



WORLD  
BIOENERGY  
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# GLOBAL BIOENERGY STATISTICS REPORT



## DISCLAIMER

WBA publishes the Global Bioenergy Statistics reports annually to increase awareness of the role of bioenergy in the global energy mix. The reports are prepared with the extreme care and due diligence. Even though every effort is made to ensure the highest quality in data presented in the report, WBA cannot be held liable for the accuracy of the information presented.

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## SUMMARY

Fossil fuels still hold a dominant position in the global energy supply, accounting for 80% of the total primary energy supply. Fossil fuels are sourced from coal, crude oil, and natural gas, showing an increase of 6% from 2020 to 2021. On the other hand, renewable energy technologies like solar, wind, hydro, biomass, and geothermal constitute only 15% of the primary energy supply in 2021, indicating a slight 0.4% decline from the preceding year – due to the COVID-19 pandemic effects.

Within the electricity sector, coal and gas remain substantial contributors to the global electricity mix, generating almost 60% of the world's electricity in 2020. Meanwhile, in the same year, renewables accounted for 29% of global electricity production, predominantly driven by the increase in solar and wind energy, with significant contributions from hydropower and biomass. Hydropower held the largest share at 58%, followed by wind at 21%, solar at 11%, and biomass, ranking fourth, at 9% generating 685 TWh.

Globally, 15.7 EJ of heat was produced in 2020 through heat only and combined heat and power plants, primarily fuelled by coal and natural gas, accounting for over 85% of global heat production. However, renewable energy technologies like biomass, geothermal, and solar thermal have doubled their contribution to global heat production over the past two decades, with 96% of renewable heat stemming from biomass.

Despite the increasing interest in renewable energy, the transportation industry remains heavily dependent on crude oil and its derivatives. In 2021, these sources accounted for over 90% of the industry's energy consumption. To diversify the industry's energy sources, there is an urgent need to focus on expanding liquid biofuels and biogas as alternative energy sources.

Gross final energy consumption, encompassing all energy sources' total final consumption across various sectors, reached 360 EJ in 2020, with renewables accounting for 20%—a noticeable increase from 18% in 2019.

Notably, in 2020, the global domestic supply of biomass reached 57.5 EJ. Solid biomass sources comprised the majority at 86%, with Asia being the primary contributor, making up 40% of the global supply. Liquid biofuels were the second most significant source, with the Americas leading the way, providing over 60% of the supply. Municipal and industrial waste accounted for 6%, with Europe contributing nearly half of the global amount.

As of 2022, data shows that 46.4 million tons of wood pellets, 1.9 billion m<sup>3</sup> of wood fuel, and 54.9 million tons of wood charcoal were produced worldwide. Europe is the leading producer of wood pellets, accounting for over 55% of the global supply. Meanwhile, Africa leads in the production of wood fuels and charcoal, representing 37% and 66% of the global production, respectively. Highlighting the pivotal roles of agriculture and forestry in advancing the potential of bioenergy utilization is essential. These sectors serve as key sources for biomass availability and accessibility, forming the foundation for future bioenergy development.

Additionally, energy generation sourced from the third major feedstock sector, municipal and industrial waste amounted to 2.65 EJ, in 2020, with 55% originating from municipal waste and the remainder from industrial sources. Europe plays the major role, accounting for almost half of the energy generated from waste globally.

In 2020, 685 TWh of electricity was generated from biomass globally. 69% of all biopower generated was from solid biomass sources followed by 17% from municipal and industrial waste. Asia accounted for 40% of all biopower generated globally with 276 TWh of production in 2020 followed by Europe at 35%. Electricity-only plants are designed to produce electricity only. In 2020, 5.3 EJ of biomass was used in electricity-only plants for power generation.

CHP or Combined Heat and Power plants refer to those plants that are designed to produce both heat and electricity. In 2020, 3.4 EJ of biomass was used in CHP plants. Solid biofuels account for 66% of all biopower produced in CHP facilities followed by municipal waste at 17%. In 2020, 1.2 EJ of heat was produced from biomass-based sources – 52% from solid biomass sources and 25% from municipal

solid waste. Europe is the world leader in producing heat from biomass in power plants with a share of 88% globally. In 2020, 0.57 EJ of bioheat was produced in heat-only plants.

Biofuel production globally saw a decrease in 2020, with a total of 146 billion Liters produced. This was largely due to the COVID-19 pandemic. North and South America combined accounted for 70% of global biofuel production, while Europe contributed 15%. In the same year, the worldwide production of biogas was 38.1 billion m<sup>3</sup>, which had an energy content equivalent to 1.46 EJ. Europe was the largest producer of biogas, accounting for 53% of the total global production, followed by Asia with 32%.

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## INTRODUCTION

The WBA Global Bioenergy Statistics report is the flagship publication of the World Bioenergy Association. First published in 2014, the annually published report is one of the only reports focussing solely on the developments in the bioenergy sector. The 2023 report is the 10<sup>th</sup> in the series.

Bioenergy is a versatile energy system. A multitude of feedstock, technology pathways, and end products encompass the biomass-to-energy conversion. Currently, bioenergy is the largest renewable energy source globally. Considering the prominence of bioenergy in the overall energy mix, the sector has not received attention due to a lack of awareness about the potential benefits of bioenergy. Secondly, it is important to note that there is a lack of reliable and updated data on bioenergy globally and locally. Due to the informal and local nature of most of the feedstock and technology used for bioenergy production, it is very challenging to gather, analyze, and report accurate and updated information on bioenergy developments.

To address this gap, this year's report will present data spanning 2020, 2021, and 2022. The primary objective is to provide the most recent and comprehensive data possible. Each section will specify the period of the data provided, ensuring clarity on the temporal context.

As readers go through the report, it is important to understand certain key terminologies and definitions used regularly in the report:

Total primary energy supply or TPES is a combination of: Indigenous production + Imports – Exports-International bunkers +/- Stock changes. The indigenous production of a particular fuel is the energy content of the fuel, for e.g. the lower heating value of charcoal. However, for fuels like solar and wind, the electricity generated is considered as TPES.

Gross final energy consumption or GFEC is a combination of: Total Final Consumption (TFC) – Non-energy use of fuels + Electricity consumption + Derived Heat consumption. TFC is the consumption of energy commodities in end-use sectors, for e.g. residential, commercial, agriculture, etc., and is calculated using the energy content of the fuel. The non-energy use of fossil fuels (e.g. in the chemical industry) is eliminated. The electricity and heat consumption are derived from 'generation' data after eliminating their use within the industry and losses occurring during transmission and distribution.

Bioenergy refers to the use of biological commodities (or biomass) used specifically for energy purposes. Energy use implies the use of biomass for electricity and heat generation and the conversion of biomass to secondary products such as biofuels to be used in the transportation sector. For bioenergy, the energy content of the fuel is considered as primary energy.

Derived heat: If the heat is generated in power plants (combined heat and power and heat only plants), then the heat is termed as derived heat. This is then transported via district heating grids for consumption in end sectors.

Units: Throughout the report, an effort is made to ensure consistent units for reporting. For all energy-related values, Exa Joule (10<sup>18</sup> Joule) is considered the standard unit. For electricity, TWh is used as a reporting unit while for energy commodities, various units like million tonnes, million m<sup>3</sup>, and billion Liters are used.

Geography: The data in the report is classified into a 2-tier system – global and continental. The continental classification is available in the Appendix. Data sources: Most of the data is obtained from the IEA Key World Energy Statistics, their online publication of the World Energy Balances - for the 2020 data, as well as the World Energy Balances Highlights 2023 Report - for 2021 data. Biomass supply data is obtained from FAOSTAT. Other data sources used in the report include publications from IRENA (e.g. energy capacity) and the WBA member network.

Base year: An attempt is made to obtain the most recent available data for each section. Most of the information available is from 2020 and some from the years 2021 and 2022 as well.

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World Bioenergy Association

# GLOBAL ENERGY SYSTEM

## ENERGY SUPPLY

Fossil fuels continue to dominate the global energy supply. In 2021, the Total Primary Energy Supply globally was 618 EJ – fossil fuels had a share of 80% (Coal 27%, Oil 29%, and Gas 24%) TPES of nuclear power was 30.7 EJ, accounting for 5% of the overall energy mix.

Renewable energy technologies of solar, wind, hydro, biomass, geothermal, etc., accounted for 90.8 EJ, representing 15% of the total primary energy supply in 2021.

Table 1 Total primary energy supply

Year	Total	Coal	Oil	Gas	Nuclear	Renewables	Renewables (%)
2000	420	96.9	154	86.5	28.3	53.7	13%
2005	481	125	168	98.6	30.2	58.3	12%
2010	537	153	173	114	30.1	66.3	12%
2015	569	161	182	122	28.1	75.1	13%
2020	585	157	172	138	29.2	88.0	15%
2021	618	168	182	146	30.7	90.8	15%

All values in EJ

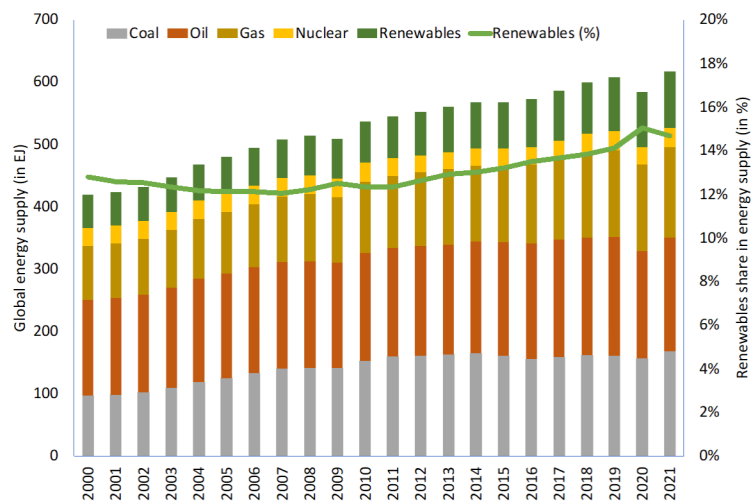


Figure 1 Total primary energy supply globally

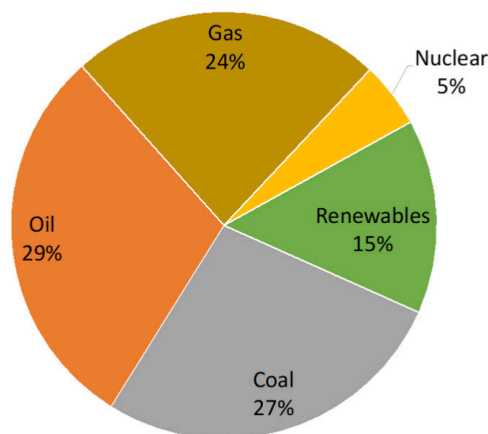


Figure 2 Total primary energy supply globally in 2021

In 2021, among continents, total primary energy supply of all energy sources is highest in Asia, with a total of 393 EJ, heavily depending on coal as its major source (~60%). On the same line, European TPES account for 125EJ, being the major source gas (36%). The Americas follow this trend, depending on crude oil and its derivatives (37%). Among renewable energy sources, the African continent has the highest renewable energy share (48%) due to the use of traditional biomass for heating and cooking.

Table 2 Total primary energy supply in continents in 2021

Continent	Total	Coal	Oil	Gas	Nuclear	Renewables	Renewables (%)
Africa	36	4	8	6	0	17	48%
Americas	135	13	50	44	10	19	14%
Asia	459	227	104	62	13	54	12%
Europe	125	17	33	45	13	16	13%
Oceania	5	2	2	2	0	1	13%

All values in EJ

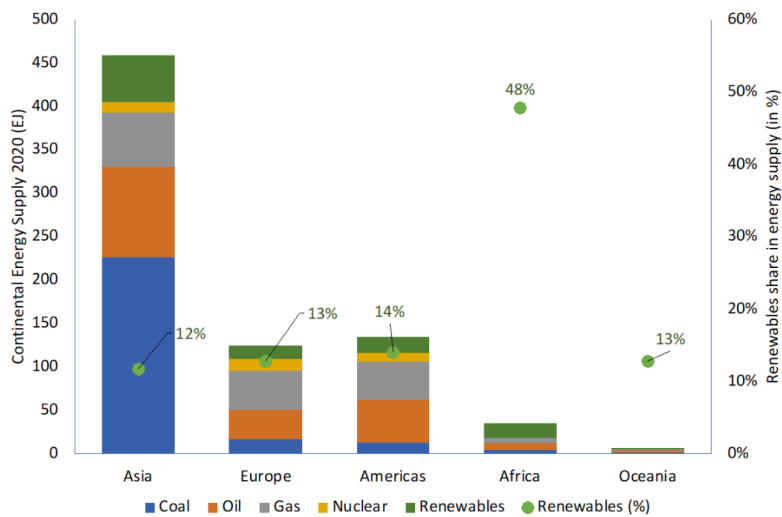


Figure 3 Total primary energy supply in continents in 2021

## ELECTRICITY

Coal is a major energy source to the global electricity mix. In 2020, 35% of electricity produced globally was from coal-based sources. In recent years, natural gas is emerging as a major electricity producing energy source. During 2000 – 2020, the share of natural gas in electricity mix increased from 18% to 24%.

In 2020, 26 833 TWh of electricity was generated globally with renewables having a share of 29%, mainly driven by the increasing use of solar and wind as well as significant contribution from hydropower and biomass.

Table 3 Electricity generation globally

Year	Total	Coal	Oil	Gas	Nuclear	Renewables	Renewables (%)
2000	15 510	5 995	1 188	2 771	2 591	2 943	19%
2005	18 369	7 326	1 129	3 701	2 768	3 413	19%
2010	21 626	8 670	969	4 856	2 756	4 342	20%
2015	24 375	9 536	1 021	5 550	2 570	5 661	23%
2020	26 833	9 452	668	6 335	2 674	7 669	29%

All values in TWh



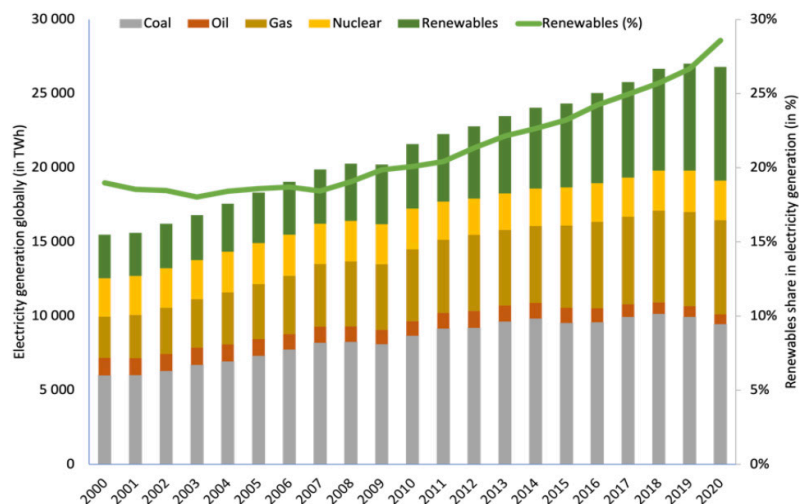


Figure 4 Total electricity generation globally and share of renewables

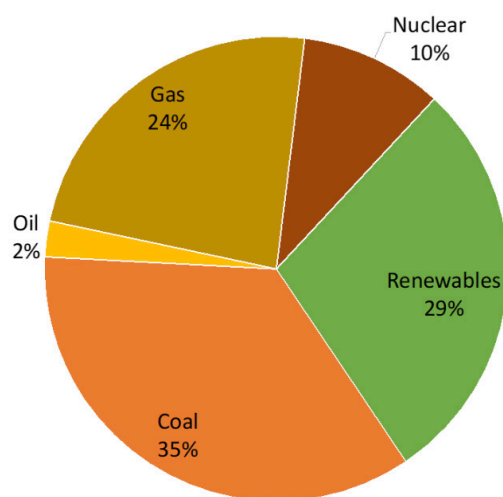


Figure 5 Total electricity generation globally in 2020

Among continents, Asia is heavily dependent on electricity from coal. In 2020, 7 499 TWh of coal power was produced in Asia – accounting for 79% of all coal electricity generated globally. Among other continents, the Americas and Europe have a major dependence on natural gas – accounting for 34% and 13% respectively. Europe has a high share of renewables in the electricity mix at 42% while at the same time, the Americas had a share of 35% in 2020. Overall, 7 699 TWh of renewable power was produced in 2020.

Table 4 Electricity generation in continents in 2020

Continent	Total	Coal	Oil	Gas	Nuclear	Renewables	Renewables (%)
Africa	840	248	47	346	10	189	23%
Americas	6 498	973	161	2 162	954	2 248	35%
Asia	15 224	7 499	402	2 965	875	3 483	23%
Europe	3 927	586	52	801	834	1 653	42%
Oceania	310	148	5	62	0	96	31%

All values in TWh

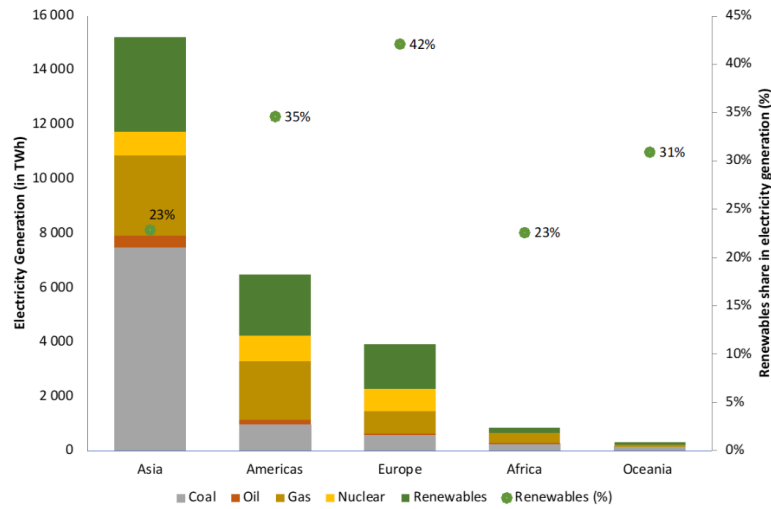


Figure 6 Electricity generation in continents in 2020

## HEAT

In 2020, 15.7 EJ of heat was produced globally via heat only and combined heat and power plants. Coal and natural gas have a combined share of more than 85% in the global heat production which has remained the same since the start of the century.

Renewable energy technologies including biomass, geothermal and solar thermal have increased by 3 times in the global heat production over the past 20 years. However, share of renewables in heat production is currently at 8%. It is important to note that the heat production only includes the heat generated in power plants and supplied to customers via district heating networks.

Table 5 Heat production globally

Year	Total	Coal	Oil	Gas	Nuclear	Renewables	Renewables (%)
2000	12.3	4.33	1.16	6.24	0.02	0.43	3.5%
2005	13.4	4.79	0.97	6.62	0.02	0.55	4.1%
2010	14.3	5.37	0.85	6.78	0.03	0.81	5.7%
2015	13.8	5.77	0.59	5.90	0.03	0.99	7.2%
2020	15.7	7.04	0.54	6.24	0.03	1.26	8.0%

All values in EJ

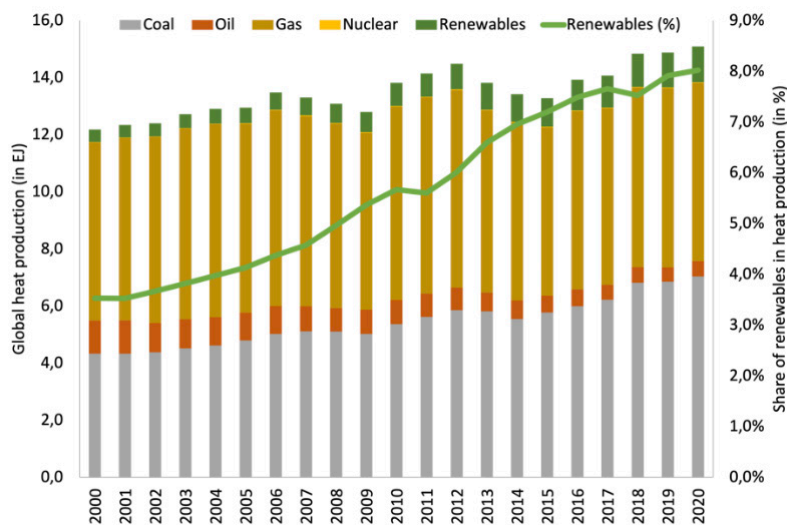


Figure 7 Total heat production globally and renewable share in heat

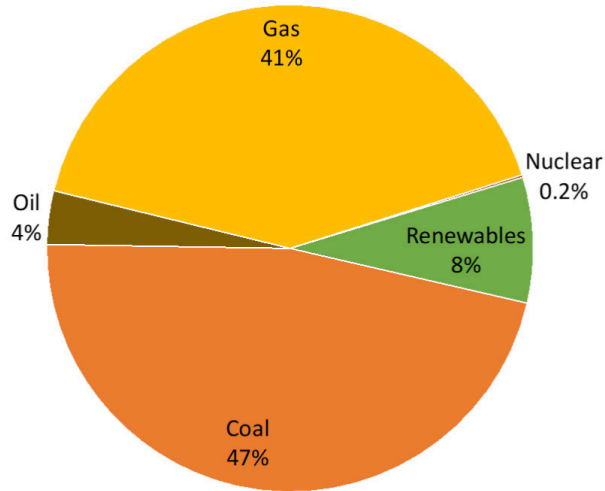


Figure 8 Total heat production globally in 2020

In 2020, derived heat production globally was concentrated in Asia and Europe with both accounting for a share of 93% in the global heat production. Coal accounts for 56% of the heat production in Asia while natural gas accounts for 77% and 47% of the heat production in Americas and Europe respectively. Europe is the leader in commercial production of renewable heat, mainly due to the increased use of biomass in power plants. In 2020, Europe accounted for 76% of all renewable heat produced.

Table 6 Heat production in continents in 2020

Continent	Coal	Oil	Gas	Nuclear	Renewables	Total	Renewables (%)
Africa	-	-	-	-	-	-	-
Americas	0.02	0.03	0.37	0.00	0.06	0.48	13%
Asia	6.46	0.42	4.46	0.01	0.24	11.60	2%
Europe	0.56	0.08	1.40	0.01	0.95	3.01	32%
Oceania	-	-	-	-	-	-	-

All values in EJ

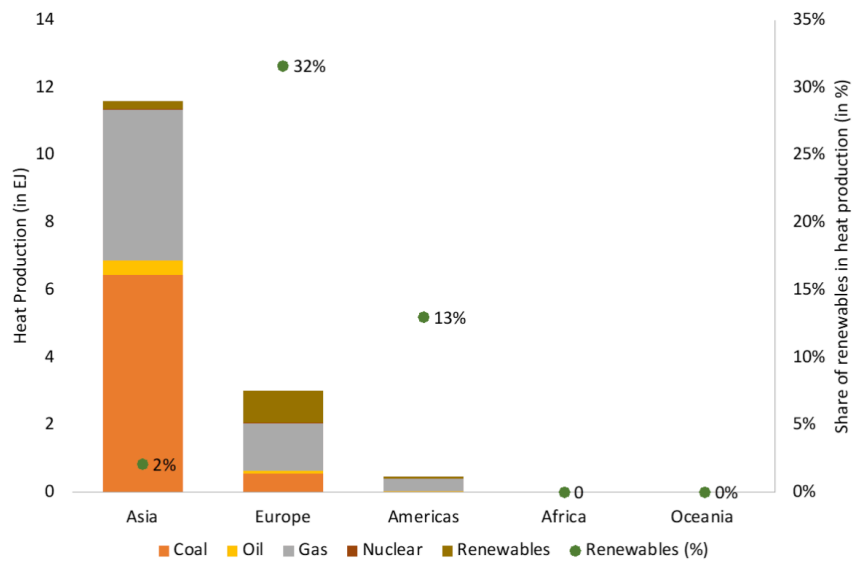


Figure 9 Heat production in continents 2020

## TRANSPORT

In 2021, 113 EJ of energy was consumed in the transport sector. Crude oil and oil products contribute 91% of the energy needs for the transport sector. The energy consumption in transport is more than the energy use for electricity globally.

Electrification is an important option for decarbonizing the transport sector, but the contribution to the overall share in transport is 1.4%. It is important to note that the share of renewables in the electricity is only about 30% and hence, the overall share of renewable electricity is much lower. At the same time, liquid biofuels and biogas currently offer commercial and renewable fuel for the sector right now. Biofuels have a share of 3.5% in the overall energy use in the transport sector.

Table 7 Energy use in transport globally

Year	Total	Coal	Oil	Gas	Renewable Fuels	Electricity	Renewables (%)
2000	82.2	0.03	78.6	2.42	0.42	0.79	0.7%
2005	92.9	0.01	88.1	3.10	0.81	0.93	1.1%
2010	102	0.01	94.5	3.74	2.37	1.06	2.5%
2015	113	0.00	104	4.12	3.29	1.21	3.2%
2020	105	0.04	95.0	4.67	3.81	1.47	4.0%
2021	113	0.03	102.1	5.06	3.94	1.49	3.5%

All values in EJ

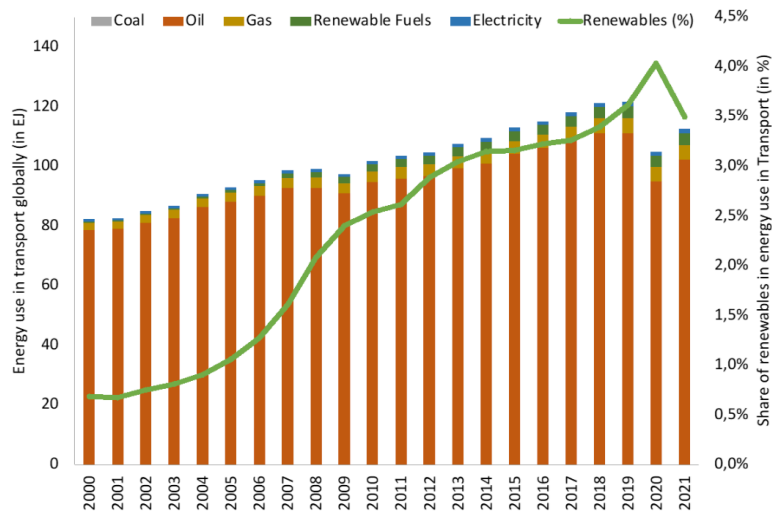


Figure 10 Energy use in transport globally

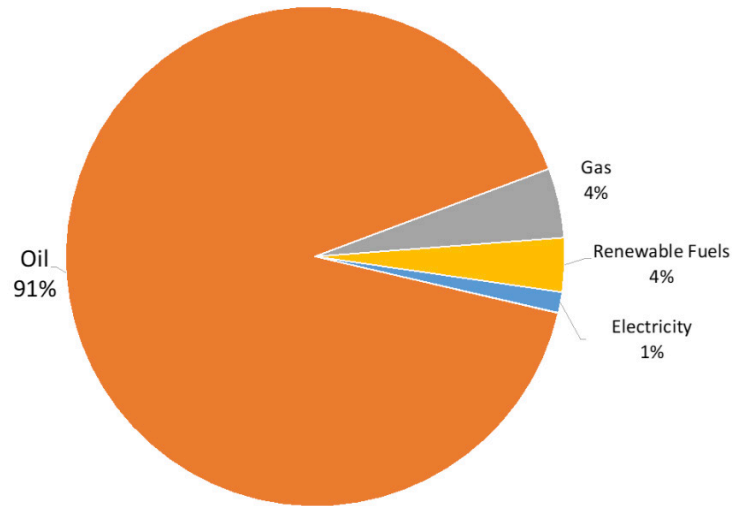


Figure 11 Energy use in transport in 2021

Crude oil and oil products are the dominant source of energy for the transport sector across all continents with its contribution ranging from 97% in Oceania to 86% in Europe. The contribution of natural gas varies from 1% to 8%. In 2021, biofuels share in the Americas was 7%. The dominance of the Americas (USA and Brazil) in the renewable fuels sector is quite evident as more than 63% of all biofuels consumed in the transport sector occur in that region.

Table 8 Energy use in transport in continents in 2021

Continent	Total	Coal	Oil	Gas	Biofuels	Electricity	Biofuels (%)
Africa	5	0	5	0	0	0	0%
Americas	36	0	32	2	3	0	7%
Asia	50	0	45	3	1	1	2%
Europe	21	0	18	2	1	1	5%
Oceania	1	0	1.4	0	0	0	1%

All values in EJ

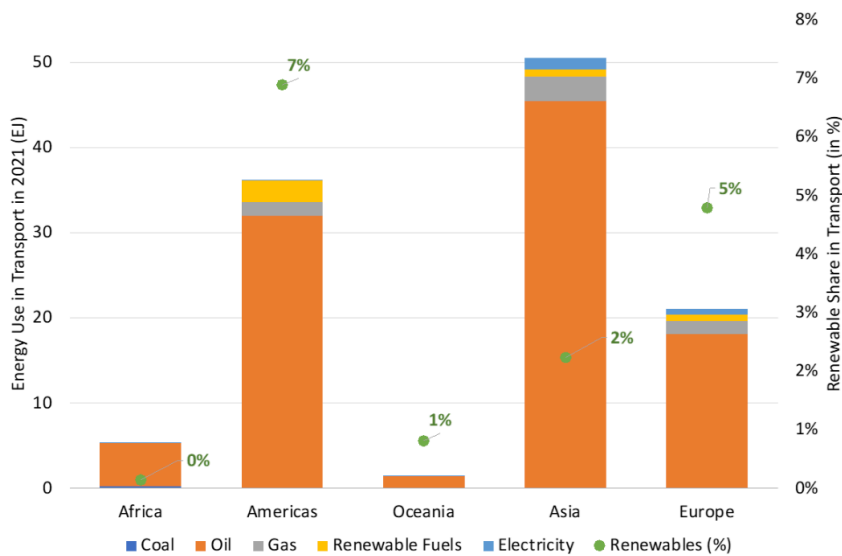


Figure 12 Energy use in Transport in 2021

## GROSS FINAL ENERGY CONSUMPTION

Gross final energy consumption includes the total final consumption of all energy sources including the electricity and heat consumption at all end-use sectors. In 2020, the gross final energy consumption of all energy sources was 360 EJ. Fossil fuels account for more than 78% of the total energy consumption while the share of renewables continues to slowly increase to 20%.

Table 9 Gross final energy consumption

Year	Coal	Oil	Gas	Nuclear	Renewables	Total	Renewables (%)
2000	43.1	115	55.9	7.64	46.2	268	17%
2005	58.9	125	61.3	8.22	49.4	303	16%
2010	73.0	130	70.4	8.26	55.1	336	16%
2015	76.8	138	74.2	7.72	61.1	358	17%
2020	70.8	128	83.0	8.09	70.3	360	20%

All values in EJ

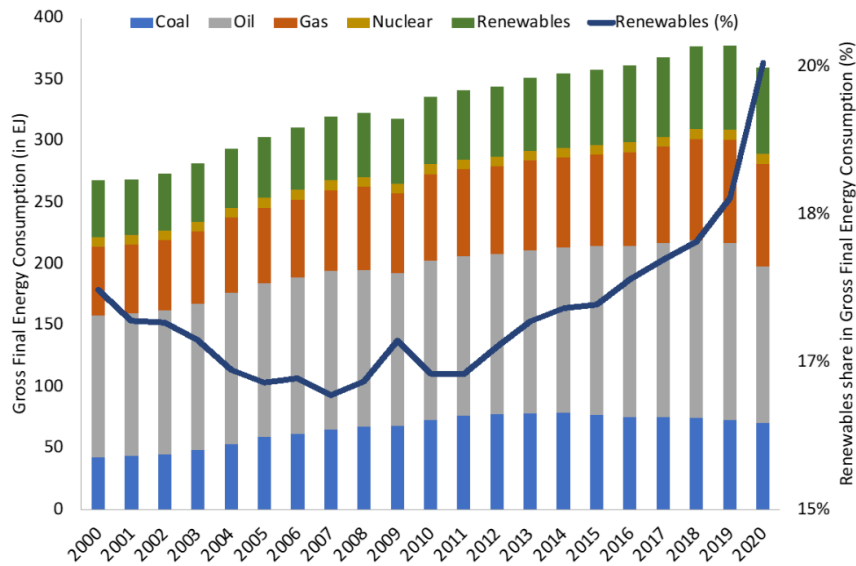


Figure 13 Gross Final Energy Consumption

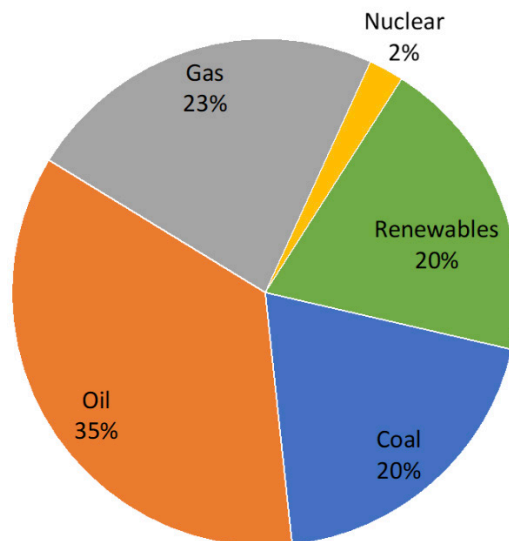


Figure 14 Gross Final Energy Consumption 2020

In 2020, Asia was the largest consumer of coal, representing 85% of all global energy from coal consumption in 2020. Additionally, 83% of its overall energy consumption is coming from fossil fuels, being also the largest consumer of fossil fuels-where China was the major user. Africa has the largest share of renewables consumption, with 58%, mainly because of the use of traditional biomass. The Americas and Europe follow that trend with 33% and 21% respectively.

Table 10 Gross Final Energy Consumption in Continents in 2020

Continent	Coal	Oil	Gas	Nuclear	Renewables	Total	Renewables (%)
Africa	1.43	6.4	2.3	0.0	14.1	24.2	58%
Americas	3.45	8.1	8.6	3.0	11.4	34.5	33%
Asia	60.3	53.5	39.2	2.6	29.5	185	16%
Europe	4.20	17.7	15.2	2.6	10.7	50.4	21%
Oceania	0.58	1.8	0.8	0.0	0.5	3.66	13%

All values in EJ

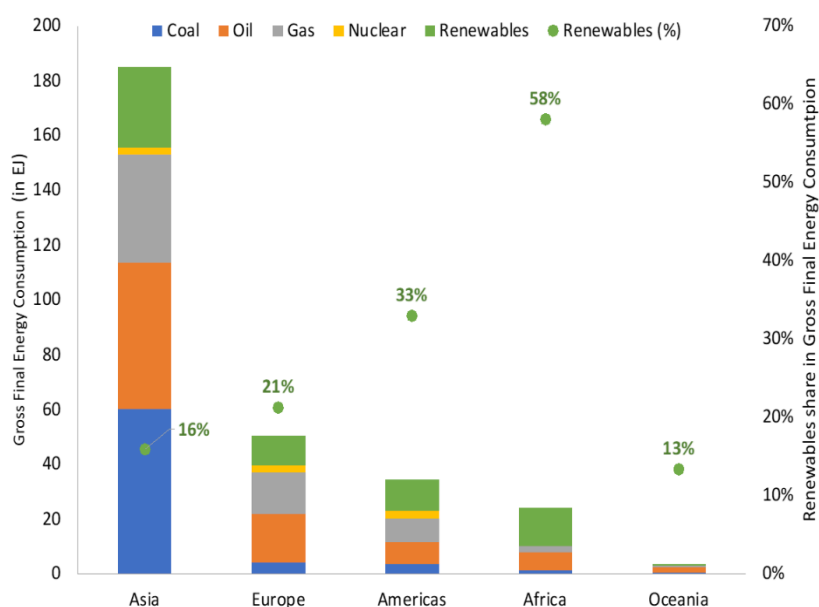


Figure 15 Gross Final Energy Consumption in Continents in 2020

# RENEWABLE ENERGY

## RENEWABLE POWER

In 2020, 7 669 TWh of renewable electricity was produced globally. Hydropower was the largest renewable electricity generating source with a share of 58% followed by wind at 21%. Bioenergy was the 4<sup>th</sup> largest renewable electricity generating source with production of 685 TWh in 2020.

Table 11 Renewable power generation globally

Year	Total	Bioenergy	Hydro	Solar	Wind	Geothermal	Tide	Biopower (%)
2000	2 943	162	2 696	1.30	31.4	52.2	0.55	6%
2005	3 413	228	3 018	4.29	104	58.3	0.52	7%
2010	4 342	362	3 536	33.7	342	67.7	0.51	8%
2015	5 661	509	3 981	254	834	81.0	1.01	9%
2020	7 669	685	4 453	837	1 598	94.9	0.99	9%

All values in TWh

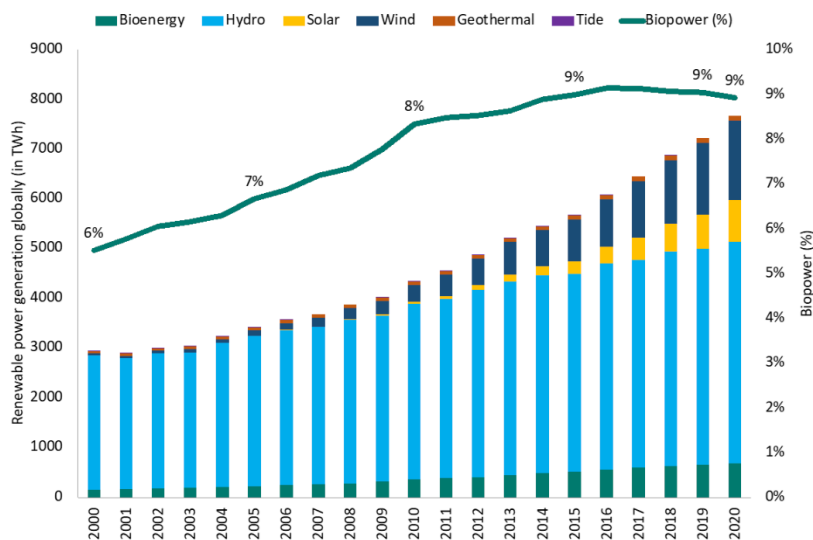


Figure 16 Renewable power generation and share of bioenergy

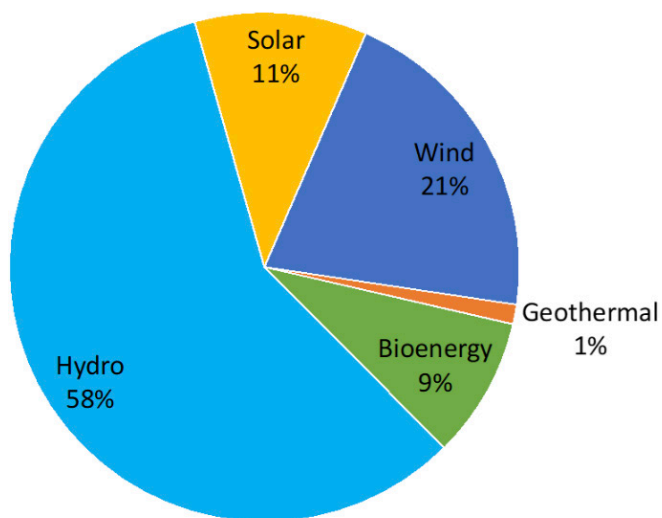


Figure 17 Renewable power generation in 2020



Within the continental level, Asia leads in terms of renewable electricity generation globally. In 2020, 45% of all renewable electricity generated was in Asia followed by the Americas (29%) and Europe (22%). Africa had a share of 2.5% - mainly due to hydropower which had a share of 79% in the African renewable electricity mix. Asia is the largest producer of biopower with an estimated generation of 276 TWh, accounting for 40% of all bioelectricity generation globally.

Table 12 Renewable power generation in continents in 2020

Continent	Total	Bioenergy	Hydro	Solar	Wind	Geothermal	Tide	Biopower (%)
Africa	189	2	150	14	18	5	0	1%
Americas	2 248	164	1 414	159	482	29	0	7%
Asia	3 483	276	2 147	466	563	30	0	8%
Europe	1 653	238	701	177	513	23	1	14%
Oceania	96	4	39	21	23	8	9	4%

All values in TWh

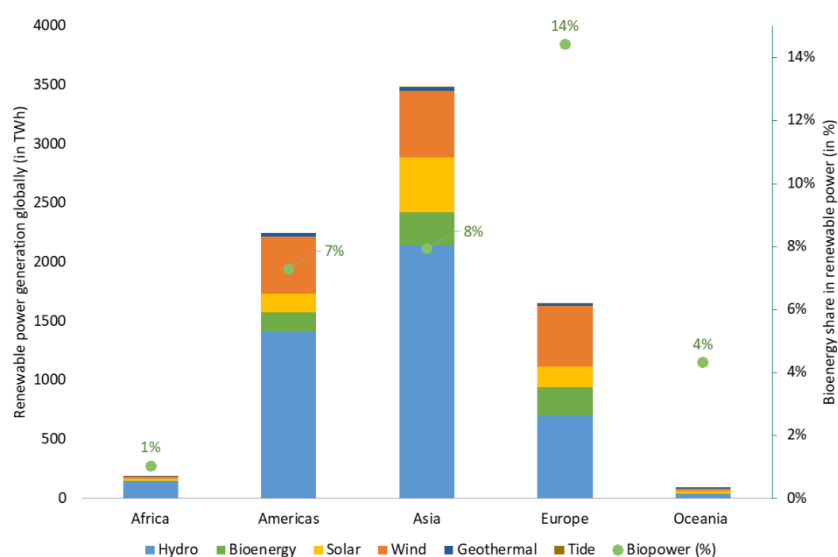


Figure 18 Renewable power generation in continents in 2020

## ELECTRICITY CAPACITY

Globally, the electricity capacity generated from bioenergy has increased exponentially in the last 20 years, from 28 120 MW in 2000 to 148 912 MW in 2022.

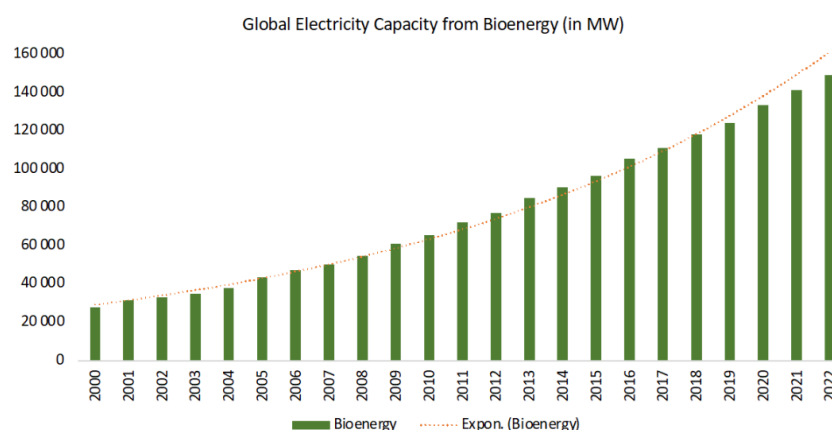


Figure 19 Total Electricity capacity from bioenergy

Within the continental level, in 2022, Asia represented 43% of the total electricity capacity harnessed from bioenergy. Europe and the Americas follow with 28% and 26% respectively.

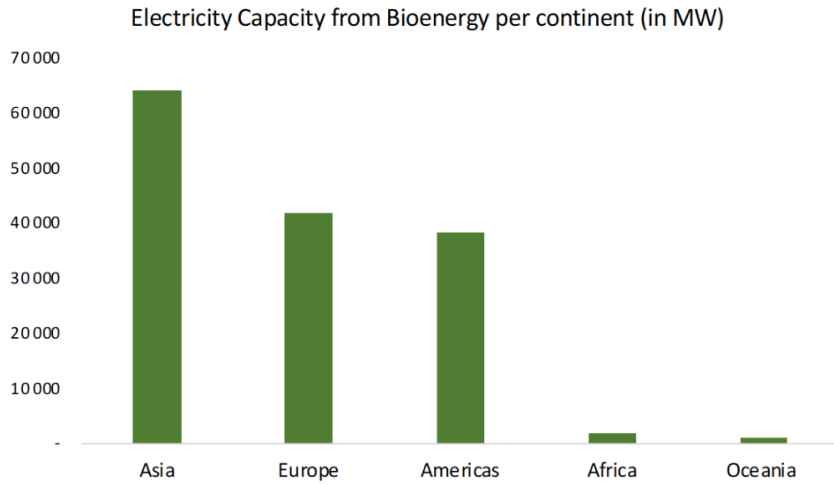


Figure 20 Electricity capacity in continents in 2022

## RENEWABLE HEAT

In 2020, 1.26 EJ of renewable heat was produced in both heat-only plants as well as combined heat and power plants. 96% of all renewable heat produced was from biomass with minor contribution from geothermal and solar thermal technologies.

Table 13 Renewable heat production globally

Year	Total	Bioenergy	Geothermal	Solar Thermal	Bioenergy (in %)
2000	0.43	0.41	0.02	-	96%
2005	0.55	0.53	0.02	-	96%
2010	0.81	0.78	0.03	-	96%
2015	0.99	0.95	0.04	0.001	96%
2020	1.26	1.20	0.05	0.003	96%

All values in EJ

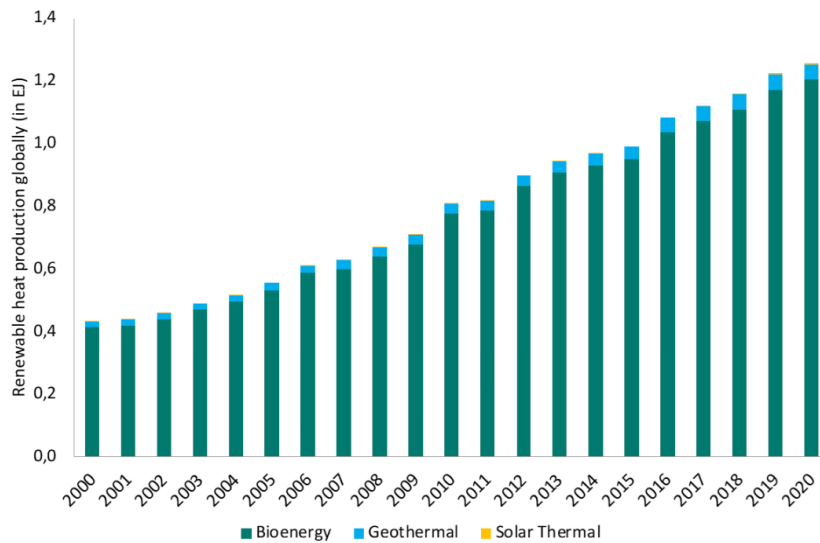


Figure 21 Renewable heat production globally

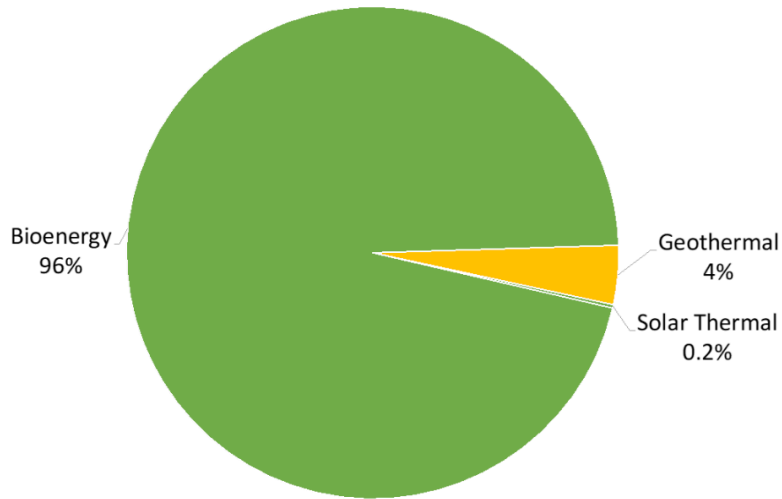


Figure 22 Renewable heat production in 2020

In 2020, almost all the heat production from solar thermal and geothermal facilities occurred in Europe. Europe also leads the way in terms of the use of biomass for heat as close to 75% of bioheat produced globally occurred in Europe.

Table 14 Renewable heat production in continents in 2020

Continent	Bioenergy	Geothermal	Solar Thermal	Total	Bioenergy (%)
Africa	-	-	-	-	-
Americas	0.06	-	-	0.06	100%
Asia	0.24	-	-	0.24	100%
Europe	0.90	0.05	0.003	0.95	95%
Oceania	-	-	-	-	-

All values in EJ

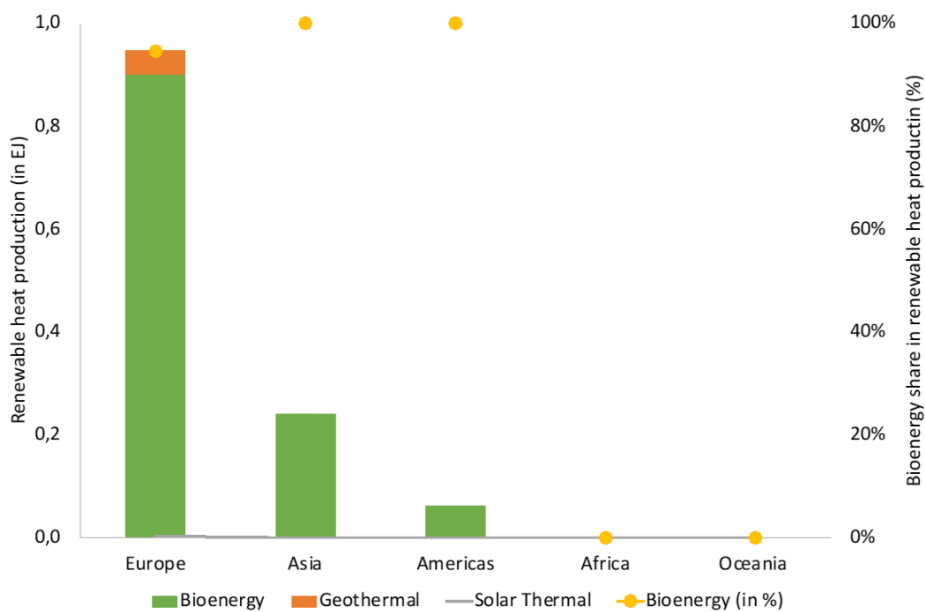


Figure 23 Renewable heat production in continents in 2020

## RENEWABLE TRANSPORT

In 2020, 4.23 EJ of renewable energy was used in the transport sector globally and liquid and gaseous biofuels accounted for 90% of all renewable energy used in the sector. Share of renewable electricity (calculated based on the share of renewables in overall electricity sector) had a share of 10%.

Table 15 Renewable energy use in transport

Year	Total	Biofuels	Renewable Electricity	Biofuels (%)
2000	0.56	0.42	0.15	74%
2005	0.98	0.81	0.17	82%
2010	2.59	2.37	0.21	92%
2015	3.57	3.29	0.28	92%
2020	4.23	3.81	0.42	90%

All values in EJ

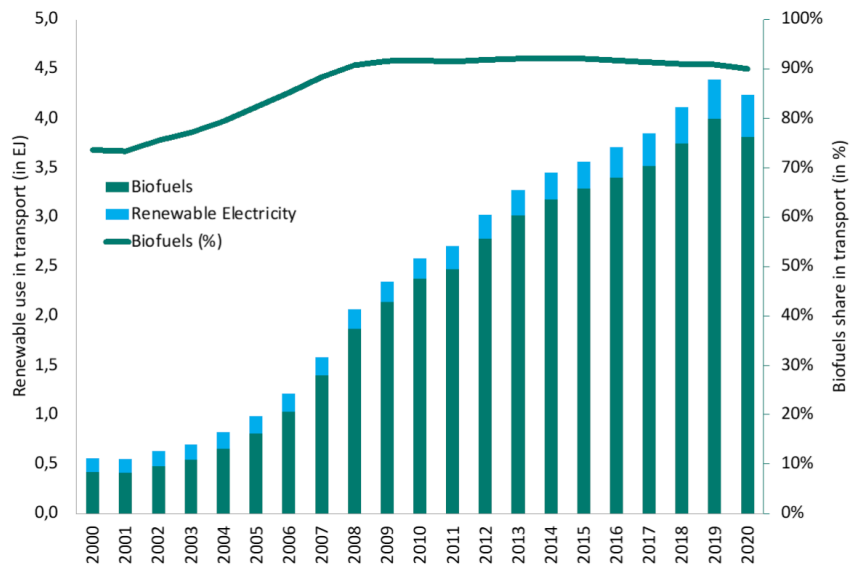


Figure 24 Renewables use in transport and biofuels share

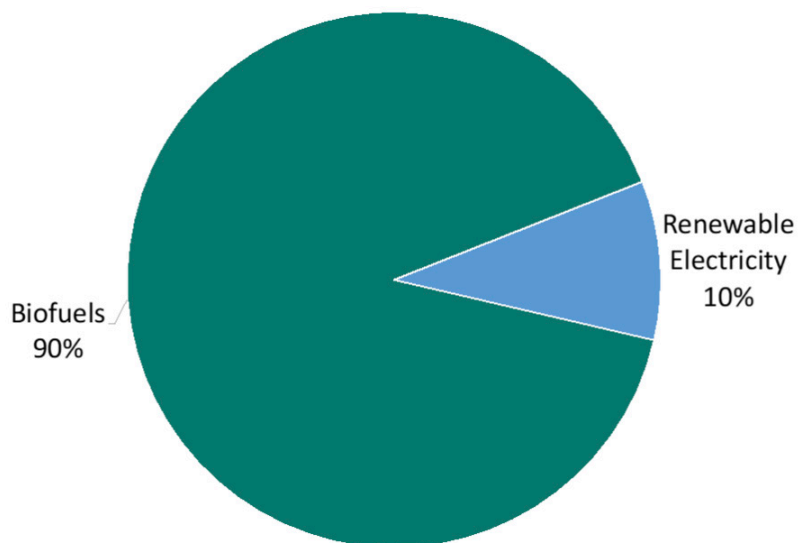


Figure 25 Renewable energy use in transport in 2020

In 2020, biofuels accounted for 99% of all renewable energy use in transport in the Americas and 63% at a global level. Both Europe and Asia had higher shares accounting for 88% and 71% respectively.

Table 16 Renewables use in transport in continents in 2020

Continent	Total	Biofuels	Renewable Electricity	Biofuels (%)
Africa	0.01	0.00	0.004	34%
Americas	2	2	0.03	99%
Asia	1	1	0.25	71%
Europe	1	1	0.11	88%
Oceania	0.01	0.00	0.01	39%

All values in EJ

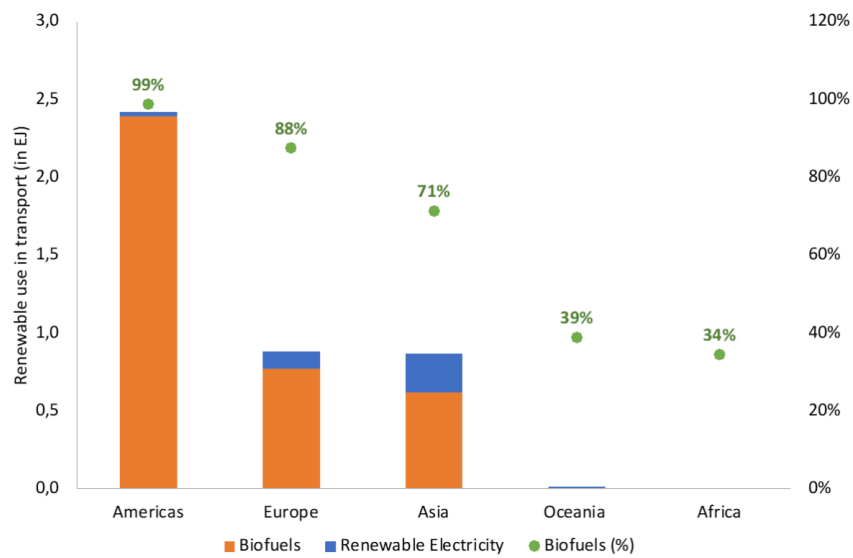


Figure 26 Renewables use in transport in continents in 2020

## BIOMASS SUPPLY

In 2020, domestic supply of biomass was 57,5 EJ globally. 86% of the domestic supply was from solid biomass sources including wood chips, wood pellets and traditional biomass sources. Liquid biofuels accounted for 7%, municipal and industrial waste sectors accounted for 2 - 3% followed by biogas at 2%.

Table 17 Domestic supply of biomass

Year	Total	Municipal Waste	Industrial Waste	Solid Biomass	Biogas	Liquid biofuels
2000	41.7	0.74	0.50	39.8	0.29	0.44
2005	44.8	0.96	0.45	42.0	0.54	0.88
2010	49.3	1.17	0.79	43.9	0.89	2.54
2015	52.6	1.38	0.92	45.5	1.34	3.46
2020	57.5	1.47	1.19	49.3	1.46	4.06

All values in EJ

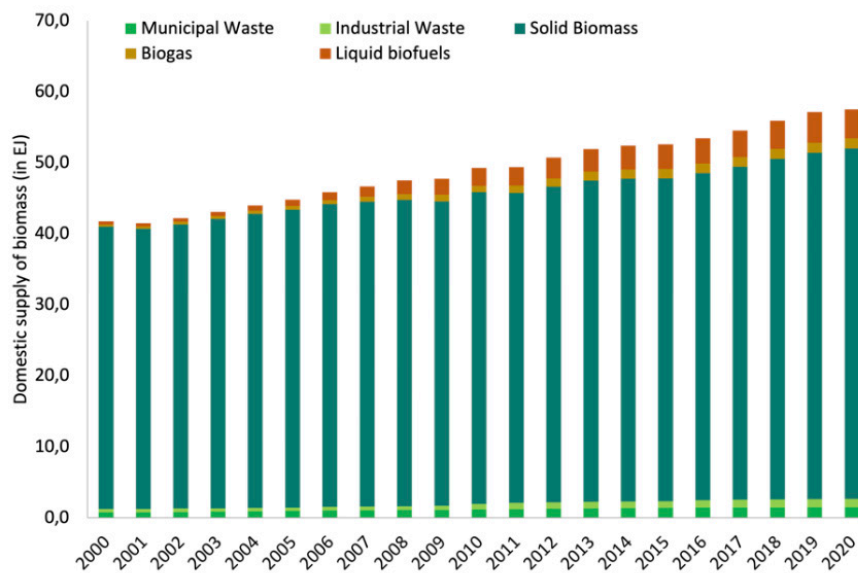


Figure 27 Domestic supply of biomass globally

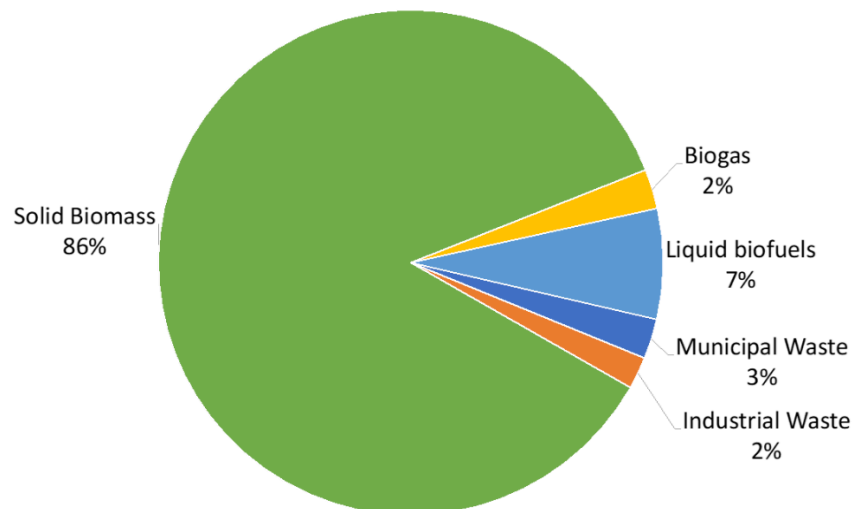


Figure 28 Domestic supply of biomass in 2020

## WOODFUEL

In 2022, 1.9 billion m<sup>3</sup> of wood fuel was produced globally. Africa and Asia accounted for most of the production with shares of 37% each.

Table 18 Woodfuel production globally

Year	World	Africa	Americas	Asia	Europe	Oceania
2000	1 795	551	314	808	109	13
2005	1 825	600	300	792	123	11
2010	1 864	644	290	764	155	11
2015	1 901	679	307	735	169	10
2020	1 928	713	328	708	169	10
2021	1 948	720	340	705	174	10
2022	1 966	720	350	704	183	10

All values in million m<sup>3</sup>

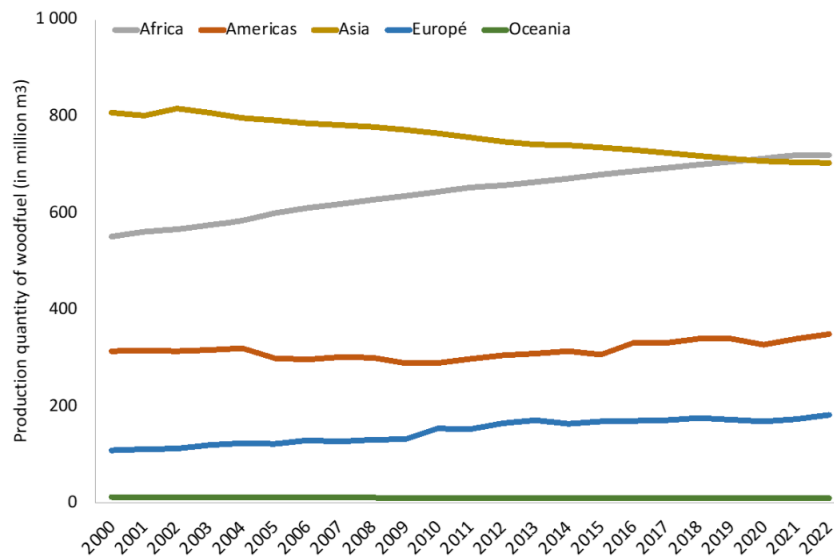


Figure 29 Woodfuel production globally

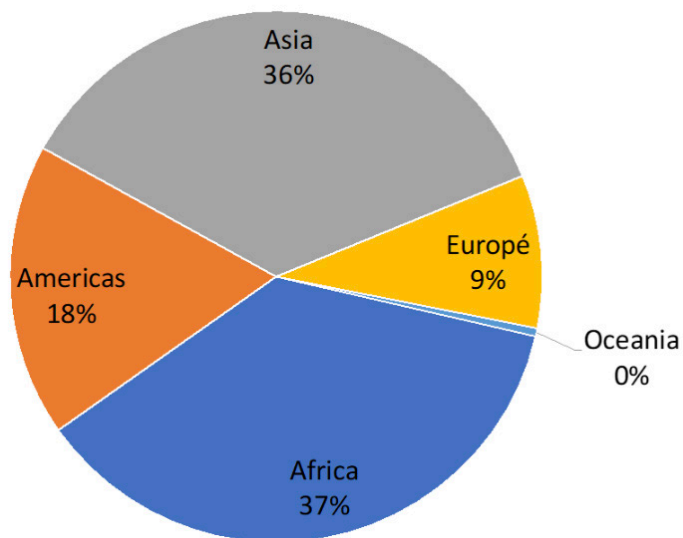


Figure 30 Woodfuel production in continents in 2022

## WOOD PELLETS

In 2022, 46.4 million tons of pellets were estimated to be produced globally. Europe accounts for the majority of wood pellets production with a share of 55% globally followed by the Americas at 31%.

Table 19 Wood pellets production globally

Year	World	Africa	Americas	Asia	Europe	Oceania
2012	18.1	0.09	5.10	0.30	12.5	0.03
2013	21.2	0.04	6.65	0.62	13.9	0.03
2014	25.1	0.04	7.96	1.72	15.2	0.14
2015	27.4	0.03	8.76	2.04	16.4	0.15
2016	29.3	0.04	9.49	2.59	17.0	0.16
2017	33.4	0.06	10.4	3.52	19.2	0.25
2018	37.6	0.07	11.3	5.58	20.5	0.21
2020	43.2	0.07	13.0	5.67	24.3	0.15
2021	44.5	0.07	13.2	6.31	24.8	0.17
2022	46.4	0.07	14.3	6.37	25.6	0.17

All values in million tonnes

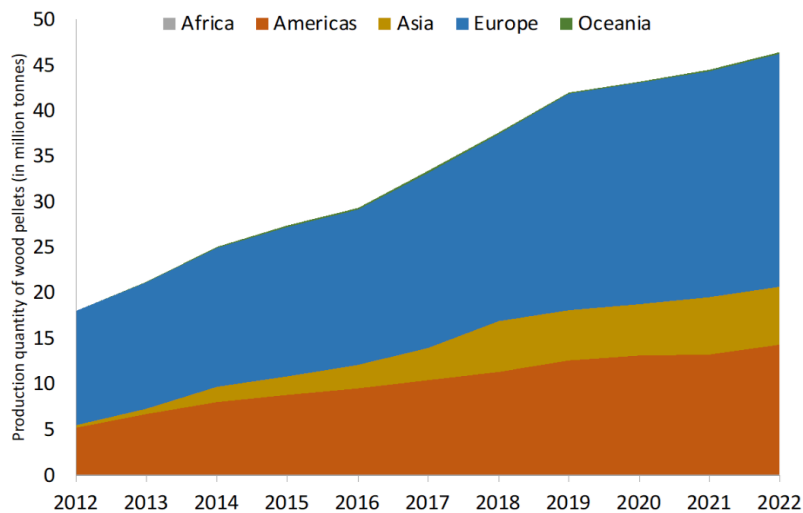


Figure 31 Wood pellets production globally

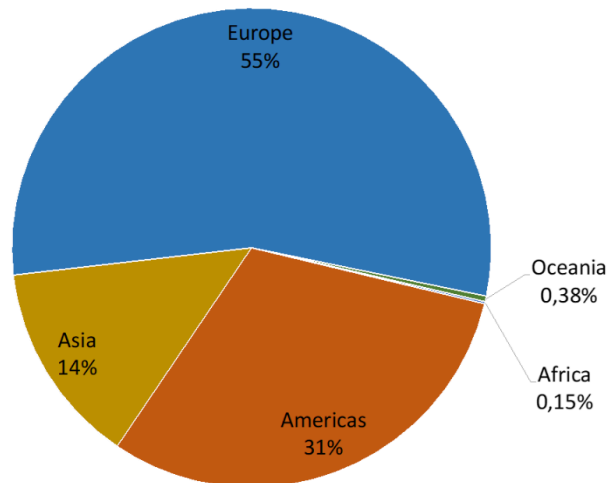


Figure 32 Wood pellets production globally in 2022



## WOOD CHARCOAL

Wood charcoal is another key bioenergy sector with significant volumes being produced globally. In 2022, almost 55 million tonnes of wood charcoal were produced globally with Africa accounting for 70% of the global production.

Table 20 Wood charcoal production globally

Year	World	Africa	Americas	Asia	Europe	Oceania
2000	36.7	20.2	9.7	6.54	0.30	0.04
2005	43.9	24.4	10.9	8.01	0.51	0.03
2010	46.5	28.5	8.9	8.54	0.57	0.04
2015	51.2	32.1	9.4	9.05	0.58	0.04
2020	52.9	35.1	10.1	8.02	0.62	0.04
2021	54.8	36.1	10.1	8.04	0.50	0.04
2022	54.9	36.1	6.5	8.04	0.58	0.04

All values in million tonnes

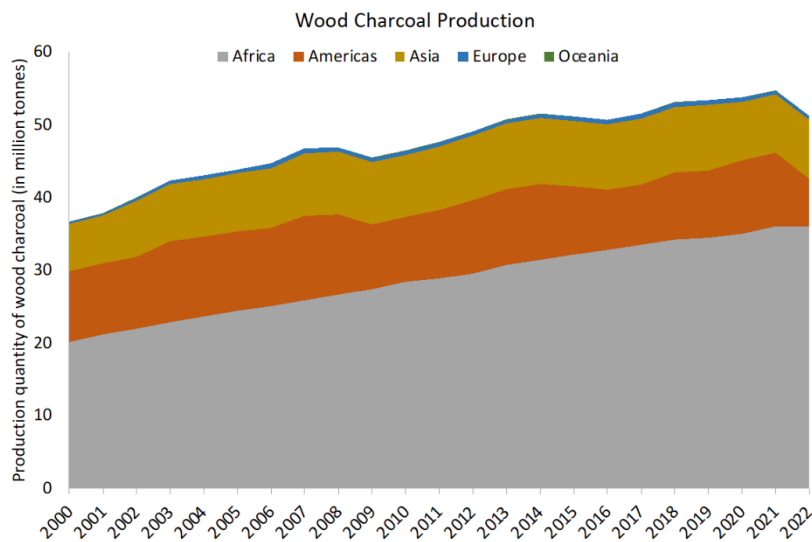


Figure 33 Wood charcoal production globally

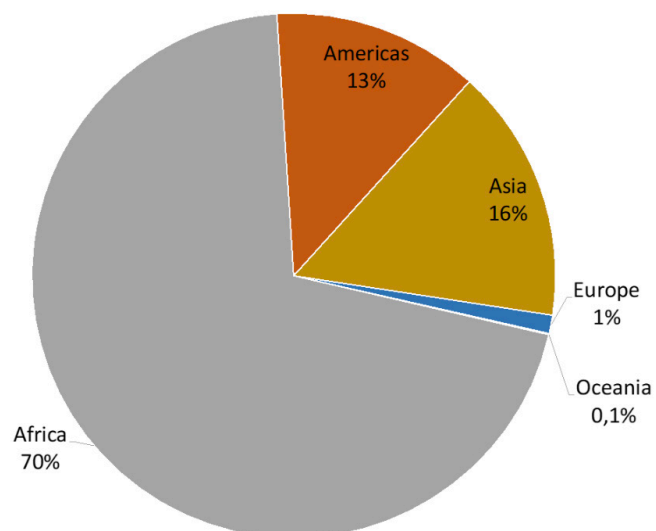


Figure 34 Wood charcoal production globally in 2022

## AGRICULTURE CROPS

Agriculture is a key sector for increased potential for bioenergy utilization in the future. Although the sector accounts for about 10% of the global biomass supply, there is significant potential for increasing its contribution. In terms of yields of major crops, there is significant potential to increase the yields in various regions to the global average.

Table 21 Production quantity of major agricultural crops in 2021

Crop	World	Africa	Americas	Asia	Europe	Oceania
Barley	146	6.81	16.3	18.2	89.4	15.0
Cassava, fresh	315	204	26.7	84.3	0	0.27
Maize (corn)	1 210	96.6	592	379	142	0.54
Oats	22.6	0.17	5.68	1.18	13.6	1.92
Olives	231	4.14	0.77	3.32	14.7	0.12
Rice	787	37.2	37.7	708	3.78	0.44
Rye	13.2	0.10	0.87	0.82	11.4	0.03
Sorghum	61.4	26.3	23.6	8.69	1.15	1.64
Soya beans	372	4.68	324	31.2	11.6	0.04
Sugar beet	270	17.5	35.5	36.5	181	0
Sugar cane	1 859	94.3	962	770	0	32.91
Sunflower seed	58.2	2.45	4.69	7.00	44.0	0.03
Wheat	771	29.2	100	340	269	32.3

All values in million tonnes

Table 22 Yield of major crops in 2021

Crop	World	Africa	Americas	Asia	Europe	Oceania
Barley	3.0	1.8	2.9	1.6	4.0	2.7
Cassava, fresh	11	8.5	13	22	-	12
Maize (corn)	5.9	2.3	7.8	5.6	7.2	7.8
Oats	2.4	1.3	2.4	2.0	2.5	1.8
Olives	2.2	1.3	3.7	1.8	2.9	2.4
Rice	4.8	2.3	6.6	4.9	6.2	8.8
Rye	3.1	1.9	2.4	2.3	3.2	0.7
Sorghum	1.5	0.9	3.7	1.6	4.0	2.9
Soya beans	2.9	1.4	3.3	1.4	2.1	1.7
Sugar beet	61	74	75	51	61	-
Sugar cane	71	60	70	72	-	80
Sunflower seed	2.0	1.1	1.9	2.0	2.1	1.4
Wheat	3.5	3.0	2.8	3.4	4.3	2.5

All values in tons/ha

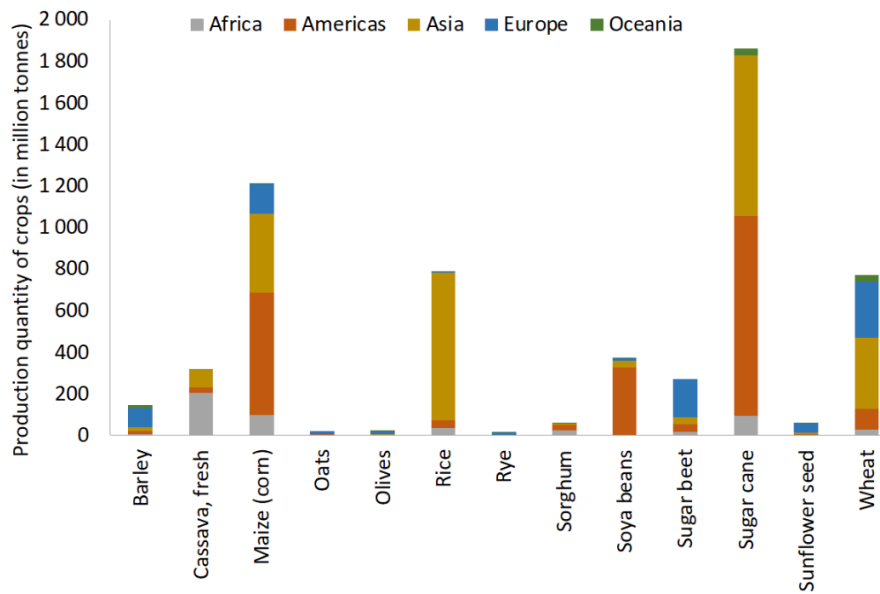


Figure 35 Production quantity of major agricultural crops in 2021

## WASTE TO ENERGY

In 2020, domestic supply of energy from municipal and industrial waste was 2,65EJ with 55% from municipal waste and remaining from industrial waste.

Table 23 Domestic supply of energy from waste

Year	Total	Municipal waste	Industrial waste
2000	1.24	0.74	0.50
2005	1.41	0.96	0.45
2010	1.96	1.17	0.79
2015	2.30	1.38	0.92
2020	2.65	1.47	1.19

All values in EJ

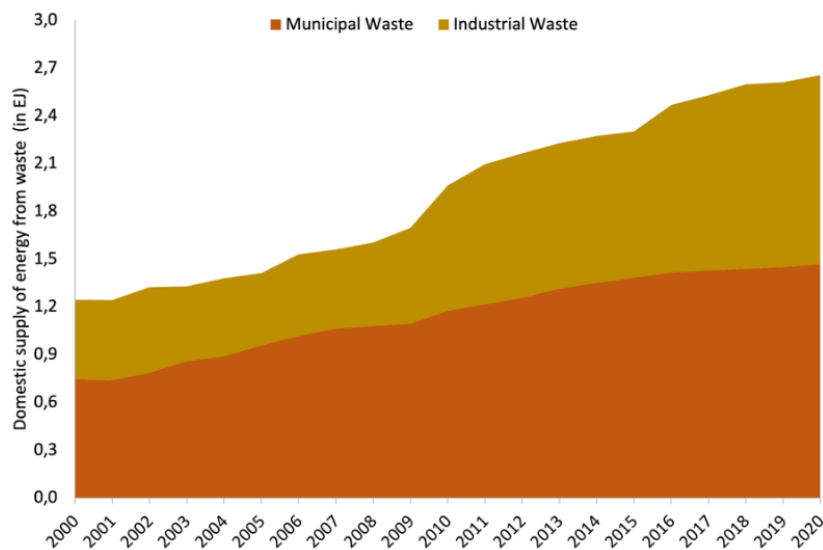


Figure 36 Domestic supply of energy from waste globally

Europe leads the world in energy production from waste, with a domestic supply of 1.27 EJ of municipal and industrial waste in 2020. Europe accounted for 48% of all global domestic supply of energy from waste, while Asia followed at 38%.

Table 24 Energy from waste in continents in 2020

Continent	Total	Municipal waste	Industrial waste
Africa	-	-	-
Americas	0.36	0.29	0.07
Asia	1.02	0.21	0.81
Europe	1.27	0.97	0.30
Oceania	-	-	-

All values in EJ

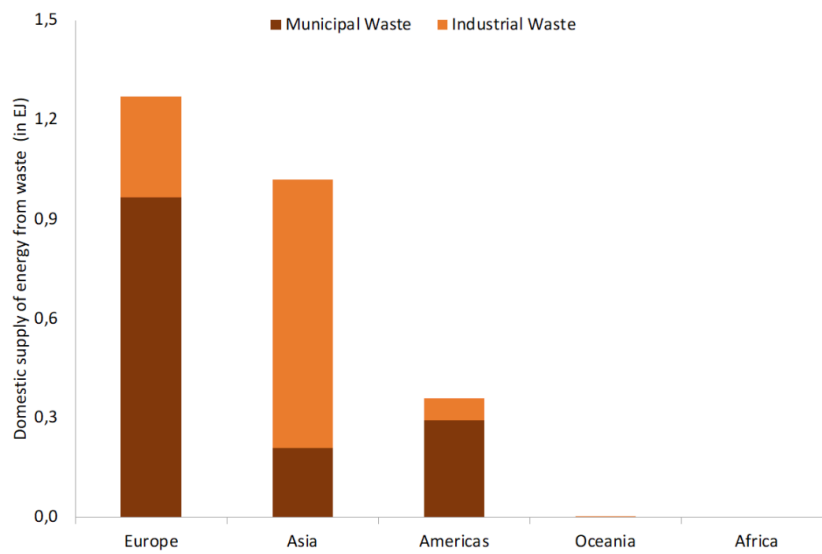


Figure 37 Energy from waste in continents in 2020

## BIOMASS TO POWER

In 2020, 685 TWh of electricity was generated from biomass globally. 69% of all biopower generated was from solid biomass sources followed by 17% from municipal and industrial waste. Biogas share was 13%.

Table 25 Biomass power generation globally

Year	Total	Municipal waste	Industrial waste	Solid biomass	Biogas	Liquid biofuels
2000	162	34.5	15.3	99	13.2	-
2005	228	46.5	11.7	146	21.1	1.98
2010	362	62.6	24.3	223	46.8	4.99
2015	509	73.2	26.1	318	83.8	8.25
2020	685	76.7	36.6	471	89.7	10.4

All values in TWh

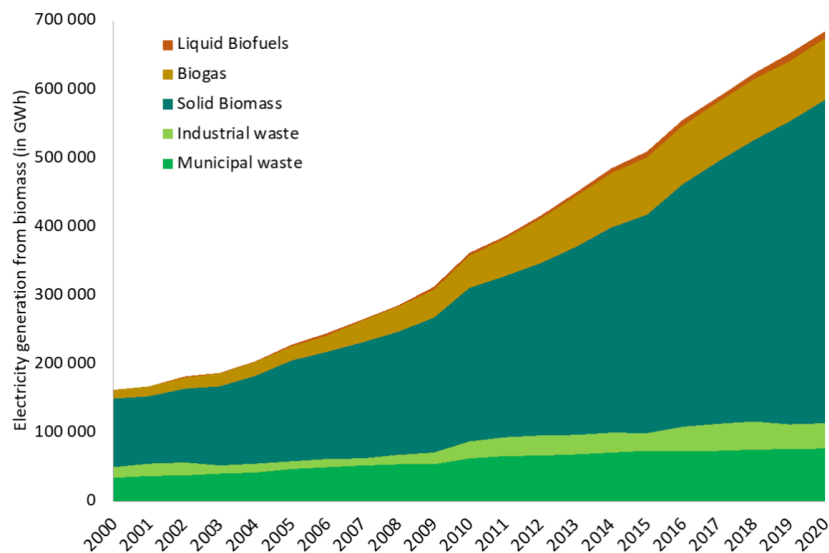


Figure 38 Biomass power generation

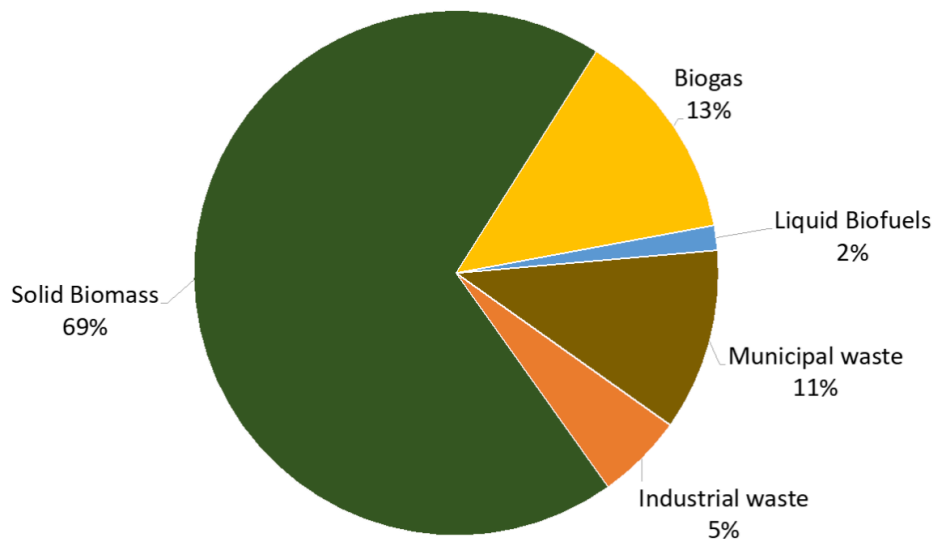


Figure 39 Electricity from biomass sources in 2020

Asia accounted for 40% of all biopower generated globally with 276 TWh of production in 2020 followed by Europe at 35% with 238TWh. Europe leads the world in biopower produced from Municipal waste accounting for 64% of the production while Asia leads in using industrial waste for electricity with a global share of 79%. Biopower from biogas is dominant in Europe with a global share of 75%.

Table 26 Biopower generation in continents in 2020

Continent	Municipal waste	Industrial waste	Solid biomass	Biogas	Liquid biofuels
Africa	0	0	2	0.03	0
Americas	16	4	127	16	1
Asia	12	29	227	5	4
Europe	49	4	113	68	5
Oceania	0	0	2	2	0

All values in TWh

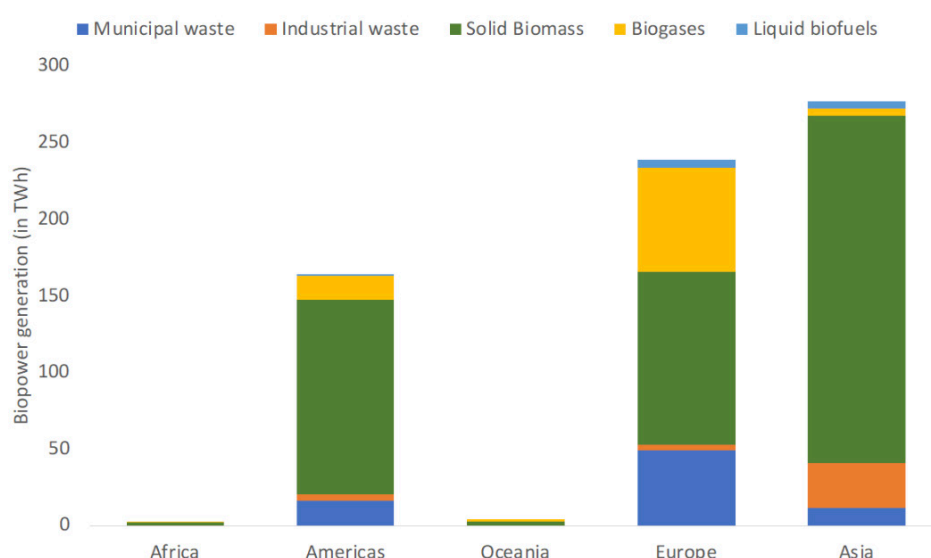


Figure 40 Biopower generation in continents in 2020

## ELECTRICITY ONLY AND CHP PLANTS

Electricity only plants are designed to produce electricity only. They do not produce any heat from biomass and have an average conversion efficiency of about 30%. In 2020, 5.3 EJ of biomass was used in electricity only plants for power generation.

Table 27 Use of biomass in electricity only plants

Year	Total	Municipal waste	Industrial waste	Solid biomass	Biogas	Liquid biofuels
2000	1.03	0.36	0.06	0.48	0.12	
2005	1.54	0.47	0.03	0.86	0.19	0.0004
2010	2.55	0.57	0.23	1.43	0.31	0.0005
2015	3.55	0.62	0.27	2.20	0.45	0.0014
2020	5.32	0.65	0.29	3.93	0.44	0.002

All values in EJ

Asia accounted for 63% of the biopower generated in electricity-only plants. Europe leads in the use of municipal waste and biogas having a share of 45% and 47% of the global use. Meanwhile, Asia leads in using industrial waste and solid biomass for electricity with a global share of 89% and 75% respectively.

Table 28 Use of biomass in electricity only plants

Continent	Municipal waste	Industrial waste	Solid biomass	Biogas	Liquid biofuels
Africa	-	-	0.03	0.0003	-
Americas	0.24	0.01	0.50	0.15	0.0002
Asia	0.11	0.26	2.93	0.07	0.001
Europe	0.28	0.02	0.46	0.21	0.0007
Oceania	0	0	0.008	0.00	0

All values in EJ

CHP or Combined Heat and Power plants refer to those plants that are designed to produce both heat and electricity. These are also referred to as cogeneration facilities. The conversion efficiency varies widely among CHP facilities.

In 2020, 3.4 EJ of biomass was used in CHP plants. Solid biomass account for 66% of all biopower produced in CHP facilities followed by municipal waste at 17%.

Table 29 Use of biomass in CHP plants

Year	Total	Municipal waste	Industrial waste	Solid biomass	Biogas	Liquid biofuels
2000	1.09	0.21	0.14	0.71	0.03	-
2005	1.47	0.33	0.12	0.96	0.05	0.0002
2010	1.94	0.41	0.14	1.24	0.15	0.0006
2015	2.70	0.54	0.14	1.70	0.32	0.0006
2020	3.43	0.58	0.16	2.29	0.40	0.0006

All values in EJ

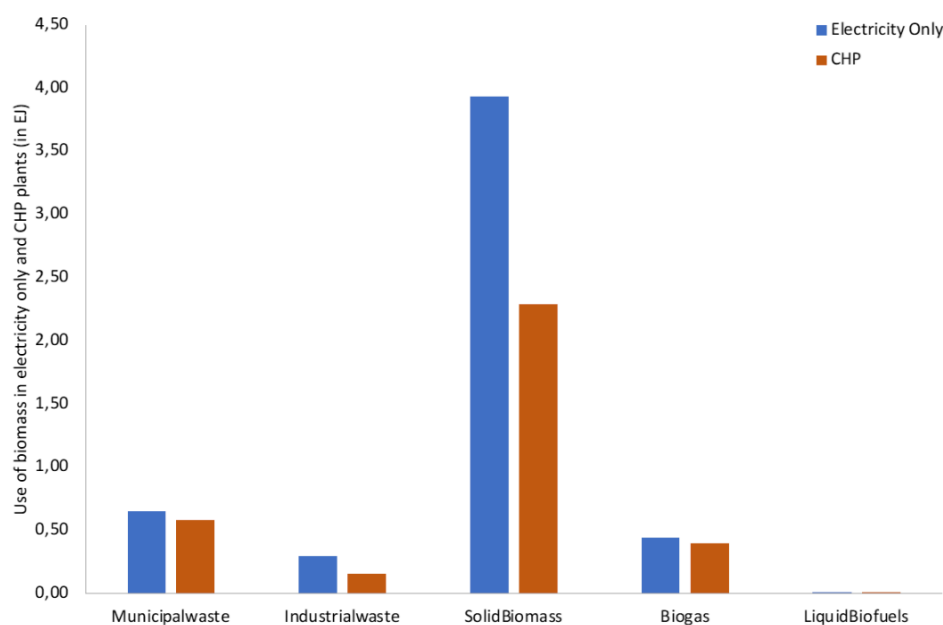


Figure 41 Use of biomass in electricity only and CHP plants in 2020

## BIOMASS TO HEAT

In 2020, 1.2 EJ of heat was produced from biomass-based sources – 52% from solid biomass sources and 25% from municipal solid waste.

Table 30 Heat generation from biomass globally

Year	Total	Municipal waste	Industrial waste	Solid Biomass	Biogas	Liquid Biofuels
2000	0.41	0.13	0.07	0.21	0.00	0.000
2005	0.53	0.15	0.08	0.28	0.01	0.004
2010	0.78	0.21	0.13	0.42	0.01	0.010
2015	0.95	0.26	0.14	0.51	0.03	0.004
2020	1.20	0.30	0.23	0.62	0.05	0.004

All values in EJ

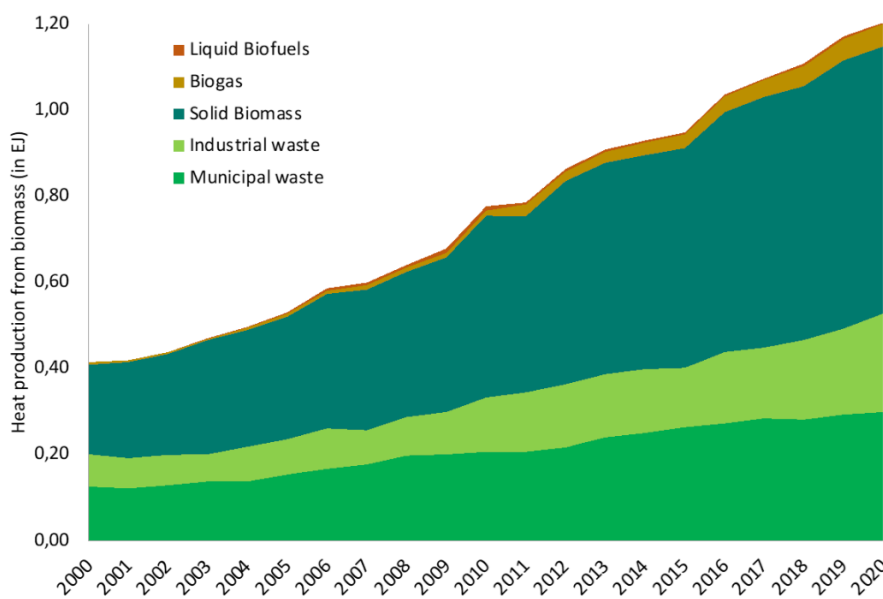


Figure 42 Biomass heat production

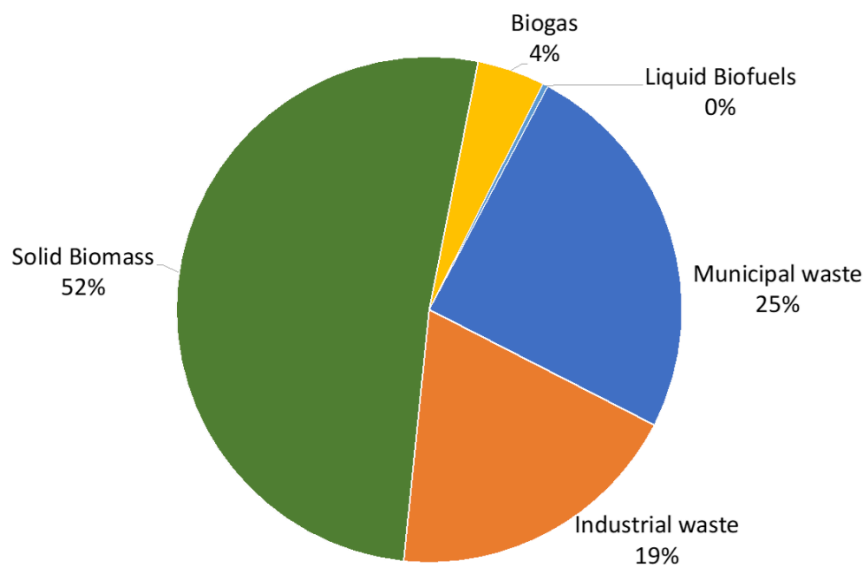


Figure 43 Heat production from biomass in 2020



Europe is the world leader in producing heat from biomass in power plants with a share of 75% globally. It is important to note that the bioheat only includes heat production in heat only and CHP plants which is transmitted and distributed to end consumers predominantly via district heating networks. It does not include the direct use of biomass for heat in end use sectors.

Table 31 Heat production from biomass in continents in 2020

Continent	Municipal Waste	Industrial Waste	Solid Biomass	Biogas	Liquid biofuels
Africa	-	-	-	-	-
Americas	0.02	0.02	0.04	0.004	0.000
Asia	0.01	0.19	0.04	0.00	0.000
Europe	0.27	0.003	0.55	0.05	0.004
Oceania	0	0	0	0	0

All values in EJ

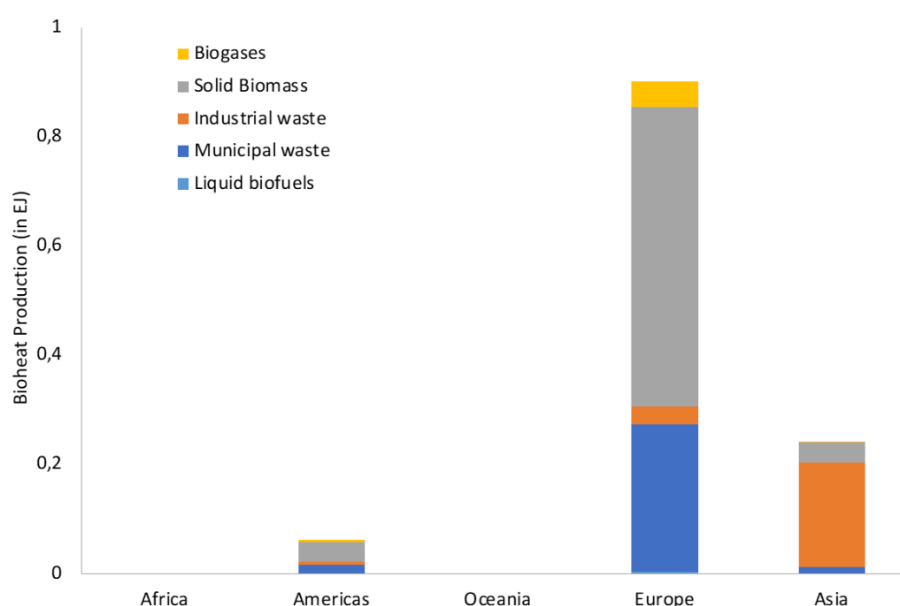


Figure 44 Bioheat production in continents in 2020

## HEAT ONLY AND CHP

Bioheat is produced either via heat only plants or CHP plants. Heat only plants are specifically designed to produce heat only and sold to a third party – e.g., residential, commercial or industrial consumers. In 2020, 0.57 EJ of biomass was used in heat-only plants.

Table 32 Use of biomass in heat only plants

Year	Total	Municipal waste	Industrial waste	Solid Biomass	Biogas	Liquid Biofuels
2000	0.24	0.05	0.04	0.15	0.001	
2005	0.31	0.07	0.05	0.19	0.003	0.00008
2010	0.44	0.10	0.10	0.23	0.006	0.0003
2015	0.48	0.08	0.12	0.27	0.006	0.00006
2020	0.57	0.08	0.17	0.32	0.006	0.00004

All values in EJ

CHP (Combined Heat and Power) plants or cogeneration plants are designed to produce both heat and electricity. In 2020, 3.43 EJ of biomass was used for heat production in CHP plants. As is the case with

heat only plants, solid biofuels are the largest contributor to heat production from biomass globally in CHP plants.

Table 33 Use of biomass in CHP plants

Year	Total	Municipal waste	Industrial waste	Solid Biomass	Biogas	Liquid Biofuels
2000	1.09	0.21	0.14	0.71	0.03	-
2005	1.47	0.33	0.12	0.96	0.05	0.0022
2010	1.94	0.41	0.14	1.24	0.15	0.0006
2015	2.70	0.54	0.14	1.70	0.32	0.0006
2020	3.43	0.58	0.16	2.29	0.40	0.0006

All values in EJ

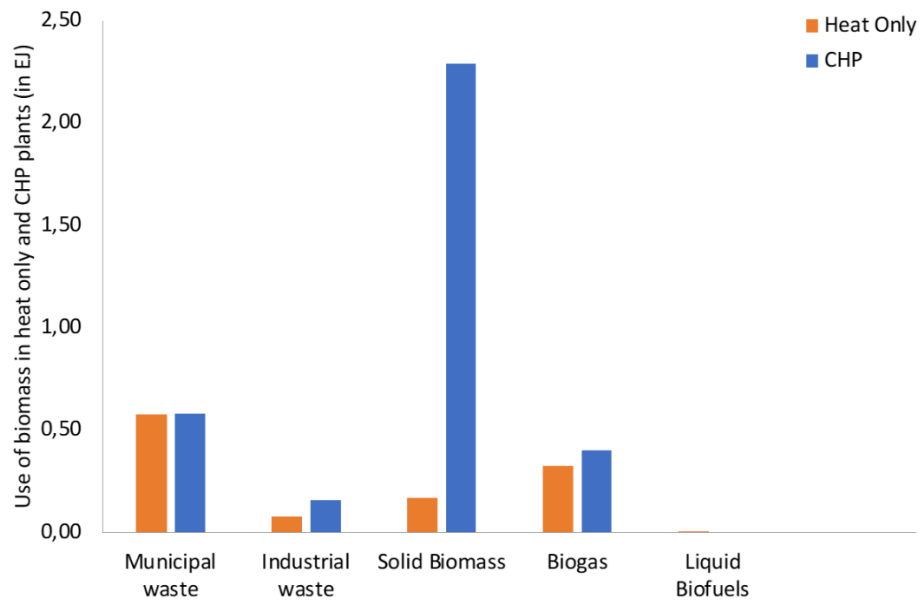


Figure 45 Use of biomass in heat only and CHP plants

## BIOMASS TO FUELS

### LIQUID BIOFUELS

In 2020, 146 billion litres of biofuels were produced globally. This was the first time that the production of biofuels decreased year on year, mainly due to the COVID pandemic.

Table 34 Liquid biofuels production

Year	Production (kt)	Production (bL)
2000	14 397	17.1
2005	31 193	37.1
2010	87 070	104
2015	106 629	127
2020	122 547	146

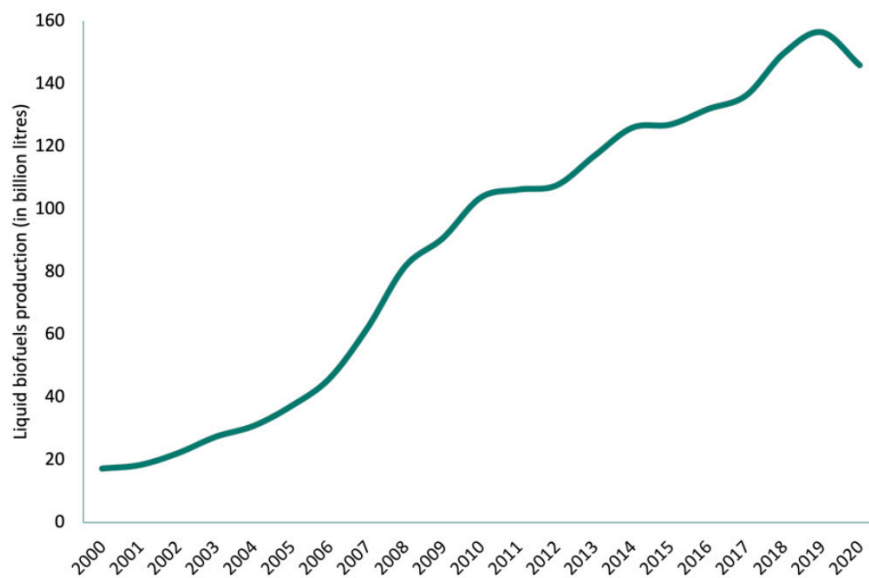


Figure 46 Liquid biofuels production globally

At the continental level, the Americas dominate biofuel production globally. North and South America together produce almost 70% of all biofuels globally, whereas Europe has a share of 16%.

Table 35 Liquid biofuels production in continents in 2020

Continent	Liquid Biofuels (kt)	Liquid Biofuels (bL)
Africa	79	0
Americas	83 426	99
Asia	19 727	23
Europe	19 150	23
Oceania	163	0

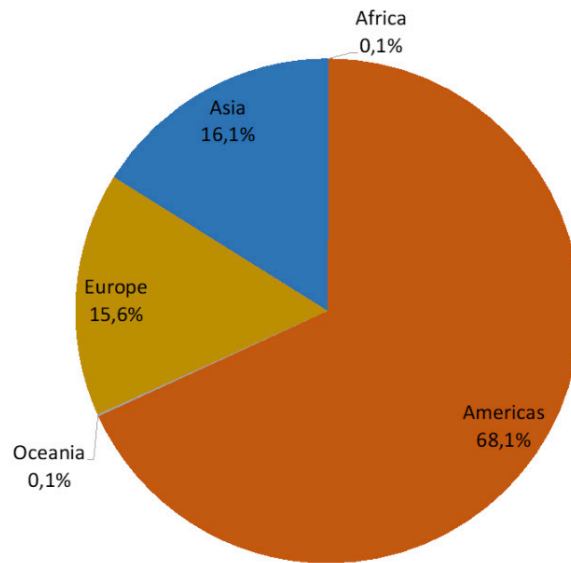


Figure 47 Liquid biofuels production in continents in 2020

## BIOGAS

Biogas is produced by anaerobic fermentation of different forms of organic matter and is composed mainly of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>). In 2020, 38,1 billion m<sup>3</sup> of biogas was produced globally with an equivalent energy content of 1.46 EJ.

Table 36 Biogas production

Year	Production (TJ)	Production (bcm)
2000	285 631	7.46
2005	538 590	14.1
2010	891 701	23.3
2015	1 335 691	23.3
2020	1 458 785	38.1

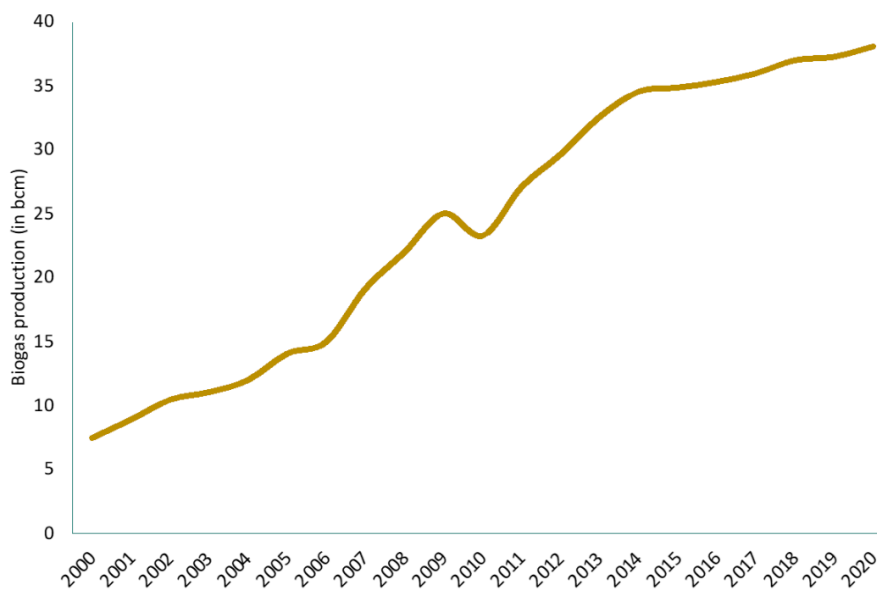


Figure 48 Biogas production globally

Europe is the world leader in biogas production. In 2020, Europe produced 20 billion m<sup>3</sup> of biogas with an energy equivalent of 0.71 EJ. The production accounted for more than half of the global biogas production with Asia coming 2nd with a share of 32%.

Table 37 Biogas supply in continents in 2020

Continent	Production (TJ)	Production (bcm)
Africa	369	0
Americas	192 243	5
Asia	469 175	12
Europe	776 905	20
Oceania	20 093	1

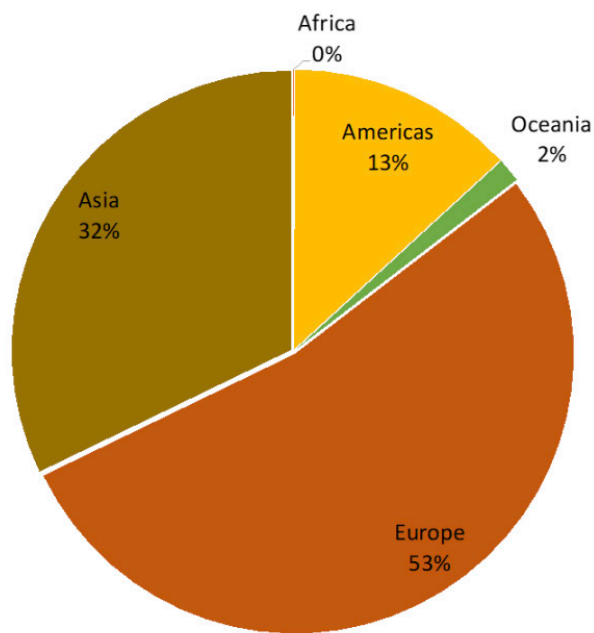


Figure 49 Biogas supply in continents in 2020

## APPENDIX

### GEOGRAPHICAL COVERAGE

**Africa:** Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Democratic Republic of the Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Guinea – Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swazi-land, Togo, Tunisia, Uganda, United Republic of Tanzania, Western Sahara, Zambia, Zimbabwe.

**Americas:** Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, British Virgin Islands, Canada, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falklands Islands, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Pierre and Miquelon, Saint Vincent and the Grenadines, Suriname, Turks and Caicos Islands, United States of America, Uruguay, Venezuela.

**Asia:** Afghanistan, Bahrain, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, China, Hong Kong SAR, China, Macao SAR, Democratic People's Republic of Korea, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Japan, Jordan, Korea Democratic Republic, Kuwait, Lao People's Democratic Republic, Lebanon, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Syrian Arab Republic, Thailand, Turkey, United Arab Emirates, Viet Nam, Yemen.

**Europe:** Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Gibraltar, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, The Former Yugoslav Republic of Macedonia, Ukraine, United Kingdom.

**Oceania:** Australia, New Zealand

### GLOSSARY

**Bioenergy:** Bioenergy is equal to sum of industrial waste, municipal waste, primary solid biofuels, biogas, bioethanol, biodiesel, other liquid biofuels and charcoal etc.

**Geothermal:** Geothermal energy is the energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam.

**Municipal Waste:** Municipal waste consists of products that are combusted directly to produce heat and/or power and comprises wastes produced by households, industry, hospitals and the tertiary sector that are collected by local authorities for incineration at specific installations. Municipal waste is split into renewable and non-renewable.

**Industrial Waste:** Industrial waste of non-renewable origin consists of solid and liquid products (e.g. tyres) combusted directly, usually in specialised plants, to produce heat and/or power. Renewable industrial waste is not included here, but with solid biofuels, biogases or liquid biofuels.

**Solid Biofuels:** Primary solid biofuels are defined as any plant matter used directly as fuel or converted into other forms before combustion. This covers a multitude of woody materials generated by industrial process or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, sulphite lye also known as black liquor, animal materials/wastes and other solid biofuels).

**Biogases:** Biogases are gases arising from the anaerobic fermentation of biomass and the gasification of solid biomass (including biomass in wastes). The biogases from anaerobic fermentation are composed principally of methane and carbon dioxide and comprise landfill gas, sewage sludge gas and other biogases from anaerobic fermentation.

**Liquid Biofuels:** Liquid biofuels is sum of Biogasoline, biodiesel and other liquid biofuels.

**Wood Fuel:** Roundwood that will be used as fuel for purposes such as cooking, heating or power production. It includes wood harvested from main stems, branches and other parts of trees (where these are harvested for fuel) and wood that will be used for the production of charcoal (e.g. in pit kilns).

and portable ovens), wood pellets and other agglomerates. The volume of roundwood used in charcoal production is estimated by using a factor of 6.0 to convert from the weight (mt) of charcoal produced to the solid volume (m<sup>3</sup>) of roundwood used in production. It also includes wood chips to be used for fuel that are made directly (i.e. in the forest) from roundwood. It excludes wood charcoal, pellets and other agglomerates. It is reported in cubic metres solid volume underbark (i.e. excluding bark)

**Wood Pellets:** Agglomerates produced either directly by compression or by the addition of a binder in a proportion not exceeding 3% by weight. Such pellets are cylindrical, with a diameter not exceeding 25 mm and a length not exceeding 100 mm. It is reported in metric tonnes.

**Wood Charcoal:** It covers the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.

**Electricity Only:** Refers to plants which are designed to produce electricity only. If one or more units of the plant is a CHP unit (and the inputs and outputs cannot be distinguished on a unit basis) then the whole plant is designated as a CHP plant.

**Heat Only:** Refers to plants (including heat pumps and electric boilers) designed to produce heat only and who sell heat to a third party (e.g. residential, commercial or industrial consumers) under the provisions of a contract.

**CHP:** Refers to plants which are designed to produce both heat and electricity (sometimes referred to as co-generation power stations). If possible, fuel inputs and electricity/heat outputs are on a unit basis rather than on a plant basis.

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