: Contribution of food-crop based biofuels limited to 7%; Higher accounting of renewable electricity in electric vehicles; Specific national targets for advanced biofuels
- Recast Renewable Energy Directive (RED II) – (EU)2018/2001 & Green Deal adaptations: relevant for future evolutions
- Deployment of the Alternative Fuels Infrastructure Directive - 2014/94/EU
- Regulation setting CO_2 emission standards for cars and vans (*relevant to reduce overall energy consumption in transport*)
- Amending Directive EU/2023/2413 (RED III) from November 2023: renewable energy target of at least 42.5% binding at EU level by 2030 - but aiming for 45%.
- FuelEU Maritime sets maximum limits for the yearly average greenhouse gas (GHG) intensity of the energy used by ships above 5,000 gross tonnage calling at European ports, regardless of their flag.
- ReFuelEU Aviation promotes the increased use of sustainable aviation fuels (SAF) as the single most powerful tool to decrease aviation CO2 emissions.

GAS CONSUMPTION AND THE ROLE OF BIOGAS/BIOMETHANE

Natural gas plays a substantial role in the EU27, representing 22% of total energy supply in 2022. The most important gas users in 2022 were energy plants (32%), industries (27%), the residential sector (25%) and public/commercial services (11%).

Figure 11 also shows the evolution since 2010. As indicated earlier, after a drop in natural gas use up to 2014, levels of gas consumption recovered again, particularly in electricity-only power plants. The drop in natural gas consumption in 2022 (likely caused by increased gas prices) was mainly in the residential sector and in industries, less in power plants.

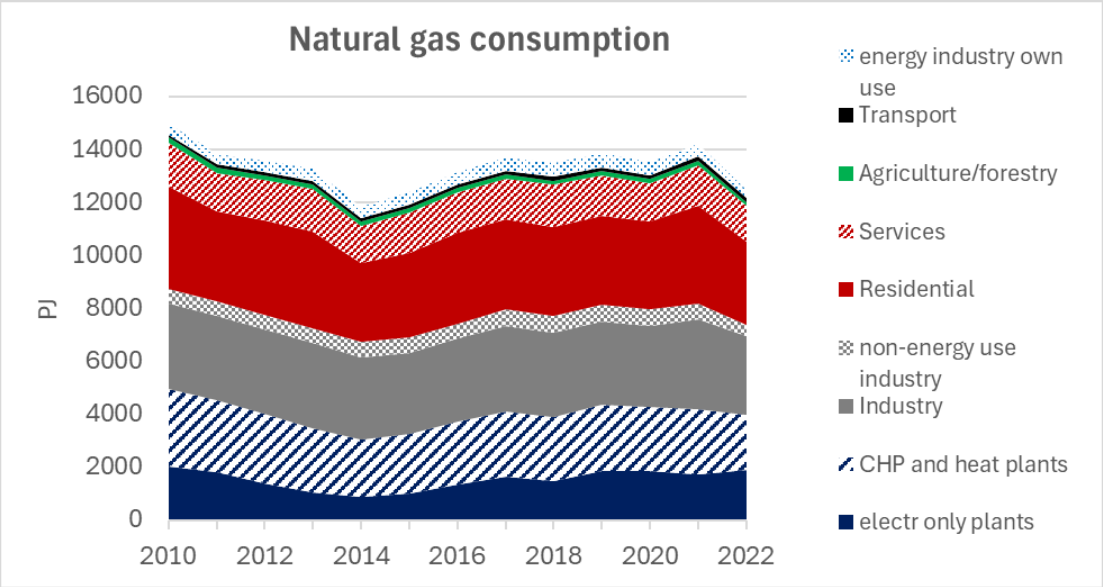

Figure 11: Evolution of gas consumption in different sectors in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

In comparison to natural gas, biogas plays a limited role. When counted together, the different uses of biogas represent less than 5% of gas consumption.

Biogas production increased to a little over 500 PJ in 2014 but stagnated for a few years. Most biogas was used in CHP plants, some also in electricity-only power plants. A smaller part of biogas was used in agriculture, some also sold to services.

Since 2019 levels of biogas are increasing again. The main growth is now in biogas that is upgraded to biomethane to be injected into the natural gas grid (some of it distributed for use in road vehicles) – in 2022 injected biomethane represented 0.8% of gas consumption from the grid.

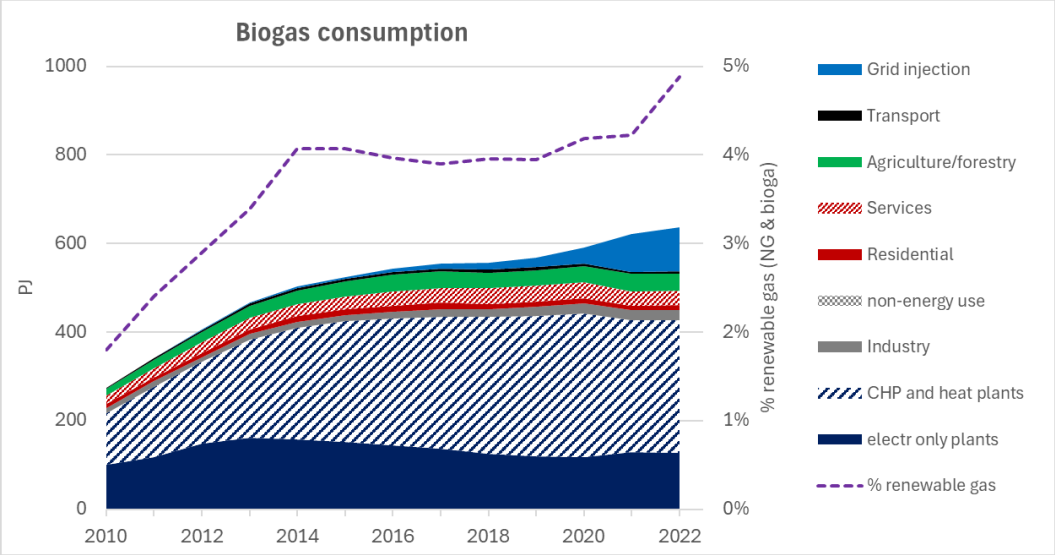

***Figure 12**: Evolution of biogas consumption in the EU27, compared to overall gas consumption (data source: IEA (2024) World Energy Balances and Renewables Information)*

Policy framework

- For details, please visit [Biomethane - European Commission (europa.eu)]
- REPowerEU plan: to increase the EU's biomethane production, either as biogas or its upgraded version, to reach 35 billion cubic metres (bcm) per year by 2030 and the estimated investment need for the period amounts to €37 billion (a non-binding target).
- Amending Directive EU/2023/2413 (RED III) from November 2023: introduces biomethane in RED and sustainability criteria and GHG emission thresholds.

FINAL ENERGY CONSUMPTION IN DIFFERENT SECTORS (EXCL TRANSPORT)

Final Energy consumption in industries

Figure 13 shows the energy consumption (fuels, heat and electricity) in EU27 industries. Electricity use is for broad purposes, including processes, machineries, electric appliances, lighting, and in some cases also for heating and/or cooling. For the renewable share of electricity consumption, we consider the average electricity mix in the EU27.

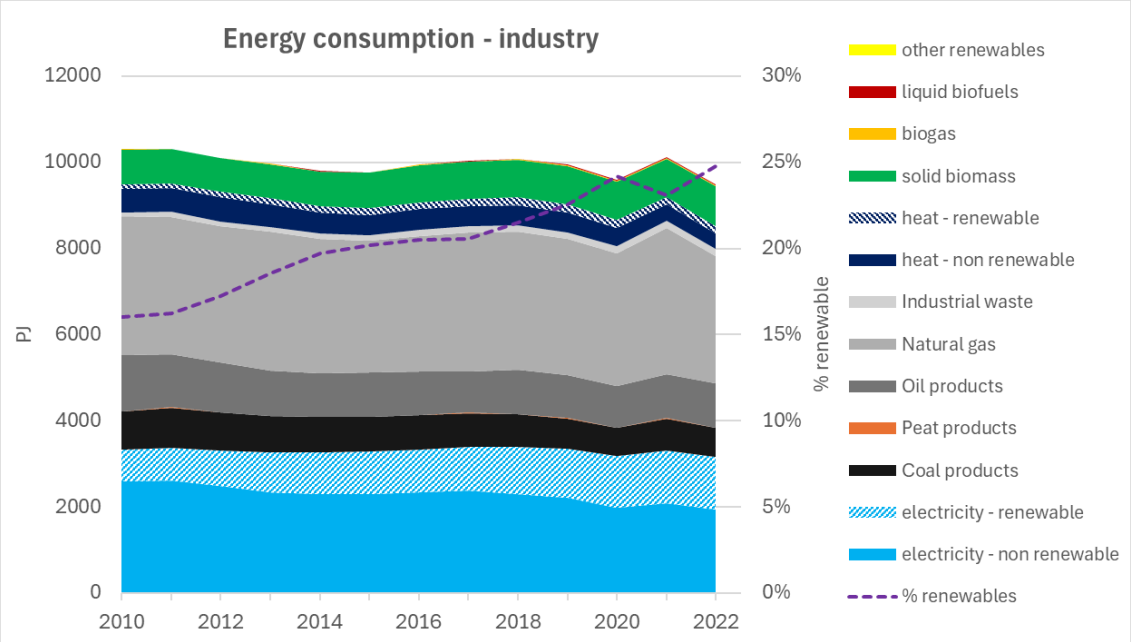

Figure 13: Evolution of final energy consumption in industries in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

In industries, electricity represents one third of final energy consumption, so the role of fuels is still substantial. Natural gas is the most important fuel, but oil products, coal, biomass and distributed heat also play a substantial role for producing heat. Overall, about 25% of final energy consumption in industries is from renewable sources, split between the renewable share of electricity (13%), bioenergy carriers (10%) and the renewable share of distributed heat (2%). The situation in the past decade has been quite stable, apart from temporary drops in 2020 and 2022.

For comparison, **Figure 14** shows the **non-energy use** of fossil resources in industries, e.g., for the production of chemicals. 72% of oil product consumption, 13% of natural gas consumption and 8% of coal consumption in EU27 industries is for non-energy purposes.

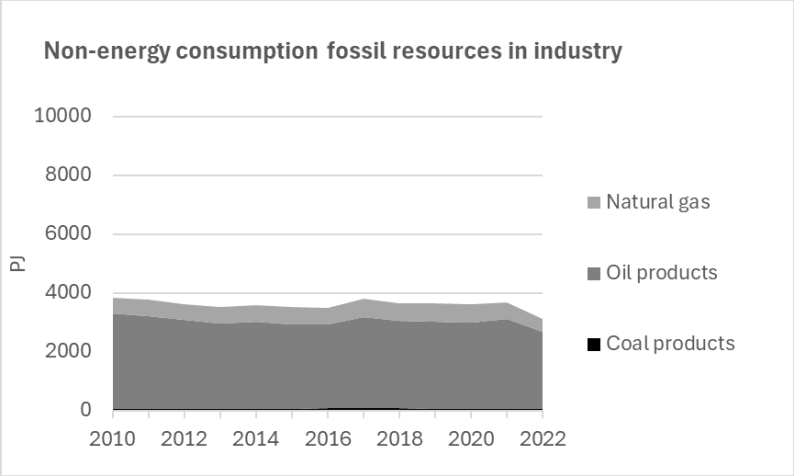

Figure 14: Evolution of non-energy use of fossil resources in industries in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

Final Energy consumption in the residential sector

Figure 15 shows energy consumption (fuels, heat and electricity) in the residential sector. Electricity use is for broad purposes, including electric appliances, lighting, and partly also for heating and cooling (e.g. in electric heating, heat pumps and air conditioning). For the renewable share of electricity consumption, we consider the average electricity mix in the EU27.

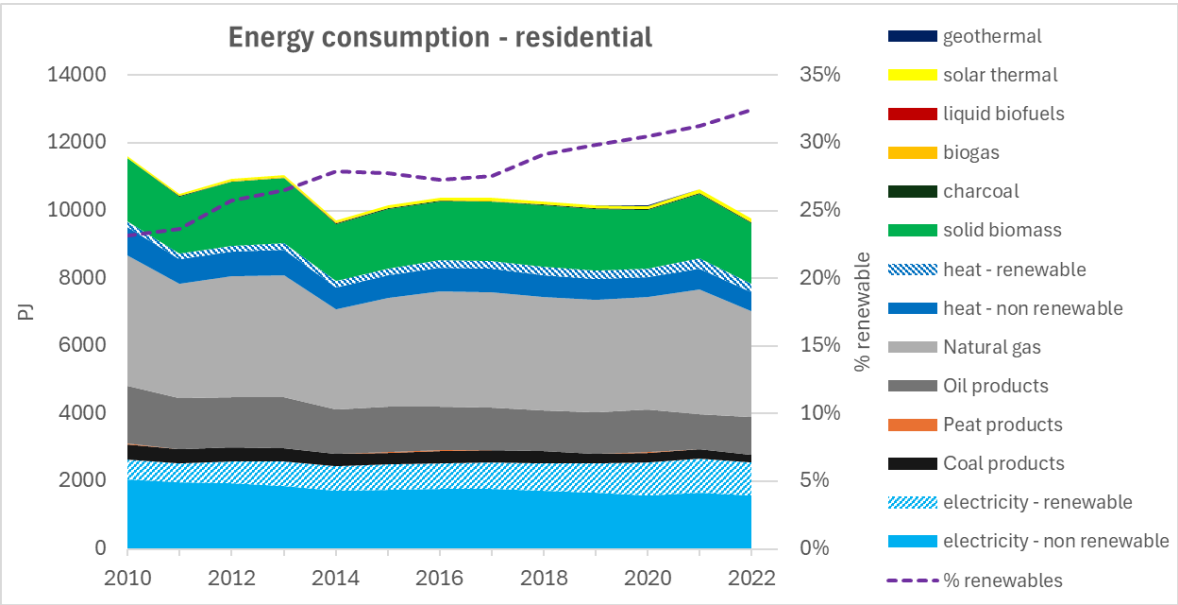

Figure 15: Evolution of final energy consumption in the residential sector in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

Energy consumption in the residential sector is on average higher than in industries, but there is high variation between EU member states. Electricity on average represents around a quarter of final energy consumption in the residential sector, so the role of energy to provide heat is substantial.

Natural gas is the most important fuel, but oil products, biomass and distributed heat also play a substantial role for producing heat.

About one third of final energy consumption in residential applications in the EU27 is from renewable sources, split between bioenergy (18.5%), renewable electricity (10%), renewable distributed heat (2.8%) and solar thermal heat (1%).

Final Energy consumption in commercial and public services

Figure 16 shows energy consumption (fuels, heat and electricity) in commercial/public services. Electricity use is for broad purposes, including electric appliances, lighting, servers, and partly also for heating and cooling (e.g. in heat pumps). For the renewable share of electricity consumption, we consider the average electricity mix in the EU27.

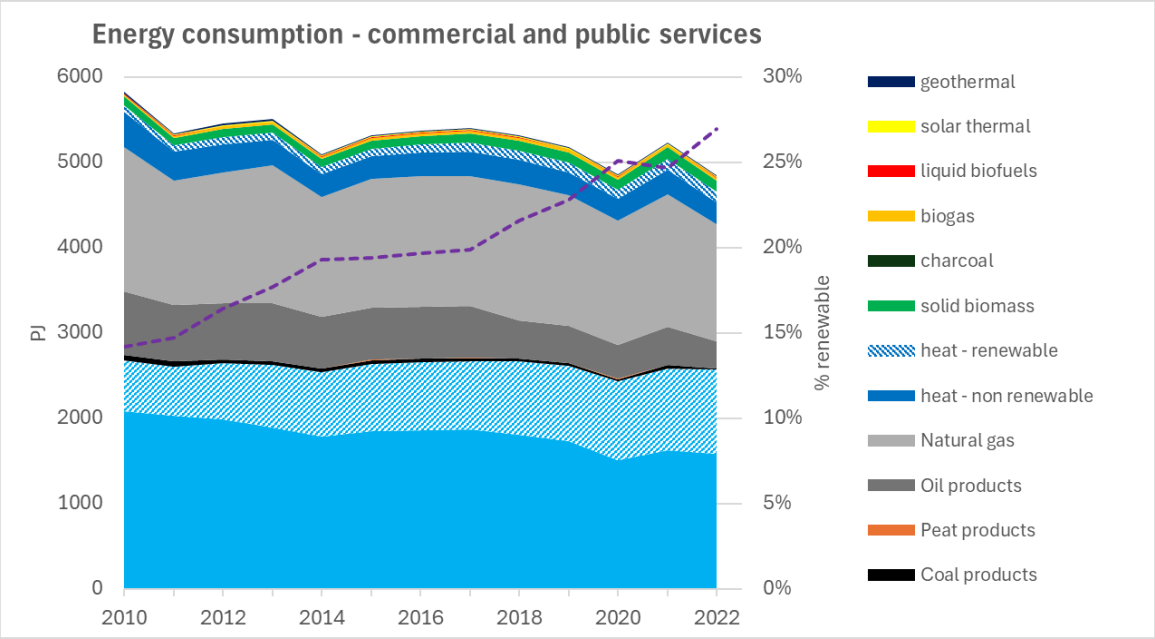

Figure 16: Evolution of final energy consumption in commercial and public services in the EU27 (data source: IEA (2024) World Energy Balances and Renewables Information)

Energy consumption by commercial and public services is about half the level of residential energy consumption. In commercial and public services, electricity plays a more important role than in households. About half of energy consumption is through electricity - electric appliances, heating and cooling (e.g. in electric heating / heat pumps / air conditioning) and lighting. Natural gas also plays an important role in these sectors. The direct use of biomass is modest; distributed heat also plays a role (which to some extent is based on biomass).

In 2022, 27% of final energy consumption in commercial and public services was from renewable sources, split between renewable electricity (20.4%), bioenergy (3.4%) and renewable distributed heat (2.6%).

COMPARISON WITH RENEWABLE ENERGY TARGETS

According to Eurostat[28], the following renewable energy shares in *gross final energy consumption* were reached.

Table 4: Share of renewables in different sectors in the EU27, according to Eurostat, and compared to the 2020 target

	2005	2010	2015	2020[29]	*2020 target*	2022	*2030 target*
Overall share	10.2%	14.4%	17.8%	22.0%	*20%*	23.1%	*42.5%*
In heating & cooling	12.4%	17.0%	20.3%	23.0%		24.9%	
In electricity	16.4%	21.3%	29.7%	37.4%		41.2%	
In transport	1.8%	5.5%	6.8%	10.3%	*10%*	9.6%	*29%**

** including multiplicators for Annex IX biofuels, renewable electricity and renewable fuels of non-biological origin. Alternatively, Member States can opt for a GHG intensity reduction target in transport of 14.5%.*

The table shows that the 2020 targets were reached, although this was also aided by the drop in energy consumption in industry and transport because of COVID restrictions. The aim for 2030 is to achieve a minimum renewable share of 42.5% (with the aspiration to reach 45%), so major efforts will be needed to reach that 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 advanced biofuels and renewable electricity towards the transport target. The heating & cooling figure in Eurostat also includes a contribution from heat pumps.

Figure 17 shows the 15-year evolution of the overall renewable energy share in gross final energy consumption for the EU27 as a whole, as well as for the 10 European Member States which are also member of IEA Bioenergy. The 2020 targets for the individual Member States are also displayed.

As indicated earlier, the EU27 as a whole has achieved the 2020 renewable energy target of 20%, also aided by the temporary drop in energy consumption in the Covid year 2020. Several countries (Austria, Denmark, Finland, Italy, Sweden) achieved their 2020 target, while other countries fell short. Some countries (Belgium, Ireland, Netherlands) used statistical transfers from overachievers (like Denmark and Sweden) to fulfil their 2020 target.

Some countries continue their efforts to increase their share of renewable energy (also keeping in mind that the 2030 target will be very ambitious. However, we also see that levels of renewable energy have stagnated somewhat between 2020 and 2022, for example in Austria, Ireland and Italy.

[28] https://ec.europa.eu/eurostat/databrowser/view/sdg_07_40/default/table?lang=en

[29] Substantial impact of COVID measures on final energy consumption in 2020 (particularly in industry and transport), somewhat inflating the shares of renewables.

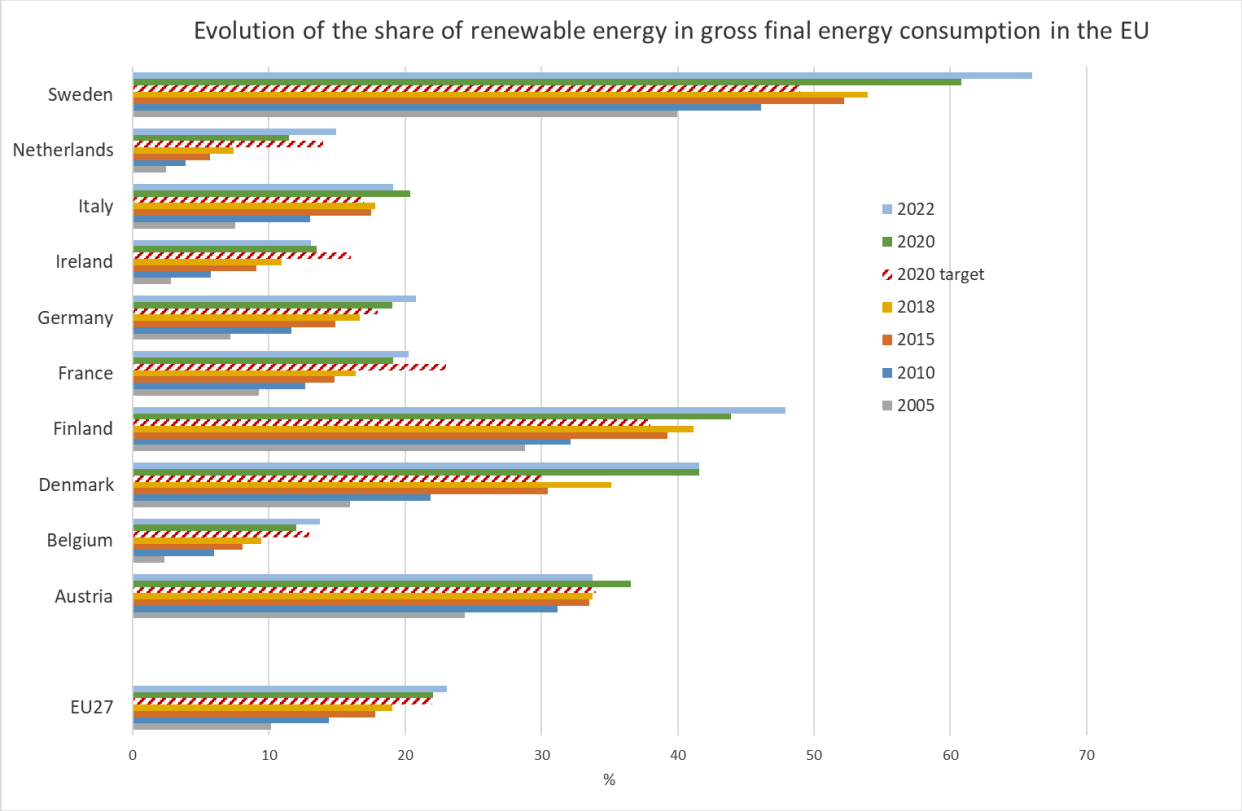

***Figure 17**: Evolution of the share of renewable energy in gross final energy consumption in the EU27, and specific EU member states between 2005 and 2022 (data source: Eurostat)*

RESEARCH FOCUS RELATED TO BIOENERGY

The EU has supported bioenergy-related research and technology development (RTD) under several successive **Framework Programmes**, covering the whole chain from feedstock production to end-use. Between 1998 and 2002 around 100 projects were supported under Framework Programme FP5 with a total budget of EUR 140 million. Priority during this time was given to research into thermal processes (heat and electricity production from biomass), yet eight projects on transport biofuels were supported. The following Framework Programme FP6, running from 2002 to 2006 funded 40 projects with a total amount of around EUR 150 million. In the area of biofuels seven projects with a clear focus on 2nd generation biofuel technologies were supported. Moreover, three Integrated Projects (IP) were established for hydrogen production, biorefineries and combustion/co-firing. A Network of Excellence (NoE) was set up to overcome barriers to bioenergy implementation. The first ERANET in Bioenergy was supported to coordinate and boost EU MS R&I in bioenergy. During FP6 the Biofuels Technology Platform (EBTP) was launched, which has become the core of the biofuels community in Europe. In 2016 the EBTP was merged with the European Industrial Bioenergy Initiative (EIBI) to form the European Technology and Innovation Platform Bioenergy (ETIP Bioenergy) which aims to implement the Strategic Energy Technology (SET) Plan of the European Commission and particular its key action on bioenergy and renewable fuels (see further). In the framework of the Intelligent Energy Europe Programme the EC is financing research aimed at overcoming non-technical barriers, which are impeding the market penetration of this type of renewable energy. The Framework Programme FP7, starting in 2007, has been focusing on advanced biofuels and renewable electricity production from biomass with about 300-million-euro EU funding. The predominance of biofuel projects was a direct result from the high oil prices during that period and an effort to push advanced biofuel technologies into the market. The follow-up of FP7, Horizon 2020, is the biggest EU Research and Innovation programme ever with nearly 80 billion euro of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract. It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market. Funding for bioenergy research is best placed under that part of Horizon 2020 that addresses societal challenges, in particular the challenge “Secure, Clean and Efficient Energy” with about 400-million-euro support on mostly advanced biofuels and bioenergy. Total budget for energy in Horizon 2020 was around EUR 8.5 billion (11.4% of the total H2020 budget). In the follow-up R&I Framework programme Horizon Europe 2021-2027 with a 95.5 billion euro budget and 15.1 billion for Cluster 5 ‘Climate, energy and mobility’, under Pillar II –Global Challenges and European Industrial Competitiveness, Renewable energies and renewable fuels including advanced biofuels and non-biological synthetic renewable fuels are addressed under the Destination of Sustainable, secure and competitive energy supply. The first Work Programmes 2021-2024 covered with around 300 million euro for advanced biofuels, non-biological renewable fuels, bioenergy and renewable energy carriers, and more support is foreseen for the last 3 years of Horizon Europe.

The **Circular Bio-based Europe Joint Undertaking** (CBE JU) is a €2 billion partnership between the European Union and the Bio-based Industries Consortium (BIC) that funds projects advancing competitive circular bio-based industries under Horizon Europe, the EU’s research and innovation programme. CBE JU is operating under the rules of Horizon Europe for the 2021-2031 period. The partnership is building on the success of its predecessor, the Bio-based Industries Joint Undertaking (BBI JU), the €3.7 billion Public-Private Partnership operated under Horizon Europe, while addressing the current challenges facing the industry. The partnership is focusing on a) Supporting research and innovation for sustainable bio-based solutions; b) De-risking investments in innovative, circular bio-based production plants; c) Addressing the technological, regulatory & market challenges of the

bioeconomy; d) Placing sustainability at the heart of its operations; e) Strengthening the collaboration of all bioeconomy actors; and f) Engaging with more stakeholders along the value chain

The **Strategic Energy Technology Plan (SET-Plan)** of the European Commission is a key stepping-stone to boost the transition towards a climate-neutral energy system through the development of low-carbon technologies in a fast and cost-competitive way. The SET Plan was established in 2007 and since the creation of the energy union in 2015, it became one of the main instruments of the energy union's 5th pillar on research, innovation and competitiveness. By improving new technologies and bringing down their costs through coordinated national research efforts, the SET Plan helps promote cooperation among EU countries, companies and research institutions. It does so by helping to coordinate national research and innovation activities in developing low-carbon energy among EU countries and associated countries, as well as aligning national research and innovation programmes with its agenda. The Communication on the revision of the SET Plan, adopted in November 2023, will help harmonise the original strategic objectives with the European Green Deal, REPowerEU and the Green Deal Industrial Plan, notably the Net-Zero Industry Act. It will ensure a unified approach towards achieving the EU's decarbonisation goals, supporting strategic net-zero energy technologies, and building a sustainable and resilient energy future. The SET Plan activities are clustered into 10 actions for research and innovation. They address the whole innovation chain, from research to market uptake, and tackle both financing and regulatory frameworks The key action on "Bioenergy and Renewable Fuels for Sustainable Transport", is implemented with an Implementation Plan approved on 13 June 2018 by the SET-Plan Steering Group+ The Implementation Plan (IP) has three common goals for the field of Bioenergy at large: Improve performance (yield and efficiency) of production, reduce GHG emissions along the value chain and reduce cost. In order to capture the major segments of bioenergy, this IP describes targeted implementation approaches for renewable fuels for sustainable transport (automotive and aviation fuels, as well as hydrogen produced from renewable sources), bioenergy (biosolids, bioliquids, and biogases) and intermediate bioenergy carriers and describes 13 groups of R&I activities for (1) Advanced liquid and gaseous biofuels, (2) Other renewable liquid and gaseous fuels, (3) Renewable hydrogen, (4) High efficiency large scale biomass CHP and (5) Solid, liquid and gaseous intermediate bioenergy carriers. The IP is currently under revision to update the targets and the R&I programme of activities. The reporting for the progress of the Implementation plans is continuous and available in SETIS[30]

Currently a discussion with MS is taking place for the update of the SET Plan to link to the new European Research Area policy[31]

Other financing mechanisms:

- The **Innovation Fund** is one of the world's largest funding programmes for the deployment of net-zero and innovative technologies. It is the EU fund for climate policy, with a focus on energy and industry. The Innovation Fund's total funding depends on the carbon price, and it may amount to about €40 billion from 2020 to 2030, calculated by using a carbon price of €75/tCO2. It aims to bring to the market solutions to decarbonise European industry and support its transition to climate neutrality while fostering its competitiveness. The goal is to help businesses invest in clean energy and industry to boost economic growth, create local future-proof jobs, and reinforce European technological leadership on a global scale. This is

[30] SET Plan implementation progress reports (europa.eu)
[31] COM(2020) 628 final

done through calls for large and small-scale projects focusing on:

- innovative low-carbon technologies and processes in energy-intensive industries, including products substituting carbon-intensive ones
- carbon capture and utilisation (CCU)
- construction and operation of carbon capture and storage (CCS)
- innovative renewable energy generation
- energy storage
- net zero mobility (maritime, aviation, road transport) and building

LINKS TO SOURCES OF INFORMATION

The following references provide useful information and data on EU policies for Energy, Climate and Mobility and EU R&I policy,

- Regulation 2021/1119 of the European parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')
- Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast)
- Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
- Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system
- Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity
- Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (recast)
- Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 setting CO2 emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC
- Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU
- Regulation of the European Parliament and of the Council on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC, July 2023

- Regulation of the European Parliament and of the Council on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation), September 2023
- RePowerEU Communication on a Joint European Action Plan for more affordable, secure and sustainable energy) COM (2022) 230 final
- The revised Directive EU/2023/2413 of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources (RED III) (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413&qid=1699364355105)
- Impact assessment on possible pathways to reach the agreed goal of making the European Union climate neutral by 2050) COM(2024) 63 final
- Horizon Europe https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/reference-documents;programCode=HORIZON

EU initiatives relevant for bioenergy:

- Strategic Energy Technology Plan:
- Renewable fuels and bioenergy Implementation Plan - European Commission (europa.eu)
- European Commission: Directorate-General for Research and Innovation, Georgiadou, M., Goumas, T. and Chiaramonti, D., Development of outlook for the necessary means to build industrial capacity for drop-in advanced biofuels – Final report, Georgiadou, M.(editor), Goumas, T.(editor) and Chiaramonti, D.(editor), Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2777/679307
- European Technology and Innovation Platform Bioenergy (ETIP Bioenergy): http://www.etipbioenergy.eu/
- Circular Bio-based Europe Joint Undertaking (CBE JU) (europa.eu)
- Innovation Fund
- EU Biodiversity Strategy for 2030 - COM(2020) 380 final
- New EU Forest Strategy for 2030 - COM(2021) 572 final
- Land use and forestry (LULUCF) regulation for 2021-2030: