Implementation of bioenergy in The Netherlands - 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 make up 7.3% of total energy supply in the Netherlands in 2019. The renewable energy share in final energy consumption is 8.6%[2]. Around 63% of renewable energy is from biomass.
- The Netherlands 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 residues and waste, as well as imports.
- Natural gas is the dominating fuel in the Dutch energy system, representing 60% of Dutch power production and over 70% for heat production (through direct use and in distributed heat). Recent declines of coal power were actually compensated by an increase in natural gas power.
- Bioelectricity was the major source of renewable electricity up to 2012. After a decline post 2012, it has again increased in 2019. The role of wind and solar power in Dutch electricity is steadily growing.
- Heat and transport fuels are still dominated by fossil fuels. Bioenergy/biofuels are the main sources of renewable energy in these sectors.
- The role of biofuels in transport has been relatively stable between 2007 and 2017 at around 3%

[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 (which is counted in energy supply, but not in final consumption).

of transport fuels. In the past years there was a substantial increase of biofuels. Biodiesel represented almost 7% by energy of diesel fuel consumption in 2019; bioethanol represented about 4.5% by energy of gasoline consumption.

- A new biomass policy was introduced in 2020, focusing on a cascading approach of the utilisation of bioresources, where a growth is foreseen in the use for chemicals and material, transport biofuels are seen as a transitional fuel, and the application of biomass for heating and power will be reduced over the next years/decade. An integrated framework for utilisation of bioresources for all applications was introduced and will be built into legislation over the next years.

COUNTRY PROFILE

Population and land use

The Netherlands is a relatively small country in West Europe. It has a total land area of 33.7 thousand km² and a population of 17.1 million people, which represents a very high population density of 508 persons per km².

Most of the country is flat and the Netherlands has quite favourable climatic growth conditions. More than half of the land area is agricultural land, almost evenly split between arable land and permanent grassland. Only 11% of the land area is forest land (*of which 40% protected*). There is also a relatively large share of artificial areas in the Netherlands, which are covered under 'other land use'.

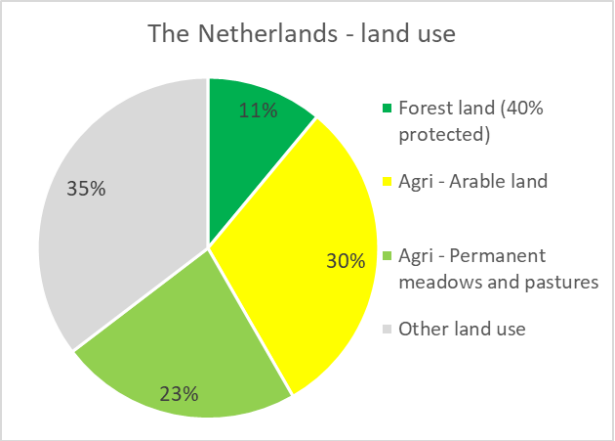


***Figure 1**: Land use in The Netherlands (2018 figures - Source: FAOstat)*

Final energy consumption

Overall final energy consumption in The Netherlands (*also including non-energy use of oil, natural gas, and coal in industry*) equates 3.3 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 important role of industries in the country. Industry represents a share of 45% of final consumption of energy carriers in the Netherlands - 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 The Netherlands (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)	0.81	24%	*0.67*
Industry (non-energy use)	0.70	21%	*0.21*
Transport	0.64	19%	*0.69*
Residential	0.54	16%	*0.57*
Commercial & public services	0.39	12%	*0.34*
other	0.24	7%	
Total	3.33		*2.34*

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

NATIONAL POLICY FRAMEWORK IN THE NETHERLANDS

TARGETS AND STRATEGIES

The Netherlands is aiming for a rapid transition to a low-carbon economy and has placed ambitious greenhouse gas (GHG) reduction targets at the centre of energy and climate policy.[i] From 2008 to 2018, the population of the Netherlands increased by 5% and gross domestic product (GDP) grew by 9%. Over the same period, energy demand declined by 5% thanks in part to a 15% improvement in the energy efficiency of the economy. The Netherlands has also achieved notable reductions in GHG emissions. In 2019, GHG emissions were down 17% from 1990 levels.[ii]

The 2019 Climate Act sets targets to reduce GHG emissions by 49% by 2030 and by 95% by 2050 (versus 1990 levels). The Netherlands has developed a detailed policy framework to drive the achievement of these targets. The core of this framework is the 2019 Climate Agreement, which was developed by a collaborative process involving over 100 stakeholders from across society. The Agreement includes emissions reductions targets and measures in five sectors: electricity, industry, the built environment, mobility, and agriculture and the natural environment.

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

*Table 2: renewable energy and climate targets in The Netherlands**

Sector	Share of renewables in gross final consumption per sector	GHG reduction target compared to 1990
Overall target	2030: 27-40 %	2030: 49% ; 2050: 95%
Heating and cooling		
Electricity	2030: 70% ; 2050: 100%	
Transport	2030: 27%	

** 2030 targets mentioned in the National Climate and Energy Plan may be reviewed in the frame of the European Fit for 55 package of 2021.*

The objectives relating to renewables are consistent with those of the European Union and established by the Renewable Energy Directive (RED). The original RED, which came into effect in 2010, established mandatory national targets for renewables in final energy consumption for 2020, with an EU wide target of 20% renewables in final energy consumption by 2020, and a target of 10% of renewables in transport.

In the Netherlands, the mandatory national target for renewables in final energy consumption by 2020 is 14%. The contribution of renewables in the Netherlands to final energy consumption had reached 7.4% in 2018, 8.6% in 2019 and 11% in 2020.[iii]

The revised Renewable Energy Directive (RED2, 2018) established EU wide targets of 32% for renewables in final energy consumption by 2030 (*the new European Fit for 55 proposal mentions 40%*), and 14% in transport. There are no legally binding national targets associated with these targets, but each Member State has designed a "Integrated National Energy and Climate Plan" which sets out a plan and trajectory designed to reach these overall targets. The NL Plan proposes an overall renewable energy contribution to final energy demand of 27% by 2030.[iv] For road transport the NL annual obligation in 2030 (65 PJ or 27.1%) is significantly higher than the obligatory 14% share in the RED2 in 2030. The 27.1 % in 2030 includes multipliers associated to certain renewable fuels and electricity. 65 PJ is around 13 - 14% of the total consumption in PJ.

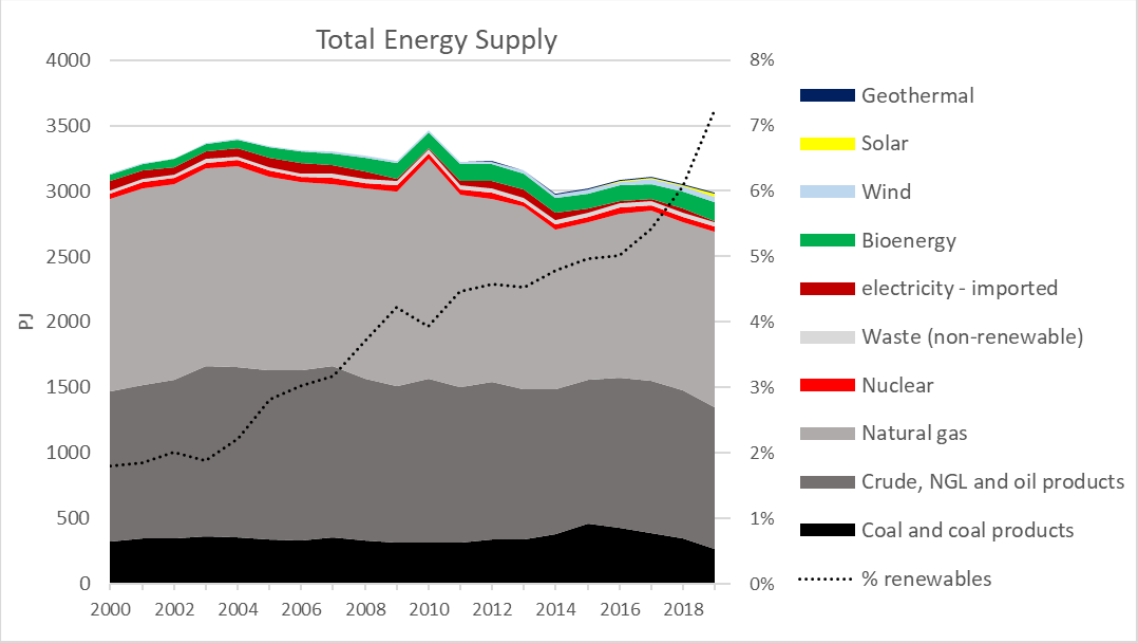
A description of renewable energy and climate policies and measures in the Netherlands is available at the IEA's Policies and Measures Database: https://www.iea.org/policies?country=Netherlands

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

THE CONTRIBUTION OF BIOENERGY IN NATIONAL ENERGY SUPPLY

TOTAL ENERGY SUPPLY

The total energy supply (TES) of the Netherlands in 2019 amounted to 2984 petajoule (PJ). It is still for around 90% dominated by fossil fuels, particularly gas and oil, which represent 45% (1342 PJ) and 36% (1077 PJ) of total energy supply, respectively. Coal represents around 9% of TES (269 PJ). Renewable energy sources have a share of 7.3% or 217 PJ. Around 70% of renewable energy supply in 2019 came from biomass (149 PJ), followed by wind energy (41 PJ) and solar energy (20 PJ).



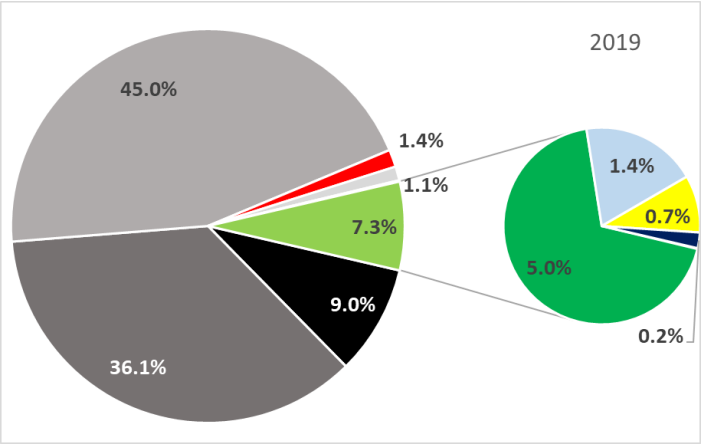


***Figure 2**: Total energy supply[4] and the contribution of different energy sources in The Netherlands, with distribution in 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Overall TES slightly declined in the past decade. **Natural gas** is the main source of energy – its consumption was fairly stable between 1400 and 1500 PJ up to 2011, which was around 45% of TES. After that there was a temporary decline to 1200 PJ in 2015. However, in recent years natural gas use increased again up to 1340 PJ in 2019. **Oil products** have been relatively stable around 1100-1200 EJ in the past decade, representing around 37% of TES. An important share of oil products

[4] 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 or condensing gas power plants).

(~360 PJ) are consumed for non-energy use (in chemical industries). **Coal** used to be quite stable around 350 PJ up to 2013 (10% of TES). With the building of new coal power plants, it increased to a level of 460 PJ (15% of TES) in 2015. Meanwhile the use of coal has started to decline, to a level of 270 PJ (9% of TES) in 2019. **Nuclear** energy only had a modest role in the Netherlands around 1.5% of TES (40 PJ), which has been quite stable in the past decades.

The share of **renewable energy** continuously increased from 2005, albeit at fairly modest levels. Since 2017 there is a clear acceleration of renewable energy, mainly in bioenergy, wind and solar energy.

Figure 3 shows that the two biggest sources of **bioenergy** in the Netherlands are solid biomass (65 PJ or 44% of bioenergy supply) and renewable municipal waste (39 PJ or 26%). 20% of bioenergy comes from liquid biofuels (30 PJ) and 10% from biogas (15 PJ).

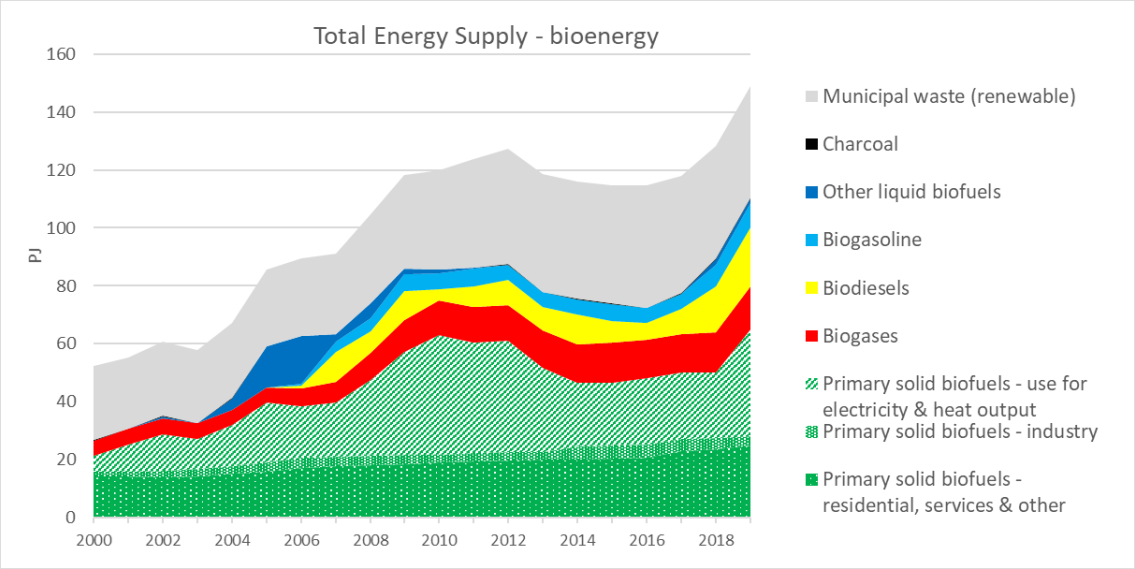


***Figure 3**: Development of total energy supply from bioenergy in The Netherlands 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Evolution of the bioenergy carriers:

- There has been consistent growth of solid biofuels for electricity and heat output from 5 PJ in 2000 to 40 PJ in 2010. This dropped back to 22 PJ between 2014 and 2018 and has continued again in 2019. This was caused by a financial support for cofiring between 2004 – 2014 and a new support system since 2016 of cofiring under the climate agreement up to 25PJ and under strict sustainability criteria. The use of solid biofuels in industry is fairly low. The use of solid biofuels for residential applications has been quite stable around 16 PJ and there has been some growth in other applications (services, agriculture).
- The use of Municipal Solid Waste (MSW) for energy production is quite significant in the Netherlands (representing 2% of total energy supply) and renewable MSW forms a substantial share of around 30% of bioenergy. Renewable MSW was already important in 2000 at 25 PJ. Between 2006 and 2013 there was an increase from 26 PJ to 40 PJ, mainly due to increased utilisation of waste heat. These levels have stabilized in recent years.
- Liquid biofuels were first introduced in industry and for power production. Since 2006 biodiesel and bioethanol were also introduced in transport. Their levels stabilized around 13 PJ between 2007 and 2016, and are steadily increasing in the past few years (reaching 26 PJ in 2019). There is still some (modest) use of liquid biofuels for non-transport uses.

- Biogas saw a strong growth from 5 PJ in 2005 up to 12 PJ in 2010. In the past decade levels stabilized around 13 PJ. In 2019 there was some increase again up to 15 PJ. The biogas is produced mainly from manure with co-digestion and from organic fractions of municipal waste. Part of the biogas is upgraded to biomethane and fed into the grid (1.9 PJ) and partly used in mobility (0.8 PJ).

Table 3 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), the Netherlands ranks at the higher end for renewable MSW and biogas, in the middle for liquid biofuels and at the lower end for solid biofuels.

***Table 3**: Total energy supply per capita in 2019 for different bioenergy carriers*

	Supply per capita	*Median IEA Bioenergy members*
Bioenergy	8.7 GJ/cap	*10.6*
Solid biofuels	3.8 GJ/cap	*7.0*
Renewable MSW	2.3 GJ/cap	*0.8*
Biogas	0.9 GJ/cap	*0.7*
Liquid biofuels	1.8 GJ/cap	*1.5*

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

The following table 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 4**: Comparison of the supply of different bioenergy carriers in 2019 to specific reference points*

	Compared to reference points			*Median**
Bioenergy	5.0 %		of total energy supply	*7.2 %*
Solid biofuels	292.3 GJ/ha_forest		compared to the domestic hectares of forest land (excl. protected)	*21.3 GJ/ha_forest*
Renewable MSW	4.35 GJ/ton_MSW		compared to the total generated MSW in the country	*1.4 GJ/ton_MSW*
Biogas	0.011 GJ/GJ_NG		compared to natural gas supply	*0.023 GJ/GJ_NG*
Liquid biofuels	0.028 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*[5]

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

Specific comments in relation to the reference points:

- The amount of solid biofuels compared to the domestic (non-protected) forest area is very high (~15 $tons_{\_dry\ mass}$ of wood per hectare[6]). It should be considered that the amount of forest in the Netherlands is very low, so much of this solid biomass is not sourced domestically. There are considerable wood pellet imports for power production; a significant part of this solid biomass are also industry residues or post-consumer wood waste. Very strict sustainability criteria[7] apply for the application of wood pellets for cofiring and large-scale heating.
- The use of renewable MSW for energy production is high compared to other European countries with well-developed waste management systems. Some flows of MSW are imported to the Netherlands for energy production.
- Biogas is relatively high per capita, but still only represents 1% of domestic gas consumption (which is related to the dominance of natural gas in the Dutch energy mix).

[6] Counted with a typical calorific value of wood (dry mass) of 19 $GJ/ton_{\_dry\ mass}$

[7] Sustainability criteria for solid biomass under the SDE+/SDE++-scheme | RVO.nl

ROLE OF BIOENERGY IN DIFFERENT SECTORS

OVERVIEW

The overall 2019 share of renewables in **final energy consumption** among electricity, transportation and heat sectors is almost 9%, with bioenergy making up 5.4% of the energy share (Table 5). Note that these figures are slightly higher than the shares in total energy supply (where unused waste heat, e.g., in fossil power production, is also included).

__Table 5__: 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[8]	4.8%	18.7% *(9.5% wind)*	121 TWh (437 PJ)
Transport energy (final consumption)	5.7%	6.0%	458 PJ
Overall fuel and heat consumption[9]	Direct biomass: 3.8% Biobased heat: 1.7%	5.6%	1057 PJ
TOTAL FINAL ENERGY CONSUMPTION	**5.4%**	**8.6%**	**1943 PJ**

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

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

ELECTRICITY

The Dutch power system is still dominated by coal and **natural gas**. Natural gas represented 58% (70 TWh) of Dutch electricity consumption in 2019. The share of natural gas power actually came down from 60% (75 TWh) in 2008 to 40% (47 TWh) in 2015 but has picked up again in recent years and saw a major increase in 2019. In fact, it seems that reductions of coal power in the past 5 years were almost completely compensated by natural gas. **Coal** power used to be quite stable around 27 TWh (22-23% of total electricity consumption). With the building of new coal power plants, it increased to a level of 42 TWh in 2015. Meanwhile the use of coal has started a steady decline, with a level of 20 TWh in 2019, still 16% of electricity consumption in the Netherlands. There is a political agreement

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

[9] 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.

to stop power from coal in 2030. **Nuclear** energy only has a modest role in the Netherlands around 3% of electricity consumption (4 TWh PJ), which has been quite stable in the past decades.

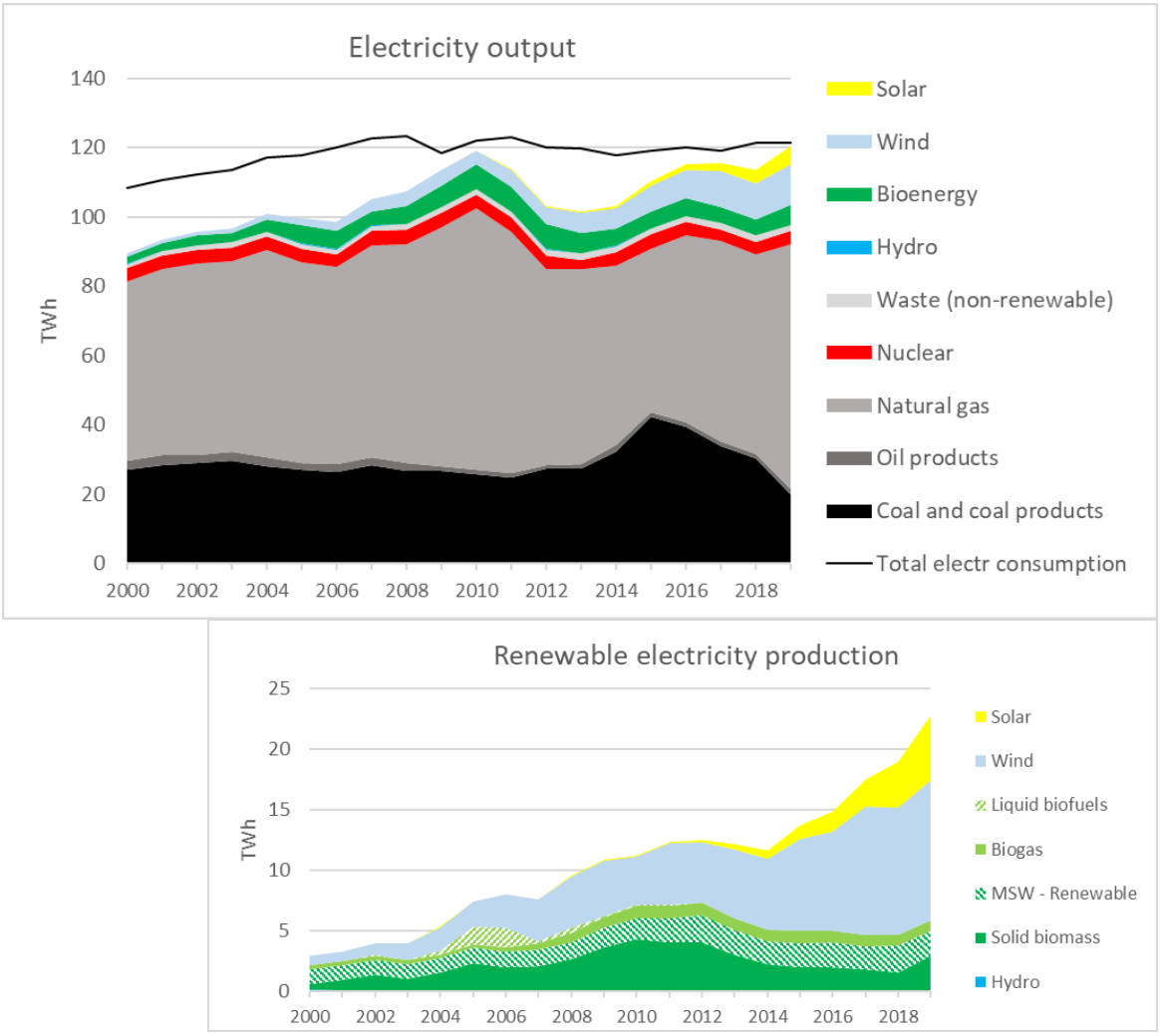


Figure 4: Evolution of the Renewable Electricity mix in The Netherlands 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

Renewable power represented 3% of electricity consumption in the early 2000s, two thirds being biomass-based electricity (most from renewable MSW) and one third wind power. Up to 2010 there was a continuous growth, both of bioelectricity and wind power up to a combined 9-10% of electricity consumption. Bioelectricity consumption was at 7 TWh at its peak in the period 2010-2012 but dropped back to 5 TWh between 2014 and 2018. Growth has resumed again in recent years reaching 6 TWh in 2019. Wind continued to grow and in 2019 produced 11 TWh, almost 10% of Dutch electricity consumption. Solar power initially saw modest growth to 1 TWh in 2015. In recent years solar power is clearly accelerating, already reaching 5 TWh in 2019 (4.4 % of electricity consumption). The total production of renewable electricity represented 18% of electricity demand in 2019. The consumer demand for green electricity is about 2.5 – 3 times higher than the national renewable electricity production. The difference is covered by imported Certificates of Origin from mainly Spain, Italy and Norway (CertiQ, 2019).

Electricity imports from neighbour countries (in the figure, the difference between electricity consumption and overall production) has been fairly important in certain periods; e.g. between 2012 and 2014, when natural gas power went down, electricity imports reached 15% of electricity consumption. This has dropped to negligible levels in 2019 with the increase of natural gas power and the increasing levels of renewable power.

Policy framework

The main relevant policy instruments (with relevance for biobased electricity) behind these evolutions are:

- **SDE+ and SDE++**[10]: financial support for Renewable Energy is arranged through the SDE+ scheme, providing a feed-in premium (FIP) subsidy that covers the difference between wholesale market prices of electricity and the cost of electricity from renewable sources (LCOE). The budget (between 8 – 12 billion €/year for all renewable energies) is made available in auctions. The budget comes from a levy on the energy consumers. A total budget for bioenergy of 18 billion € was contracted over the last 10 years. Since 2012 also renewable heat projects have been supported. The contracts typically last between 10 and 15 years.

- **RED:** The Renewable Energy Directive provides the background for European member states to produce a certain amount of renewable energy.

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 (e-boiler) or through heat pumps) is not included in these figures as this is not separately reported in the IEA database.

The overall consumption of fuel/heat slightly declined from 2005 to 2014 and stabilized between 1000 and 1100 PJ in recent years. The provision of heat is still largely dominated by fossil fuels (85%), with natural gas being the main energy source (65%). The direct use of biomass for heat represents only 4% (40 PJ). Zooming in on renewable heat (Fig 6.b), shows that more than 90% is supplied by bioenergy, either through the direct use of biomass, or through district heating derived from biomass.

[10] Stimulation of sustainable energy production and climate transition (SDE++) | RVO.nl

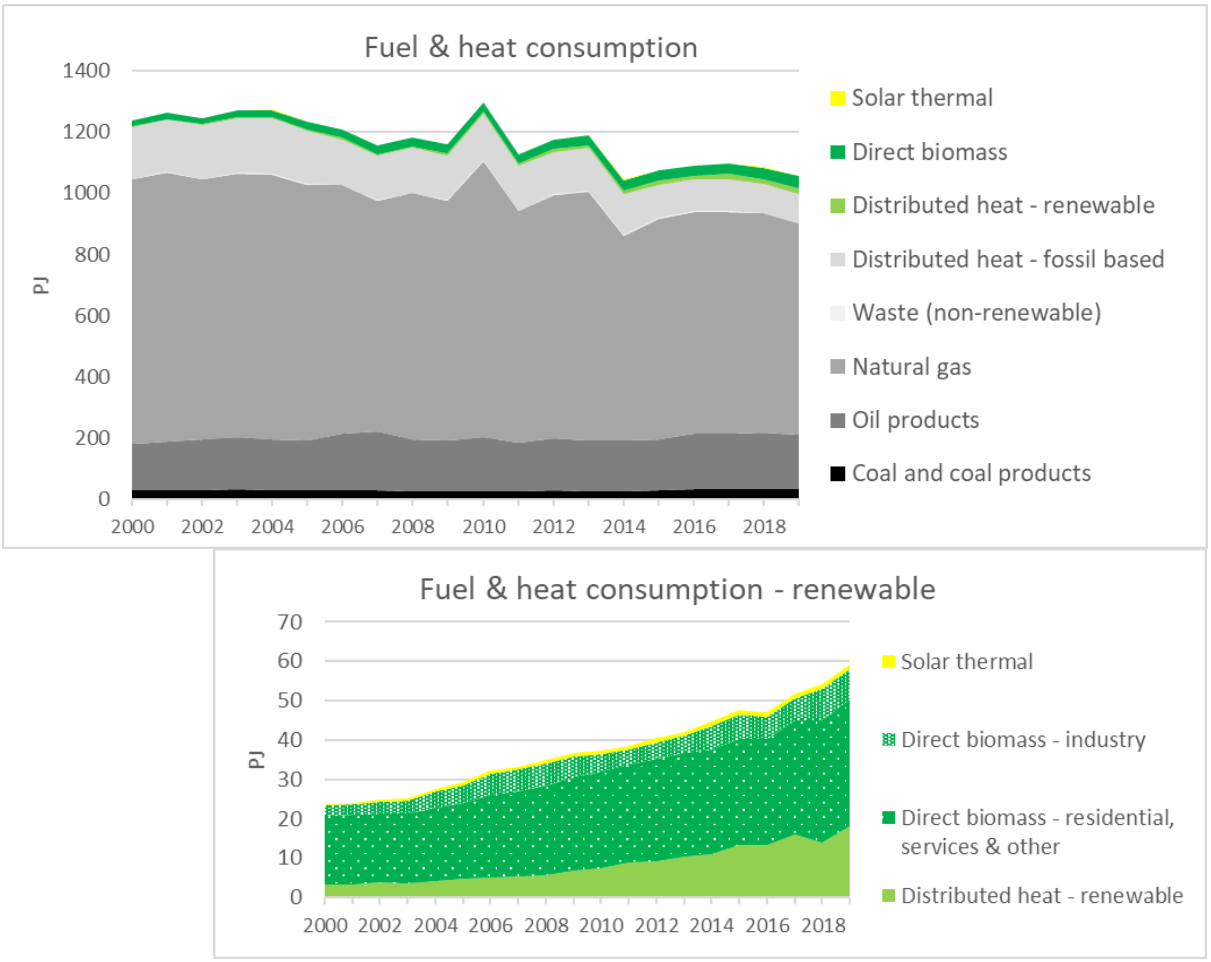


***Figure 5**: Evolution of fuel and heat consumption in the Netherlands 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Heating Grids:

Heat from CHP plants and heating plants (e.g., through district heating) is sold as heat to the grid and this amount of heat represents around 11% of fuel/heat provided, but its share has declined in the past 10 years. Figure 6 shows that this heat output for the grids is still for more than 60% fossil based, with a dominant role for natural gas. The use of biomass for heat output increased over the years and now represents 16% of heat output. Residual heat is also relevant at 8% of heat output.

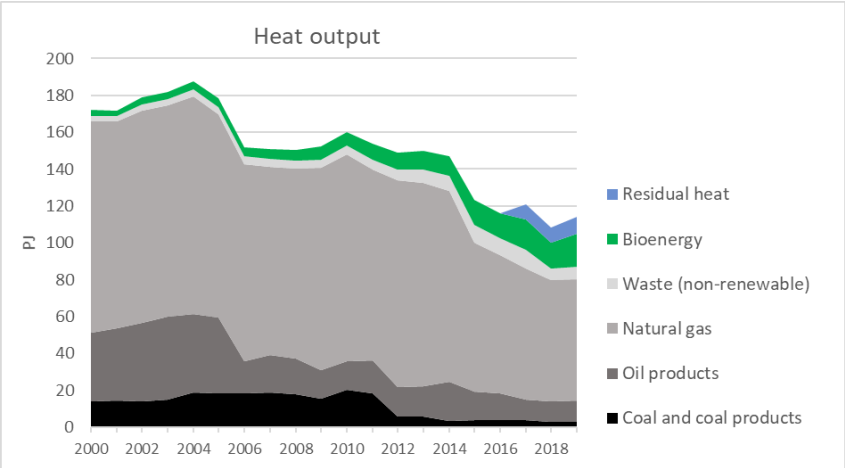


***Figure 6**: Evolution of fuels for heat in heating grids in the Netherlands 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Policy framework

The main relevant policy instruments (with relevance for biobased heat) behind these evolutions are:

- The main driver for renewable heat has been the financial support through the SDE+ scheme. Since 2012 renewable heat has been included in the support scheme and could be realized at a lower price than electricity (€/kWh). For final energy targets in the Renewable Energy Directive the kWh electricity and kWh heat sum up in the same way, so renewable heat was a cheaper option for projects over the last years. The financial support comes available through the SDE+ scheme and, depending on technology and the competing technologies, the support could be between 0.05 – 0.08 €/kWh. For example, see the call of 2018[11].

- In recent years, the support for heating with biomass was reduced and there is also a strong public opposition due to perceived health risks and questions about sustainability and realized GHG emission reduction. Though good examples exist, a final decision has not been taken in August 2021.

TRANSPORT

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

Gasoline is the dominant fuel for cars in the Netherlands and diesel for heavy duty vehicles. Mind that diesel consumption is higher with 52% of transport energy use, while gasoline represents 39%. There used to be a relevant share of LPG in the Netherlands at 5% of transport fuels in 2000, but this dropped to 1.3% in recent years.

In 2006, biodiesel and bioethanol were introduced and there was a very strong growth in 2007 to a combined level of around 14 PJ, almost 3% of transport fuel consumption. However, these levels stabilized (with some fluctuations) up to 2017. In 2018 and 2019 there was important growth again, with a doubling in 2 years' time. Biodiesel (FAME and HVO together) represents almost 7% by energy of diesel fuel consumption; bioethanol represents about 4.5% by energy of gasoline consumption. 80% of biofuels consumed in the Netherlands are qualified as 'advanced biofuels', meaning that they are produced from residues and waste (particularly used oils for biodiesel).

Electricity represents a share of 1.9% of total transport energy use. This is mostly in rail, but also about one third (0.6% of total transport energy use) in road vehicles. This can be expected to grow in the coming years, considering relatively high sales of electric cars in the Netherlands.

[11] Brochure SDE+ Spring 2018 (rvo.nl): https://english.rvo.nl/sites/default/files/2018/06/Brochure%20SDE%20Spring%202018.pdf

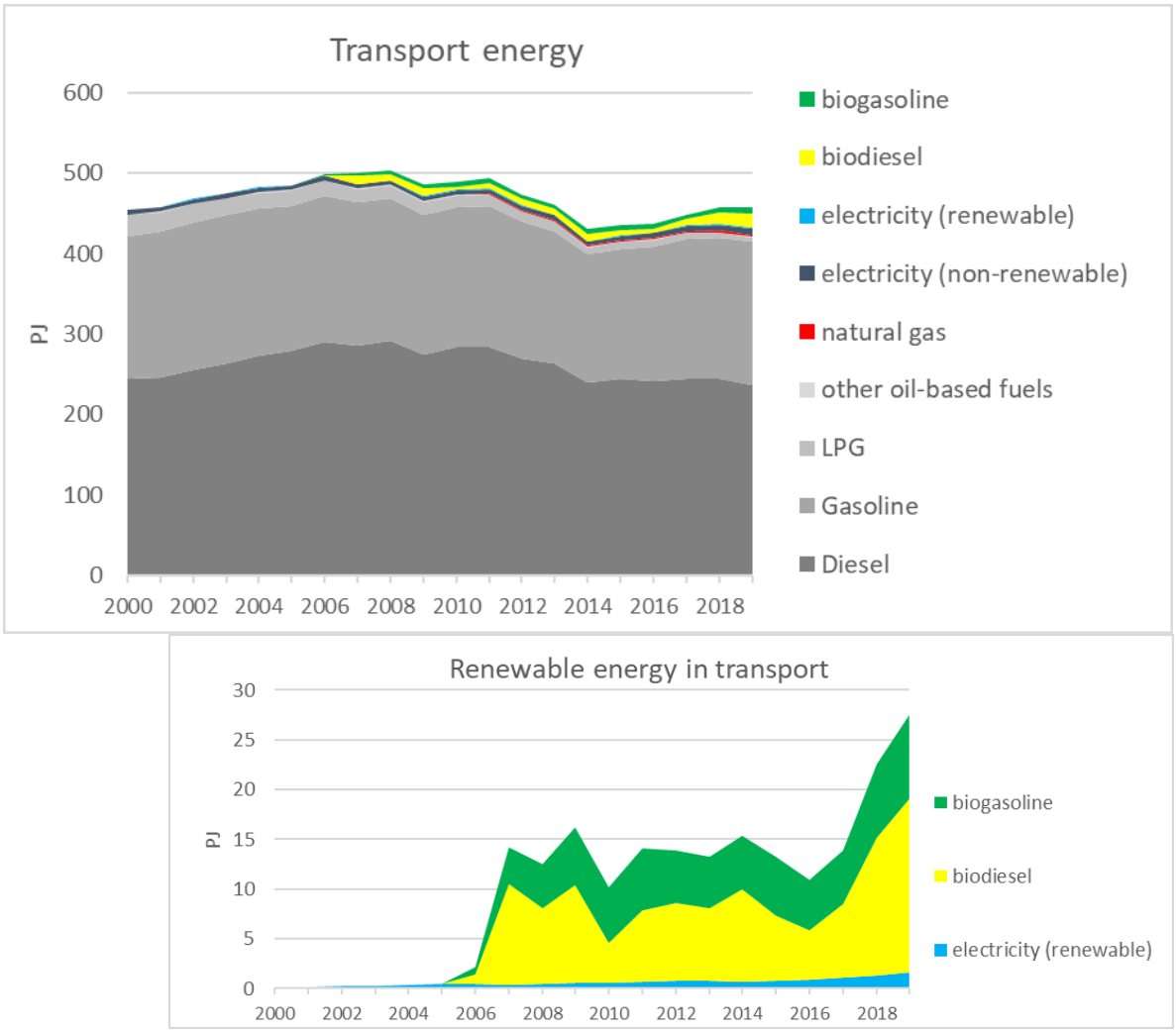


***Figure 7**: Evolution of transport fuels in the Netherlands 2000 – 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Policy framework

The main relevant policy instruments behind these evolutions are:

- Through the Annual Obligation[12] fuel suppliers are obliged to achieve a minimum blending level or else face financial sanctions for non-compliance. The obligation mirrors the EU wide scheme, allowing "double-counting" for biofuels based on wastes and residues and other non-food cellulosic and hemi-cellulosic feedstocks as specified in Annex IX of the RED. There are also limits on the proportion that can come from "food and feed crop-based biofuels" and from feedstocks listed in Annex IX Part B (principally used cooking oil), and a mandatory level for" advanced biofuels". The levels of the obligation are being set through to 2030, providing market certainty.
- The NL Climate Agreement sets the intention to reduce emissions in road transport by an additional 2 MT $CO2_{eq}$, compared to the 2030 projection of the National Energy Exploration 2017. This includes the use of up to 60 PJ of biofuels in road transport, plus a further 5 PJ to be used in inland shipping.

[12] https://www.emissionsauthority.nl/topics/obligations---energy-for-transport/annual-obligation

- Fuel suppliers to road transport must comply with the annual obligation. Companies that supply fuels to the maritime and aviation sectors do not have an obligation but can “opt in” by a voluntary contribution. Fuel suppliers to inland shipping need to comply with the reduction obligation (FQD) from 2022 onwards, as required by the European Commission.
- The sustainability governance of biofuels in the Netherlands is based on the comprehensive EU RED (2) framework. This defines a series of sustainability and GHG emission criteria that transport biofuels must meet in order be counted towards targets and to be eligible for financial support by public authorities. In particular RED II reinforces the measures aimed at reducing ILUC effects.
- While the Obligation applies to the road transport sector, an “opt-in” scheme for marine and aviation biofuels has successfully led to an increase in use of biofuels in this sector.
- Support (not financially, but through the obligation system with associated certificates) for biofuels production and use is provided by the award of tradable renewable energy units for biofuels (HBE’s; 1 HBE = 1 GJ) These units have a value of between 10 and 15 Euros/GJ. Fuels produced from waste and residues can qualify for 2 units for each GJ of energy used (double counting verification is a requirement for this). The total additional cost of using biofuels therefore amounts to between 10 and 30 Euros/GJ.

BIOGAS AND GREEN GAS

Biogas saw a strong growth between 2005 and 2010. In the past decade levels stabilized around 13 PJ. In 2019 there was some increase again up to 14.8 PJ.

The biogas is produced mainly from manure with co-digestion and from organic municipal waste. Part of the biogas is upgraded to biomethane and fed into the grid (1.9 PJ) and partly used in mobility (0.8 PJ). The rest is converted to renewable electricity and heat.

Table 6: Sources of biogas production and utilization (2019)

Type of biogas	production (TJ)	utilisation of produced gas			final use:		#plants	biomethan [MNm3]
		CHP	Green Gas	Mobility	Electricity	Heat		
landfill	532	312	127	22	104	154	NE	4
sewage sludge	2636	2133	127	22	753	1432	NE	4
co-digestion (1)	5879	4280	1615	281	1880	2838	89	51
Others (municipal waste	5763	2327	2660	465	1151	3311	NE	84
Total	14810	9052	4529	790	3888	7735		143
(1) installed capacity 98 MW, since 2018 is the growth in biogas for a part 'artificial' because before								
injected biomethane in the grid is 0,34% of gros natural gas consumption								
source: CBS publication: Renewable energy in the Netherlands 2019, published september 2020								

COMPARISON WITH RENEWABLE ENERGY TARGETS

According to Eurostat[13], the following renewable energy shares in *gross final energy consumption* were reached.

Table 7: Share of renewables in different sectors in the Netherlands, according to Eurostat, and compared to the 2020 target

	2005	2010	2015	2019	*2020 target*
Overall share	2.5%	3.9%	5.8%	8.8%	*14%*
In heating & cooling	2.4%	3.1%	5.5%	7.1%	*8.7%*
In electricity	6.3%	9.6%	11.1%	18.2%	*37%*
In transport	0.4%	3.3%	5.3%	12.5%	*16%*

There has been important acceleration in renewable energy deployment in recent years in the Netherlands. Nevertheless, in 2019 levels were still quite distant from the overall renewable energy target for 2020. According to the latest figures of CBS, renewable energy accounted for 11.1 percent of total Dutch energy consumption in 2020. The Netherlands will rely on statistical transfers from other countries to fulfil the 14% 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 advanced biofuels and renewable electricity towards the transport target. The Netherlands put high focus on waste oil based biodiesel, which can be double counted to the transport target, but the actual biofuel volumes are at lower level. The heating & cooling figure in Eurostat also includes heat pumps, which are gaining importance in the Netherlands.

BIOREFINERIES

The new Dutch policy on bioresources since 2020 requests the valorisation of biomass and an increased production of biofuels, chemicals and materials from biomass in industry to replace fossil based resources. There are efforts to monitor the replacement of fossil carbon by renewable carbon and reporting is expected in the future. At this moment research on biorefineries and the first demonstration plants are being established. See chapter *Major developments* below.

RESEARCH FOCUS RELATED TO BIOENERGY

In 2015 a new Research Agenda for the Biobased Economy was produced by the Top Consortium for Knowledge and Innovation BioBased Economy: TKI-BBE14. The TKI-BBE operates within the Top sector Chemistry and Top sector Energy. Besides energy, biomass streams can also be used for materials. By separating biomass into fractions, and by valorisation of the molecular capital, financial gains are enhanced, and at the same time the use of fossil fuels in the chemical sector is reduced. The TKI BBE stimulates the development of this bio-cascading. The Research Agenda15 is being developed via existing programme lines of the TKI BBE. These programme lines are linked to the relevant Top Sectors. They cover i) thermal conversion from biomass; ii) chemical catalytic conversion technologies; iii) biotechnological conversion technologies and iv) solar capturing (and biomass production). The TKI-BBE formulated with all stakeholders a research agenda: 2015 – 2027. http://edepot.wur.nl/379629 (in Dutch).

A new Mission driven research approach was developed in 2019, and resulted in a new focus in research, where electrification and H2 play a major role. Bioresources are seen as a crucial contributor for decarbonization, but first of all for chemicals and materials and fuels, and there is now the research priority.

RECENT MAJOR BIOENERGY DEVELOPMENTS

Due to political pressure based on consumer attitude there is negative attitude towards the burning of biomass, though it has been proven the only short term solution for heat from biomass. Due to this political pressure the financial support for biomass power and heating has been reduced, and no further growth is expected is this area, unless policies change.

In 2019 the Climate Agreement was signed by a number of parties and lays down the future transition to a sustainable electricity from solar, wind, smart grids and storage of energy (e.g. in H2). It is expected that wind and solar can grow a 10-fold (wind from 1 GW in 2020 to 10 – 14 GW in 2030). This requires an improved infrastructure and flexibility. Innovation is crucial to realize this. By 2030 the coal fired power plants will be closed and biomass in large scale power plants will also fade out.

A sustainability framework for high value use of biobased raw materials was developed in 2019 – 2020 and agreed upon with the Parliament in 2020, and lays down a preference for cascading use of bioresources: First for chemicals and materials, Secondly for (transport) fuels, heavy road, aviation, shipping and it is recommended to reduce the use of biomass for heating and power. The new biomass sustainability approach puts a strong focus on biorefineries to capture the value of bioresources in an efficient way. These biorefineries are being developed and some examples can be presented:

- Chaplin[16]: Asphalt Applications from lignin, is being developed and demonstrated

[15] https://www.topsectorenergie.nl/sites/default/files/uploads/BBE/Kennis-en-Innovatie-agenda-2016-2019-Biobased-Economy.pdf

[16] World's first bio-asphalt test road made with lignin - Agro & Chemistry (agro-chemistry.com)

- Chemport: utilisation of saccarides[17]
- Total- Corbion [18]: PLA (Polylactic Acid) plant in Europe
- Biondoil[19]: Advanced fuels and chemicals from residues
- SkyNRG, SHV Energy, KLM: Aviation fuels production[20]

LINKS TO SOURCES OF INFORMATION

See footnotes

[i] IEA Energy Policy Review, Netherlands 2020. https://www.iea.org/reports/the-netherlands-2020
[ii] Netherlands Environment Assessment Agency (PBI), Climate and Energy Outlook 2020 (Klimaat en Energie Verkenning, (KEV2020)), Klimaat- en Energieverkenning 2020 (pbl.nl)
[iii] Eurostat, Renewable Energy Tables and Figures – 2020 Update, File: Renewable energy-tables and figures 2020-update.xlsx - Statistics Explained (europa.eu)
[iv] NL Ministry of Economic Affairs and Climate Policy (2019), Integrated National Energy and Climate Plan, 2021 – 2030, November 2019. https://ec.europa.eu/energy/topics/energy-strategy/national-energy-climate-plans_en

[17] Saccharide Agenda: a point on the horizon for green chemistry - Chemport
[18] https://www.total-corbion.com
[19] Biondoil | Mission & Vision
[20] SHV Energy, SkyNRG and KLM announce project to build first European plant for sustainable aviation fuel | SHV.nl