BIOENERGY EUROPE

STATISTICAL REPORT

2018

FULL REPORT

Bioenergy EUROPE

Report citation

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Bioenergy Europe

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BIOENERGY EUROPE'S STATISTICAL REPORT

ABOUT & TIMELINE

Every year since its debut release in 2007, Bioenergy Europe's Statistical Report has provided an in-depth overview of the bioenergy sector in the EU-28 Member States.

Bioenergy Europe's Statistical Report has been enriched each year with new figures and information, collecting unique data on the developments of the European bioenergy market from a growing number of international contributors.

Bioenergy Europe is therefore able to develop a detailed report that helps industry leaders, decision makers, investors and all bioenergy professionals to understand the situation of bioenergy in Europe.

With more than 150 graphs and figures, readers of Bioenergy Europe´s Statistical Report can get accurate and up-to-date information on the EU-28 energy system such as the final energy consumption of biomass for heat and electricity, the number of biogas plants in europe, the consumption and trade of pellets, the production capacity of biofuels and other key information to help break down and clarify the complexity of a sector in constant evolution.

In 2017, the Report was rewarded by the European Association Awards for being the "best Provision of Industry Information and Intelligence", a recognition after a decade of collective work.

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ABOUT

BIOENERGY EUROPE

BIOENERGY EUROPE is the common voice of the bioenergy sector with the aim to develop a sustainable bioenergy market based on fair business conditions.

BIOENERGY EUROPE is a non-profit Brussels-based international organisation founded in 1990 which brings together 45 national associations and over 100 companies from all over Europe – thus representing more than 4000 indirect members, including mainly companies and research centers.

www.bioenergyeurope.org

ACADEMIA

ASSOCIATIONS

ABOUT

BIOENERGY EUROPE

COMPANIES

BIOENERGY EUROPE's

NETWORKS

The European Pellet Council (EPC) is an umbrella organisation of Bioenergy Europe founded in 2010, representing the interests of the European wood pellet sector. Its members are national pellet associations or related organisations from 16 countries. EPC represents the interests of the sector in Brussels and communicates the contributions the European pellet sector can make to increase the use of renewable energy in Europe.

EUROPEAN PELLET COUNCIL

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The European Pellet Council is a platform for the pellet sector to discuss the issues that need to be managed in the transition from a niche product to a major energy commodity. These issues include the standardisation and certification of pellet quality, safety, security of supply, education and training, and the quality of pellet-using devices.

EPC is managing the EN*plus*® quality certification.

www.pelletcouncil.eu
www.enplus-pellets.eu

The International Biomass Torrefaction Council (IBTC) is an umbrella organisation of Bioenergy Europe launched in 2012 and aims to building the first platform for companies having common interests in the development of torrefied Biomass markets. Currently, the IBTC initiative is supported by more than 20 companies active worldwide.

INTERNATIONAL BIOMASS TORREFACTION COUNCIL

A NETWORK OF BIOENERGY EUROPE

IBTC's objective is to promote the use of torrefied biomass as an energy carrier and to assist the development of the torrefaction industry. In this respect, IBTC's key activities are to undertake studies or projects, and to commonly voice its members' concerns to third parties to help to overcome barriers of market deployment. IBTC takes part in initiatives and projects dedicated to biomass torrefaction market development such as: collection of statistical data, standardization issues, certification of, and permissions for ,the product, communication initiatives and matters related to health and safety.

www.ibtc.bioenergyeurope.org

A WORD FROM BIOENERGY EUROPE'S

SECRETARY GENERAL

THE PELLET SECTOR IS ON AN EXCELLENT PACE TO BECOME A MAINSTREAM FUEL OF THE FUTURE IN THE HEAT MARKET. FLOURISHING TRENDS CAN BE SEEN WHEN IT COMES TO TECHNOLOGIES TOO.

Jean-Marc JOSSART
Secretary General
BIOENERGY EUROPE

Dear reader,

The energy transition is ongoing. Renewables, leaded by bioenergy, are nibbling about 1% of the energy market every year. We are now relatively less and less dependent on third countries for our energy supply: in Europe, the production of indigenous biomass overtook the production of fossil gas in 2014 and more recently coal in 2016. It is quite an achievement to become the first European energy source! This new energy paradigm is here to stay thanks to the steady growth of bioenergy (about 3% per year) and the constant substitution of dirty, expensive fossil fuels. This report will show you how much we can still win in these markets.

Heat leads the growth of the energy sector, pouring over 2 million tons oil equivalent per year into the energy system over the last 10 years. The pellet sector is on an excellent pace to become a mainstream fuel of the future in the heat market. Flourishing trends can be seen when it comes to technologies too. For example, more and more companies provide medium and small-scale combined heat and power, or new, efficient and low emission stoves and boilers. Bioenergy is in good hands.

This report will also help you to evaluate the role of bioenergy in the decarbonisation of the economy. With the Paris agreement on climate we now have a global carbon budget of emissions (570 billion tons of CO_2 equivalent) allowing us to likely reach the 1,5 °C target. To keep this carbon budget, we know that emissions should peak before 2030 and we should reach net-zero emissions within 25 years, which is well before mid-century.

This challenge requires both a radical change in people's minds and a steady calibration of European policies to change our energy system. Bioenergy is part of the solution. Europe should see the opportunity in such challenges and maintain its leadership in bioenergy. The biomass potential in Europe (over 700 million tons oil equivalent) is 5 times higher than the current consumption.

As biomass resources around the world are widely available, there is no doubt that a European industry leadership would bring tangible benefits for the economy. With such potential in mind we should develop innovative technologies for specific sectors. Now the question is: for which sectors? Should we invest in low emission stoves to replace oil and gas in the domestic sector? Should we deploy waste-wood combustion plants in industries and district heating? Develop advanced biofuels for the growing demand of aviation, or biomethane from syngas to feed the grid? This report will again help you to fine-tune your opinion based on market data.

Special thanks to my colleagues, especially Cristina, Thomas, Nino, Gilles, Nathalie and Anna for their strong commitment and the extra hours they put into this report. Thank you!

May this report be helpful for your work!

FOREWORD

THANKS TO THIS VERSATILITY, IT IS CLEAR THAT BIOENERGY WILL REMAIN CRUCIAL TO ACHIEVE THE CLIMATE AND ENERGY OBJECTIVES OF THE EUROPEAN UNION.

Cristina Calderón
Market Intelligence Director
BIOENERGY EUROPE

The European Union's energy system faces a difficult period of adjustment. Increasing demand for heat and power must be balanced with the imperative need to phase out fossil fuels. In light of these challenges, energy policy has risen to the top of the agenda both at national and European level. In these discussions bioenergy is in the spotlight due to its strategic importance to drive Europe towards a competitive and sustainable energy system.

Throughout Europe, decision-makers from both the public and private sectors are looking forward to the opportunities and challenges of the transition to renewable and zero-carbon energy network. They need solid evidence now more than ever to guide them through this difficult but promising period. Bioenergy Europe has therefore decided to make the 2018 edition of its Statistical Report freely accessible to the public.

It presents key statistics about bioenergy, sourced primarily from Eurostat and the European Pellet Council. It provides information on the raw biomass materials and the sectors where bioenergy is being used in Europe.

Bioenergy is currently the main renewable energy source in the EU, accounting for 63.83% of renewable energy consumption. It is also the most versatile of all renewable energy sources – it can be used for electricity and heat generation and as a substrate for transport fuels. Thanks to this versatility, it is clear that bioenergy will remain crucial to achieve the climate and energy objectives of the European Union.

I hope this report helps to make the complex energy system more understandable and to dispel the myths surrounding bioenergy. Among other facts, we show in this report that biomass being consumed for energy is almost entirely produced domestically – only 4% is imported – and is in most cases derived from residues of other forestry and industrial processes. Bioenergy reduces EU energy dependency and improves energy prosperity, using a clean, domestic source of energy. The remarkable growth of bioenergy attested to by the figures in this report is accompanied by a tremendous number of jobs, a flourishing EU industry and an economic stimulus to rural areas.

Finally I would like to thank all my colleagues in Bioenergy Europe who worked on this report, as well as the ever-increasing list of contributors that enable the originality and relevance of the information within.

I wish you an enjoyable reading!

ABOUT OUR

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DLG

Impulses for progress

The DLG (Deutsche Landwirtschafts-Gesellschaft – German Agricultural Society) was founded by the engineer and author Max Eyth in the year 1885. It has over 25,000 members and is a leading organisation in the agricultural and food sectors.

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The DLG is an expert organisation, open to all and politically independent.

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The DLG's mandate is to promote technical and scientific progress. With its projects and activities the DLG sets standards and provides impulses for progress.

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The DLG operates internationally. It shares knowledge and expertise worldwide with leading international practitioners, experts and other specialist organisations.

Its activity areas are

+ knowledge transfer (agriculture / food)
+ trade exhibitions (agriculture / food)
+ machinery and farm input tests
+ food tests

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1

OVERVIEW OF THE EU ENERGY SYSTEM

1.1 Energy breakdown

Table 1.1 EU28 energy balance in 2016 – key components (ktoe)*

Primary production	**755.389**		
Solid fuels	131.850		
Total petroleum products	74.354		
Gas	107.238		
Nuclear heat	216.703		
Renewable energies	210.708		
Waste (non-renewable)	14.537		
Transactions	**Import**	**Export**	**Stock change**
All products	1.483.219	579.508	21.263
Solid fuels	134.902	38.239	11.807
Total petroleum products	941.564	411.746	3.423
Gas	357.102	87.613	5.944
Derived heat	6	5	0
Renewable energies	16.395	10.575	89
Electrical energy	32.865	31.301	0
Waste (non-renewable)	385	29	0
Gross inland consumption	**1.640.615**		
Solid fuels	240.724		
Total petroleum products	567.143		
Gas	382.970		
Nuclear heat	216.703		
Derived heat	1		
Renewable energies	216.618		
Electrical energy	1.564		
Waste (non-renewable)	14.893		
Energy Available for Final Consumption	**1.205.158**		
Final Non-energy Consumption	**97.773**		
Final Energy Consumption	**1.107.818**		

Final energy consumption 1.107.818 ktoe

By fuel/ product	
Solid fuels	45.338
Total petroleum products	437.131
Gas	245.284
Derived heat	47.932
Renewable energies	88.950
Electrical energy	239.405
Waste (non-renewable)	3.780
By sector	
Industry	276.823
Transport	367.272
Residential	284.832
Services	150.043
Other sectors	28.848

* According to Bioenergy Europe, this figure could be misleading for a reader not familiar with the Eurostat´s methodology. This methodology is based on the physical energy content method according to which the primary energy form should be the first energy form in the production process for which various energy uses are practiced. Consequently, for directly combustible energy products (for example coal, crude oil, natural gas, biomass) it is their energy content. For products that are not directly combustible, the application of this principle leads to the choice of heat as the primary energy form for nuclear. In case the amount of heat produced in the nuclear reactor is not known, the primary energy equivalent is calculated from the electricity generation by assuming an efficiency of 33%.
Nevertheless, it should be stated that nuclear is not an indigenous source and more than half of the world's uranium comes from mines in Canada, Australia and Kazakhstan. Which means that the figure on energy dependency showed in figure 1.3 (54%) is in reality much higher due to nuclear.

Source: Eurostat

Table 1.2 Primary energy production by fuel in EU28 Member States in 2016 (ktoe)

	All products	Solid fuels	Total petroleum products	Gas	Nuclear heat	Waste (non-renewable)	Renewable energies	Out of which: Biomass and renewable waste
EU28	755.389	131.850	74.354	107.238	216.703	14.537	210.708	134.497
AT	12.349	0	785	975	0	819	9.769	5.581
BE	14.969	0	0	0	11.227	677	3.066	2.275
BG	11.218	5.081	23	77	4.084	32	1.921	1.284
CY	129	0	0	0	0	5	124	22
CZ	27.159	15.973	184	180	6.239	305	4.279	3.862
DE	115.650	39.725	3.547	6.551	21.832	4.514	39.481	26.741
DK	14.949	0	7.026	4.054	0	376	3.492	2.273
EE	4.677	3.146	0	0	0	70	1.461	1.407
EL	6.723	3.973	179	10	0	60	2.502	1.034
ES	33.970	736	141	48	15.125	235	17.685	7.154
FI	17.563	720	71	0	5.985	270	10.517	8.891
FR	130.575	0	1.004	18	104.006	1.651	23.896	15.804
HR	4.409	0	748	1.369	0	10	2.282	1.579
HU	11.356	1.463	985	1.429	4.161	125	3.194	2.965
IE	4.201	679	0	2.483	0	66	973	371
IT	33.798	0	4.056	4.738	0	1.183	23.821	10.980
LT	1.620	5	64	0	0	53	1.498	1.354
LU	159	0	0	0	0	34	125	96
LV	2.447	1	0	0	0	9	2.437	2.209
MT	18	0	0	0	0	0	18	3
NL	46.059	0	1.571	38.079	1.022	676	4.711	3.770
PL	66.415	52.092	1.002	3.553	0	742	9.027	7.675
PT	5.998	0	0	0	0	174	5.823	3.086
RO	25.044	4.235	3.940	7.784	2.911	79	6.096	3.786
SE	34.565	127	0	0	16.277	786	17.376	10.689
SI	3.570	942	0	4	1.474	45	1.105	639
SK	6.198	452	10	77	3.858	198	1.603	1.168
UK	119.605	2.501	49.016	35.810	18.502	1.346	12.429	7.804

*Biomass and renewable wastes, covers organic, non-fossil material of biological origin. They comprise wood and wood waste, biogas, municipal RES solid waste, and biofuels.
Source: Eurostat

Primary energy production refers to the indigenous production that is any kind of extraction of energy products from natural sources to a usable form. Primary production takes place when the natural sources are exploited, for example in coal mines, crude oil fields, hydro power plants or fabrication of biofuels. Transformation of energy from one form to another, such as electricity or heat generation in thermal power plants is not included in primary production.

Gross inland consumption is the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration. It is calculated using the following formula: primary production + recovered products + imports +stock changes – exports – bunkers. International Marine Bunkers are quantities of fuels delivered to ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters.

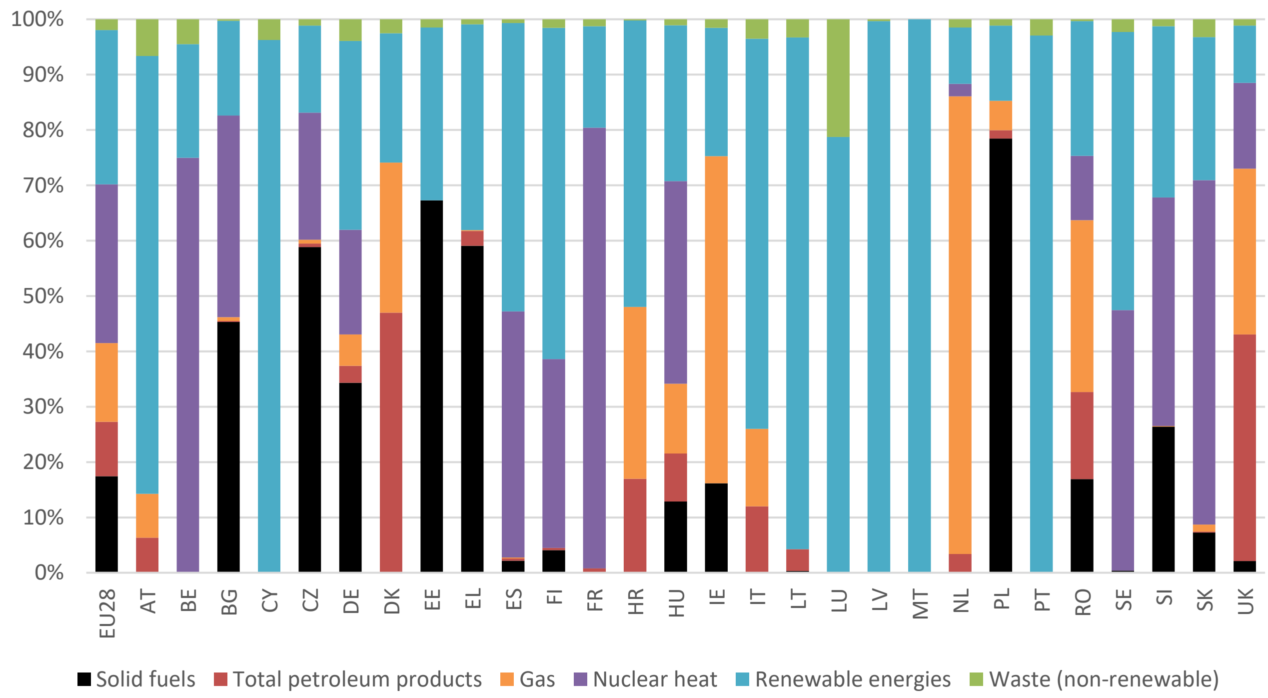
Final energy consumption: Final energy consumption cover energy supplied to the final consumer´s door for all energy uses. Is the sum of the final energy consumed in the transport, industrial, agricultural/forestry, fishing, services, household and other unspecified sector it excludes deliveries to the energy transformation sector and to the energy industries themselves.

Gross final energy consumption is defined in Directive 2009/28/EC as the sum of:
- final energy consumption
- consumption of electricity and heat by the energy branch for electricity and heat generation (own use by plant),
- losses of electricity and heat in transmission and distribution.

The 2020 RES targets are calculated as a share of gross final consumption of energy from RES in gross final energy consumption of energy.

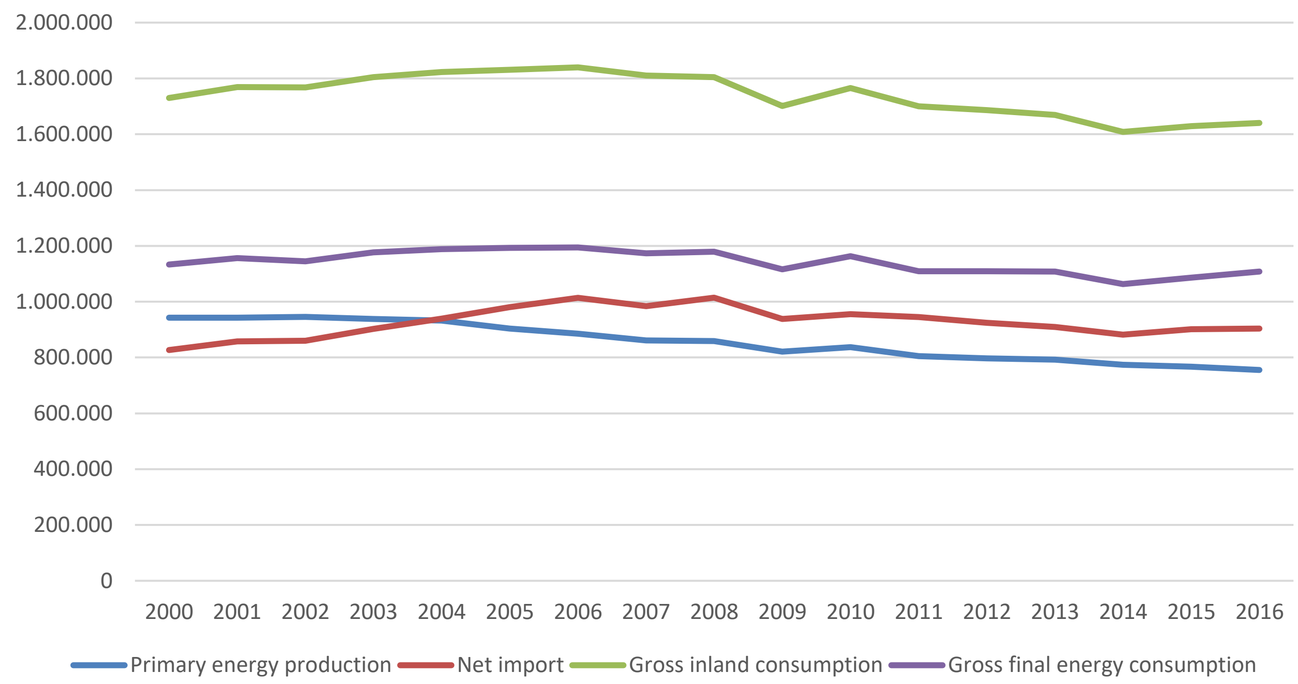
More definitions in the Annexes at the end of the Report

Figure 1.1 Share of fuels in primary energy consumption in EU Member States in 2016 (%)



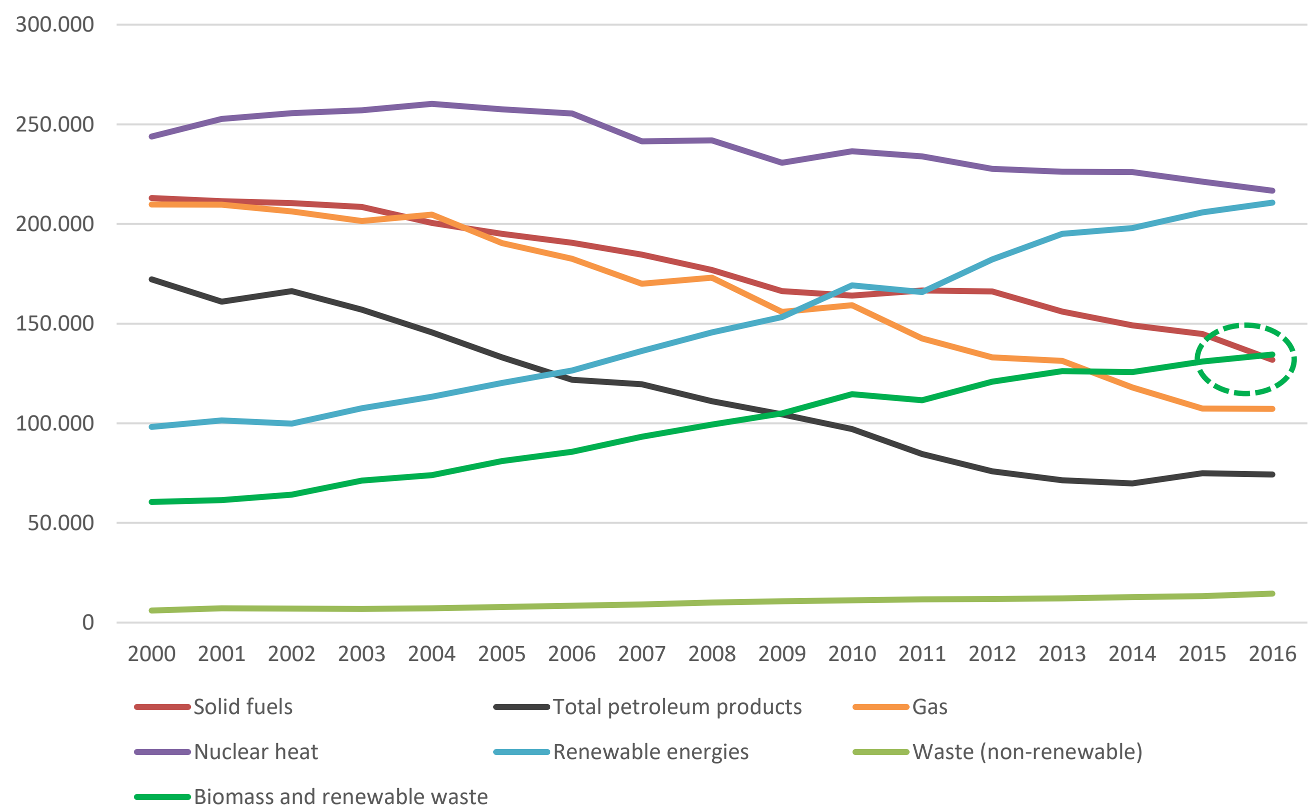
Source: Eurostat

Figure 1.2 Evolution of the main energy indicators in EU28 (ktoe)



Source: Eurostat

Figure 1.3 Evolution of primary energy production by fuel type in EU28 (ktoe)



Note: Biomass and renewable waste is also counted under the "renewable energy" label.
Source: Eurostat

For the first time, in 2016, bioenergy overtook coal in terms of primary energy production. The EU is still highly dependent on fuel imports, especially oil and gas. Switching to renewables, including bioenergy, is a way for the EU to improve its energy independence. 95,9% of bioenergy consumed in the EU is locally produced. It is important to highlight the local aspect of bioenergy and that by incentivizing a switch to bioenergy Member States and the EU as a whole is improving its security of energy supply and reduces its dependence from other economies.

Table 1.3 Total imports by fuel in 2016 by EU28 Member States (ktoe)

	All products	Solid fuels	Total petroleum products	Gas	Waste (non-renewable)	Renewable energies	Out of which: Biomass and renewable waste
EU28	1.483.219	134.902	941.564	357.102	385	16.395	16.395
AT	31.606	2.859	13.752	11.858	0	870	870
BE	79.391	2.854	59.223	14.959	4	1.091	1.091
BG	12.466	561	8.763	2.594	0	156	156
CY	2.637	0	2.590	0	15	32	32
CZ	21.582	2.995	10.252	6.715	0	431	431
DE	254.829	39.647	130.244	81.613	0	889	889
DK	18.177	1.615	13.070	612	59	1.531	1.531
EE	2.606	15	1.842	428	0	14	14
EL	37.502	190	32.858	3.462	0	145	145
ES	124.069	8.098	85.154	28.194	0	744	744
FI	25.254	2.790	18.376	2.059	0	128	128
FR	147.345	8.072	95.415	41.234	0	911	911
HR	7.448	664	4.638	1.051	0	29	29
HU	19.329	1.139	9.159	7.225	33	230	230
IE	12.127	1.155	9.056	1.700	0	141	141
IT	152.789	10.967	82.213	53.468	0	2.428	2.428
LT	14.771	175	11.564	1.889	0	188	188
LU	4.189	52	2.642	709	0	122	122
LV	4.338	38	2.794	923	25	143	143
MT	2.778	0	2.638	0	0	9	9
NL	222.285	30.481	156.115	32.894	213	496	496
PL	51.311	5.044	32.044	12.185	0	832	832
PT	25.543	2.911	17.812	4.261	34	128	128
RO	13.440	1.078	10.613	1.176	0	214	214
SE	35.956	2.244	30.501	818	0	1.165	1.165
SI	6.231	197	4.595	701	0	19	19
SK	15.007	2.748	7.395	3.617	3	102	102
UK	138.214	6.312	86.246	40.756		3.206	3.206

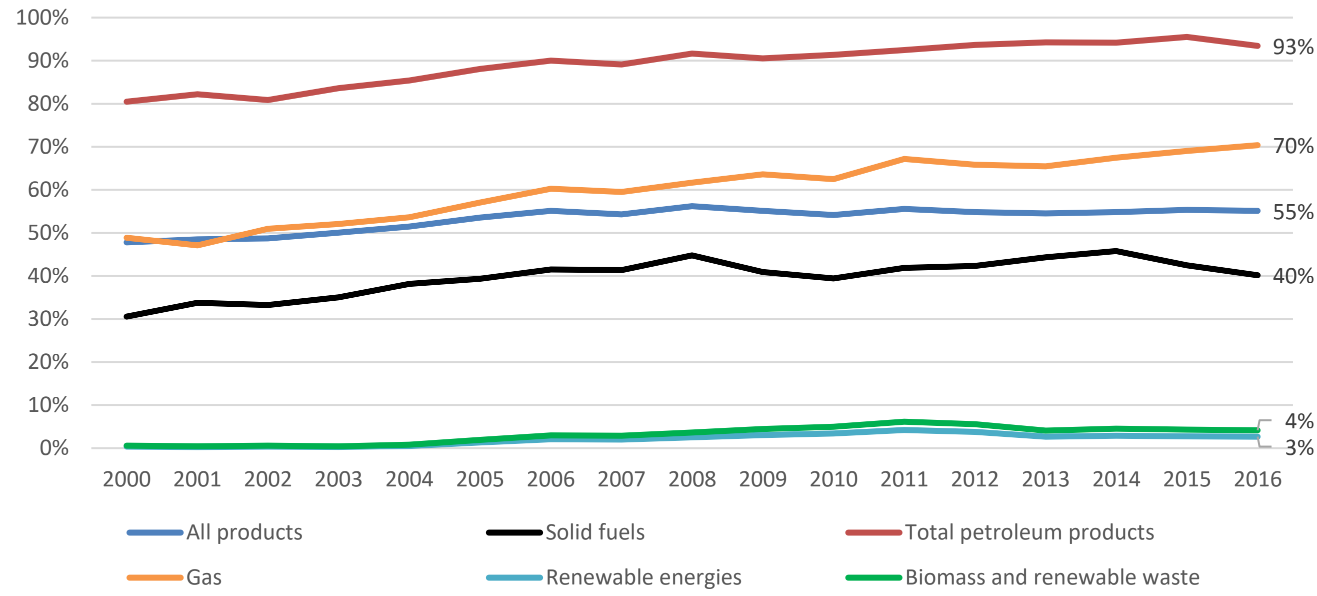
Source: Eurostat

Table 1.4 Total exports by fuel in 2016 by EU28 Member States (ktoe)

	All products	Solid fuels	Total petroleum products	Gas	Waste (non-renewable)	Renewable energies	Out of which: Biomass and renewable waste
EU28	579.508	38.239	411.746	87.613	29	10.575	10.575
AT	10.447	35	2.475	5.698	0	588	588
BE	30.672	51	29.072	579	0	241	241
BG	5.699	4	4.624	2	0	128	128
CY	17	0	17	0	0	0	0
CZ	7.900	3.149	2.219	0	0	398	398
DE	51.619	1.344	22.709	19.328	0	1.455	1.455
DK	15.655	12	12.865	1.897	0	29	29
EE	2.164	14	1.158	0	0	509	509
EL	18.455	0	18.360	0	0	6	6
ES	30.843	351	24.666	3.469	0	1.139	1.139
FI	9.457	70	9.084	0	0	32	32
FR	29.590	57	20.715	3.336	0	202	202
HR	3.341	0	2.115	324	0	312	312
HU	5.039	359	2.900	893	0	436	436
IE	1.770	14	1.620	0	0	0	0
IT	31.082	255	29.897	174	0	228	228
LT	9.198	3	8.689	37	0	226	226
LU	155	0	6	0	0	26	26
LV	2.121	3	829	0	0	962	962
MT	279	:	279	0	0	0	0
NL	180.705	21.184	113.636	42.742	29	1.452	1.452
PL	20.990	10.921	7.239	716	0	1.082	1.082
PT	7.977	0	6.808	0	0	336	336
RO	6.208	1	5.311	1	0	105	105
SE	19.583	19	17.073	0	0	253	253
SI	2.886	0	2.067	0	0	0	0
SK	5.264	62	4.160	0	0	131	131
UK	70.393	332	61.156	8.418	0	301	301

Source: Eurostat

Figure 1.4 Evolution of the energy dependency* by fuel type in EU28 (%)



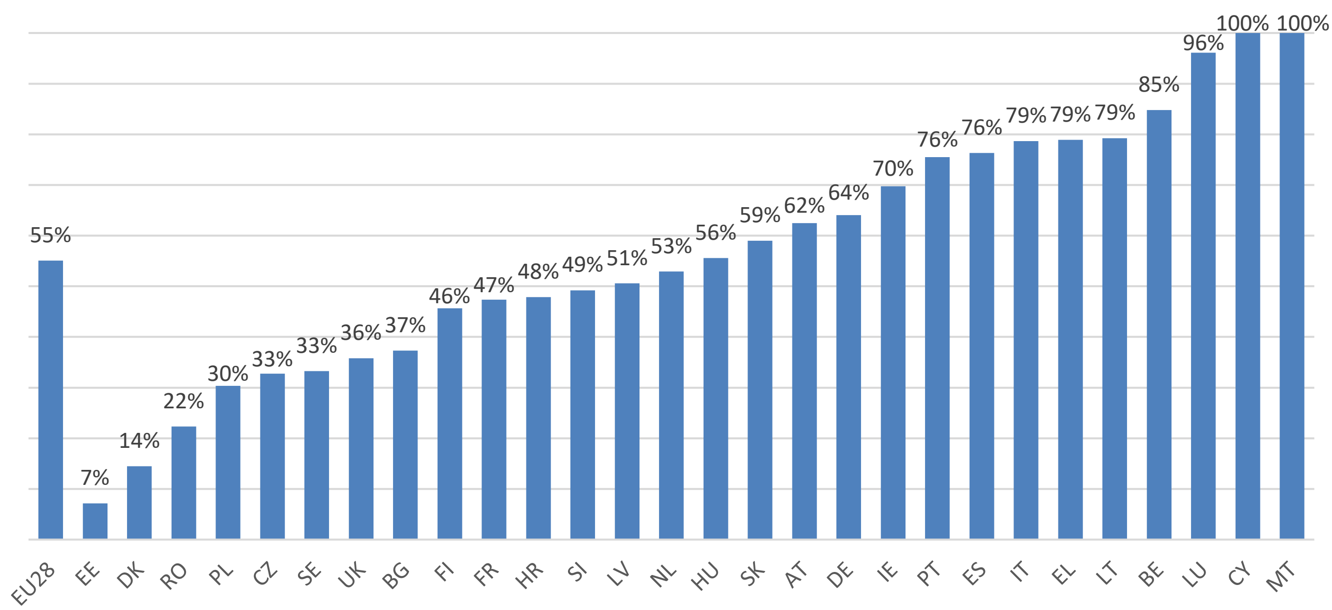
* Energy dependence is calculated as net imports divided by the sum of gross inland energy consumption and maritime bunkers. Hence, it describes the extent to which an economy relies on imports to meet its energy needs

Note: Nuclear energy is considered to be produce domestically by Eurostat; dependency does not take into account uranium imports.

Source: Eurostat

While the EU is highly and increasingly dependent on fossil fuels imports, the dependency on imported biomass is only 4,1%. Decarbonising the EU, through a gradual switch to renewable sources of energy, will not only allow the EU to reach its long-term climate commitments, but also to improve the security of its supply.

Figure 1.5 Energy dependency in EU28 Member States in 2016 (%)



Note: Nuclear energy is considered to be produce domestically by Eurostat. Therefore, the dependency for all product is higher in reality.

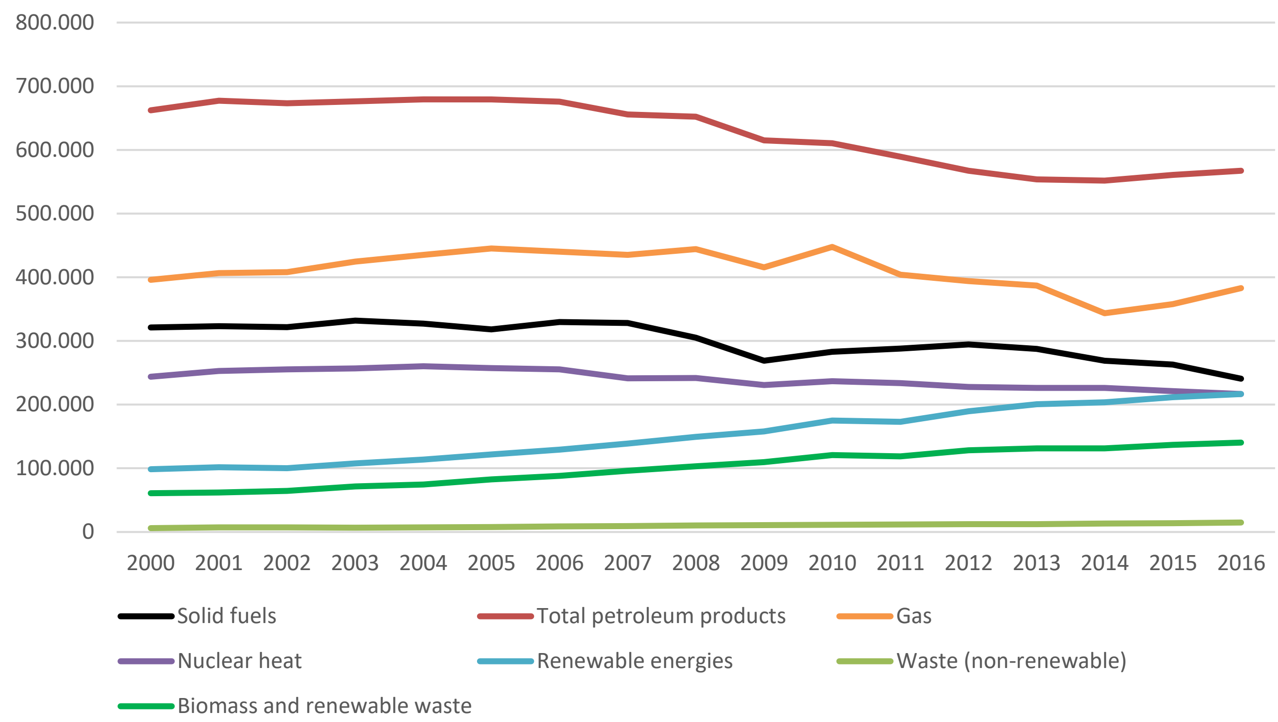
Source: Eurostat

Table 1.5 Gross inland consumption by fuel in EU28 Member States in 2016 (ktoe)

	All products	Solid fuels	Total petroleum products	Gas	Nuclear heat	Waste (non-renewable)	Renewable energies	Out of which: Biomass and renewable waste
EU28	1.640.615	240.724	567.143	382.970	216.703	14.893	216.618	140.407
Share in %	100,00%	14,67%	34,57%	23,34%	13,21%	0,91%	13,20%	8,56%
AT	33.865	2.957	12.243	7.182	0	819	10.048	5.860
BE	57.451	2.955	23.841	14.300	11.227	681	3.916	3.125
BG	18.128	5.695	4.231	2.687	4.084	32	1.947	1.310
CY	2.443	0	2.274	0	0	16	153	50
CZ	41.807	16.617	8.265	7.016	6.239	305	4.310	3.893
DE	317.268	77.227	108.798	70.330	21.832	4.514	38.916	26.175
DK	17.422	1.895	6.751	2.896	0	435	5.008	3.789
EE	6.219	3.797	1.132	428	0	71	966	912
EL	24.142	4.370	12.830	3.490	0	60	2.637	1.170
ES	122.176	10.192	53.493	25.040	15.125	235	17.432	6.900
FI	34.620	4.525	9.533	2.066	5.985	270	10.613	8.987
FR	248.746	8.576	75.185	38.306	104.006	1.651	24.591	16.499
HR	8.585	650	3.276	2.171	0	10	2.002	1.300
HU	25.705	2.260	7.006	8.028	4.161	157	3.000	2.771
IE	14.846	2.085	7.406	4.242	0	66	1.108	506
IT	154.748	10.985	55.298	58.080	0	1.183	26.018	13.177
LT	7.034	193	2.774	1.842	0	53	1.461	1.317
LU	4.197	52	2.635	714	0	34	221	192
LV	4.385	41	1.488	1.107	0	37	1.623	1.394
MT	726	0	570	0	0	0	25	9
NL	78.528	10.213	32.190	30.127	1.022	860	3.695	2.754
PL	99.930	49.079	26.535	14.633	0	742	8.769	7.418
PT	23.264	2.846	10.726	4.300	0	208	5.622	2.885
RO	32.402	5.330	9.312	9.008	2.911	80	6.193	3.883
SE	49.231	2.051	12.018	825	16.277	786	18.283	11.596
SI	6.797	1.147	2.403	705	1.474	45	1.125	658
SK	16.511	3.225	3.525	3.895	3.858	201	1.577	1.142
UK	189.440	11.763	71.404	69.554	18.502	1.346	15.362	10.737

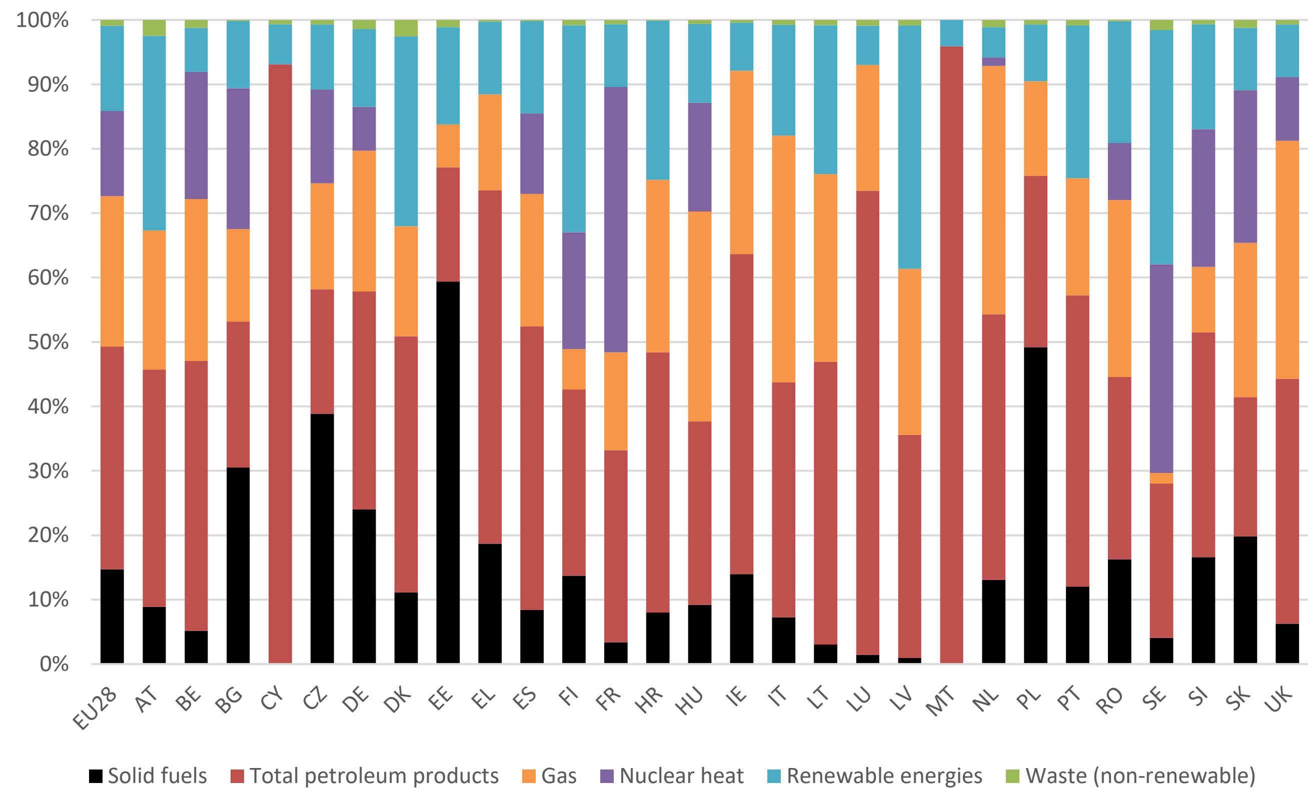
Source: Eurostat

Figure 1.6 Evolution of the gross inland consumption by fuel type in EU28 (ktoe)



Source: Eurostat

Figure 1.7 Share of fuels in gross inland consumption in EU Member States in 2016 (%)



Source: Eurostat

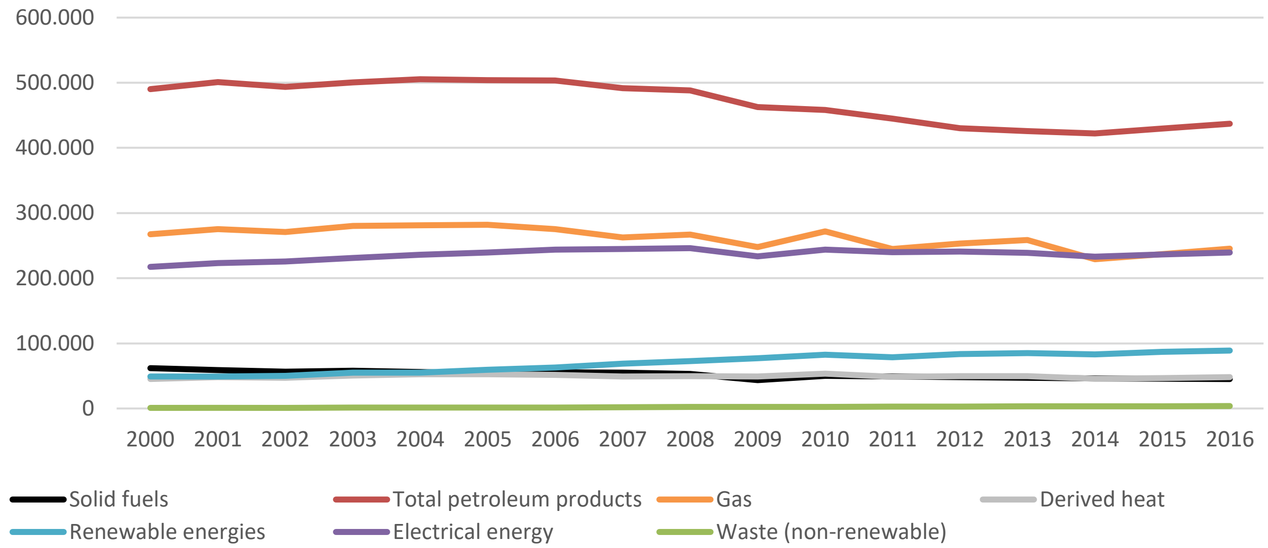
Table 1.6 Final energy consumption by fuel in EU28 Member States in 2016 (ktoe)

	All products	Solid fuels	Total petroleum products	Gas	Derived heat	Out of which: Derived heat generated from RES	Renewable energies*	Electrical energy	Out of which: Electricity generated from RES	Waste (non-renewable)
EU28	1.107.818	45.338	437.131	245.284	47.932	**14.305**	88.950	239.405	82.541	3.780
AT	28.128	1.425	10.130	5.128	1.737	948	4.045	5.318	4.524	344
BE	36.333	1.748	15.298	9.726	498	45	1.884	7.038	1.227	142
BG	9.663	336	3.448	1.313	783	18	1.267	2.485	633	32
CY	1.758	0	1.252	0	1	1	111	378	36	16
CZ	24.881	2.424	6.802	5.676	2.129	211	2.784	4.819	833	246
DE	216.447	10.163	82.226	54.388	9.782	1.593	14.270	44.486	16.410	1.132
DK	14.450	113	6.009	1.498	2.566	1.626	1.562	2.679	1.641	22
EE	2.818	29	1.012	252	472	308	411	628	135	13
EL	16.703	199	9.495	1.048	51	0	1.286	4.597	1.232	28
ES	82.498	1.414	41.924	13.675	0	0	5.487	19.993	8.781	6
FI	25.249	703	7.186	845	4.127	1.949	5.388	6.950	2.483	51
FR	147.159	3.605	59.788	29.867	3.369	1.669	12.366	38.037	8.416	127
HR	6.639	66	2.818	1.031	223	29	1.176	1.316	729	10
HU	17.865	391	5.296	5.706	1.064	204	2.154	3.192	276	63
IE	11.610	476	6.747	1.775	0	0	371	2.199	687	42
IT	115.931	1.768	43.828	33.472	3.950	928	8.043	24.594	9.504	277
LT	5.108	189	2.008	551	834	501	688	838	173	0
LU	4.039	52	2.594	633	53	16	146	548	41	13
LV	3.820	36	1.396	321	581	274	892	557	329	37
MT	584	0	389	0	0	0	12	182	11	0
NL	49.517	1.553	17.671	17.865	2.139	325	1.173	9.082	1.293	34
PL	66.652	12.069	21.627	9.688	5.669	334	5.540	11.422	1.932	637
PT	16.115	12	8.028	1.619	211	0	2.168	3.986	2.511	91
RO	22.280	793	7.360	5.363	1.284	82	3.684	3.719	2.188	79
SE	32.591	1.046	8.770	644	4.430	3.049	6.738	10.963	8.040	0
SI	4.876	36	2.280	598	175	35	631	1.120	415	36
SK	10.418	1.293	2.342	3.210	670	142	574	2.149	570	183
UK	133.689	3.399	59.409	39.393	1.136	18	4.099	26.131	7.493	121

*Does not include electricity from RES and Derived Heat from RES.

Source: Eurostat and Bioenergy Europe's calculations

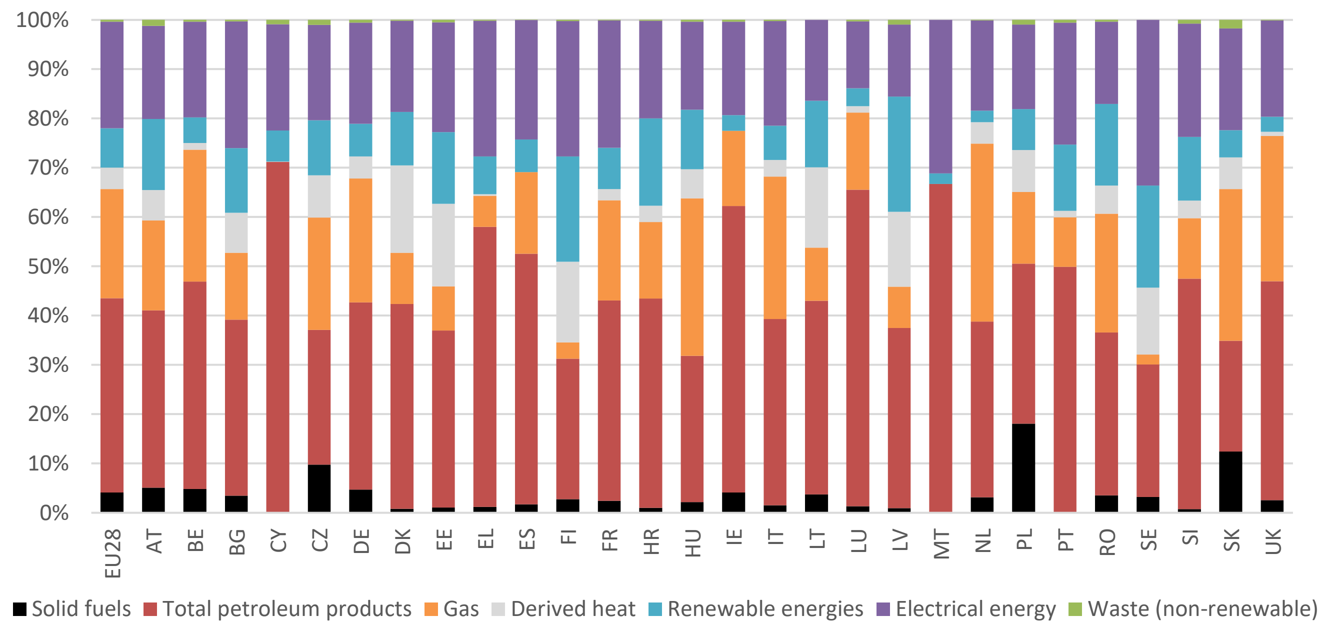
Figure 1.8 Evolution of final energy consumption by fuel type in EU28 (ktoe)



Source: Eurostat

In the recently enacted Renewable Energy Directive II, the EU institutions agreed to set an objective of 32% renewable energy share in the final energy consumption. This target is only binding at the EU level, so Member States will not have to submit national targets as was the case for the first Renewable Energy Directive, which was enacted in 2009. Instead, under the new directive Member States are obligated to submit National Energy and Climate Plans, or NECPs, to the European Commission. These NECPs will detail the measures that Member States intend to implement in order to increase their share of RES. By the end of 2018, each Member State must send a draft of their NECP to the Commission, so that the final draft may be published before the end of 2019. In the case of bioenergy, it will be crucial that the NECPs produced by Member States, which affect to the demand for bioenergy, correspond with the respective national forest plans (National Forest Reference levels) and agricultural plans (mandated by the Common Agricultural Policy) which affect to the supply for bioenergy.

Figure 1.9 Share of fuels in final energy consumption in EU Member States in 2016 (%)



Source: Eurostat

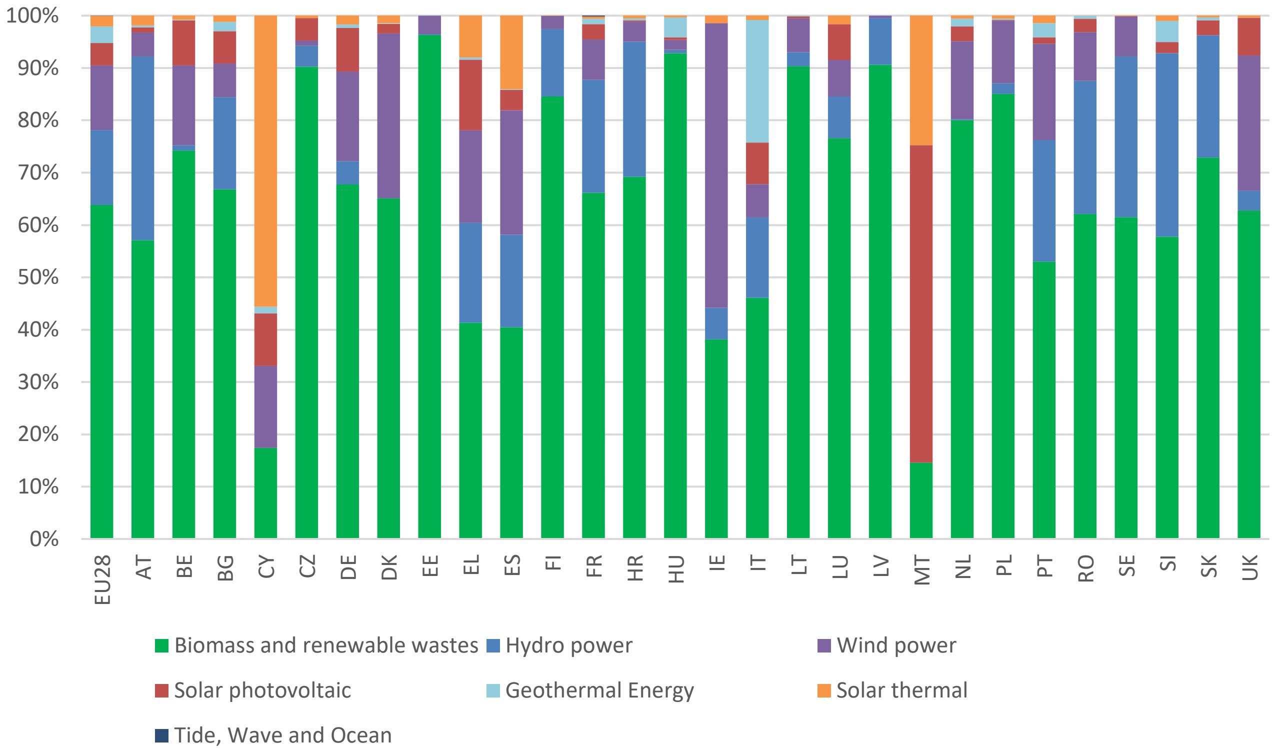
1.2 Renewables in Europe

Table 1.7 Primary production of renewable energy in EU28 Member States in 2016 (ktoe)

	Renewable energies	Biomass and renewable wastes	Hydro power	Wind power	Solar photovoltaic	Geothermal Energy	Solar thermal	Tide, Wave and Ocean
EU28	210.708	134.497	30.105	26.044	9.047	6.660	4.312	43
Share (%)	100,00%	63,83%	14,29%	12,36%	4,29%	3,16%	2,05%	0,02%
AT	9.769	5.581	3.426	450	94	34	185	0
BE	3.066	2.275	32	467	265	3	23	0
BG	1.921	1.284	339	123	119	35	22	0
CY	124	22	0	19	13	2	69	0
CZ	4.279	3.862	172	43	183	0	19	0
DE	39.481	26.741	1.767	6.758	3.276	269	671	0
DK	3.492	2.273	2	1.099	64	5	50	0
EE	1.461	1.407	3	51	0	0	0	0
EL	2.502	1.034	477	443	338	10	200	0
ES	17.685	7.154	3.129	4.205	694	19	2.484	0
FI	10.517	8.891	1.359	264	2	0	2	0
FR	23.896	15.804	5.163	1.840	702	243	101	43
HR	2.282	1.579	589	87	6	9	12	0
HU	3.194	2.965	22	59	17	120	11	0
IE	973	371	59	529	0	0	14	0
IT	23.821	10.980	3.649	1.521	1.901	5.571	200	0
LT	1.498	1.354	39	98	6	2	0	0
LU	125	96	10	9	9	0	2	0
LV	2.437	2.209	218	11	0	0	0	0
MT	18	3	0	0	11	0	4	0
NL	4.711	3.770	9	703	134	68	27	0
PL	9.027	7.675	184	1.082	11	22	52	0
PT	5.823	3.086	1.352	1.073	71	158	84	0
RO	6.096	3.786	1.550	567	157	36	1	0
SE	17.376	10.689	5.333	1.331	12	0	11	0
SI	1.105	639	387	1	23	45	11	0
SK	1.603	1.168	375	1	46	8	6	0
UK	12.429	7.804	464	3.213	896	1	51	0

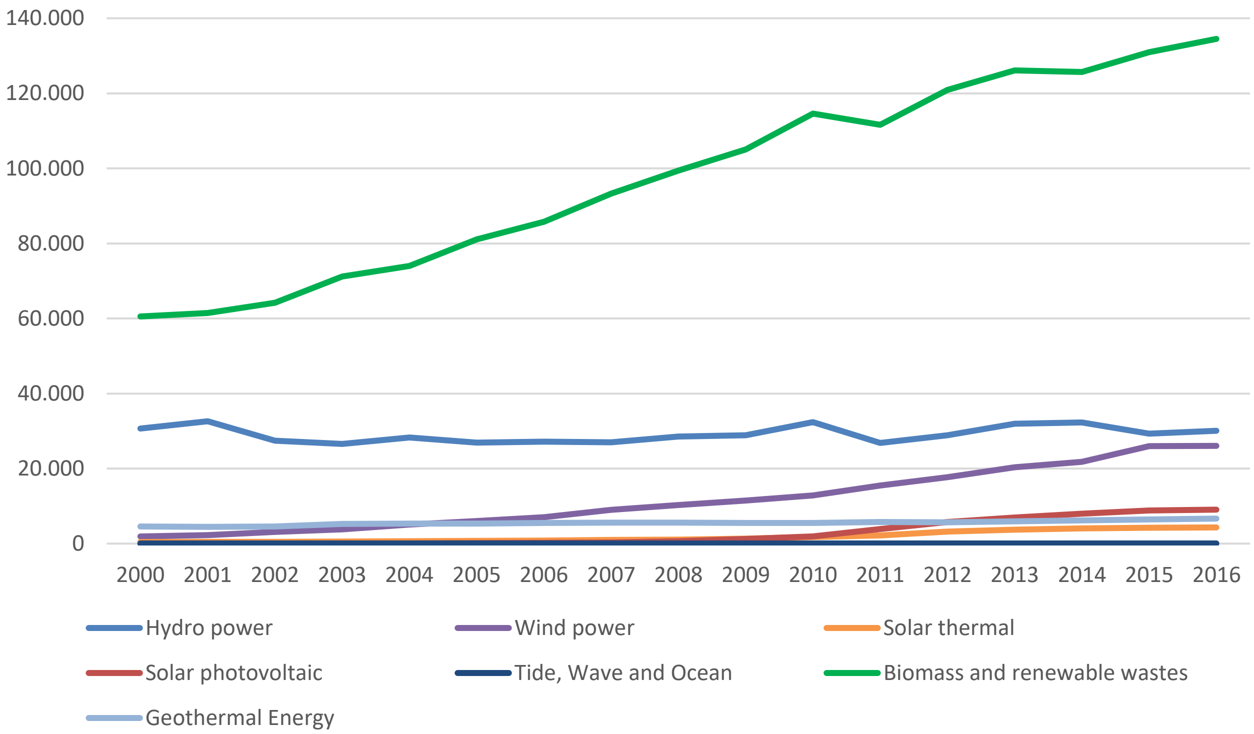
Source: Eurostat

Figure 1.10 Share of the different renewable energy sources out of total primary energy production of renewables in EU28 Member States in 2016 (%)



Source: Eurostat

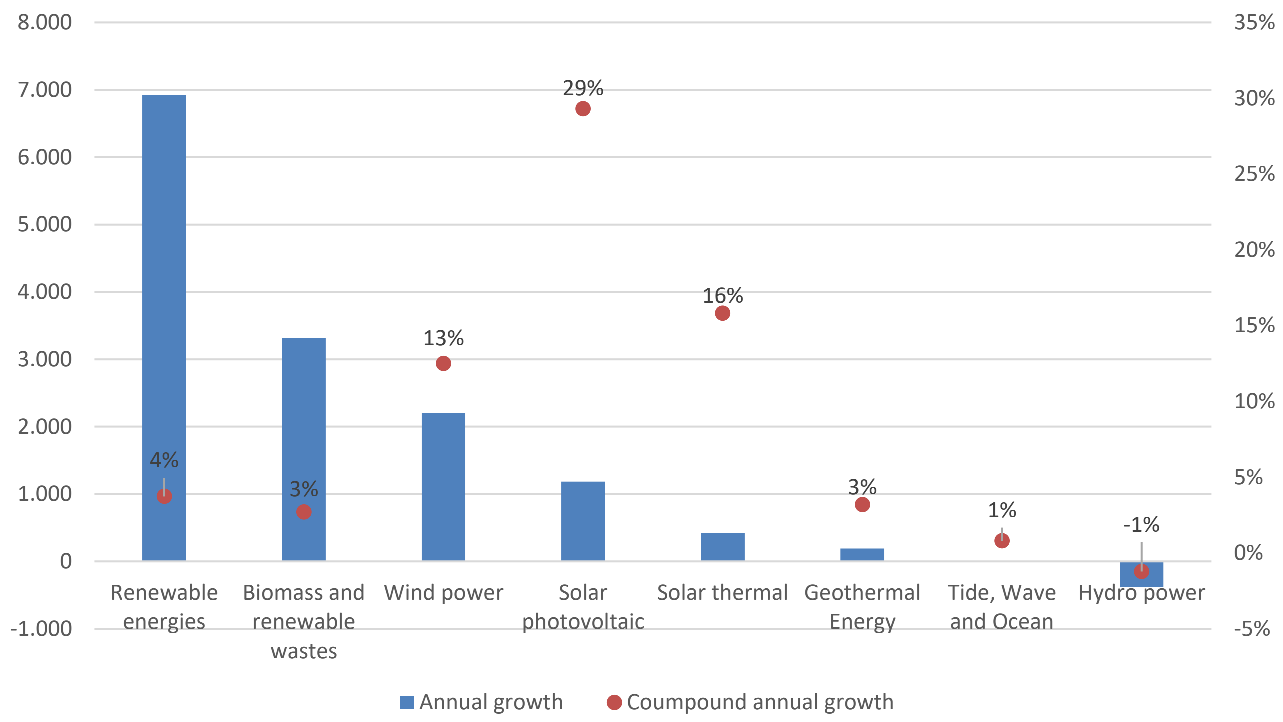
Figure 1.11 Evolution of primary production of renewable energy in EU28 (ktoe)



Source: Eurostat

Bioenergy is currently the main renewable energy source consumed in the EU, accounting for 63.83% of renewable energy consumption. Despite the rapid growth of other renewable resources like wind and PV, bioenergy is expected to remain the main renewable energy source for decades to come.
Bioenergy is also the most versatile class of renewable energy. It can be used for electricity generations, to meet heating and cooling needs, and as a substrate for transport fuels. In some sectors it is also one of the few decarbonised solutions at hand. If the EU wishes to reach a net-zero emissions economy in 2050 it will be necessary to phase out fossil fuels, which will only be possible through the use of bioenergy to ensure security of supply.

Figure 1.12 Growth in primary energy production (ktoe/year) of renewable energy and compound annual growth rate (%) between 2010 and 2016 in EU28



Source: Eurostat

The renewable energy share, or RES, refers to the proportion of gross final energy consumption that is supplied by renewable energy sources. The RES share is one of the headline indicators of the Europe 2020 Energy and Climate package. The EU has set a target of 20% RES to be reached by 2020. Each EU Member State has set its own RES target for 2020, in order to reach the collective 20% goal. In 2016, RES had reached 16,7% for the EU as a whole, nearly double the RES share of the EU in 2004, which was then 8,5%.

The Europe 2020 Energy and Climate package also sets a collective EU RES target for transport fuel of 10% by 2020. For the calculation of transport fuel RES, the package defines a specific methodology that gives additional weight to transport fuels from renewable sources. In this methodology, consumption of some classes of renewable transport fuel is multiplied by a factor defined in the package for the purpose of RES share calculations. This means that the RES contribution of these classes of renewable fuel will exceed their actual share of energy consumption. The methodology is described in more detail in chapter 6 of this report. The following graphs display RES calculated according to this methodology.

For 2030, the EU institutions have agreed to target an RES of 32%, which will be binding on an EU level. Member States will no longer be obligated to comply with national RES targets, but will instead submit National Energy and Climate Plans, or NECPs to the European Commission. NECP drafts must be submitted to the Commission by the end of 2018 in order to ensure that a final draft may be published before the end of 2019.

Table 1.8 Share of renewable energy in gross final energy consumption in electricity, heat-cooling and transport in EU28 Member States in 2015 (%)

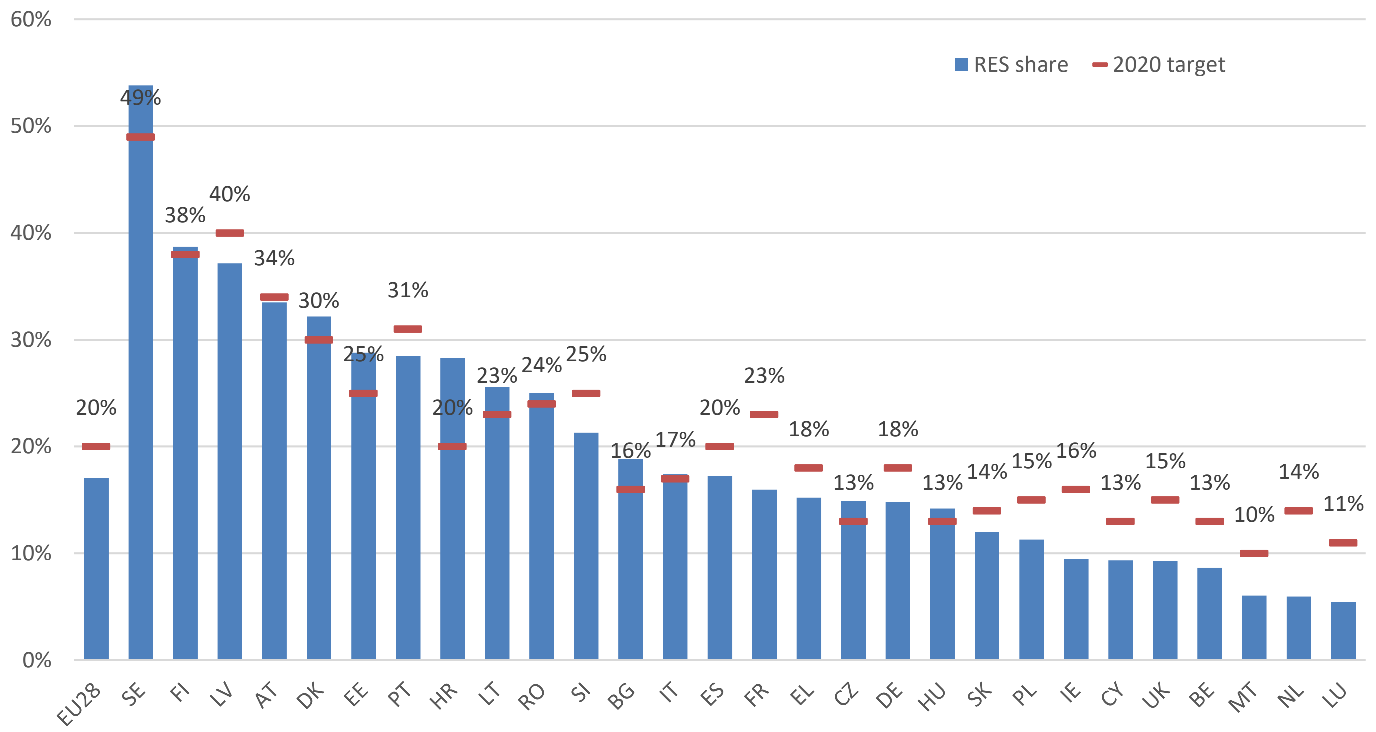
	RES - Electricity	RES – Heat & Cooling	RES – Transport*
EU28	29,6%	19,1%	7,1%
AT	5,6%	33,3%	10,6%
BE	72,6%	8,1%	5,9%
BG	15,8%	30,0%	7,3%
CY	46,7%	23,0%	2,7%
CZ	19,2%	19,9%	6,4%
DE	13,6%	13,0%	6,9%
DK	8,6%	41,7%	6,8%
EE	32,2%	51,2%	0,4%
EL	15,5%	24,5%	1,4%
ES	23,8%	16,8%	5,3%
FI	32,1%	53,7%	8,4%
FR	36,6%	21,1%	8,9%
HR	32,9%	37,6%	1,3%
HU	16,8%	20,8%	7,4%
IE	53,7%	6,8%	5,0%
IT	19,2%	18,9%	7,2%
LT	27,2%	46,5%	3,6%
LU	34,0%	7,3%	5,9%
LV	7,2%	51,9%	2,8%
MT	6,7%	15,3%	5,4%
NL	51,3%	5,5%	4,6%
PL	12,5%	14,7%	3,9%
PT	13,4%	35,1%	7,5%
RO	54,1%	26,9%	6,2%
SE	22,5%	68,6%	30,3%
SI	42,7%	34,0%	1,6%
SK	64,9%	9,9%	7,5%
UK	24,6%	7,0%	4,9%

*Includes RES electricity used in transport which also counts towards the RES for electricity.
Renewable electricity used in transport is weighted according to a methodology described in Chapter 6 – Biofuels for transport.
Source: Eurostat, SHARE 2016

As shown in the table above, both the heating and cooling (or H&C) and the transport sectors are lagging when it comes to renewable energy consumption. Decarbonising the H&C sector, which representing 50% of EU final energy consumption, will be key to reach long-term climate objectives. It is crucial that Member States put the right measures in place to decarbonise this sector.

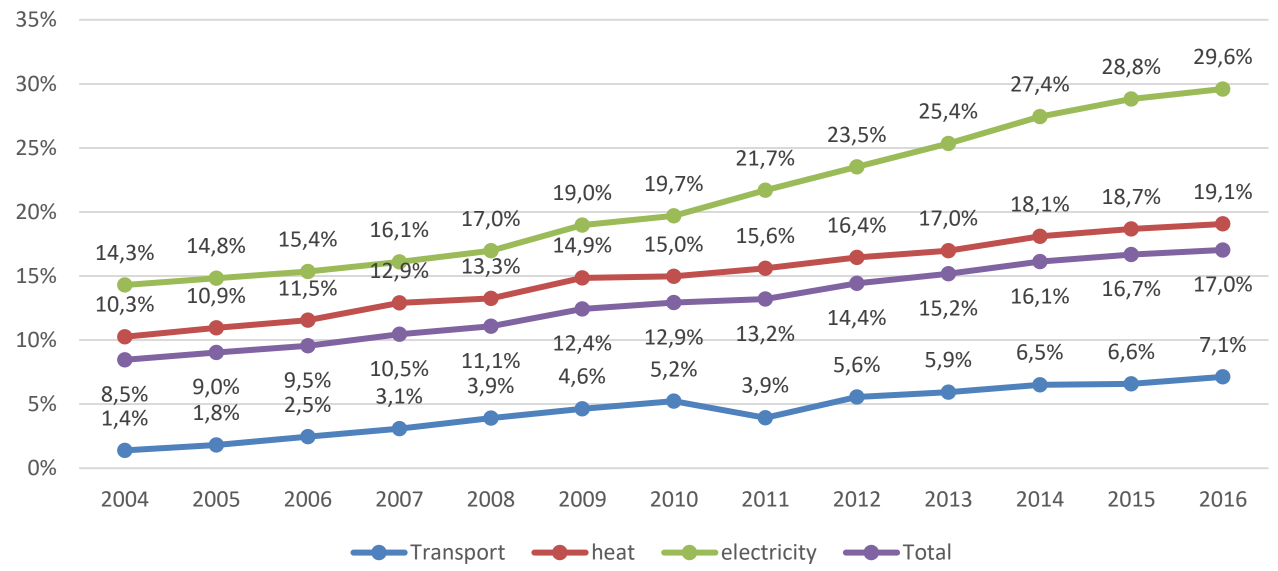
The recently enacted RED II addresses the H&C sector with a soft obligation, established in Article 23 of the directive, for Member States to increase their share of RES in the H&C sector. This should boost the demand for renewbale sources of energy providing heat, including biomass.

Figure 1.13 Share of renewable energy in gross final energy consumption in EU28 Member States in 2016 and targets for 2020* (%)



* The 2020 targets specified here refer to the indicator described in Directive 2009/28/EC. Each Member State shall ensure that the share of energy from renewable sources in gross final consumption of energy in 2020 is at least its national overall target for the share of energy from renewable sources, as set out in the Directive. More information about the renewable energy shares calculation methodology can be found in the Renewable Energy Directive 2009/28/EC.
Source: Eurostat, Share 2016

Figure 1.14 Evolution of the share of renewable energy in gross final energy consumption in the different sectors in EU28 (%)



* This includes RES electricity used in transport which, at the same time, is not extracted from the contribution of RES in electricity. Renewable electricity used in transport is calculated applying a specific methodology with multipliers. More info in Chapter 6 – Biofuels for transport.
Source: Eurostat, SHARE 2016

Bioenergy Prospects in the European Union from the IEA's *Renewables 2018* market report

The IEA's *Renewables 2018* market report provides forecasts for renewables across electricity, heat and transport looking forward until 2023. Across all three sectors modern bioenergy is the largest form of renewable energy in the European Union (EU), providing around two thirds of all renewables in 2017. By the end of our forecast in 2023, this only falls slightly to 60%, with wind the only renewable source with larger growth in energy terms.

Bioenergy for heat in the European Union is anticipated to increase by around 8% by 2023, to reach 3.5 exajoules (EJ). Most biomass heat is used in buildings. The voluntary target within the updated Renewable Energy Directive (RED), for member states to increase renewable energy in heating and cooling by 1.3 percentage points/year should open up opportunities for biomass heating. Regarding industry, *Renewables 2018* highlights the leading role of Europe's cement sector in meeting a high share of thermal demand with bioenergy and waste.

We anticipate bioenergy capacity in the electricity sector to increase 18% (7.5 GW) by 2023. More robust growth of wind and solar PV means bioenergy accounts for just 6% of forecast EU capacity additions, but still contributes almost a fifth of EU renewable generation in 2023. Conventional biofuel production in the EU contracts slightly in the forecast as transport fuel demand declines due to the increasing efficiency of the vehicle fleet and as the RED becomes less supportive of food crop biofuels after 2020, limiting investment in new facilities. Conversely the updated RED should boost advanced biofuel deployment. Europe accounts for a third of all projects currently in development. *Renewables 2018* is available from the IEA webstore.

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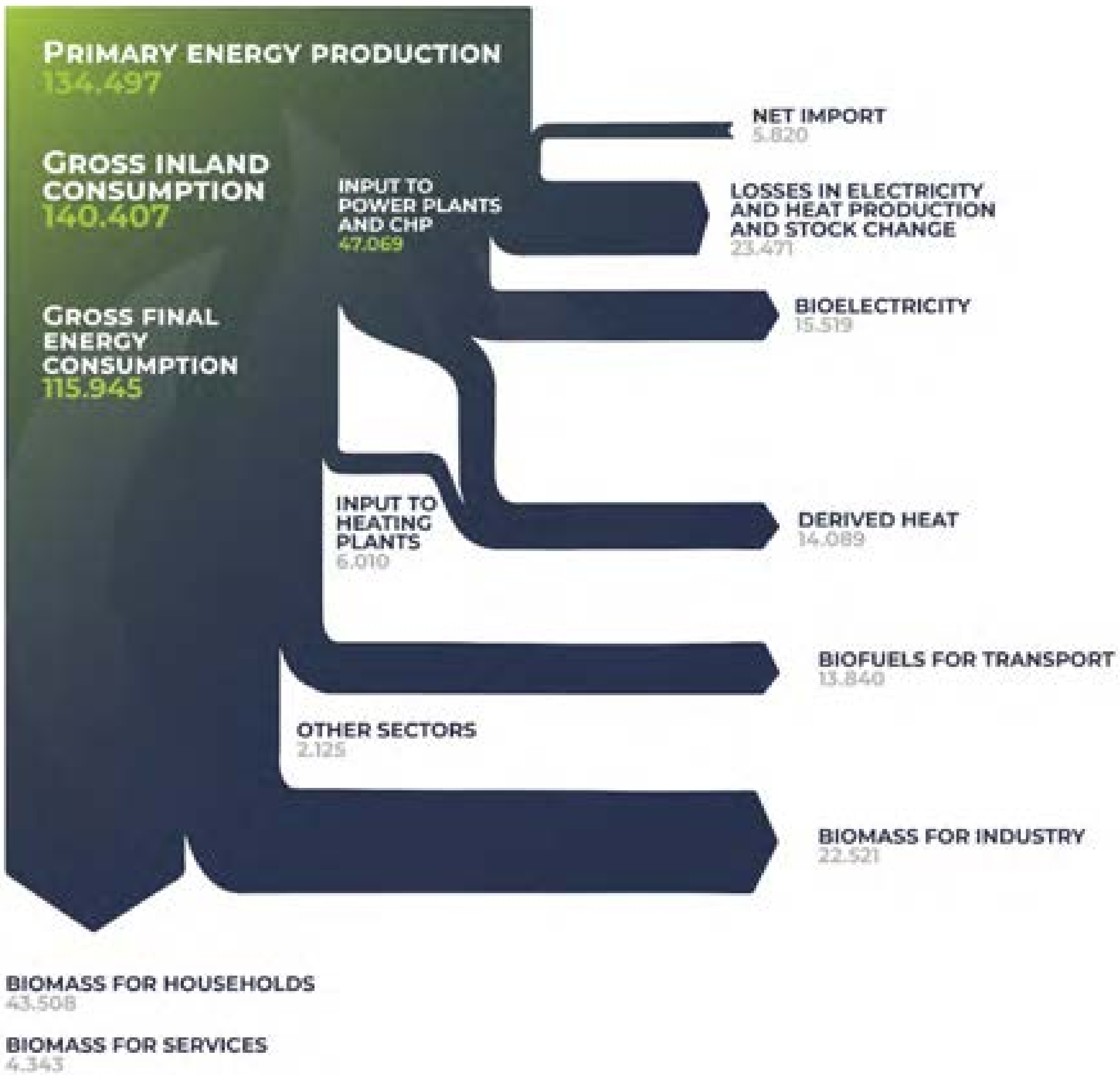
International Energy Agency

2

BIOENERGY LANDSCAPE

2.1 Current bioenergy balance

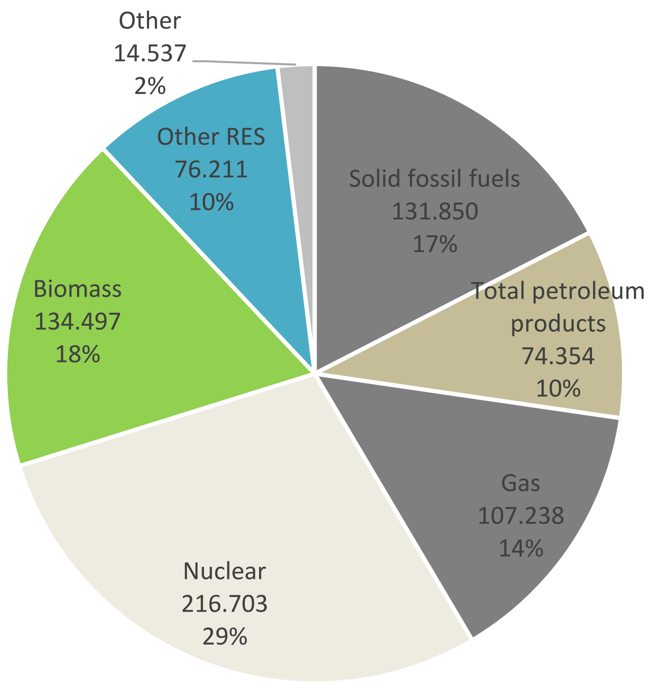
Figure 2.1 Bioenergy balance in 2016 in EU28 (ktoe)



Sources: Eurostat

Figure 2.1 breaks down European bioenergy consumption by sector. It is notable that almost all biomass originates in Europe, with only 4,1% of consumption coming from imports.
Bioheat represents 75% of the gross final energy consumption of bioenergy. Households and services are the main consumers of biomass for heating purposes. Bioelectricity and biofuels for transport represent similar shares of around 13% of the gross final energy consumption. With this distribution, biomass appears to be a solution for the decarbonisation of all three sectors (heating, transport and electricity). Bioenergy has specific characteristics that will be key in a future 100% renewable-based energy system.

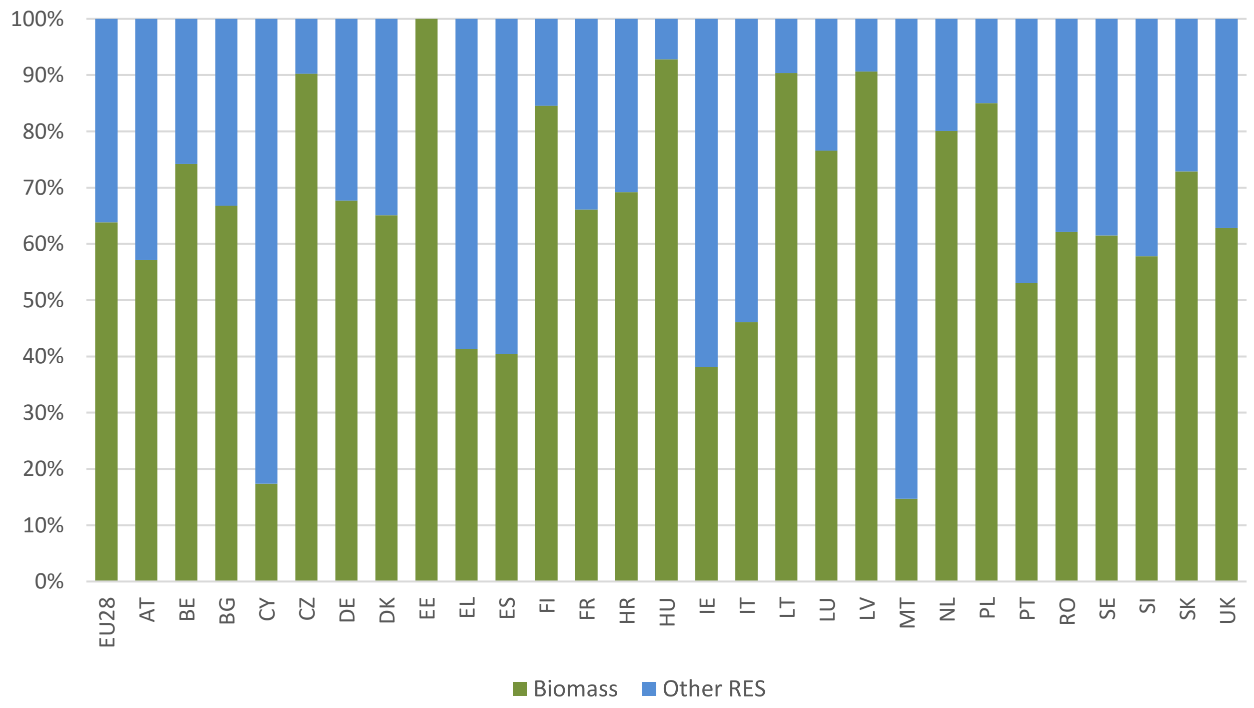
Figure 2.2 Contribution of biomass to the total EU28 primary energy production in EU28 in 2016 (ktoe, %)



Note : Eurostat´s methodology considers heat as the primary energy form for nuclear. In case the amount of heat produced in the nuclear reactor is not known, the primary energy equivalent is calculated from the electricity generation by assuming an efficiency of 33%. However, it should be remarked that nuclear is not an indigenous source and most of it is imported.

Source: Eurostat

Figure 2.3 Contribution of biomass to the total primary renewable energy production in 2016 in EU28 Member States (%)



Source: Eurostat, Bioenergy Europe calculations

Table 2.1 Primary energy production of biomass in EU28 Member States in 2016 (ktoe)

	Total biomass	Solid biomass (excluding charcoal)	Biogas	Municipal waste (renewable)	Liquid biofuels
EU28	134.497	94.125	16.600	10.001	13.771
AT	5.581	4.698	313	175	395
BE	2.275	1.292	227	381	375
BG	1.284	1.121	60	29	74
CY	22	9	12	0	0
CZ	3.862	2.970	601	86	206
DE	26.741	12.169	8.095	3.102	3.374
DK	2.273	1.588	218	460	7
EE	1.407	1.396	11	0	0
EL	1.034	794	102	0	138
ES	7.154	5.304	245	235	1.370
FI	8.891	8.309	112	309	161
FR	15.804	11.097	760	1.541	2.406
HR	1.579	1.531	47	0	1
HU	2.965	2.400	89	66	411
IE	371	226	56	64	24
IT	10.980	7.232	1.875	871	1.002
LT	1.354	1.200	32	22	100
LU	96	63	20	13	0
LV	2.209	2.076	90	0	43
MT	3	0	2	0	1
NL	3.770	1.366	319	794	1.292
PL	7.675	6.415	261	77	922
PT	3.086	2.605	80	104	298
RO	3.786	3.579	18	2	187
SE	10.688	9.402	174	832	281
SI	639	609	30	0	0
SK	1.168	835	152	20	162
UK	7.804	3.840	2.601	820	543

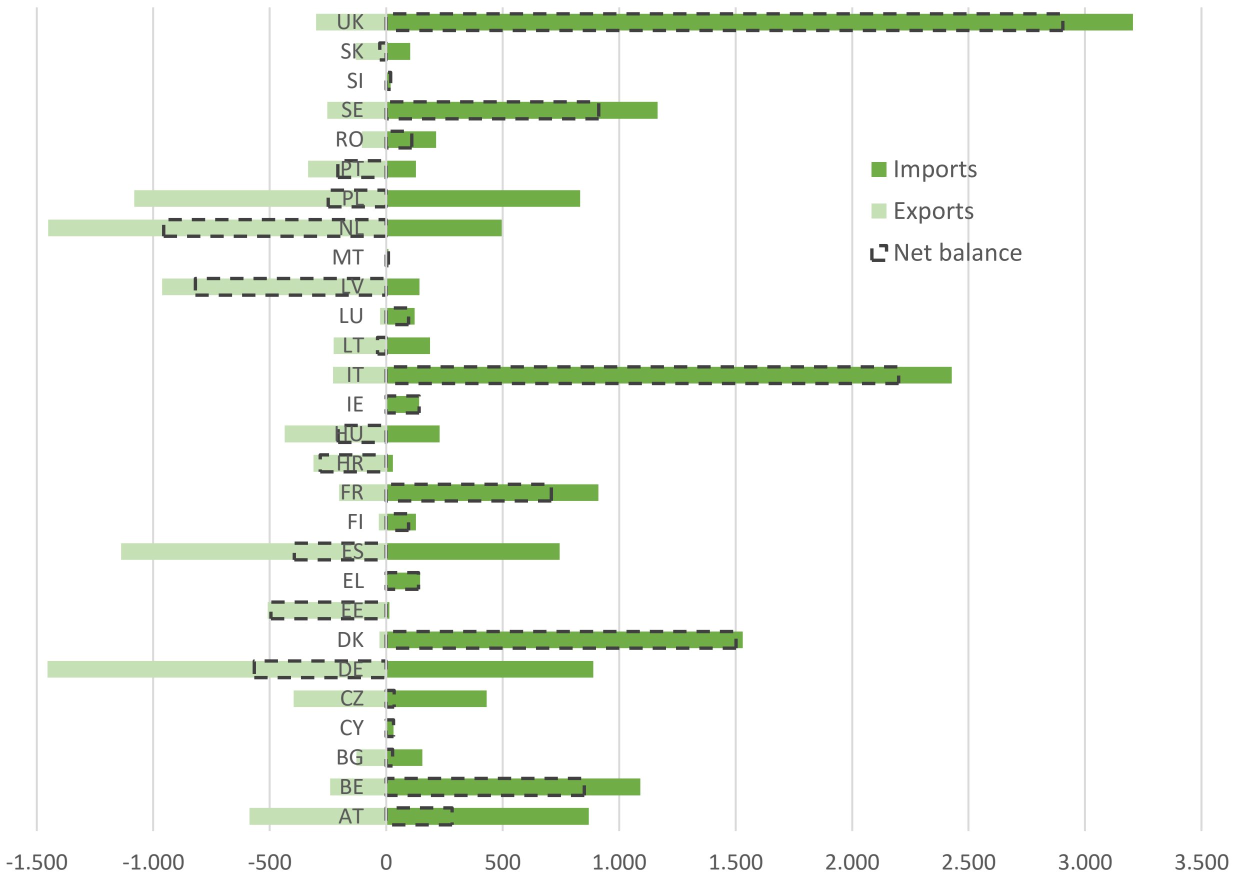
Source: Eurostat

Table 2.2 Evolution of primary energy production of biomass by type (ktoe) and annual growth (%) in EU28

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Solid biomass (excluding charcoal)	69.422	72.889	76.795	79.507	86.238	82.271	88.724	90.395	87.230	91.834	94.125
Annual growth solid biomass fuels		4,99%	5,36%	3,53%	8,47%	-4,60%	7,84%	1,88%	-3,50%	5,28%	2,49%
Biogas	4.461	5.849	6.678	7.494	8.706	10.612	12.354	14.102	15.119	15.887	16.600
Annual growth biogas		31,11%	14,17%	12,22%	16,17%	21,89%	16,42%	14,15%	7,21%	5,08%	4,49%
Municipal waste (renewable)	6.504	7.425	7.409	7.653	8.111	8.393	8.671	8.987	9.303	9.649	10.001
Annual growth Municipal waste		14,16%	-0,22%	3,29%	5,98%	3,48%	3,31%	3,64%	3,52%	3,72%	3,65%
Biofuel	5.343	7.133	8.517	10.346	11.570	10.359	11.187	12.658	13.996	13.572	13.771
Annual growth biofuel		33,50%	19,40%	21,47%	11,83%	10,47%	7,99%	13,15%	10,57%	-3,03%	1,47%
Total biomass	85.730	93.296	99.399	105.000	114.625	111.635	120.936	126.142	125.648	130.942	134.497
Annual growth total biomass		8,83%	6,54%	5,63%	9,17%	-2,61%	8,33%	4,30%	-0,39%	4,21%	2,71%

Source: Eurostat

Figure 2.4 Imports and exports of biomass and renewable wastes in EU28 Member States in 2016 (ktoe)



Source: Eurostat

Table 2.3 Breakdown of imports and exports of biomass in EU28 Member States in 2016 (ktoe)

	Imports					Exports				
	Total	Solid biomass (excluding charcoal)	Municipal waste (renewable)	Charcoal	Liquid biofuels	Total	Solid biomass (excluding charcoal)	Municipal waste (renewable)	Charcoal	Liquid biofuels
EU28	16.395	8.026	355	165	7.849	10.575	3.877	34	30	6.634
AT	870	362	0	12	497	588	270	0	1	316
BE	1.091	766	4	6	316	241	0	0	0	241
BG	156	35	0	2	119	128	97	0	1	29
CY	32	2	12	10	9	0	0	0	0	0
CZ	431	209	0	0	223	398	272	0	0	126
DE	889	0	0	0	889	1.455	0	0	0	1.455
DK	1.531	1.205	72	0	254	29	0	0	0	29
EE	14	12	0	0	3	509	509	0	0	0
EL	145	58	0	46	41	6	1	0	0	5
ES	744	0	0	0	744	1.139	0	0	0	1.139
FI	128	56	0	0	72	32	32	0	0	0
FR	911	0	0	0	911	202	0	0	0	202
HR	29	23	0	5	0	312	307	0	5	1
HU	230	88	17	0	125	436	77	0	0	359
IE	141	46	0	0	95	0	0	0	0	0
IT	2.428	1.233	0	45	1.151	228	24	0	1	203
LT	188	148	0	5	35	226	145	0	4	77
LU	123	32	0	0	90	26	26	0	0	0
LV	143	126	0	5	12	962	906	0	12	44
MT	9	1	0	0	8	0	0	0	0	0
NL	496	100	250	6	139	1.452	257	34	0	1.161
PL	832	581	0	0	252	1.082	375	0	0	707
PT	128	77	0	23	28	336	280	0	4	52
RO	214	111	0	0	103	105	79	0	0	26
SE	1.165	113	0	0	1.052	253	97	0	0	156
SI	19	0	0	0	19	0	0	0	0	0
SK	102	0	0	0	102	131	11	0	0	120
UK	3.206	2.644	0	0	562	301	114	0	0	188

Source: Eurostat

Solid biomass is the main class of biomass consumed in the EU-28, accounting for 70% of the total gross inland consumption of biomass for energy, with 98.280 ktoe consumed. The remainder is accounted for by liquid biofuel (10,7% of consumption, 15.072 ktoe consumed) and biogas (11,8% of consumption, 16.600 ktoe consumed), and energy from municipal waste (7,3% of consumption, 10.320 ktoe consumed).

Table 2.4 Gross inland consumption of bioenergy in EU28 Member States in 2016 (ktoe)

	Total bioenergy	Solid biomass (excluding charcoal)	Biogas	Municipal waste (renewable)	Liquid biofuels	Charcoal
EU28	140.407	98.280	16.600	10.320	15.072	135
AT	5.860	4.792	313	175	570	10
BE	3.125	2.058	227	385	449	6
BG	1.310	1.057	60	29	163	1
CY	51	10	12	10	9	10
CZ	3.894	2.906	601	86	301	0
DE	26.174	12.169	8.095	3.102	2.808	0
DK	3.788	2.793	218	532	245	0
EE	912	898	11	0	3	0
EL	1.170	852	102	0	170	46
ES	6.900	5.304	245	235	1.116	0
FI	8.987	8.333	112	309	233	0
FR	16.499	11.097	760	1.541	3.101	0
HR	1.300	1.253	47	0	1	-1
HU	2.771	2.410	89	83	189	0
IE	506	271	56	64	115	0
IT	13.177	8.441	1.875	871	1.946	44
LT	1.318	1.206	32	22	57	1
LU	192	69	20	13	90	0
LV	1.395	1.300	90	0	12	-7
MT	9	1	2	0	6	0
NL	2.754	1.209	319	1.010	210	6
PL	7.417	6.620	261	77	459	0
PT	2.885	2.402	80	104	280	19
RO	3.884	3.607	18	2	257	0
SE	11.597	9.419	174	832	1.172	0
SI	658	609	30	0	19	0
SK	1.143	826	152	20	145	0
UK	10.737	6.370	2.601	820	946	0

Source: Eurostat

The energy dependency of EU-28 countries, defined as net energy imports divided by gross inland consumption, is displayed in table 2.5 below. Negative figures identify net exporting countries. It should be notice that energy dependency for Member States includes also intra-EU trade.

Table 2.5 Bioenergy dependency in EU28 Member States in 2016 (%)

	Total biomass	Solid biofuels (excluding charcoal)	Liquid biofuels
EU28	4,1%	4,2%	8,1%
AT	4,8%	1,9%	31,7%
BE	27,2%	37,2%	16,6%
BG	2,1%	-5,9%	55,0%
CY	61,6%	16,0%	93,3%
CZ	0,9%	-2,2%	32,3%
DE	-2,2%	0,0%	-20,2%
DK	39,7%	43,1%	92,0%
EE	-54,3%	-55,4%	86,7%
EL	11,9%	6,8%	20,8%
ES	-5,7%	0,0%	-35,3%
FI	1,1%	0,3%	30,8%
FR	4,3%	0,0%	22,9%
HR	-21,8%	-22,6%	-50,0%
HU	-7,5%	0,5%	-124,1%
IE	27,8%	16,8%	82,9%
IT	16,7%	14,3%	48,7%
LT	-2,9%	0,3%	-73,3%
LU	50,1%	8,6%	100,2%
LV	-58,7%	-60,0%	-264,2%
MT	100%	100%	100%
NL	-34,7%	-13,0%	-486,4%
PL	-3,4%	3,1%	-99,0%
PT	-7,2%	-8,4%	-8,6%
RO	2,8%	0,9%	29,8%
SE	7,9%	0,2%	76,5%
SI	2,9%	0,0%	102,1%
SK	-2,5%	-1,2%	-12,4%
UK	27,1%	39,7%	39,6%

Source: Eurostat and Bioenergy Europe

The import dependency of the EU-28 states is only 4,1% for bioenergy, which compares favorably to the import dependency for fossil fuels, which is close to 90% according to Eurostat, table 2.5. Bioenergy remains a local source of energy in the EU-28. It is also notable that bioenergy has decreased it imports´ dependency since 2015, from 4,4% to 4,1%. It is clear from these figures that trade of biomass takes place primarily between EU Member States. This underlines the necessity of harmonised sustainability criteria and quality standards to ensure a fair bioenergy market withing EU Member States.

Table 2.6 Gross final energy consumption, overall RES and bioenergy in EU28 Member States in 2016 (ktoe)

	Total	RES*	%RES/Total Final energy	Bioenergy*	% Bioenergy /Total Final energy	% Bioenergy /RES
EU28	1.107.818	188.207	17,0%	115.945	10,5%	61,6%
AT	28.128	9.624	34,2%	5.184	18,4%	53,9%
BE	36.333	3.244	8,9%	2.358	6,5%	72,7%
BG	9.663	1.950	20,2%	1.258	13,0%	64,5%
CY	1.758	149	8,5%	46	2,6%	30,9%
CZ	24.881	3.906	15,7%	3.385	13,6%	86,7%
DE	216.447	32.538	15,0%	19.471	9,0%	59,8%
DK	14.450	4.784	33,1%	3.563	24,7%	74,5%
EE	2.818	850	30,2%	796	28,2%	93,6%
EL	16.703	2.568	15,4%	1.099	6,6%	42,8%
ES	82.498	14.783	17,9%	5.664	6,9%	38,3%
FI	25.249	10.048	39,8%	8.326	33,0%	82,9%
FR	147.159	22.824	15,5%	14.412	9,8%	63,1%
HR	6.639	1.941	29,2%	1.221	18,4%	62,9%
HU	17.865	2.634	14,7%	2.410	13,5%	91,5%
IE	11.610	1.043	9,0%	416	3,6%	39,9%
IT	115.931	18.418	15,9%	10.306	8,9%	56,0%
LT	5.108	1.419	27,8%	1.225	24,0%	86,3%
LU	4.039	323	8,0%	172	4,3%	53,3%
LV	3.820	1.466	38,4%	1.237	32,4%	84,4%
MT	584	24	4,1%	9	1,5%	37,5%
NL	49.517	2.761	5,6%	1.821	3,7%	66,0%
PL	66.652	7.876	11,8%	6.483	9,7%	82,3%
PT	16.115	5.044	31,3%	2.347	14,6%	46,5%
RO	22.280	6.129	27,5%	3.780	17,0%	61,7%
SE	32.591	17.907	54,9%	10.823	33,2%	60,4%
SI	4.876	1.125	23,1%	636	13,0%	56,5%
SK	10.418	1.307	12,5%	854	8,2%	65,3%
UK	133.689	11.525	8,6%	6.646	5,0%	57,7%

*Note: Unlike the Eurostat methodology, Bioenergy Europe statistics for final energy consumption of RES and of biomass include gross electricity production and derived heat.
Source: Eurostat, Bioenergy Europe

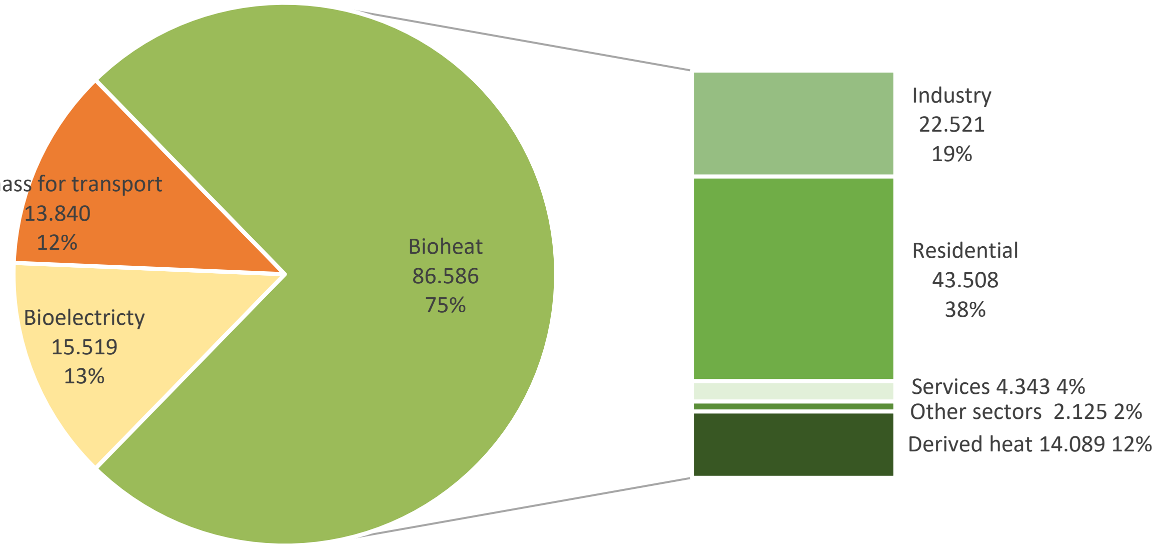
The EU has pledged to derive 20% of its energy consumption from renewable sources by 2020. Currently, bioenergy is the largest single source of renewable energy in Europe, accounting for more than 60% of renewable energy consumption, so it is safe to say that bioenergy will play an important role in meeting the 2020 renewable energy target. Looking ahead, the target for renewable energy consumption rises to 32% by 2030, and by 2050 a large majority of energy must come from renewable sources. Again, bioenergy will play a crucial role in achieving these objectives. A clear pathway towards the 2050 climate objectives should be set now, with renewable sources forming the backbone of EU energy mix.

Table 2.7 Bioenergy balance in Europe in EU28 Member States in 2016 (ktoe)

	Primary energy Production	Import	Export	Gross inland consumption	Input to Power and CHP plants	Input to heating plants	Gross final energy consumption (1+2+3+4+5+6+7)	Final use industry (1)	Final use residential (2)	Final use services (3)	Final use transport (4)	Final use other sectors (5)	Bioelectricity (6)	Derived heat (7)
EU28	134.497	16.395	10.575	140.407	47.069	6.010	115.945	22.521	43.508	4.343	13.840	2.125	15.519	14.089
AT	5.581	870	588	5.860	1.326	678	5.184	1.433	1.596	121	533	171	396	934
BE	2.275	1.091	241	3.125	1.264	0	2.358	697	617	56	440	50	454	44
BG	1.284	156	128	1.310	75	23	1.258	256	758	16	162	18	30	18
CY	21,6	32	0	51	8	0	46	13	9	6	8	4	5	1
CZ	3.862	431	398	3.894	1.100	28	3.385	482	1.777	59	300	147	409	211
DE	26.741	889	1.455	26.174	11.269	843	19.471	2.774	5.846	2.327	2.571	0	4.379	1.574
DK	2.273	1.531	29	3.788	1.673	563	3.563	167	1.031	57	236	57	423	1.592
EE	1.407	14	509	912	275	224	796	11	384	11	3	3	76	308
EL	1.034	145	6	1.170	87	0	1.099	145	728	25	149	28	24	0
ES	7.154	744	1.139	6.900	1.613	0	5.664	1.383	2.522	108	1.088	74	489	0
FI	8.891	128	32	8.987	2.754	795	8.326	3.670	1.300	86	177	153	991	1.949
FR	15.804	911	202	16.499	3.232	907	14.412	1.574	6.952	537	3.030	143	613	1.563
HR	1.579	29	312	1.300	134	0	1.221	20	1.128	7	0	0	37	29
HU	2.965	230	436	2.771	598	65	2.410	138	1.719	32	187	16	178	140
IE	371	141	0	506	161	0	416	173	33	33	118	0	59	0
IT	10.980	2.428	228	13.177	5.353	99	10.306	380	6.173	89	1.042	35	1.677	910
LT	1.354	188	226	1.318	183	445	1.225	96	484	40	56	12	37	500
LU	95,7	123	26	192	38	5	172	24	25	2	90	3	12	16
LV	2.209	143	962	1.395	329	166	1.237	331	450	80	13	18	71	274
MT	3	9	0	9	1	0	9	0	1	1	6	0	1	0
NL	3.770	496	1.452	2.754	1.634	32	1.821	138	455	107	242	136	422	321
PL	7.675	832	1.082	7.417	1.893	59	6.483	1.557	2.662	268	457	521	684	334
PT	3.086	128	336	2.885	790	0	2.347	1.020	764	29	265	5	264	0
RO	3.786	214	105	3.884	155	40	3.780	295	2.975	1	257	130	46	76
SE	10.688	1.165	253	11.597	4.018	939	10.823	4.269	961	66	1.300	130	988	3.109
SI	638,	19	0	658	71	10	636	73	483	1	20	0	24	35
SK	1.168	102	131	1.143	510	65	854	342	33	14	140	38	149	138
UK	7.804	3.206	301	10.737	6.527	25	6.646	1.061	1.641	165	947	234	2.583	15

Source: Eurostat, Bioenergy Europe calculations

Figure 2.5 Gross final energy consumption of biomass in heat, electricity and transport in EU28 Member States in 2016 (ktoe)



Note: The 22.521 ktoe of bioheat consumed in the industry refers only to the biomass directly used to produce heat for their own consumption. Besides this amount, the industry is using also biomass to produce electricity (partly for their own use and the rest to be put in the grid).
Source: Eurostat, Bioenergy Europe

Bioenergy solutions are manifold, each of them has a role to play in the decarbonization of our economies.As it can be seen in Figure 2.5, in 2016, 75 % of the final energy consumption, or 86.586 ktoe, of bioenergy came as heat production, mainly for residential and industrial applications. This shows that bioenergy consumption is decentralised. This is not reflected in public debate, which tends to focus on imported biomass used in dedicated power plants. It is important to put things into context: three quarters of all bioenergy is consumed as heat, and only 4.1% of bioenergy comes from imports.

The new bioenergy landscape in European Union shows that biomass continues as the largest renewable energy source and in fact, biomass supply is higher than any fossil fuel in EU 28 nations combined. On a country level, biomass is an integral part as 22 countries have more than 50% biomass in their renewable energy portfolio.

In 2016, all biomass sources (MSW, biogas, liquid biofuels and solid biomass) have shown good annual growth rates of 2 – 5% although it is lower than a decade ago. In terms of targets, even though biomass deployment according to individual NREAP (National Renewable Energy Action Plans) is well on schedule in heating (96%) and electricity (78%) sectors, transport sector is lagging far behind (48%).

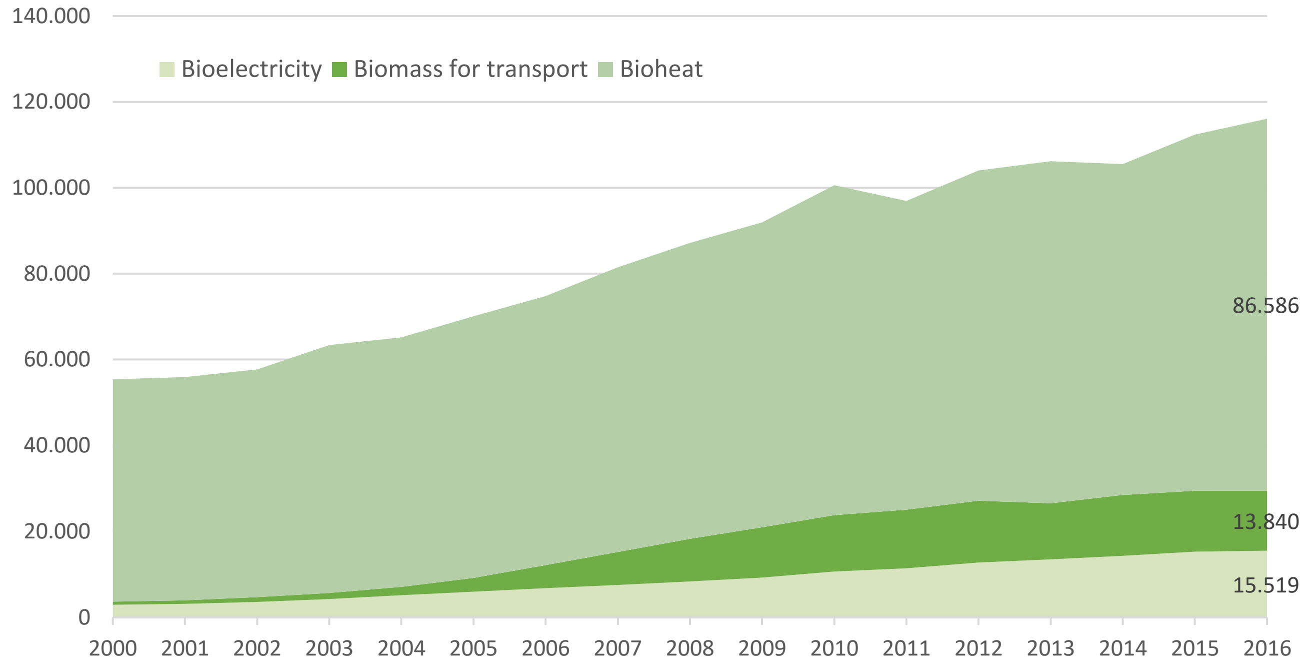
Bioenergy sector creates millions of jobs and generates billions in revenues internationally and also within EU, data shows that biomass employs an impressive 660 000 people with a turnover of 56 billion euros annually.

I commend the authors of Bioenergy Europe Statistics Report and their excellent work in producing high quality data.

Bharadwaj Kummamuru
Executive Director
World Bioenergy Association

WORLD BIOENERGY ASSOCIATION

Figure 2.6 Evolution of gross final energy consumption of bioenergy 2000-2016 in EU28 (ktoe)



Source: Eurostat, Bioenergy Europe calculations

Bioenergy consumption has increased markedly since 2000, growing from from 55,4 Mtoe at the turn of the century to 116 Mtoe in 2016. According to Member State projections, bioenergy consumption in Europe should account for 139 Mtoe by 2020, playing a major role in the achievment of the 2020 renewable energy target. With 116 Mtoe consumed, the whole sector grew by 3.29 % from 2015 to 2016. This increase is much lower than the year before (6.53%) and the average annual growth rate recorded in the period 2000-2015 (4.83 %).

According to Member State projections, bioenergy production should account for 139 Mtoe by 2020. To reach Member State objectives, bioenergy production will need to grow at an average rate of 4% per year between 2016 and 2020. In 2016, production only grew at 3.29%, although it grew 6.53% in 2014, and has averaged 4.83% per year in the period from 2000 to 2015.

This finding becomes even clearer when looking at the different sectors. The sector that experienced the highest growth from 2014 to 2015 was the bioheat sector with 4.4 %. At this rate, the objectives set by the Member States will be achieved in this segment. By contrast, the biopower sector was stagnant, growing only 1.5% in 2016, and production of biofuels for transport decreased by 1.3%. If bioenergy production continues to follow the trend of the past few years, Member States will be 30% below their 2020 projections for biofuels. This can be partly explained by the changing and uncertain EU-28 regulatory framework.

The recently enacted Renewable Energy Directive introduces sustainability requirements for solid and gaseous biomass that will go into effect in 2020. Before that time, Member States are obligated to incorporate these sustainably requirements in national legislation. Bioenergy Europe will closely follow this process. Above all, it will be crucial to ensure a stable regulatory framework both at the EU and at the national-level to increase investor confidence and ensure future growth of bioenergy consumption.

2.2 Overview of the National Renewable Energy Action Plans

This section presents the progress of Member States in deploying bioenergy to achieve the 2020 targets. Progress is assessed on the basis of Eurostat data and compared with the targets submitted by Member States in the National Renewable Energy Action Plans (NREAPs).

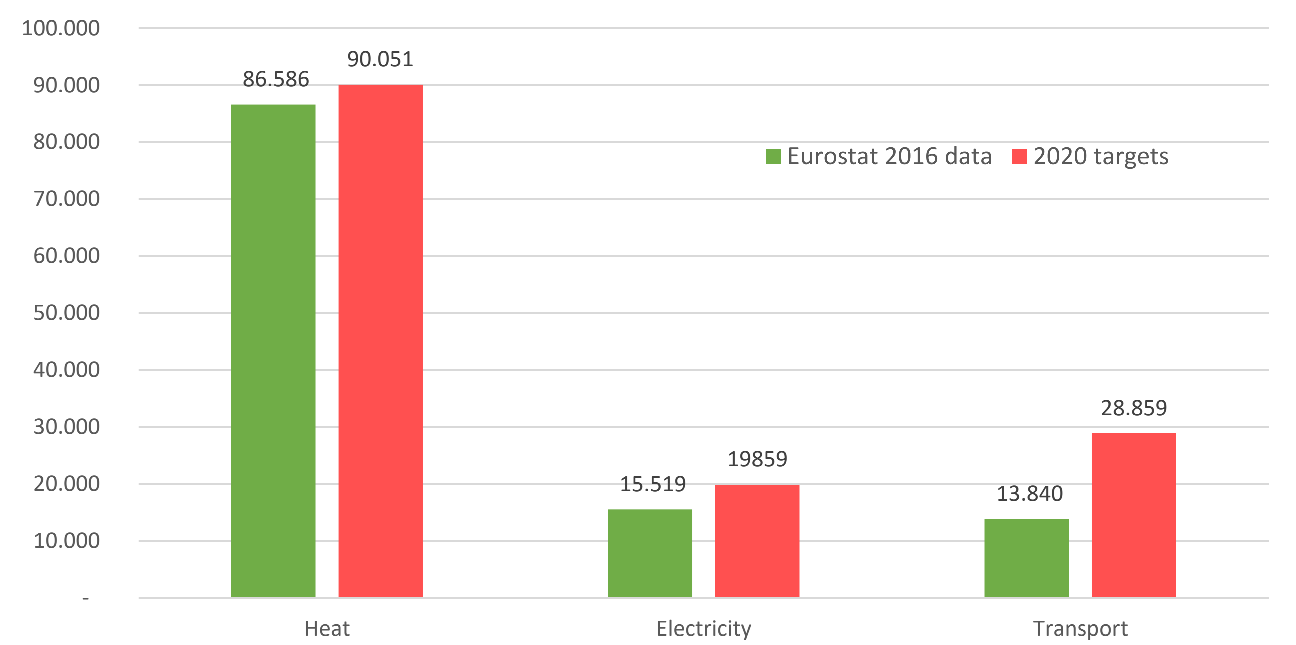
From the information displayed in the following graphs we can conclude that EU and most Member States are currently set to surpass their 2020 targets for biomass in heating and cooling. 14 Member States have already met the 2020 target for bioheat (Austria, Czech Republic, Germany, Denmark, Estonia, Finland, Croatia, Hungary, Italy, Latvia, Malta, The Netherlands, Poland and Slovenia). France, Spain and Sweden will have the most challenging path towards their 2020 goals for bioheat. Nevertheless, efforts should be put by most of the Member States to achieve the 2020 targets of renewables in heating and cooling which mean that there is room for growth of bioheat to contribute to the overall RES target.

With respect to electricity generation, the adoption of biomass has been far more uneven among the Member States. The Czech Republic, Germany, Estonia, Italy, Slovakia and United Kingdom have all fulfilled their targets, but Bulgaria, Greece, Lithuania, Malta, the Netherlands and Romania have still not met even 40% of their target.

In the transport sector, the target for 2020 is to achieve 10% share of renewable energy, the bulk of which is still expected to come from biofuels. However, the progress in the past five years towards this target has been slow – the contribution of biomass for transport decreased by 1.3% between 2015 and 2016.

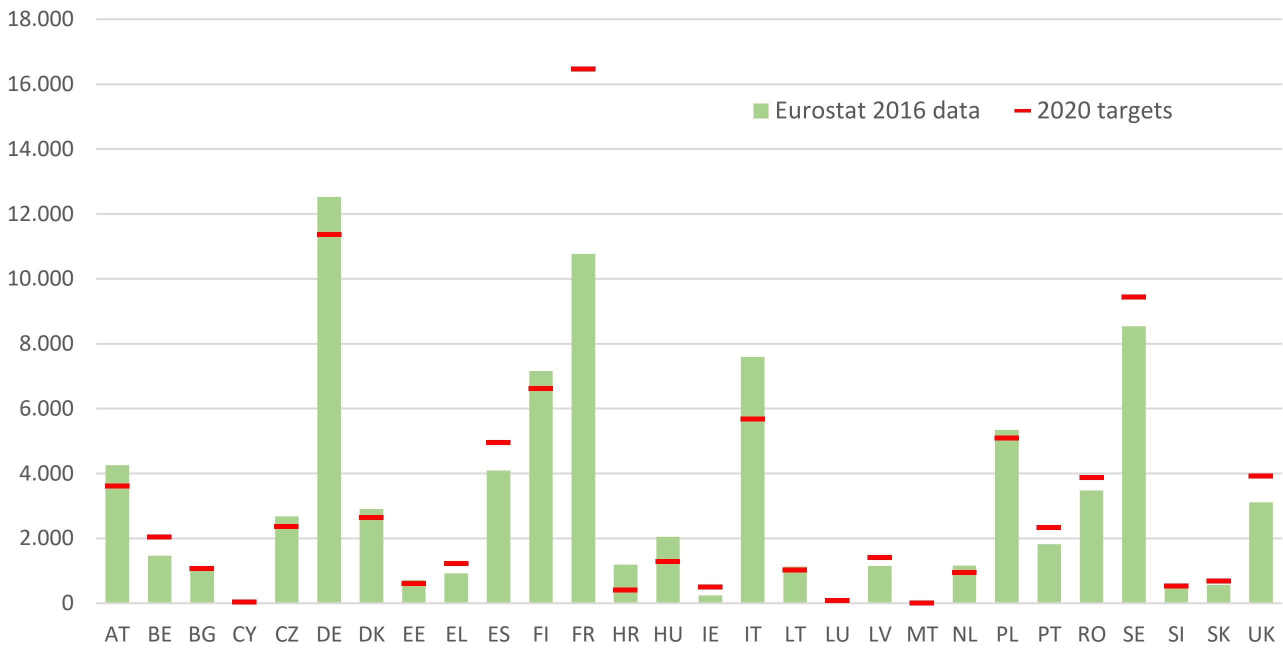
In light of this analysis, and looking ahead to 2030, it is crucial that Member States set ambitious National Energy and Climate Plans (NECP) for 2030. According to the recently enacted Clean Energy Package (2020-2030), Member States will have to submit their NECP to the European Commission by the end of 2019, to ensure that renewable energy accounts for 32% total final energy consumption in the EU-28 by 2030.

Figure 2.7 Gross final energy consumption of bioenergy in 2016 (Eurostat) compared with the 2020 objectives (NREAPs) in EU28 (ktoe)



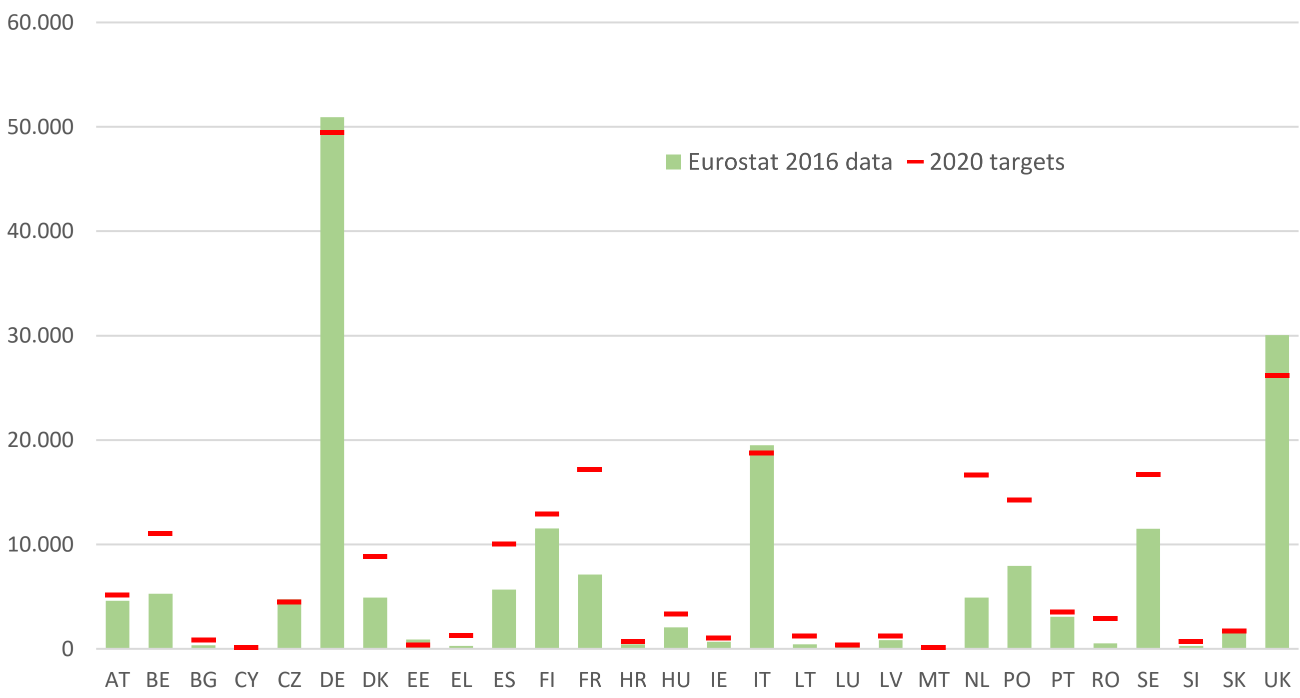
* EU 2020 targets figures are calculated by Bioenergy Europe as a sum of all Member States figures.
Source: Eurostat and NREAPs targets

Figure 2.8 Gross final energy consumption of bioheat in 2016 (Eurostat) compared with the 2020 objectives (NREAPs) in EU28 (ktoe)



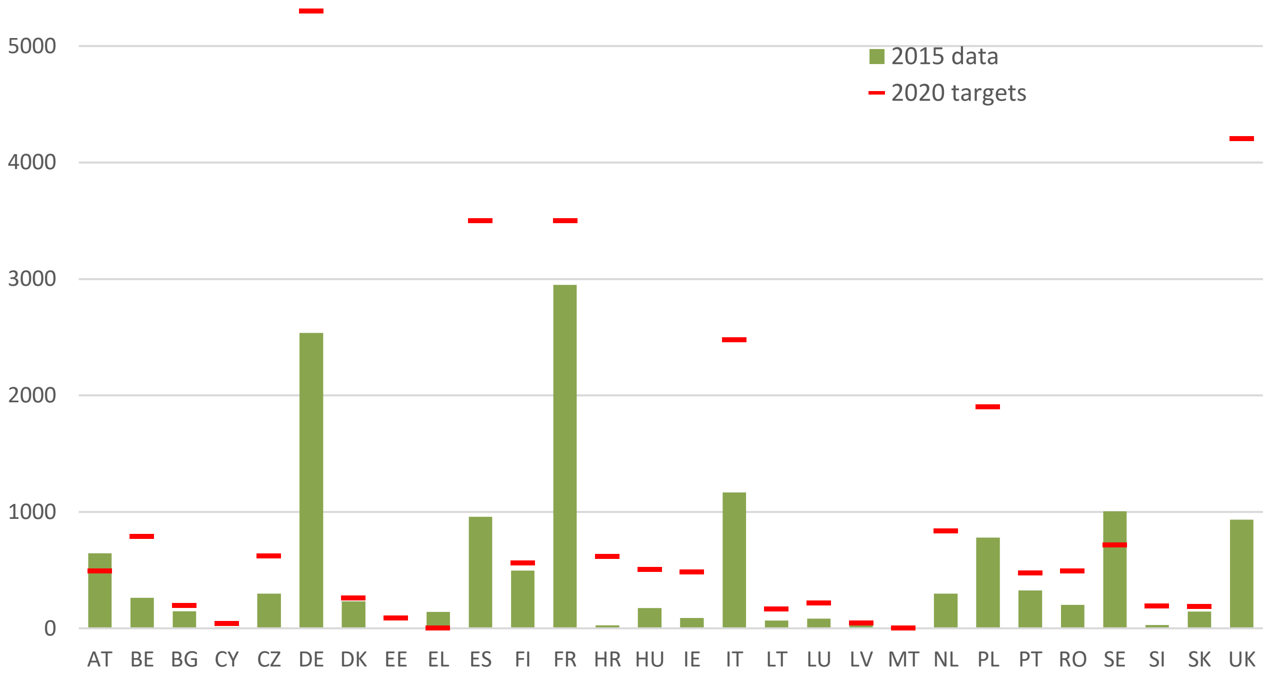
Source: Eurostat for 2013 data and NREAPs targets for 2020 data.

Figure 2.9 Gross final energy consumption of bioelectricity in 2016 (Eurostat) compared with the 2020 objectives (NREAPs) in EU28 (ktoe)



Source: Eurostat for 2013 data and NREAPs targets for 2020 data.

Figure 2.10 Gross final energy consumption of biofuels for transport in 2016 (Eurostat) compared with the 2020 objectives (NREAPs) in EU28 (ktoe)



*For the calculations of the shares of RES in transport to compile with the second generation biofuels, some multipliers are applied to advance biofuels and RES electricity used in transport.
Source: Eurostat and NREAPs targets

2.3 Socio-economic indicators

Table 2.8 Employment (direct and indirect jobs) in the different bioenergy markets in EU28 Member States in 2016

	Total	Solid biomass	Renewable Municipal Waste	Liquid Biofuels	Biogas
EU28	659.600	352.500	25.700	205.100	76.300
AT	12.200	8.600	200	2.900	500
BE	2.600	1.000	300	900	400
BG	13.400	9.600	<100	3.000	800
CY	n.a.	<100	<100	<100	<100
CZ	23.900	11.400	200	8.000	4.300
DE	107.000	42.500	7.000	21.800	35.700
DK	9.500	8.500	500	200	300
EE	10.300	10.000	<100	200	100
EL	8.700	3.400	<100	4.500	800
ES	35.500	18.400	700	15.100	1.300
FI	29.400	25.400	700	2.900	400
FR	74.400	35.400	4.000	33.200	1.800
HR	17.500	15.000	<100	1.900	600
HU	30.200	12.000	1.000	15.700	1.500
IE	2.000	1.700	<100	<100	300
IT	50.900	32.600	3.800	6.500	8.000
LT	15.000	4.700	300	9.200	800
LU	3.100	<100	<100	3.100	<100
LV	22.600	21.800	<100	<100	800
MT	n.a.	<100	<100	<100	<100
NL	7.100	3.900	2.000	400	800
PL	64.000	26.100	<100	34.800	3.100
PT	8.200	6.500	500	400	800
RO	35.400	11.400	<100	23.800	200
SE	27.200	18.700	900	7.600	<100
SI	2.500	2.300	<100	<100	200
SK	13.300	8.700	<100	4.000	600
UK	31.200	12.600	2.300	4.500	11.800

Source: EurObserv'er Report on "the State of Renewable Energies in Europe"- 2016 edition

Bioenergy is the largest renewable energy source in terms of direct and indirect employment[1],accounting for 659.600 jobs in the solid biomass, biofuels, biogas and renewable municipal waste sectors. Relying on feedstocks from agriculture and forests, biomass is relatively job-intensive in comparison to other types of energy. For instance, it generates ten times more jobs than nuclear energy for each unit of energy produced. Also, bioenergy is largely produced in rural areas and thus has a positive impact on the income of farmers and forest owners.

[1] Employment initiated from renewable investments, operation and maintenance activities, production and trading of equipment and biomass feedstock

Table 2.9 Turnover in the different bioenergy markets in EU28 Member States in 2016 (million €)

	Total	Solid biomass	Renewable Municipal Waste	Liquid Biofuels	Biogas
EU28	56.120	31.940	3.430	13.110	7.640
AT	2.240	1.740	30	390	80
BE	660	260	60	240	100
BG	410	270	<10	110	30
CY	n.a.	<10	<10	<10	<10
CZ	1.360	690	10	420	240
DE	12.560	5.110	1.030	2.300	4.120
DK	1.640	1.450	110	30	50
EE	560	560	<10	<10	<10
EL	340	150	<10	150	40
ES	1.840	770	80	900	90
FI	4.790	4.320	120	300	50
FR	8.020	4.090	550	3.160	220
HR	510	380	<10	100	30
HU	1.210	350	40	750	70
IE	230	200	<10	<10	30
IT	4.550	2.540	500	630	880
LT	570	260	<10	290	20
LU	140	<10	<10	130	10
LV	760	720	<10	<10	40
MT	n.a.	<10	<10	<10	<10
NL	960	480	290	70	120
PL	2.480	1.010	<10	1.310	160
PT	670	580	40	20	30
RO	1.080	330	<10	750	<10
SE	4.580	4.090	160	330	<10
SI	150	130	<10	<10	20
SK	680	340	<10	300	40
UK	2.850	1.090	270	370	1.120

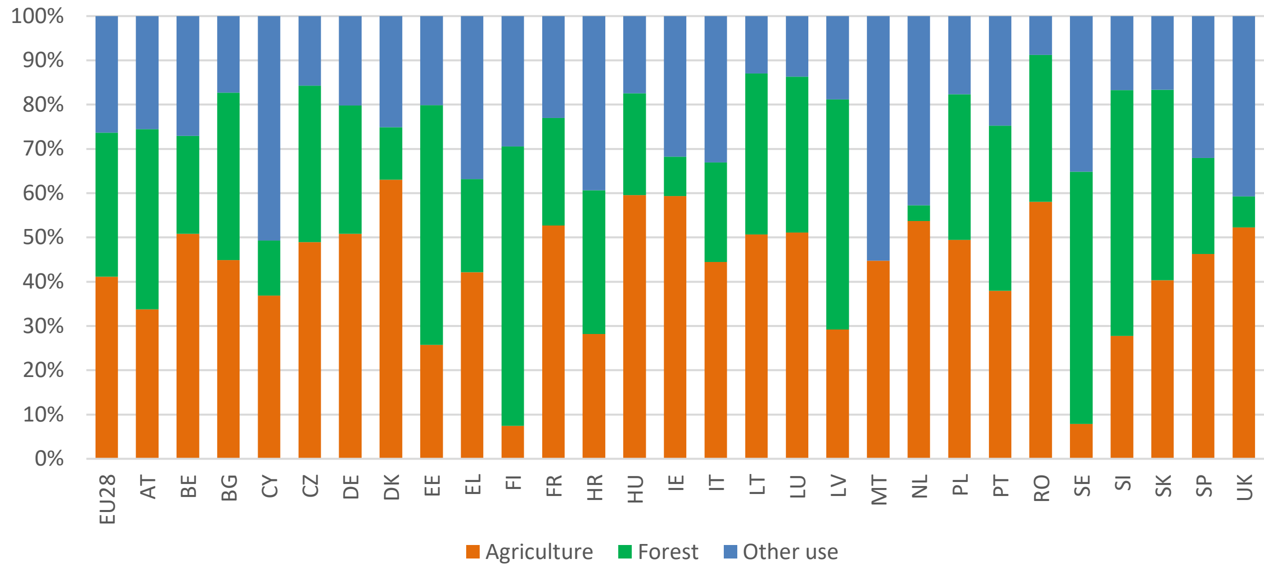
Source: EurObserv'er Report on "the State of Renewable Energies in Europe" 2017 edition

In 2015, the overall turnover of bioenergy represented 56 bn€ in the EU-28. Solid bioenergy experienced strong growth in recent years with an increase in turnover from 25 bn€ in 2010 to around 32 bn€ in 2016 in the EU-28. With this amount, the European Union is the global leader in bioenergy. It is crucial that in the future, the right regulatory and market conditions are set to ensure the EU keeps this industrial leadership.

3 BIOMASS SUPPLY

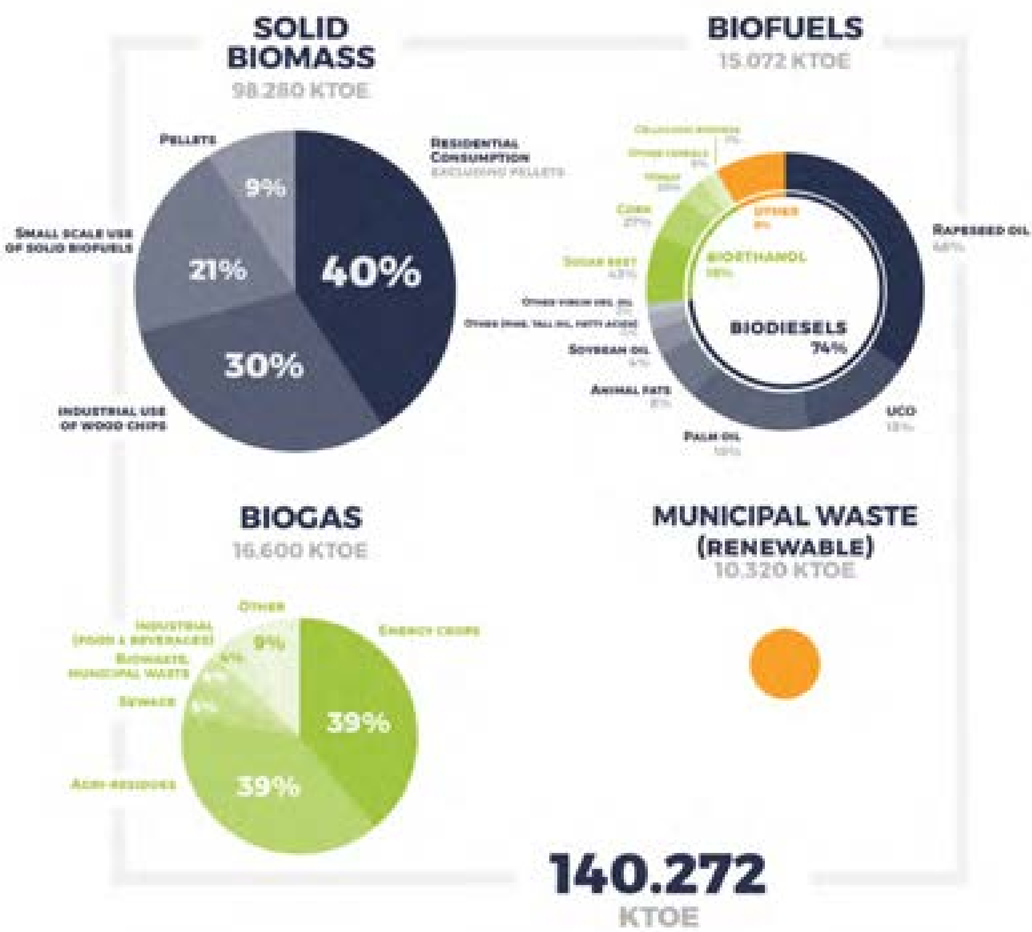
3.1 OVERVIEW

Figure 3.1 Land Use by Type in EU28 2015 (%)



Source: Eurostat

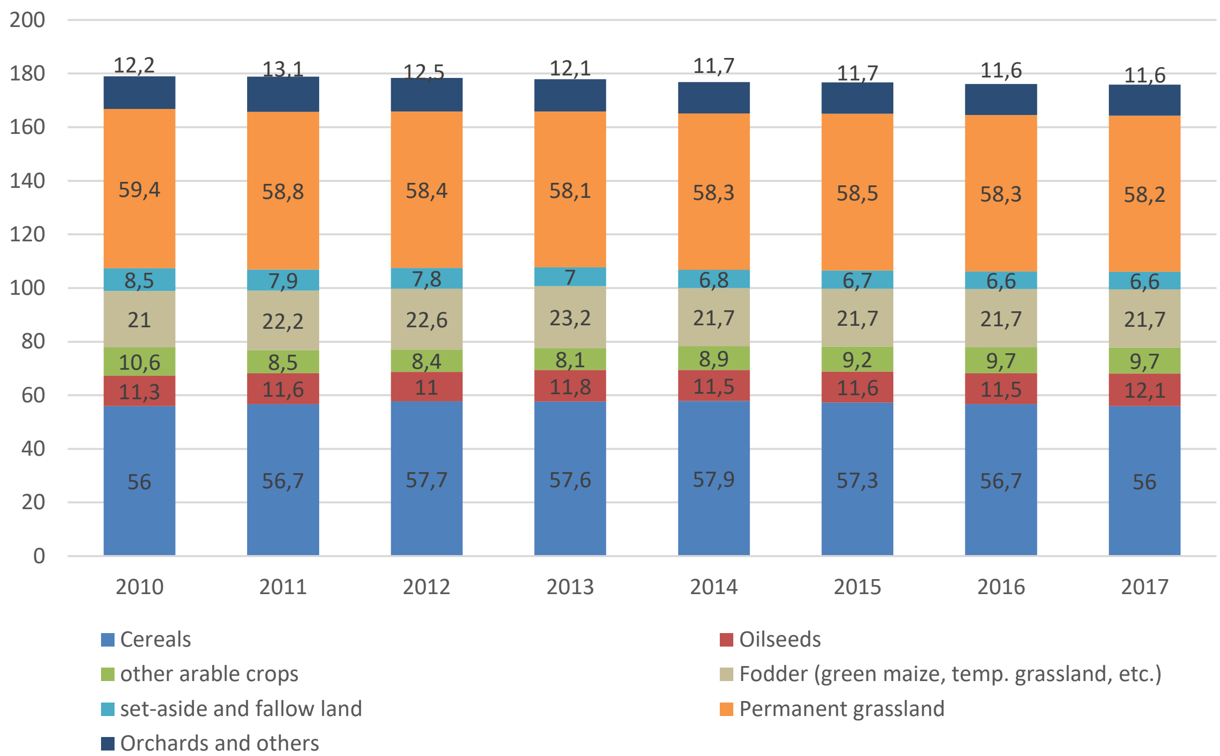
Figure 3.2 Gross inland consumption of biomass by type, use and source in the EU28 in 2016 (ktoe and %)



Note: UCO means "Used Cooking Oils" Source: Bioenergy Europe, EPC, Eurostat, USDA

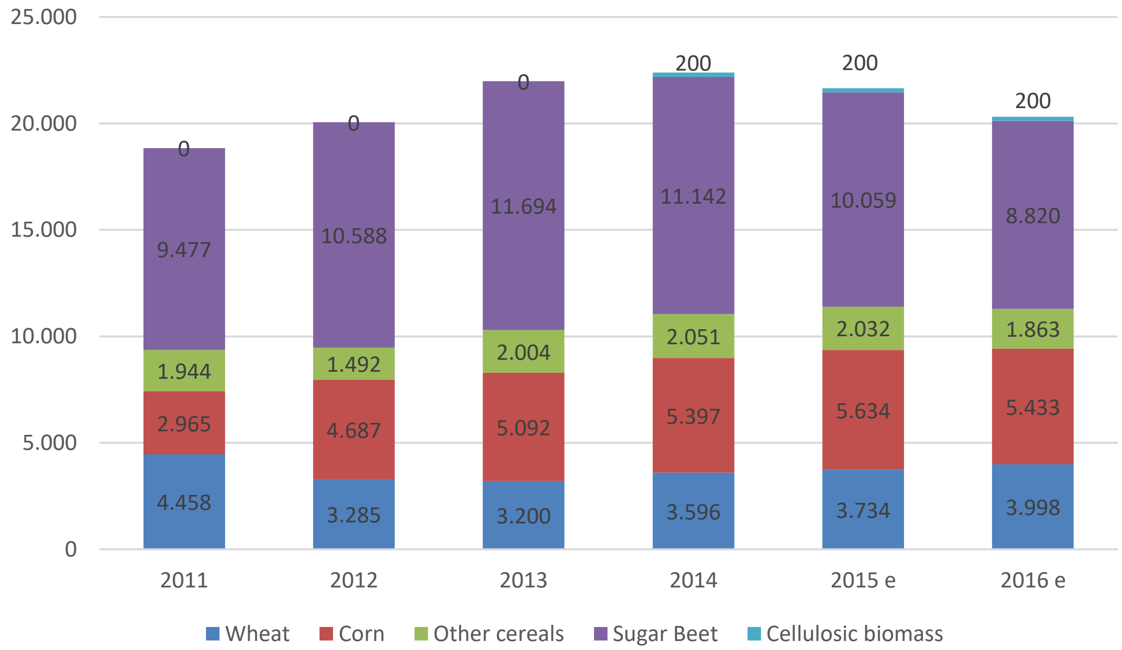
3.2 BIOMASS FROM AGRICULTURAL LAND AND BY-PRODUCTS

Figure 3.3 Evolution of the composition of EU28 agricultural land use (million ha)



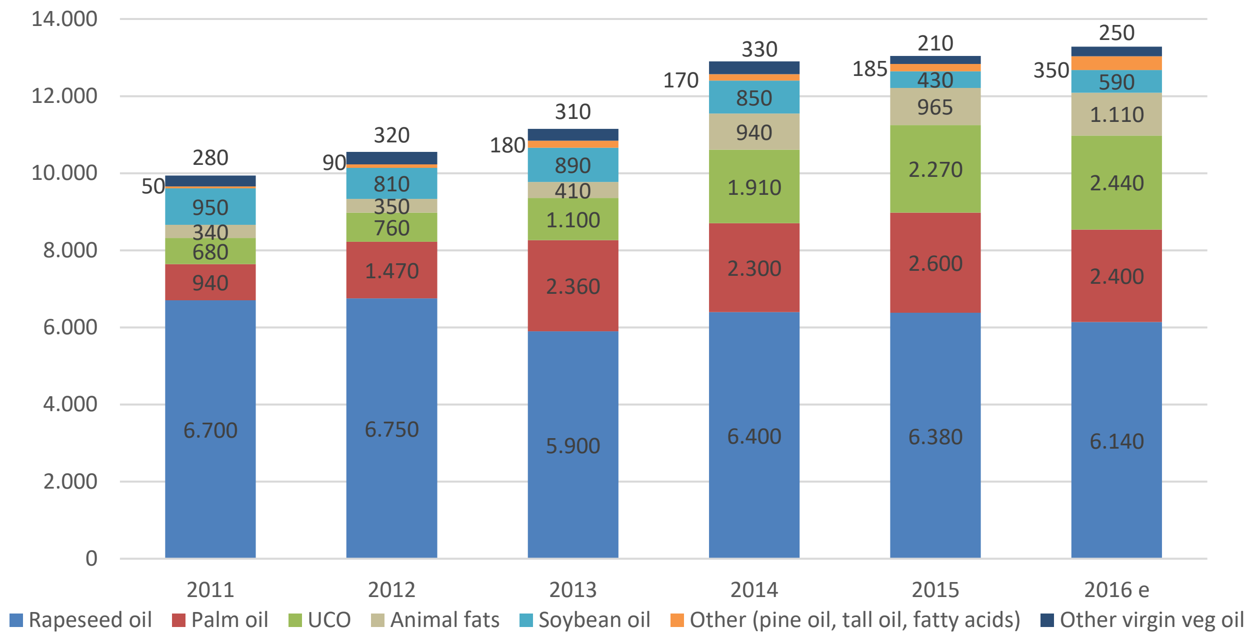
Source: European Commission (Medium-term prospects for EU agricultural markets and income 2017-2030)

Figure 3.4 Evolution of bioethanol feedstock in EU28 (1000 tonnes)



Note : e : stands for estimation
Source: USDA, EU Biofuels Annual 2017

Figure 3.5 Evolution of biodiesels feedstock in EU28 (1000 tonnes)



Source: USDA, EU Biofuels Annual 2017

Crop dedicated to the production of biomass for energy purposes are not provided yet with wide statistics in the EU. The figures in the table below are estimates or result from Bioenergy Europe's enquiry.

Dedicated energy crops are a promising form of bioenergy. They have very low fertilizer requirements and short carbon cycles, provide ecosystem services and contribute to climate change mitigation. These attractive characteristics cause dedicated energy crops to be seen a source of bioenergy with significant potential for growth. However, current land use in the EU for the production of dedicated energy crops is so marginal (Estimation of 50.764 ha), that the EU still does not collect statistics on the production of dedicated energy crops. Bioenergy Europe has therefore developed its own dataset, displayed in table 3.1. To allow the EU to benefit from the promise of dedicated energy crops, political incentives should be applied to encourage more widespread plantation of energy crops, like short rotation coppice and miscanthus. In particular, it is imperative that dedicated energy crops be reflected in the specific objectives of the CAP reform.

Table 3.1 Energy crops in some of the EU28 Member states (ha)

	Miscanthus	Willow (SRC)	Poplar (SRC)	Total Short rotation coppice	Total	Year
EU28	14.788	25.880	12.675	38.829	50.764	
AT	1.128	N.A.	1.500	1.500	2.628	2017
BE	227	N.A.	N.A.	42		2017
DE		N.A.	5.000	5.000		2017
DK	N.A.	5.500	N.A.	5.500		2015
FR	3.000	N.A.	N.A.	220		2015
HR		0	0	0	Experimental field only	2017
IE	700	1.100	0	1.100	1.800	2017
NL		N.A.	N.A.	13	245	2016
PL	733	7.728	3.175	10.903	22.539	2013
SE		11.552	3.000	14.552	14.552	2016
UK	9.000	N.A.	N.A.	N.A.	9.000	2017

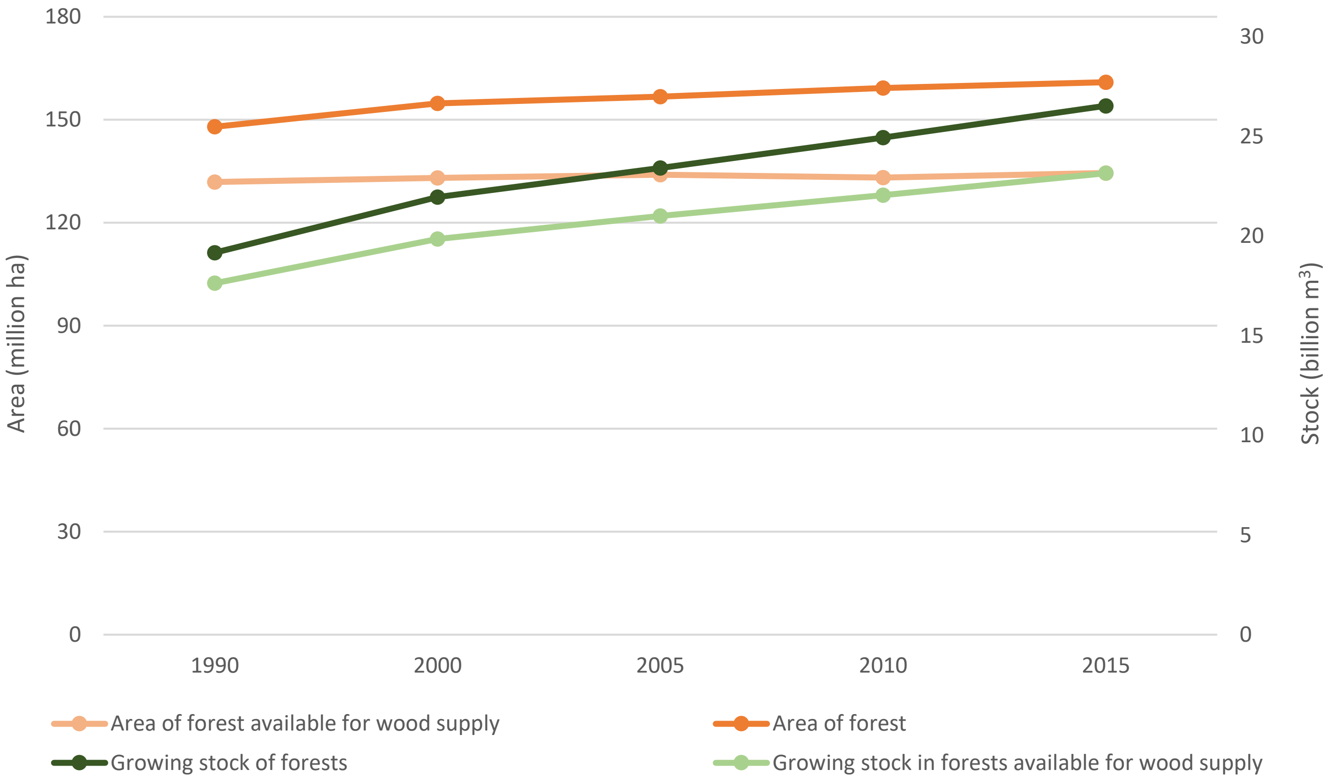
Source: Data collected by Bioenergy Europe; AT: ABA;BE: Valbiom & Provinciaal Agrarisch Centrum; DE: Markus Hartmann; FR: ADEME; IE: Teagasc; HR: BEECO; NL: Centraal Bureau voor de Statistiek; PL: POLbiom; SE: SVEBIO; UK: Terravesta

3.3 BIOMASS FROM FORESTRY

In 2015 (the most recent year in which statistics were available for forest resources at a European level), the EU28 had approximately 181 million hectares of forests and other wooded land, corresponding to 42 % of its land area. This is roughly equivalent to the land area used for agriculture in the EU. Out of these 181 million hectares, 161 million hectares are forest, with the forest area available for wood supply amounting to 134 million hectares.

In contrast to the trend elsewhere in the world, the area covered by forests and other wooded land in the EU28 is currently increasing. In the period from 1990 to 2015, the area of forest cover and other wooded land in the EU28 increased by 5,2 %, equivalent to an average increase of 0,2% per annum.

Figure 3.6 Evolution of total area and available stock of forest and forest available for wood supply in EU28 (million hectares and billion m³)



Source: Eurostat

Contrary to common belief, EU28 forests have been growing over the past decades. In 1990, European forests represented a total of 19.1 billion m^3, meaning that forest stock has increased by 32% over the last quarter century. This growth can be attributed to two main reasons: forest areas increasing (1) and an increase in standing volume (2):

(1) According to Eurostat, EU-28 forest coverage gained 322.800 hectares every year, meaning that European forests are increasing by the size of a football field every minute.
(2) On average, about 63% of the annual forest increment in Europe is felled, meaning that 38% of this annual increment remains in forests.

Bioenergy can play a major role in combatting forest degradation, thanks to additional sources of income to forest owners, municipalities and governments to manage forest sustainably in the long run.

In 2015, 7 of the EU28 Member States had at least half of their land area covered by forests and other wooded land (Portugal, Spain, Latvia, Estonia, Slovenia, Sweden and Finland). In Finland and Sweden, forest area accounts for approximately three quarters of the land area was covered by forests and other wooded land.

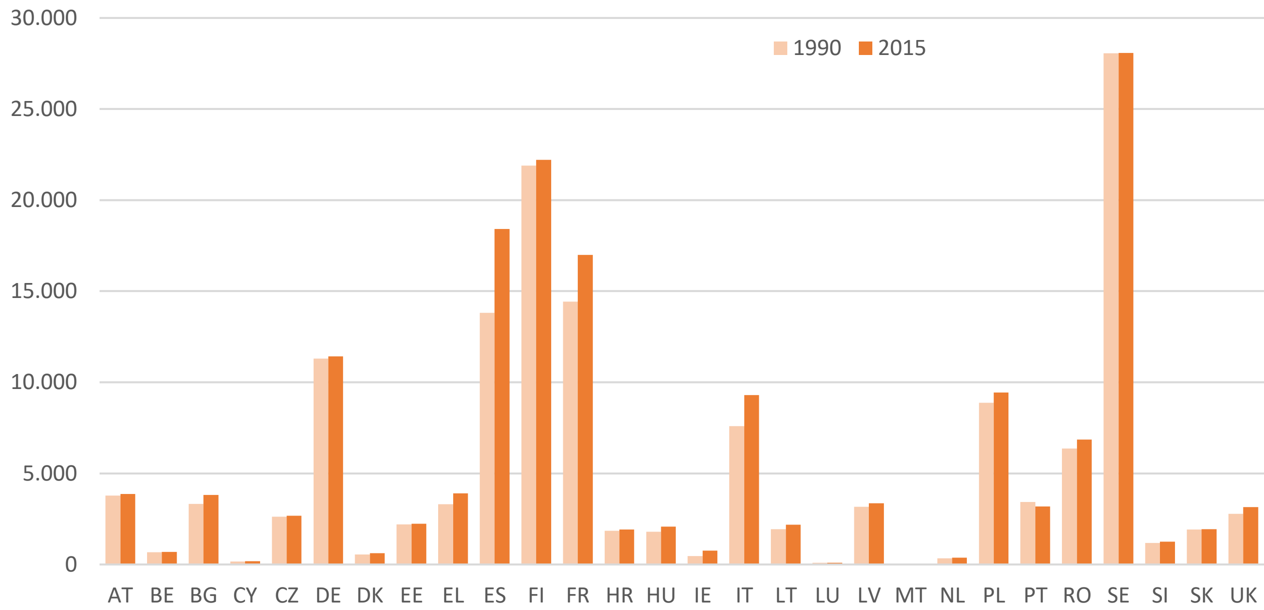
Table 3.2 Forest area in the EU28 Member States, 2015 (1000 hectares)

	Total area of forests and other wooded land	Forests	Other wooded land	Forests available for wood supply
EU28	181.925	161.082	20.843	134.486
AT	4.022	3.869	153	3.339
BE	719	683	36	670
BG	3.845	3.823	22	2.213
CY	386	173	213	41
CZ	2.667	2.667	0	2.301
DE	11.419	11.419	0	10.888
DK	658	612	45	572
EE	2.456	2.232	224	1.994
EL	6.539	3.903	2.636	3.595
ES	27.627	18.418	9.209	14.711
FI	23.019	22.218	801	19.465
FR	17.579	16.989	590	16.018
HR	2.491	1.922	569	1.740
HU	2.190	2.069	121	1.779
IE	801	754	47	632
IT	11.110	9.297	1.813	8.216
LT	2.284	2.180	104	1.924
LU	88	87	1	86
LV	3.468	3.356	112	3.151
MT	0	0	0	0
NL	376	376	0	301
PL	9.435	9.435	0	8.234
PT	4.907	3.182	1.725	2.088
RO	6.951	6.861	90	4.627
SE	30.505	28.073	2.432	19.832
SI	1.271	1.248	23	1.139
SK	1.940	1.940	0	1.785
UK	3.164	3.144	20	3.144

Source: Eurostat

The change in forest area from 1990 to 2015 varied substantially l EU28 Member States. Among the 28 countries, Portugal was the only country whose forest area decreased slightly. In some other almost no change was observed (Belgium, Cyprus, Luxembourg, Malta, Slovakia and Sweden)). Increases ranging from of 10 % to 25 % were observed in Bulgaria, Denmark, Greece, Spain, France, Italy, Lithuania, Hungary and the United Kingdom, while Ireland recorded a 62% increase during these 25 years.

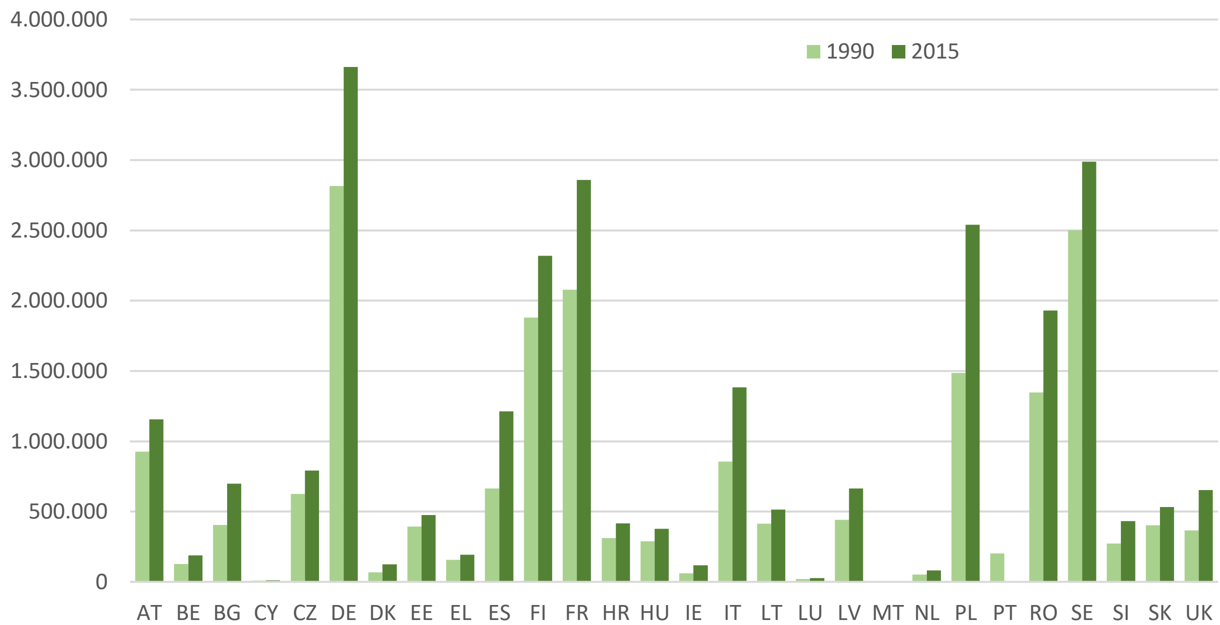
Figure 3.7 Evolution of forest area in EU28 MS between 1990 and 2015 (1000 hectares)



Source: Eurostat

The total forests stock in the EU28 come to some 26,5 billion m^3 in 2015. Germany had the highest share (13,8 %), followed by Sweden (11,3 %) and France (10,8%).

Figure 3.8 Evolution of available stock of forest in EU28 MS between 1990 and 2015 (1000 m^3)



Source: Eurostat

Socioeconomically, EU28 forests are divided into small family holdings, state-owned forests, and large estates owned by companies, which are often exploited by the forest and wood products industry. In total, around 60% of the EU28´s forests were privately owned in 2010. This percentage is highest (98,4%) in Portugal and lowest in Bulgaria (13,2%).

The high share of privately owned forests, which are often small and dispersed among many forest owners, makes forest management a challenging proposition. Economic incentives play a major role to sustainable forest management. Bioenergy provides such an incentive by permitting the valorisation of low-quality wood such as tops, branches and early thinnings.

Table 3.3 Forest ownership in 2010 for EU28 Member States (1000 ha)

	In public ownership	In private ownership	% of private ownership
EU28	63.044	94.995	60%
AT	878	2.527	74%
BE	317	364	53%
BG	3.286	451	12%
CY	119	54	31%
CZ	2037	621	23%
DE	5.932	5.477	48%
DK	139	448	76%
EE	923	1.038	53%
EL	2.907	845	23%
ES	5.333	12.855	71%
FI	6.744	15.474	70%
FR	4.064	12.360	75%
HR	1.376	544	28%
HU	1.178	853	42%
IE	386	339	47%
IT	3.032	5.996	66%
LT	1.333	837	39%
LU	41	46	53%
LV	1.755	1.594	48%
MT	0	0	n.a.
NL	181	192	51%
PL	7.643	1.686	18%
PT	98	3.141	97%
RO	4.363	2.152	33%
SE	6.822	21.192	76%
SI	315	932	75%
SK	974	786	45%
UK	868	2.191	72%

Source: Eurostat

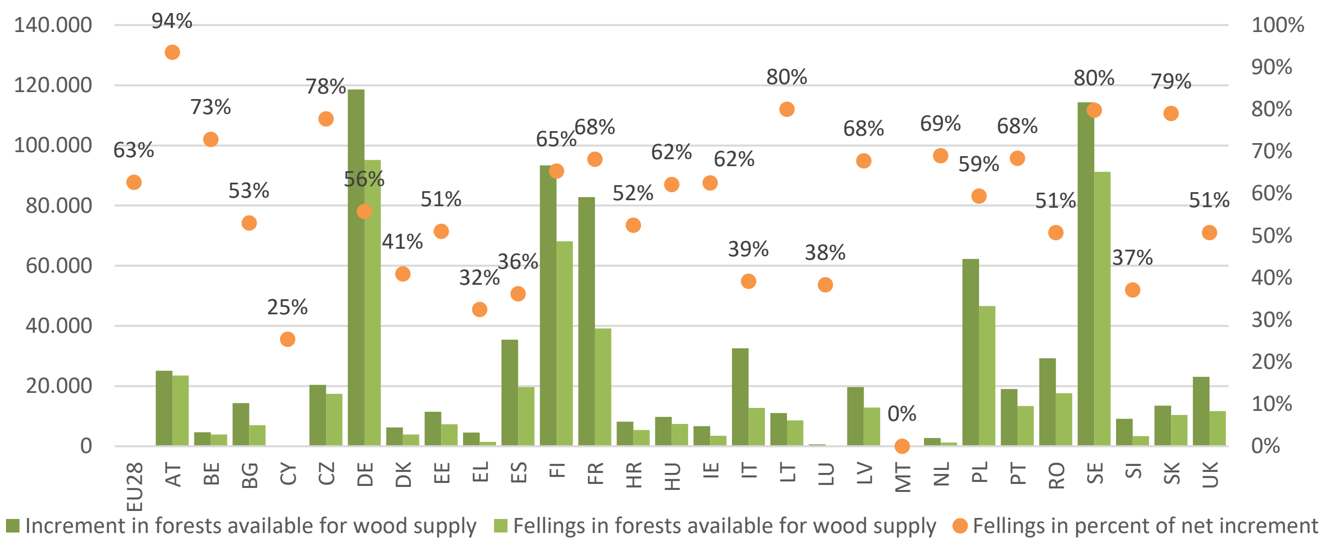
Table 3.4 Certified areas in the EU28 Member States in 2018 (1000 ha)

	PEFC	FSC
EU28	71.461	35.100
AT	3.126	1
BE	299	24
BG	0	1.486
CZ	1.833	53
DE	7.574	1.363
DK	269	213
EE	1.242	1.487
ES	2.186	272
FI	18.132	1.611
FR	8.013	56
HR	0	2.049
HU	0	304
IE	376	447
IT	807	64
LU	35	22
LV	1.698	1.045
NL	3	168
PL	7.160	6.934
PT	257	414
RO	0	2.825
SE	15.815	12.246
SI	0	265
SK	1.223	148
UK	1.413	1.603

Source: PEFC & FSC

53% of EU28 forest area is certified PEFC and 26% is certified FSC (some forests may be certified both PEFC and FSC). This represents a substantial proportion of forest owners who, by certifying their forests demonstrate commitment to sustainable forest management. With sustainability criteria for solid biomass introduced in the post-2020 Renewable Energy Directive (RED II), forest certification will become even more important in the near future.

Figure 3.9 Increment and fellings in forest available for wood supply (1000 m3) and percentage of fellings compared with net increment per EU28 Member States in 2010 (%)



Source: Eurostat

Data from the UNECE (Joint Forest Sector Questionnaire and Joint Wood Energy Enquiry) confirm that wood directly from forests accounts for about 38% of the solid biomass used for energy in the region. In the past five years, indirect wood fuels (industrial co-products and pellets) have become more important, for the first time supplying over 50% of solid biomass.

The availability of wood from indirect sources depends significantly on the current market situation for wood and wood products. The forest products industries reduced their output in the wake of the global economic crisis in 2008 and consequently the availability of wood from co-products was also reduced. Data from the JWEE indicate that from 2007-2011 co-products as a source decreased and direct use of wood for energy was the most important source. Since then, the gap between the current leading source for energy, co-products, and the direct sources has increased to levels never reported before, with a gap of 15 percentage points (53% indirect, 38% direct in 2015).

Two reasons seem to play an important role in this trend. First, the very strong economic situation of the forest-based industries and with it the increased production of co-products; secondly the significant increase of imported processed wood-based fuels, mainly pellets for power plants. Much of this (over a third of supply) comes from outside the EU, particularly from the United States, Canada and Russia. The percentage of imports in total primary energy production from solid biofuels was 8.5% in 2016, double the level of 10 years earlier.

Source ECE/FAO Forest Products Annual Market Review, 2017-2018, www.unece.org/forests/fpamr2018, and presentation at www.unece.org/fileadmin/DAM/timber/meetings/2018/20180322/item-4a-c-steierer-glasenapp.pdf).

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UNECE

Among EU Member States, Sweden produced the most roundwood (74 million m^3) in 2016, followed by Finland, Germany and France. 23,1% of EU28's roundwood production in 2016 was used for fuel, while the remainder became industrial roundwood either as sawnwood and veneers or for pulp and paper production.

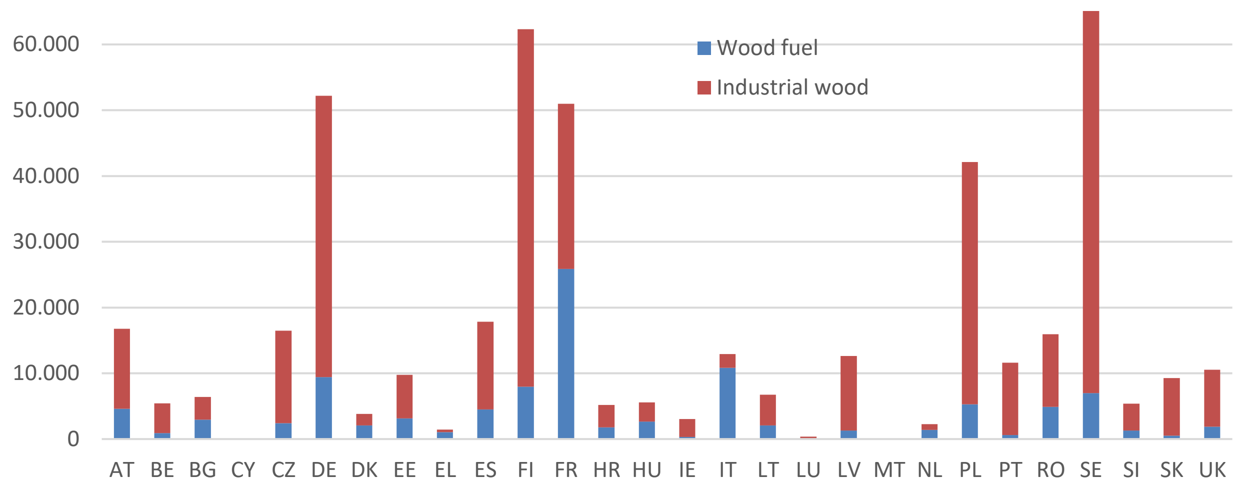
In most countries, the majority of roundwood removal was for industrial purposes. In Sweden, Ireland, Slovenia and Portugal, more than 90 % of total roundwood production was used as industrial roundwood in 2016, while Cyprus, The Netherlands, Denmark, Greece, France, and Italy were the only Member States where more than half of the total roundwood produced in 2016 was destined for fuelwood.

Table 3.5 Wood removals from forests in EU28 Member States by assortment in 2016 (1000 m3)

	Roundwood	Wood fuel	Industrial wood	Sawlogs and veneer logs	Pulpwood, round and split, all species (production)	Other industrial roundwood
EU28	461.236	106.707	354.529	196.306	148.537	9.686
AT	16.763	4.590	12.173	9.006	3.167	0
BE	5.412	893	4.519	2.965	1.381	173
BG	6.410	2.928	3.481	1.502	1.919	61
CY	16	13	3	3	0	0
CZ	16.472	2.390	14.082	9.074	4.918	90
DE	52.194	9.413	42.780	28.183	11.992	2.605
DK	3.842	2.061	1.781	1.070	381	330
EE	9.735	3.161	6.574	4.076	2.445	52
EL	1.432	1.065	367	304	0	63
ES	17.848	4.523	13.325	3.874	9.167	284
FI	62.291	7.964	54.327	23.410	30.917	0
FR	50.971	25.859	25.112	16.468	8.128	516
HR	5.165	1.768	3.397	2.402	988	6
HU	5.586	2.636	2.950	1.130	949	872
IE	3.050	316	2.734	1.738	830	166
IT	12.928	10.839	2.089	1.120	682	287
LT	6.747	2.085	4.662	3.494	1.168	0
LU	381	70	311	113	198	0
LV	12.651	1.300	11.351	7.969	2.640	742
MT	0	0	0	0	0	0
NL	2.271	1.397	874	392	470	13
PL	42.136	5.294	36.842	16.797	19.113	932
PT	11.613	600	11.013	2.054	8.635	324
RO	15.927	4.882	11.046	8.993	1.045	1.008
SE	74.200	7.000	67.200	35.700	31.000	500
SI	5.381	1.272	4.110	2.989	990	131
SK	9.267	515	8.752	5.003	3.717	32
UK	10.545	1.872	8.673	6.477	1.698	498

Note: The term “removal” differs from "felling" as it excludes trees that were felled but not removed.
Source: FAOSTAT

Figure 3.10 Roundwood removals in EU28 Member States according to end use in 2016 (1000 m³)

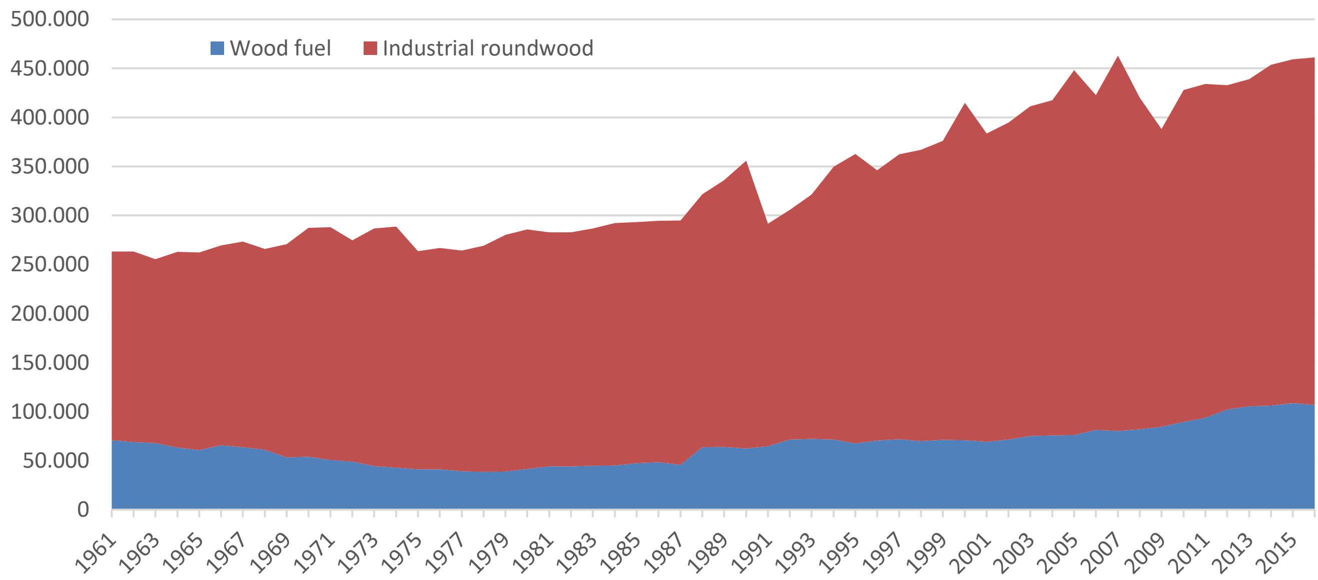


Source: FAOSTAT

Generally, roundwood production is driven by demand from the wood products industry rather than by demand for bioenergy. This reflects the substantial price difference between industrial roundwood, pulpwood and wood residues from sawmills, which ensures that high quality timber is used for high-value products such as furniture and construction. There is no market incentive for bioenergy producers to buy high-quality wood (*i.e.* sawlogs). Only low-value residues and other unmarketable wood are affordable for the energy sector.

Looking at the evolution of the roundwood production by type of end-use (Figure 3.13), it can be clearly seen that the strong increase of bioenergy in the last decade did not drive roundwood production. The percentage of wood removal harvested for the purpose of wood energy slightly increased from 18% in 2000 to 22% in 2016. This remains around one fifth of the total harvest in the EU28, a proportion that has not changed signficantly since the 1990s, even while consumption of bioenergy in Europe doubled. This shows that the energy sector is not the main driver for forest owner to mobilise their forest resources, and that the bioenergy sector relies mainly on wood by-products and other types of biomass.

Figure 3.11 Stacked area of the evolution of roundwood production by type of end use in the EU28 (1000 m³)



Source: FAOSTAT

EU28 is a net importer of wood fuels, but these imports account for less than 2% of the total solid biomass production in the EU.

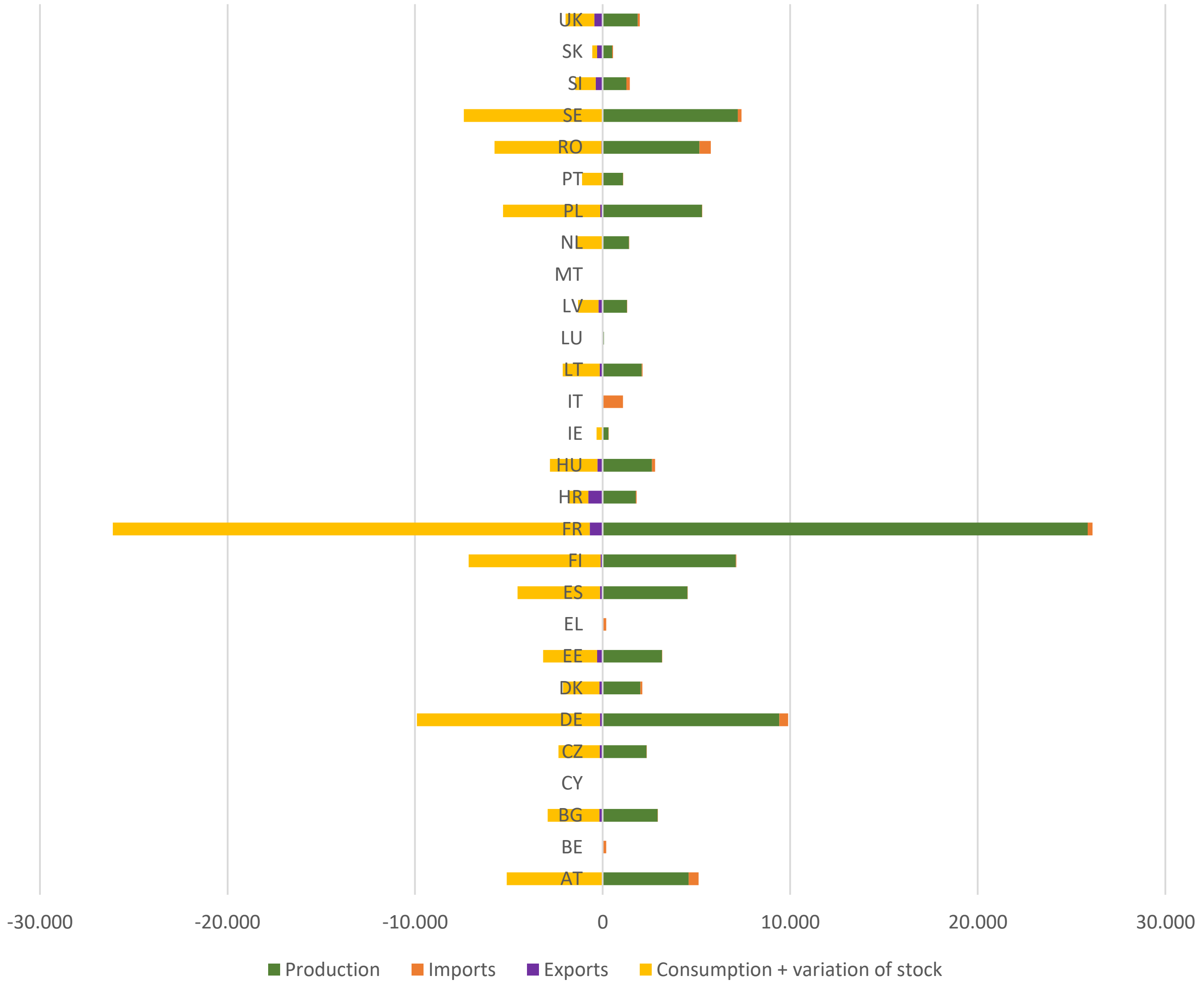
Table 3.6 Roundwood trade in EU28 Member States in 2016 (1000 m³)

	Fuelwood (including wood for charcoal)				Industrial roundwood			
	Imports from third countries	Imports total	Exports to third countries	Exports total	Imports from third countries	Imports total	Exports to third countries	Exports total
EU28	2.083*	n.a.	236*	n.a.	16.093*	n.a.	4222*	n.a.
AT	66	530	0	12	247	9.188	5	879
BE	36*	198*	3*	27*	64,5*	4.488*	582*	1.344*
BG	0	2	7	171	0	10	64	170
CY	1	2	0	0	0	1	0	0
CZ	4*	19*	6*	161*	225*	2.329*	37*	4.530*
DE	190	482	1	136	1.164	8.349	761	3.734
DK	12	102	0	167	494	385	632	667
EE	1	11	53	294	1	188	230	2.527
EL	33*	189*	0*	6*	9,3*	435*	9*	41*
ES	0	14	4	136	18	596	6	1.966
FI	23	29	3	112	5.110	5.911	66	783
FR	2	263	19	689	217	1.370	565	3.920
HR	49	50	0	760	3	72	16	418
HU	134	166	0	273	100	315	28	683
IE	2	6	0	1	1	307	0	377
IT	569*	1.078*	2*	30*	332*	2.677*	15*	213*
LT	11	47	4	165	344	493	179	1.473
LU	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
LV	n.a.	5	26*	214	689*	1.530	380*	2.676
MT		1*	n.a.	n.a.	0*	0*	0*	n.a.
NL	5*	18	3*	40	39*	238	63*	508
PL	17	18	3	128	1.981	2.482	67	2.576
PT	0	12	6	48	33	2.134	11	270
RO	601	601	8	73	1.676	1.769	65	85
SE	38	188	6	27	2.974	6.807	407	573
SI	122	184	0	366	22	274	42	2.718
SK	22	37	0	292	25	539	34	2.157
UK	12	102	0	446	6	542	35	303

*data from 2015
Note: Import from third countries=import from countries outside the EU28, import total = the total import from all countries
Source: Eurostat

Figure 3.12 displays the total volume of production, trade (intra and extra EU28) and consumption and the stock variation of the wood fuel in the EU28 Member States. The figure shows that trade in wood fuel is not a significant factor affecting bioenergy use in the EU28 Member States, and most production is consumed directly in the country of production

Figure 3.12 EU-28 member state* wood fuel balance in 2016 - production, import, export, consumption + stock variation (1000 m³)



Note: Consumption + stock variation has been estimated with the data of production and trade
Source: Eurostat

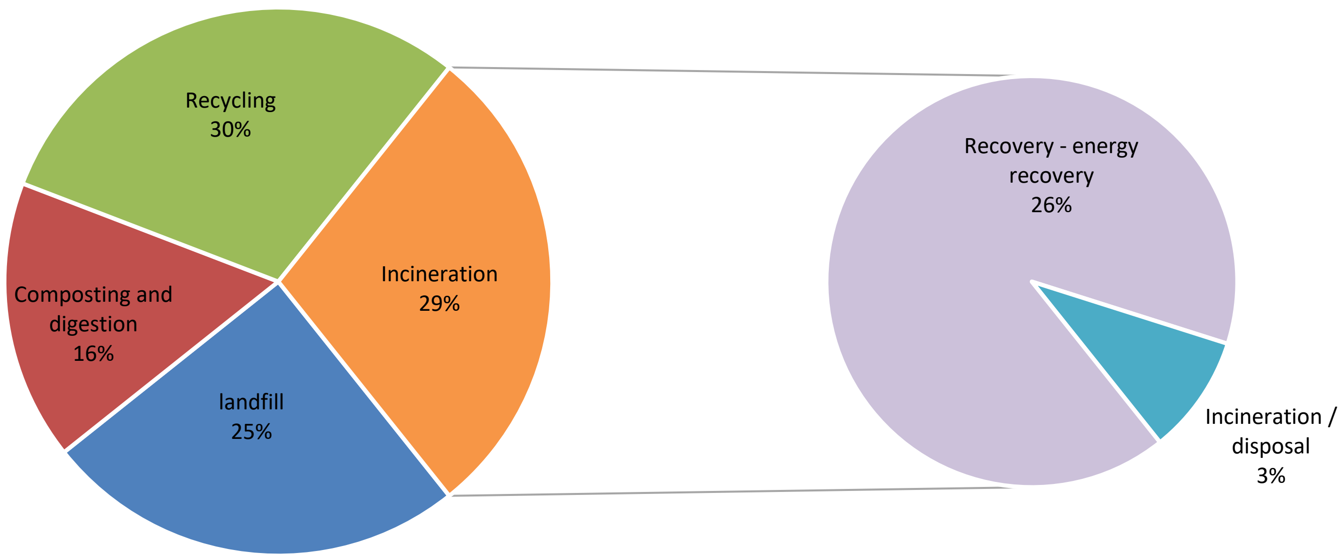
3.4 BIOMASS FROM WASTE

Table 3.7 Municipal waste by waste operation in EU28 member states, 2016 (1000 tonnes)

	Waste generated	Waste treatment	landfill	Incineration / disposal	Recovery – energy recovery	Recycling	Composting and digestion
EU28	246.515	242.207	60.246	6.452	62.288	71.963	39.799
AT	4.928	4.825	132	0	1.855	1.254	1.584
BE	4.757	4.708	38	48	2.077	1.588	956
BG	2.881	2.877	1.851	0	109	654	263
CY	545	504	410	0	0	73	21
CZ	3.580	3.580	1.789	4	584	958	245
DE	51.633	51.633	763	3.598	13.159	24.839	9.275
DK	4.450	4.450	45	0	2.281	1.271	853
EE	494	453	51	0	242	125	14
EL	5.362	5.362	4.415	0	27	738	182
ES	20.585	20.585	11.680	0	2.800	3.745	2.359
FI	2.768	2.768	90	0	1.515	808	355
FR	34.143	34.143	7.661	210	12.034	7.992	6.249
HR	1.680	1.642	1.288	0	1	322	31
HU	3.721	3.734	1.888	0	554	998	294
IE	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
IT	30.117	26.888	7.432	1.999	3.866	7.870	5.721
LT	1.272	1.211	379	0	221	312	299
LU	358	358	61	0	123	103	70
LV	802	718	516	0	0	121	81
MT	283	255	235	0	1	20	0
NL	8.848	8.848	127	96	3.931	2.238	2.457
PL	11.654	11.654	5.331	152	2.114	3.243	814
PT	4.897	4.649	2.185	0	950	700	814
RO	5.136	5.079	3.568	0	220	331	352
SE	4.393	4.393	28	0	2.218	1.433	715
SI	963	822	78	19	169	412	144
SK	1.890	1.875	1.236	0	197	291	143
UK	31.683	31.694	5.942	326	10.615	8.695	5.353

Source: Eurostat

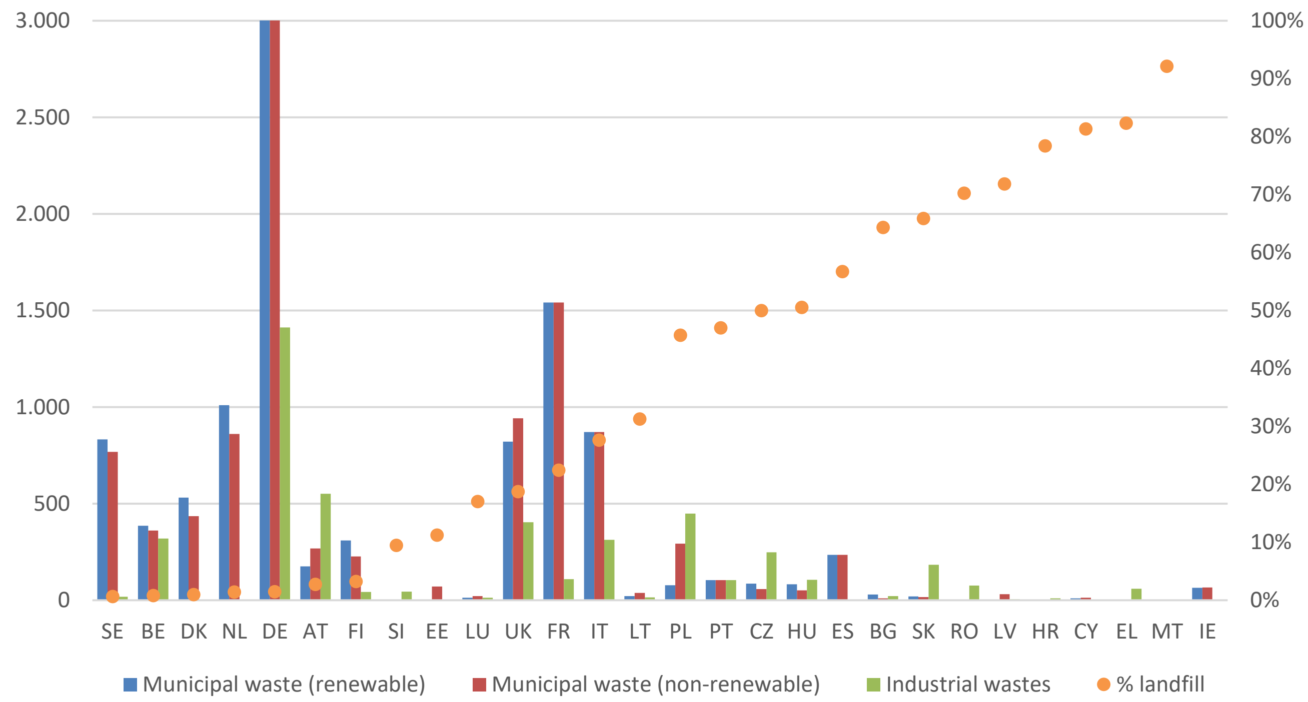
Figure 3.13 Municipal waste treatment in EU28 by treatment in 2016 (%)



Source: Eurostat

The figure below shows the relation between the energy production from municipal waste in the EU28 member states and the percentage of municipal waste sent to landfill. Countries with a low rates of landfill use tend to produce more energy from their municipal waste. A high percentage of waste sent to landfill indicates potential resources for energy and recycling.

Figure 3.14 Gross inland consumption of energy from waste by type (left axis, in ktoe) and % of waste sent to landfill (right axis, in %) in the EU28 Member State in 2016



Source: Eurostat

Figure 3.15 Map of incineration plants in EU28 and mass of waste thermally treated in 2015

* Includes plant in Andorra
Source: CEWEP (Data supplied by CEWEP members unless national sources)

4

BIOHEAT

4.1 Heat and RES heat demand in Europe

Table 4.1 Total heat consumption and contribution of renewable heat in EU28 Member States in 2016* (ktoe)

	Total heat consumption	RES heat	% of RES heat in total heat consumption	Bioheat	% of bioheat in total heat consumption	% of bioheat in total RES heat
EU28	521.023	99.318	19,1%	86.585	16,6%	87,2%
AT	13.993	4.667	33,3%	4.255	30,4%	91,2%
BE	18.840	1.533	8,1%	1.463	7,8%	95,4%
BG	4.010	1.203	30,0%	1.065	26,6%	88,5%
CY	449	103	23,0%	33	7,4%	31,9%
CZ	14.092	2.800	19,9%	2.675	19,0%	95,5%
DE	109.899	14.238	13,0%	12.521	11,4%	87,9%
DK	7.553	3.148	41,7%	2.904	38,4%	92,2%
EE	1.523	779	51,2%	717	47,1%	92,0%
EL	5.624	1.377	24,5%	926	16,5%	67,3%
ES	28.359	4.774	16,8%	4.087	14,4%	85,6%
FI	14.122	7.582	53,7%	7.159	50,7%	94,4%
FR	62.656	13.195	21,1%	10.768	17,2%	81,6%
HR	3.245	1.219	37,6%	1.183	36,5%	97,0%
HU	10.483	2.176	20,8%	2.044	19,5%	93,9%
IE	4.525	308	6,8%	239	5,3%	77,6%
IT	55.812	10.538	18,9%	7.587	13,6%	72,0%
LT	2.434	1.132	46,5%	1.131	46,5%	99,9%
LU	1.093	80	7,3%	70	6,4%	87,4%
LV	2.224	1.153	51,9%	1.154	51,9%	100,0%
MT	88	13	15,3%	2	2,3%	14,9%
NL	26.545	1.447	5,5%	1.157	4,4%	79,9%
PL	37.157	5.469	14,7%	5.342	14,4%	97,7%
PT	5.388	1.892	35,1%	1.819	33,8%	96,1%
RO	13.061	3.509	26,9%	3.476	26,6%	99,1%
SE	14.347	9.842	68,6%	8.535	59,5%	86,7%
SI	1.905	648	34,0%	593	31,1%	91,6%
SK	5.772	571	9,9%	565	9,8%	99,0%
UK	55.825	3.920	7,0%	3.116	5,6%	79,5%

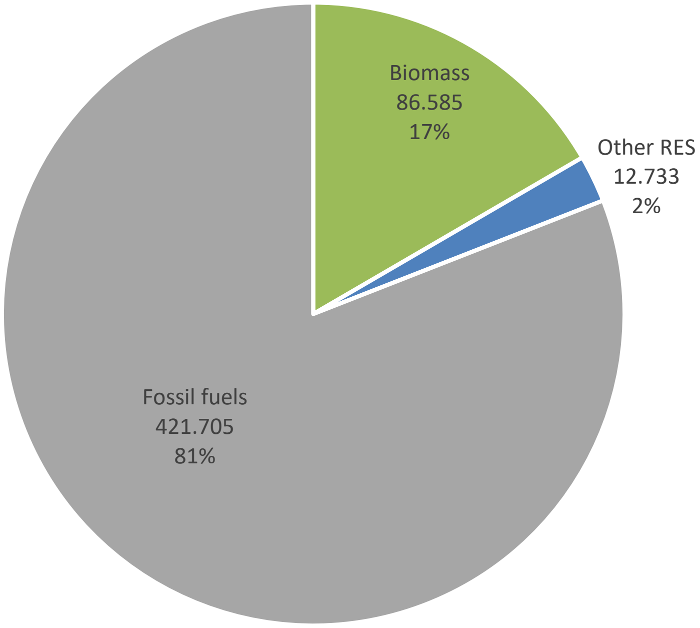
***** Calculated according to the methodology described in Directive 2009/28/EC and also Regulation (EC) No 1099/2008. Total heat is defined as the fraction of the gross final consumption of energy that is not consumed as electricity or for transport.
Source: Eurostat, SHARE 2016

The share heat consumption from renewable sources for the entire EU hides strong disparities between Member States. Forest-rich countries such as Estonia, Finland, Latvia and Sweden have already achieved very high shares of renewable heat (over 50%) thanks to bioenergy. Other countries are lagging far behind – six Member States have a renewable share of heat consumption below 10%, and almost half the EU countries are below 20%. It is clear that political incentives for the entire range of renewable heating solutions need to be implemented.

The introduction of a non-binding objective for renewable heating and cooling in the recently-enacted Renewable Energy Directive (RED II – Article 23) puts new focus on the decarbonization of the heating sector and ensures that Member States develop ambitious measures to fill the renewable heating gap.

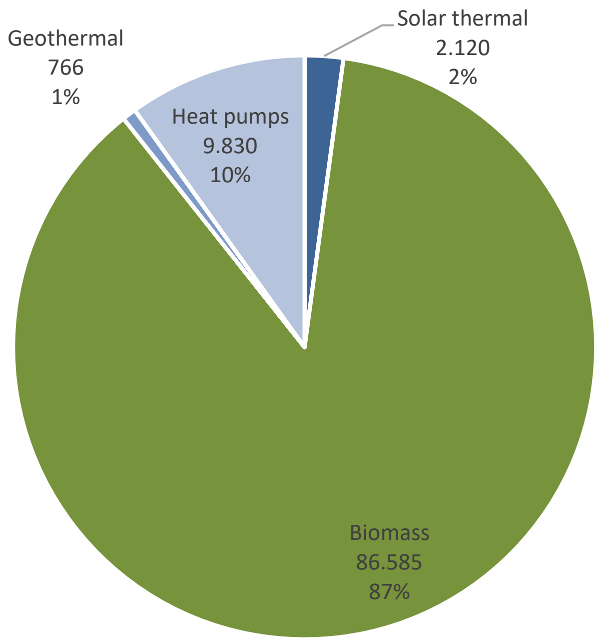
The long-term strategy of the European Commission should aim to further increase the focus on the heating sector. To meet the long-term trajectory towards a net-zero carbon economy by 2050, an acceleration of the deployment of renewable heat is needed. Unless considerable efforts are made to increase the share of renewable heat, Member States will fail to meet their climate commitments in the long term.

Figure 4.1 EU28 share of energy from renewable sources in the gross final energy consumption for heating and cooling (ktoe, %)



Source: Eurostat, SHARES 2016, Bioenergy Europe's calculation

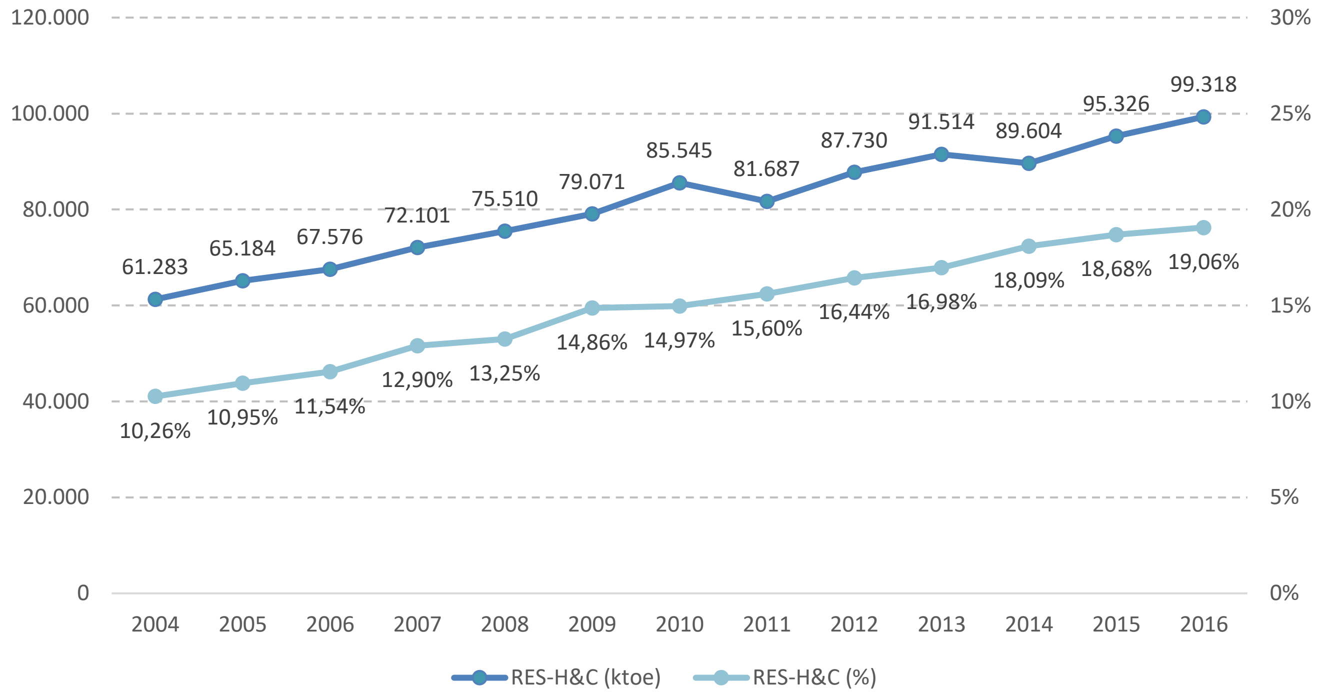
Figure 4.2 Contribution of the different renewables in heating and cooling in 2016 in EU28 (ktoe, %)



Note: Article 5 of Directive 2009/28/EC establishes the guidelines for calculating the quantity of renewable energy produced from different heat pump technologies. Only renewable energy from heat pumps with a Seasonal Performance Factor (SPF) greater than 2.5 should be considered towards the target.

Source: Eurostat, SHARES 2016, Bioenergy Europe's calculation

Figure 4.3 Evolution of share of RES in heating and cooling* (ktoe, %)



* Calculated according to the methodology established on Directive 2009/28/EC and also Regulation (EC) No 1099/2008.
Source: Eurostat, SHARES 2016

Deployment of renewables is much slower in heat than in the electricity sector. On average, the increase has been of 0,73 percentage points each year between 2004 and 2016. The Renewable Energy Directive sets an indicative target of 1,3 percentage points with the possibility to include a maximum of 40% waste heat. When deducting the share of waste heat, the renewable heating target decreases to 0,78 percentage points, almost equal to the business as usual scenario.

Despite this unambitious objective agreed by the three EU institutions (European Commission, European Parliament and European Council), the attempt to address the heating and cooling sector is a step in the right direction.

However, in order to reach EU's long-term decarbonisation objectives, it is essential that efforts to decarbonise the heating sector be accelerated. Long-term strategies to decarbonise theresidential sector and investments in research and innovation for the industrial sector will be needed.

Table 4.2 gives an overview of the fuels used in Europe for the production of heat from CHP and dedicated heating plants.

Table 4.2 Fuels used for the production of heat in district heating plants and CHP in EU28 in 2016 (ktoe)

Fuels	CHP plants		District heating plants		Total Derived Heat	
All fuels (excluding nuclear heat)	155.667	100,0%	21.015	100,0%	176.682	100,0%
Solid fossil fuels	58.182	37,4%	3.545	16,9%	61.726	34,9%
Oil	6.166	4,0%	963	4,6%	7.129	4,0%
Gas	57.179	36,7%	8.654	41,2%	65.833	37,3%
Waste (non-ren.)	5.017	3,2%	1.011	4,8%	6.029	3,4%
Renewables	28.248	18,1%	6.459	30,7%	34.707	19,6%
Solid biomass	15.596	10,0%	4.785	22,8%	20.381	11,5%
Biogas	6.994	4,5%	146	0,7%	7.140	4,0%
Municipal waste renewable	5.288	3,4%	1.012	4,8%	6.300	3,6%
Biofuels	370	0,2%	67	0,3%	437	0,2%
Other RES	0	0,0%	449	2,1%	449	0,3%

Source: Eurostat

98.7 % of all renewable fuel used in CHP and district heating plants is bioenergy.

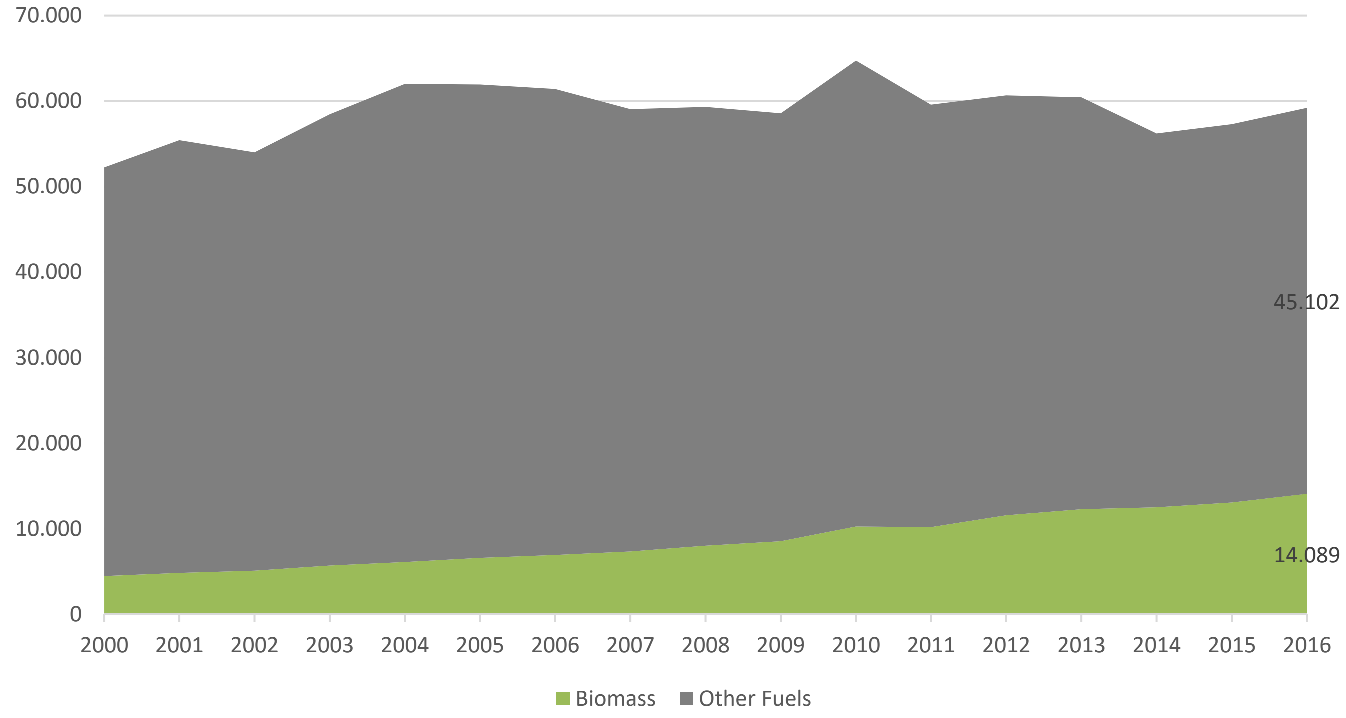
Almost one third of fuel used in district heating plants is renewable is renewable, demonstrating the potential for bioenergy in district heating. Bioenergy produced in high-efficiency CHPs can be transferred to the residential sector and to public buildings via district heating.

Currently, the benefits of bioenergy heating remain largely untapped. The majority of district heating plants still rely on fossil fuels, and as figure 4.4 shows, the conversion to renewable fuels remains a slow process.

Fortunately, this could soon change: The Renewable Energy Directive creates incentives for the use of efficient and renewable district heating solutions by allowing consumers the right to disconnect from inefficient district heating solutions in order to produce their own renewable heat. This provision will not only encourage individual consumers to produce their own renewable heat, but also push district heating plant providers to switch to renewable fuels in order to prevent consumers to disconnect.

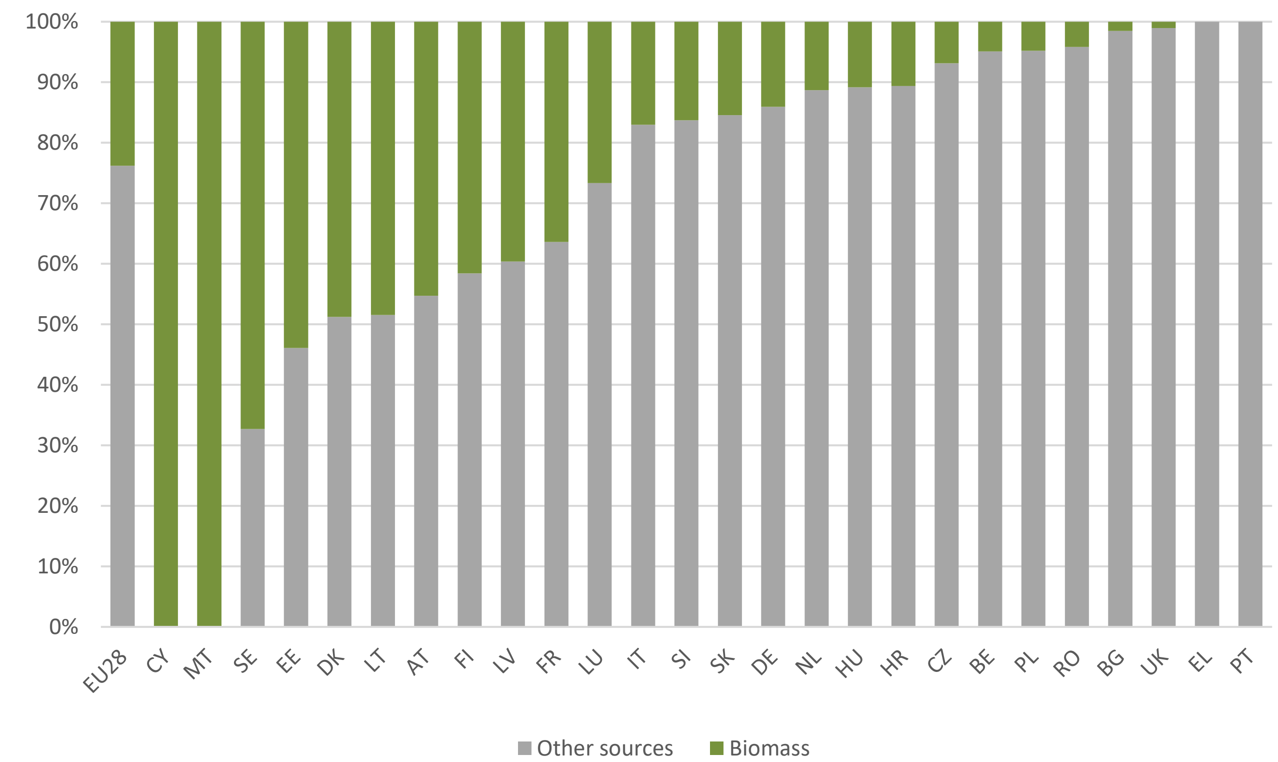
In order to foster the switch from fossil fuels to biomass, the ‘polluter pays principle’ should be strengthened under the emissions trading system (ETS) and support to fossil production of heat gradually phased out.

Figure 4.4 Evolution of derived heat production from biomass and other fuels in EU28 (ktoe)



Source: Eurostat

Figure 4.5 Share of derived heat produced from biomass in the EU28 Member States in 2016 (%)



Source: Eurostat

Table 4.3 Gross production of derived bioheat by type of biomass in EU28 Member states in 2016 (ktoe)

	Total biomass	Solid biomass	Biogas	Renewable waste	Liquid biofuels	Other sources
EU28	14.089	10.305	695	2.975	115	45.103
AT	934	870	5	58	1	1.127
BE	44	6	10	27	0	848
BG	18	15	3	0	0	1.134
CY	1	0	1	0	0	0
CZ	211	161	14	36	0	2.857
DE	1.574	616	223	732	3	9.634
DK	1.592	1.137	82	367	6	1.673
EE	308	308	1	0	0	264
EL	0	0	0	0	0	51
ES	0	0	0	0	0	0
FI	1.949	1.760	20	168	2	2.740
FR	1.563	920	41	602	0	2.731
HR	29	22	7	0	0	244
HU	140	124	4	12	0	1.150
IE	0	0	0	0	0	0
IT	910	542	208	117	44	4.436
LT	500	487	2	10	0	531
LU	16	13	2	0	0	43
LV	274	251	23	0	0	418
MT	0	0	0	0	0	0
NL	321	50	7	265	0	2.514
PL	334	319	14	0	0	6.660
PT	0	0	0	0	0	450
RO	76	72	4	0	0	1.757
SE	3.109	2.477	7	566	60	1.511
SI	35	28	7	0	0	180
SK	138	125	11	2	0	758
UK	15	3	0	13	0	1.394

Source: Eurostat

Table 4.4 Fuels* used in the residential, service and industrial sectors for heat production in EU28 in 2016 (ktoe)

Fuels	Residential	Services	Industry	Of which: Paper, pulp & print industry	Of which: Wood and wood product industry
TOTAL	193.190	67.989	170.885	21.591	5.940
Solid fossil fuels	9.507	923	33.774	1.023	38
Oil	33.139	15.668	27.513	744	215
Gas	105.175	46.281	86.242	6.775	641
Waste (non-ren.)	0	229	812	81	0
Charcoal	156	33	8	0	0
Solid biomass	43.281	2.169	21.371	12.756	5.043
Biogas	71	1.751	475	108	2
Municipal waste renewable	0	220	582	100	0
Biofuels	1	169	86	4	1
Other RES	1.861	546	21	0	0

* Fuels directly consumed in these sectors for heat production. It should be noticed that those sectors consumed more heat produced in heating or CHP plants. Excluding electrical energy, district heating and heat pumps.
Source: Eurostat

In order to keep the global mean temperature rise 1.5°C, there is an urgent need to decarbonise the residential sector. As can be seen in table 4.3, residential heating is still dominated by the consumption of fossil fuels, mainly gas. By offering a cheap, renewable alternative to fossil fuels, biomass heating systems could make a significant impact on residential fossil fuel use, especially in remote areas. Long-term strategies to decarbonise the residential sector are needed to encourage conversion from fossil to renewable solutions but also to promote the replacement of outdated biomass solutions with highly efficient biomass stoves and boilers.

In the industrial sector, bioenergy is of particular importance for forest and wood product industries. 60% of the heat used by the pulp and paper industry is produced by bioenergy (see table4.4). This important share shows that wood-working industries and bioenergy work very well together. The symbiosis of industrial processes, such as a sawmill or a pulp mill combined with bioenergy production, can increase resource efficiency as residues are used instead of ending up as waste. The specific form that this industrial symbiosis takes will depend on the local context and should thus not be influenced by rigid implementation of the cascading principle in legislation.

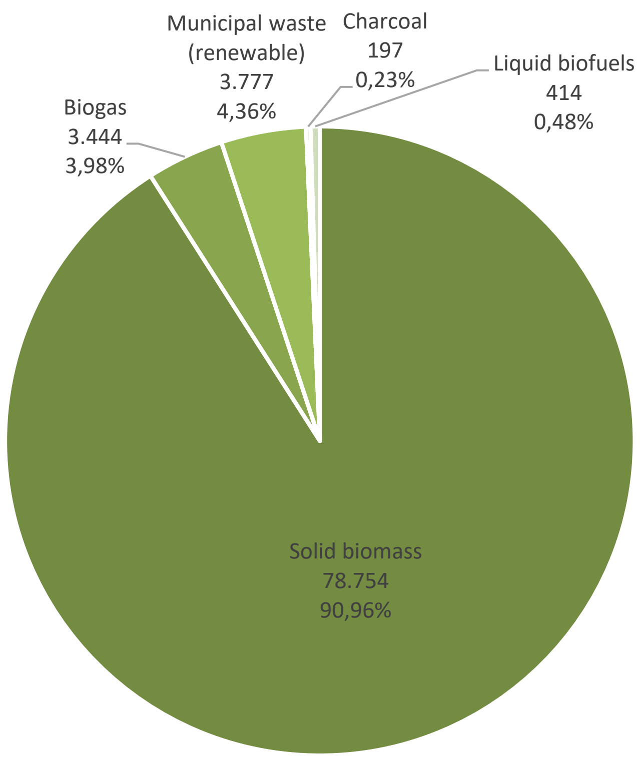
For industrial activities requiring high-temperature process heat, bioenergy is one of the few technologies that can offer a renewable solution to decarbonize this segment of our economy.

4.2 Bioheat

In 2016, 87% of the renewable heat consumed in the EU-28 was derived from biological sources. With this important share, biomass, and solid biomass in particular, is a key component of the drive to reach the renewable energy targets in the heating sector.

Solid biomass is by far (91%) the first source of fuel used for bioheat, most of it being woody biomass. Both for environmental and economic reasons, this is mostly sourced from by-products of forest management operations and the wood industry, such as sawmills.

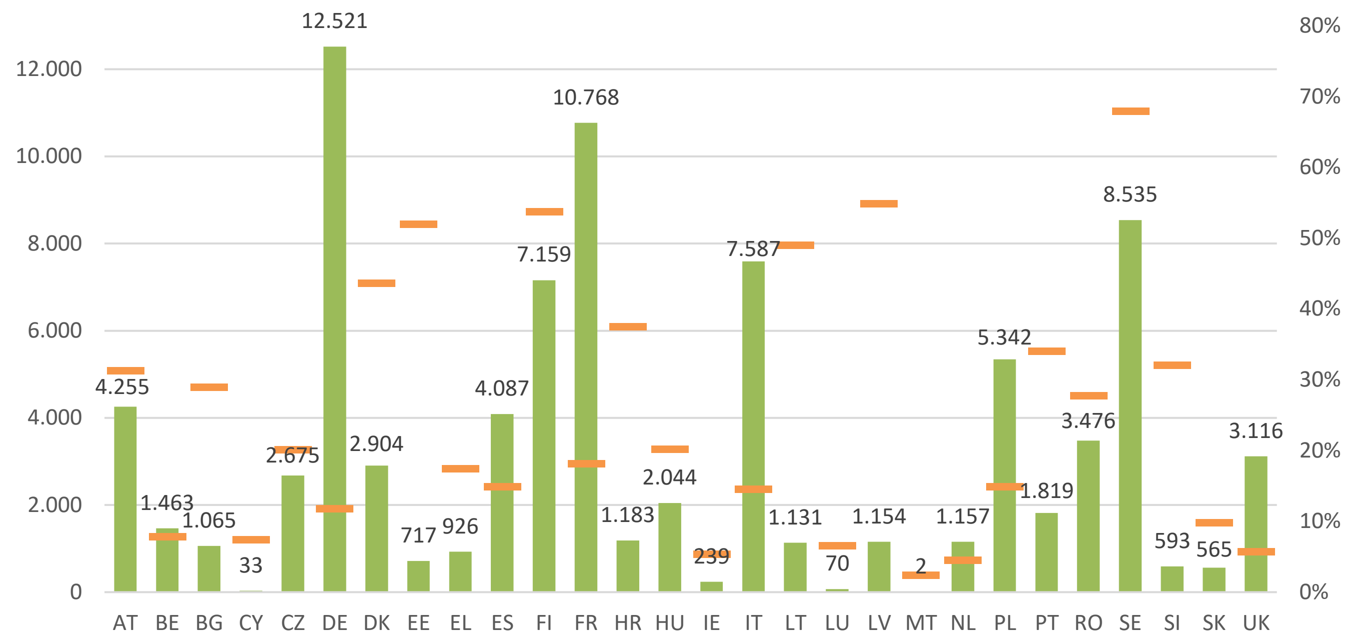
Figure 4.6 Types of biomass used in EU28 for bioheat in 2016 (ktoe, %)



Source: Eurostat

Figure 4.7 shows the importance of bioenergy in the decarbonisation of the H&C sector of some Member States like Sweden, Latvia, Lithuania, Finland and Estonia.
In most Member States, there is no price on carbon emitted in the H&C sector because the EU ETS system covers only installations above 20 MW. Most of the heat consumption happens in installations below 20 MW, except in countries where district heating exists. The graph above clearly shows that Member States with high share of bioheat are either countries with district heating traditions (installations above 20 MW falling under ETS), either countries that have introduced carbon taxes (Sweden, Finland).
In order to foster the decarbonisation of the H&C sector, the introduction of carbon taxes in sectors outside ETS is recommended.

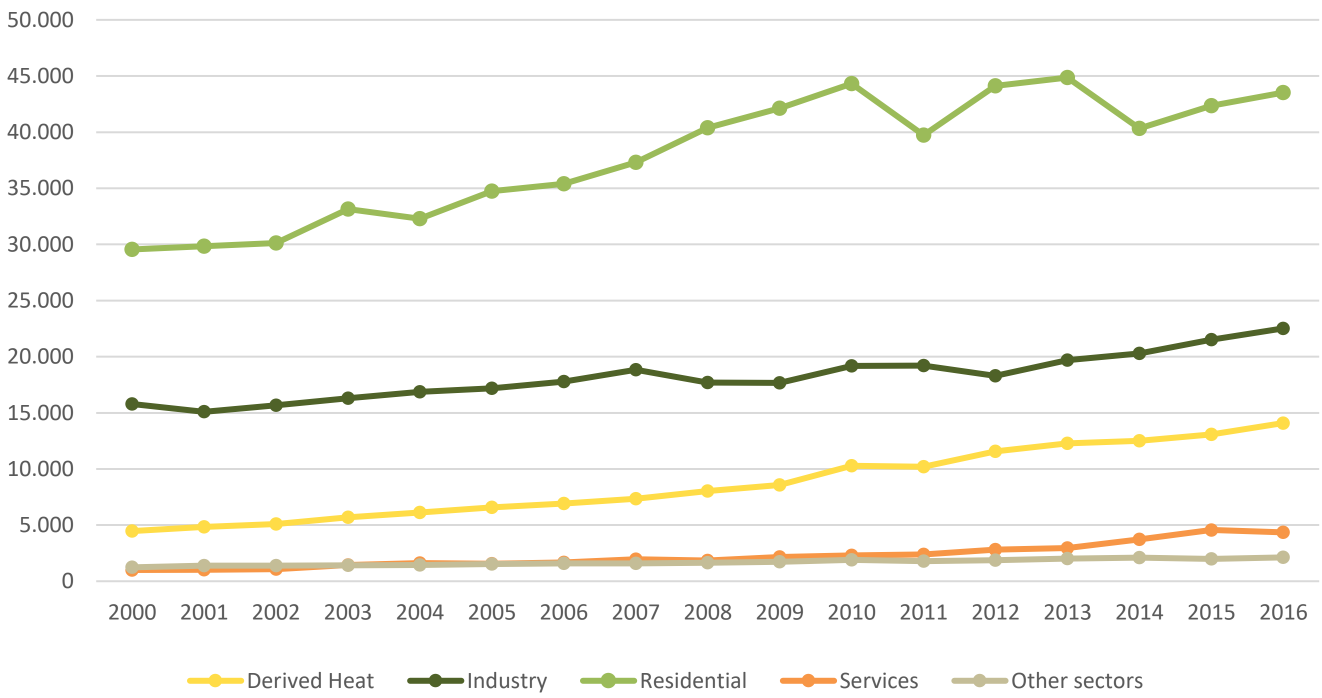
Figure 4.7 Final energy consumption of bioheat (ktoe) and share of bioheat in the total heating and cooling consumption in 2016 in the EU28 Member States (%)



Source: Eurostat

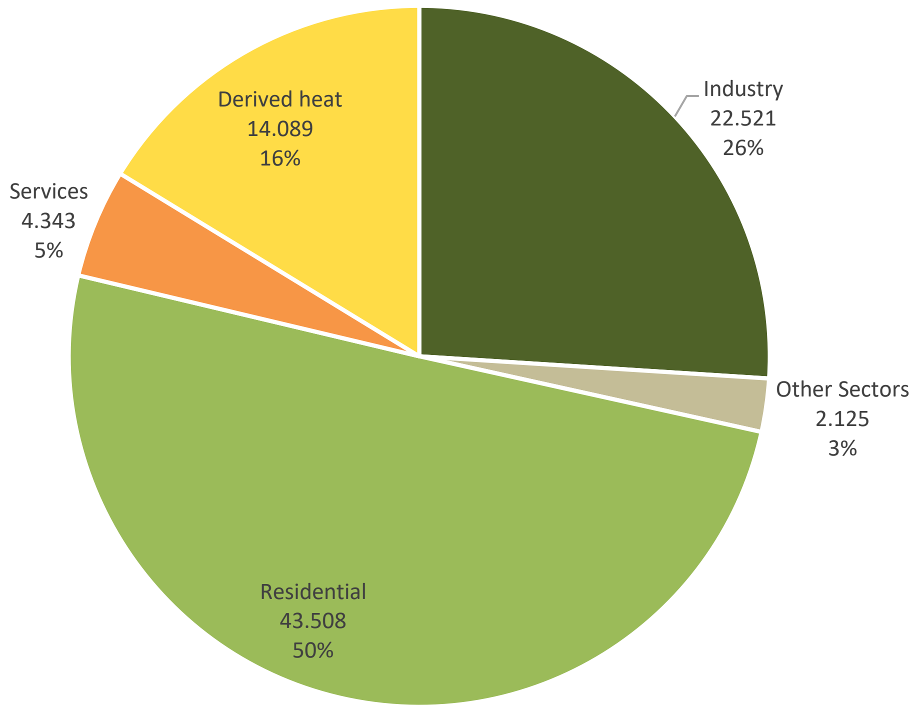
Figure 4.8 shows that the consumption of bioheat is steadily growing in all sectors, especially in the industrial and derived heat segment. The fluctuation in the residential can be explained by the mildness of winters and the fluctuation of fuel prices.

Figure 4.8 Evolution of final energy consumption of bioheat by sector in EU28 (ktoe)



Source: Eurostat

Figure 4.9 Final energy consumption of bioheat in EU28 in 2016 in the different sectors (ktoe, %)



Source: Eurostat, Bioenergy Europe's calculations

At the EU level, half of the heat produced from biomass is consumed by households (43.508 ktoe). This is only counting the biomass directly consumed in the houses for the production of heat, excluding heat supplied though district heating. The residential sector is followed by 22.521 ktoe of biomass for heat in industry and 14.089 ktoe of derived heat (mostly being district heating).

This important share of bioheat going to the residential and service sector (schools, hospitals, hotels) shows that there is a great number of small and medium installations producing bioheat. Nevertheless, despite the important share of biomass in the residential sector, this sector is still dominated by the consumption of fossil fuels. Increasing further the deployment of biomass in this sector is crucial if Member States want to reach their 2050 climate objectives. It is also important to replace the existing stock of old and inefficient biomass installations with highly efficient nearly-zero emissions modern biomass installations, not only to improve the increase the resource efficiency but also improve air quality. In order to accelerate the deployment of modern biomass heating installations, increasing awareness and establishing financial support at local levels will be essential.

Between 2015 and 2016, European consumption of RES heat increased 5%, almost twice as quickly as the total heat consumption. While this is a significant expansion, but RES heat still supplies less than 20% of the overall heating demand.

Across the European Union, the evolution of RES heat consumption varies greatly from country to country – the top five countries by RES heat use represent around 54% of the overall bioheat consumption in Europe. It is clear that most countries will have to be much more committed to the promotion of bioheat if they wish to reach their targets for 2020; there is not much time left!

Even if the industry and derived heat (mainly district heating) have a significant impact on emssions, the residential sector remains crucially important for the development of bioheat in the years ahead. The key factors for a quicker expansion of bioheat in this sector are obviously multiple.

Financial incentives have significantly increased the sales of appliances burning solid biofuels in some countries. European and national regulations of course have a major impact on the balance between heat sources. National and local authorities also have a big responsibility in the image of bioheat, with woody biomass in particular, spread amongst the public.

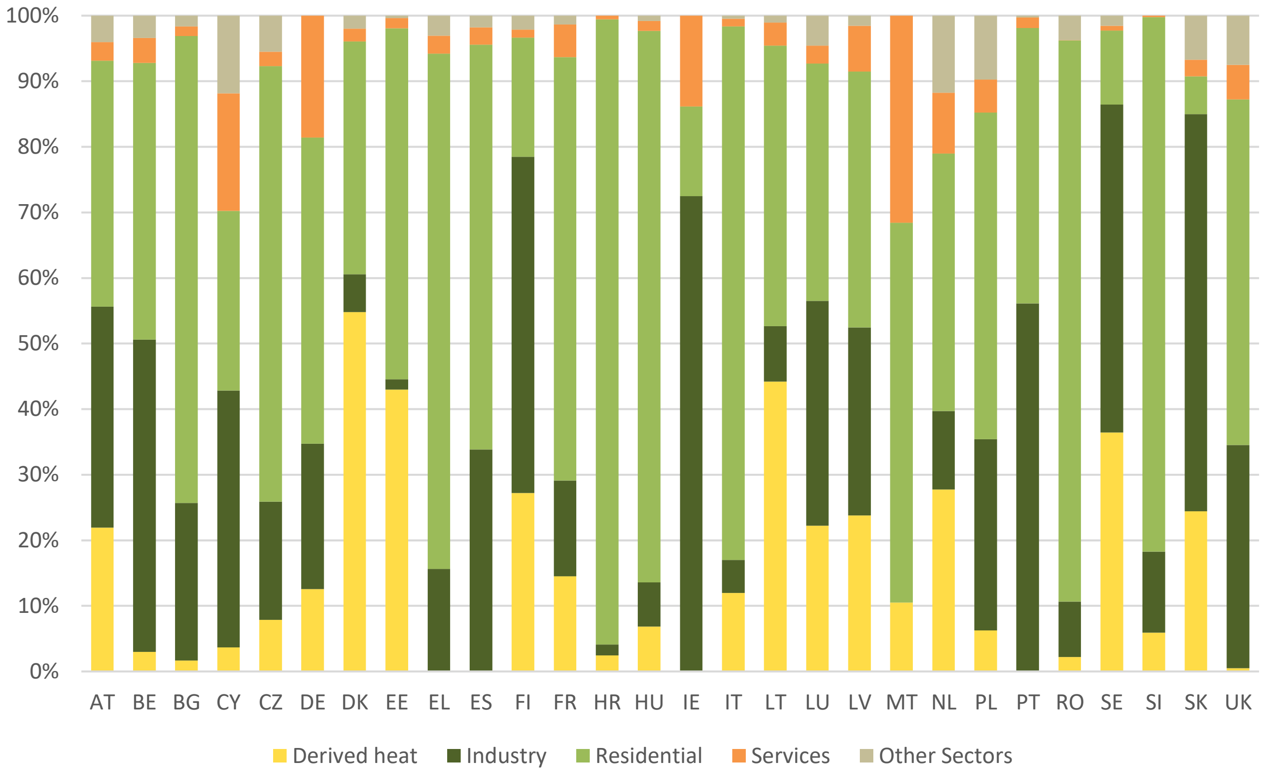
The Ecodesign directive and some quality labels promoted in several countries bring their contribution (the efficiency of wood stoves for instance has gone up 70% in the last 20 years; you must keep this in mind when you read statistics about biofuels/bioheat). No doubt that the appliance manufacturers, the biomass suppliers and the exhaust system manufacturers will have to intensify their collaboration to propose solutions for new build and renovation which will make bioheat even more clean, reliable and competitive, as secondary but also as primary heating source.

Last but not least, training of the installers and information of the public on good practices must contribute to convince the public that bioheat is the right choice for the future. The good news is that the potential for growth is considerable!

Jean-Jacques ADAM
EURO ENERGIES

Euro Energies

Figure 4.10 Importance of the different sectors in the final energy consumption of bioheat in EU28 Member States in 2016 (%)



Source: Eurostat

Heat deployment strongly differs between Member States. The residential sector remains the predominant sector for bioheat consumption in a majority of Member States even though the industrial and derived heat sector is increasing. The consumption of bioheat in the industry sector has a high importance in countries such as Belgium, Finland, Ireland, Portugal, Sweden and Slovakia. The countries with the biggest share of bioheat consumption through district heating are Denmark, Estonia, Lithuania and Sweden with shares higher than 30%. On the contrary, there is not much bioheat district heating in Ireland or in Mediterranean countries like Spain, Greece and Portugal. The use of bioheat in the service sector (schools, hospitals, hotels) is rather limited in most countries. Only Germany, Cyprus and Malta present more than 15% shares.

Table 4.5 Final energy consumption of bioheat in EU28 Member States in 2016 by sector of activity (ktoe)

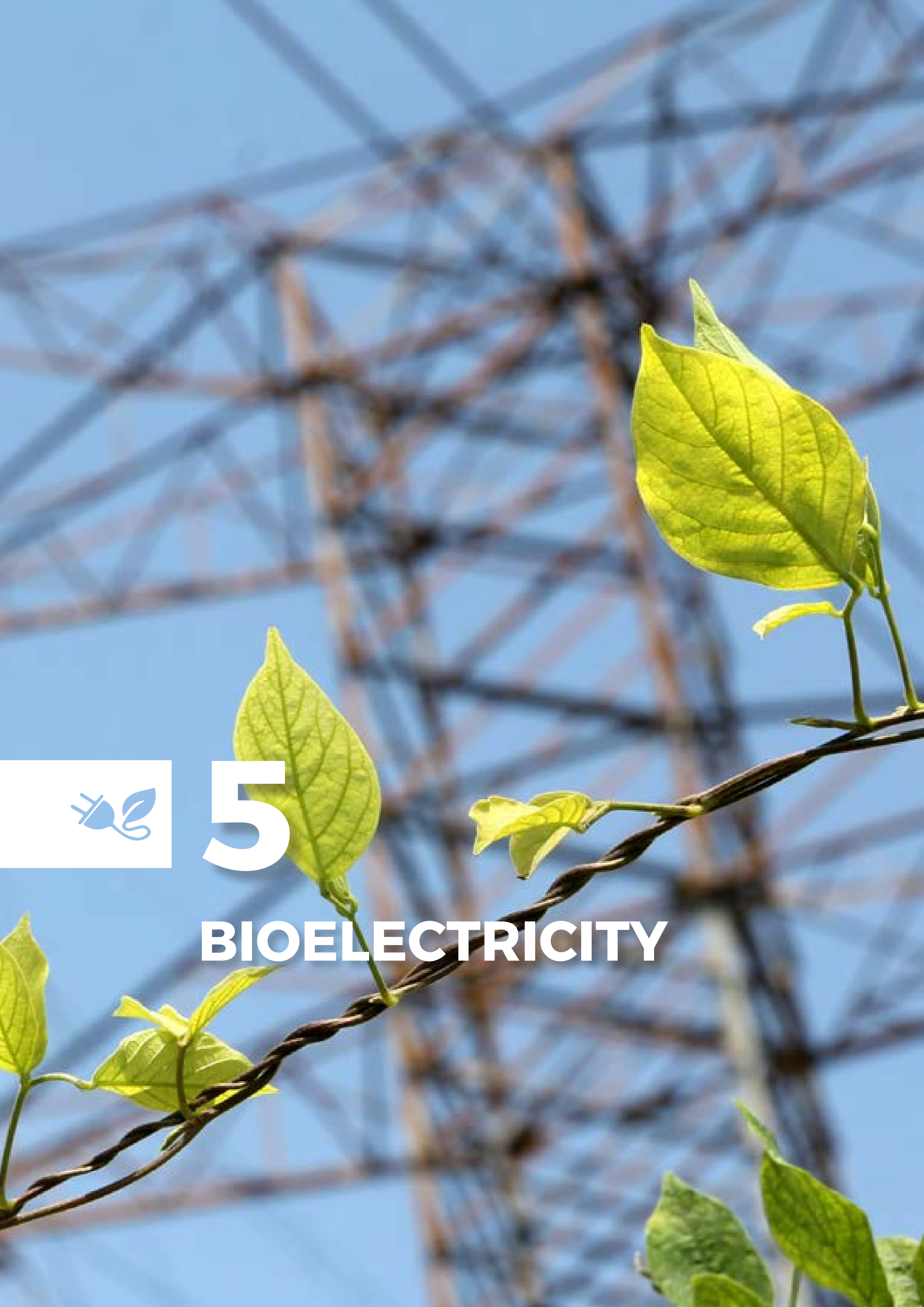
	Total	Residential	Services	Other sectors	Industry	Derived Heat
EU27	86.585	43.508	4.343	2.125	22.521	14.089
AT	4.255	1.596	121	171	1.433	934
BE	1.463	617	56	50	697	44
BG	1.065	758	16	18	256	18
CY	33	9	6	4	13	1
CZ	2.675	1.777	59	147	482	211
DE	12.521	5.846	2.327	0	2.774	1.574
DK	2.904	1.031	57	57	167	1.592
EE	717	384	11	3	11	308
EL	926	728	25	28	145	0
ES	4.087	2.522	108	74	1.383	0
FI	7.159	1.300	86	153	3.670	1.949
FR	10.768	6.952	537	143	1.574	1.563
HR	1.183	1.128	7	0	20	29
HU	2.044	1.719	32	16	138	140
IE	239	33	33	0	173	0
IT	7.587	6.173	89	35	380	910
LT	1.131	484	40	12	96	500
LU	70	25	2	3	24	16
LV	1.154	450	80	18	331	274
MT	2	1	1	0	0	0
NL	1.157	455	107	136	138	321
PL	5.342	2.662	268	521	1.557	334
PT	1.819	764	29	5	1.020	0
RO	3.476	2.975	1	130	295	76
SE	8.535	961	66	130	4.269	3.109
SI	593	483	1	0	73	35
SK	565	33	14	38	342	138
UK	3.116	1.641	165	234	1.061	15

Source: Eurostat

Table 4.6 Evolution of bioheat consumption in 2000, 2010 and 2016 by sector of activity in EU28 Member States (ktoe)

	Industry			Residential			Other sector			Derived heat		
	2000	2010	2016	2000	2010	2016	2000	2010	2016	2000	2010	2016
EU28	15.772	19.186	22.521	29.551	44.314	43.508	2.243	4.211	6.468	4.469	10.271	14.089
AT	705	1.165	1.433	1.435	1.548	1.596	185	235	292	177	839	934
BE	255	588	697	152	518	617	1	42	106	9	44	44
BG	34	166	256	489	711	758	24	14	33	0	2	18
CY	1	8	13	0	6	9	0	7	10	0	0	1
CZ	128	407	482	1.000	1.509	1.777	7	92	205	122	90	211
DE	453	2.161	2.774	4.028	6.079	5.846	0	998	2.327	254	987	1.574
DK	109	183	167	424	952	1.031	100	94	114	535	1.260	1.592
EE	79	104	11	332	423	384	14	23	14	64	142	308
EL	233	245	145	702	606	728	11	16	53	0	0	0
ES	1.302	1.144	1.383	1.995	2.464	2.522	64	124	181	0	0	0
FI	3.386	2.987	3.670	936	1.494	1.300	158	273	240	834	1.585	1.949
FR	1.563	1.463	1.574	6.681	7.230	6.952	256	396	680	287	848	1.563
HR	53	51	20	948	1.187	1.128	0	3	7	0	2	29
HU	60	85	138	553	1.568	1.719	81	49	48	13	72	140
IE	100	153	173	17	27	33	0	16	33	0	0	0
IT	228	208	380	1.280	7.163	6.173	8	23	123	0	258	910
LT	32	76	96	527	574	484	47	43	52	29	186	500
LU	0	28	24	15	18	25	1	5	5	0	3	16
LV	59	226	331	674	598	450	91	94	98	88	102	274
MT	0	0	0	0	1	1	0	0	1	0	0	0
NL	61	103	138	345	409	455	81	184	243	81	175	321
PL	625	921	1.557	2.269	2.693	2.662	629	740	790	44	255	334
PT	1.264	1.451	1.020	1.150	712	764	0	5	34	0	0	0
RO	261	252	295	2.454	3.526	2.975	20	131	131	14	36	76
SE	4.334	4.231	4.269	616	684	961	339	362	196	1.912	3.261	3.109
SI	75	68	73	358	509	483	2	2	1	6	23	35
SK	91	376	342	0	43	33	0	18	52	0	100	138
UK	281	336	1.061	172	1.065	1.641	120	221	399	0	3	15

Source: Eurostat



5 BIOELECTRICITY

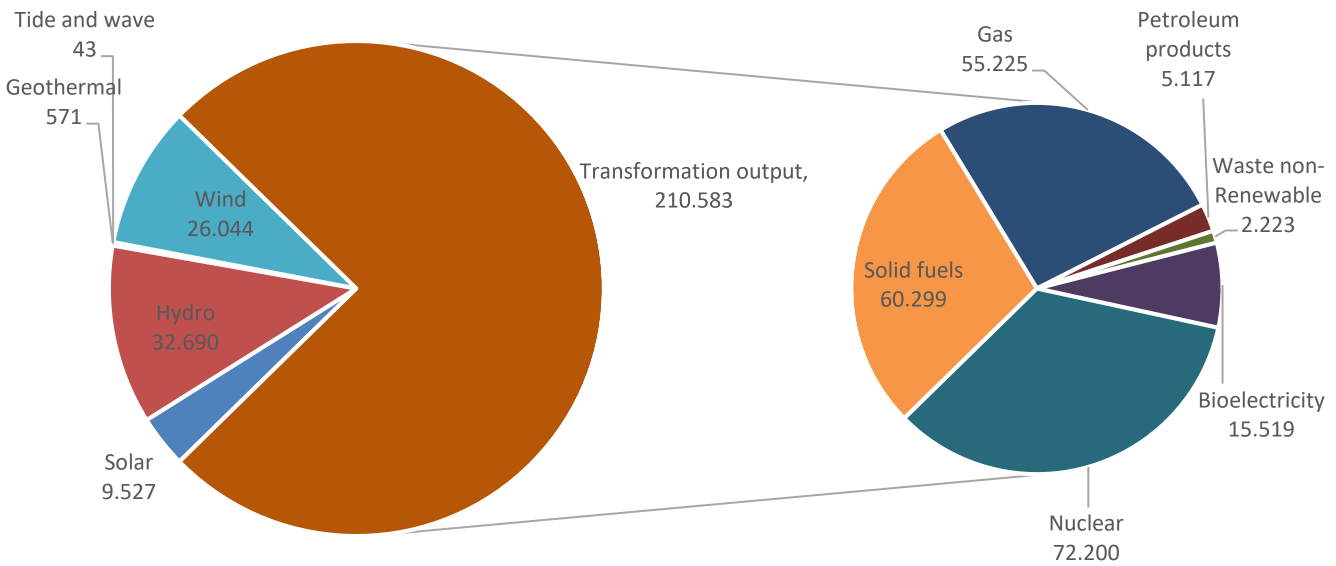
5.1 Electricity and RES electricity in Europe

Table 5.1 Fuel inputs for the production of electricity in EU28 in 2016 (ktoe)

Fuels	Transformation input		
	Power only plants	CHP	Total
Solid fossil fuels	107.251	58.182	165.433
Oil	6.654	6.166	12.820
Gas	57.396	57.179	114.575
Nuclear	216.703	0	216.703
Wastes (non-ren.)	3.271	5.017	8.288
Renewables	26.729	28.248	54.977
➢ **of which**			
Solid biomass	9.207	15.596	24.803
Biogas	5.787	6.994	12.781
Municipal waste renewable	3.184	5.288	8.472
Biofuels	643	370	1.013
TOTAL	418.004	154.792	572.796

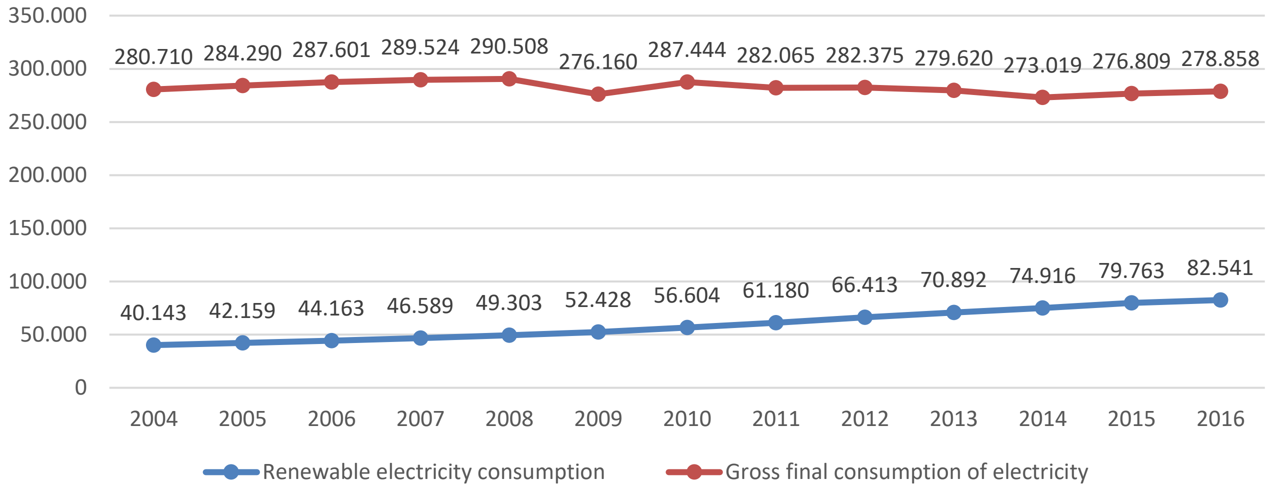
Note: Transformation input covers all inputs into the transformation plants destined to be converted into derived products or transformation output (electricity and derived heat). Transformation is only recorded when the energy products are physically or chemically modified to produce other energy products, in this case electricity. Hydro, wind, photovoltaic, tide, wave and ocean energies are not accounted in this table.
Source: Eurostat

Figure 5.1 Gross electricity generation by product type in the EU28 in 2016 (ktoe)



Note: transformation output refers to the electricity output of the power plants.
Source: Eurostat

Figure 5.2 Evolution of the gross final consumption of electricity* and gross final consumption of electricity from renewable sources in EU28 (ktoe)

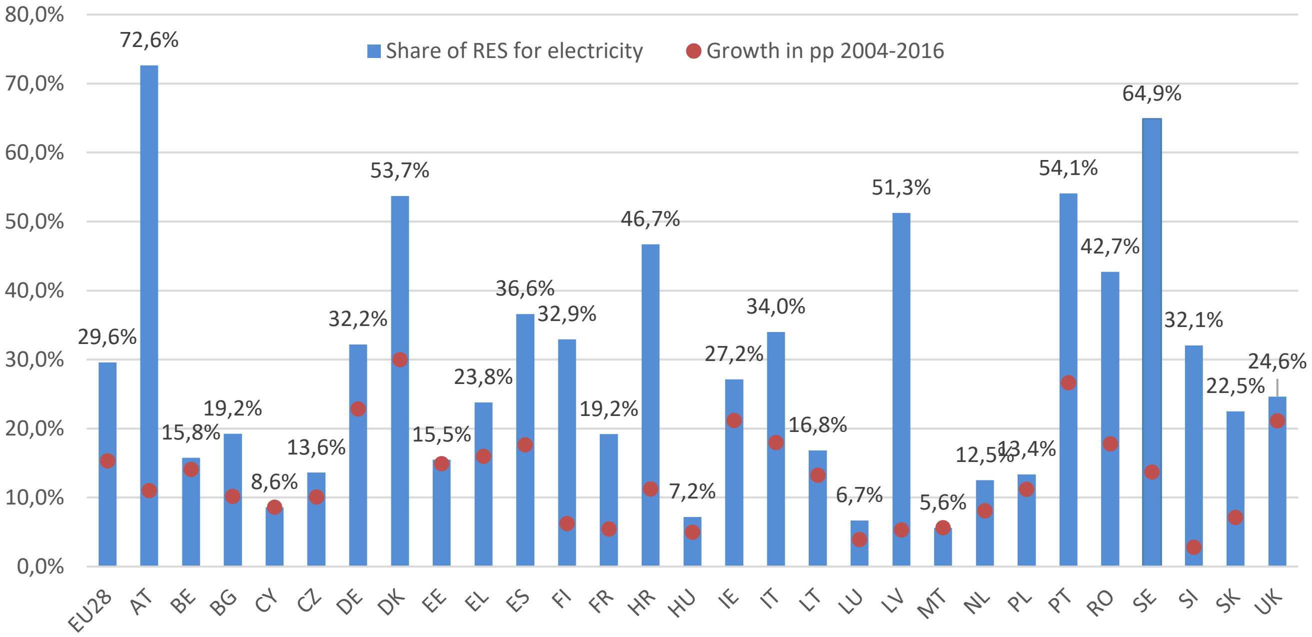


*Calculated according to the methodology described in Directive 2009/28/EC and also Regulation (EC) No 1099/2008.
Hydro is normalised and excludes pumping. Wind is normalised. Solar includes solar photovoltaic and solar thermal generation. All other renewables include electricity generation from gaseous and liquid biofuels, renewable municipal waste, geothermal, and tide, wave & ocean.
Source: Eurostat, SHARE 2016

As of 2016, almost one third of electricity consumed in Europe is renewable electricity, twice the renewable share of the gross final consumption of electricity in 2004 (see figure 5.2).

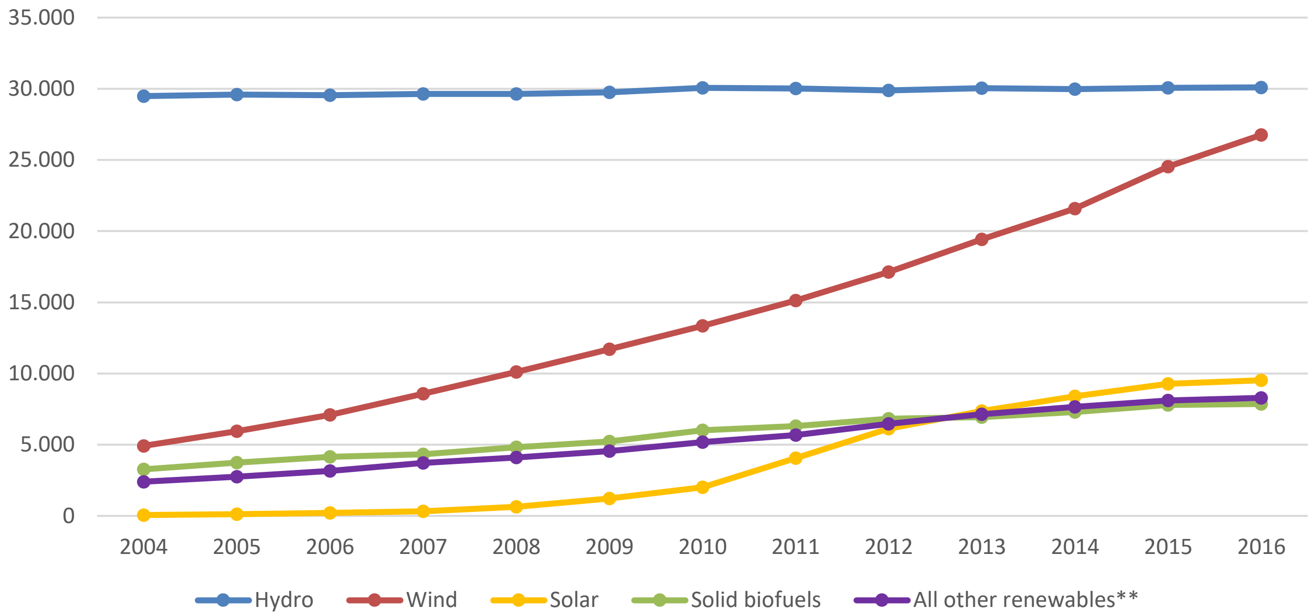
While this is an impressive rate of growth, the current renewable energy capacity is a long way from being able to supply all of Europe. Today and also in the near future, electrification is by no means equal to decarbonisation. For the EU to generate 100% renewable electricity, further efforts are needed to phase out non-renewable fuels. This could be accomplished by strengthening the ETS system to increase the price of polluting, or by removing indirect subsidies to fossil fuels.

Figure 5.3 Share of RES in gross final consumption of electricity* in EU28 Member States in 2016 (%) and growth of this share between 2004 and 2016 (in percentage points)



* Calculated according to the methodology established in Directive 2009/28/EC and also Regulation (EC) No 1099/2008.
Source: Eurostat, SHARE 2016

Figure 5.4 Evolution of gross final consumption of electricity from renewable sources* in EU28 between 2004 and 2016 (ktoe)



* Calculated according to the methodology established on Directive 2009/28/EC and also Regulation (EC) No 1099/2008.
** All other renewables includes electricity generation from gaseous and liquid biofuels, renewable municipal waste, geothermal, and tide, wave & ocean
Source: Eurostat

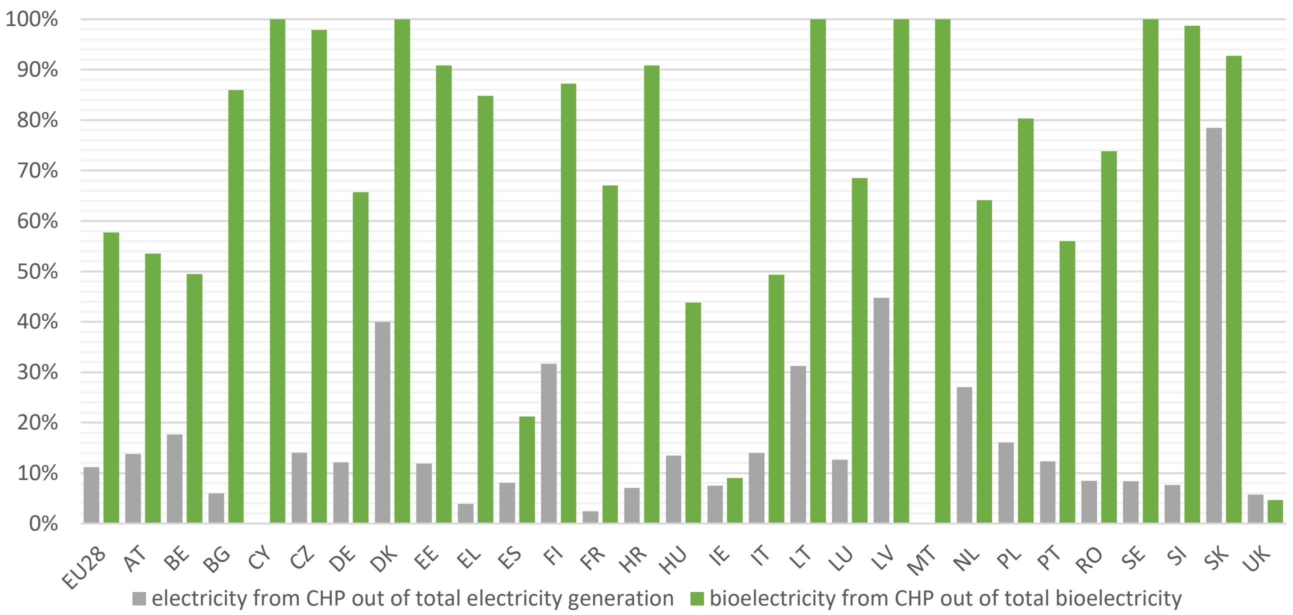
Over the last decade, there has been increasing use of renewable energy in many forms in the power sector. The greatest increase in renewable energy use has been in the form of electrical power, where use of renewables increased from 14,3% in 2004 to 29,6% in 2016. Wind and solar power experienced the greatest increases in capacity but because of their variable nature, they require flexible and dispatchable electricity generation to complement them. Bioenergy is one renewable energy source which can act as a base load and is dispatchable whenever needed.

In the framework of the discussion on the design of the future electricity market, the proposal to exclude most polluting fuels (emitting more than 550g CO_2/ kWh) from being eligible for a capacity mechanism is a step in the right direction.

It is also interesting to note the decentralisation trend of energy production which provides the consumer with more influence over the energy system. in addition tothe heat sector, where decentralised production of bioheat has an important role to play, but also in the electricity sector where micro and medium-scale CHP can play an important role in empowering citizens in the fight against climate change.

As can be seen in Figure 5.3, there is still significant disparity between Member States in terms of the deployment of renewable electricity infrastructure. In the years to come, the role of baseload and dispatchable sources of electricity, such as bioenergy, will be increasingly important to bring stability to electricity grids and facilitate the fast deployment of other variable sources of renewable electricity.

Figure 5.5 Share of gross electricity generation of conventional and nuclear power plants produced from CHP and share of bioelectricity produced from CHP in 2015 in EU28 Member States (%)

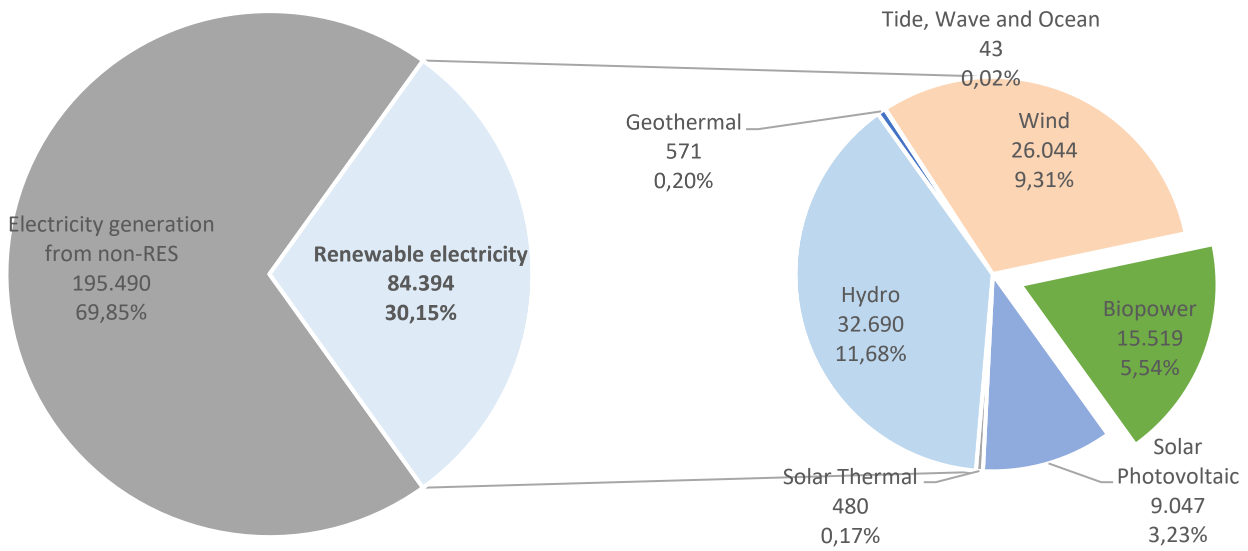


Source: Eurostat

As can be seen in figure 5.5, the majority of bioelectricity produced in the EU is generated in combined heat and power plants, referred to as CHP. This is the case for 22 of the 28 EU Member States. Only Belgium, Spain, Hungary, Ireland, Lithuania and the United Kingdom produce less than 50% of their bioelectricity from CHP. On the other hand, six Member States produce bioelectricity exclusively in CHP plants.

In 2015, only 11,2% of total electricity was generated in CHP, 57,7% of biopower was in CHP. This reflects the synergies between renewable energies and energy efficiency and how bioenergy is a strong promoter of energy efficiency. Biopower is mostly produced in efficient CHP but it is also important to recognize the role of biopower-only installations in locations where heat is less or not needed. In fact, the form of energy needed depends strongly on the local circumstances and rigid top-down approaches should be avoided. The recognition of the role of efficient biopower installations in the Renewable Energy Directive (Article 26.8) reflects this reality and is welcomed by the sector.

Figure 5.6 Share of renewable gross electricity generation in the EU28 in 2016 (ktoe and %)



Source: Eurostat

Biopower represents 18,4% of renewable electricity and 5,5% of all electricity generated in the EU. While the share of other renewable sources of energy is increasing, electricity generated from biomass will remain important as a renewable solution for baseload and dispatchable production of power in an increasingly intermittent electricity system.

Table 5.2 Gross electricity generation from renewables in EU28 Member States in 2016 (ktoe)

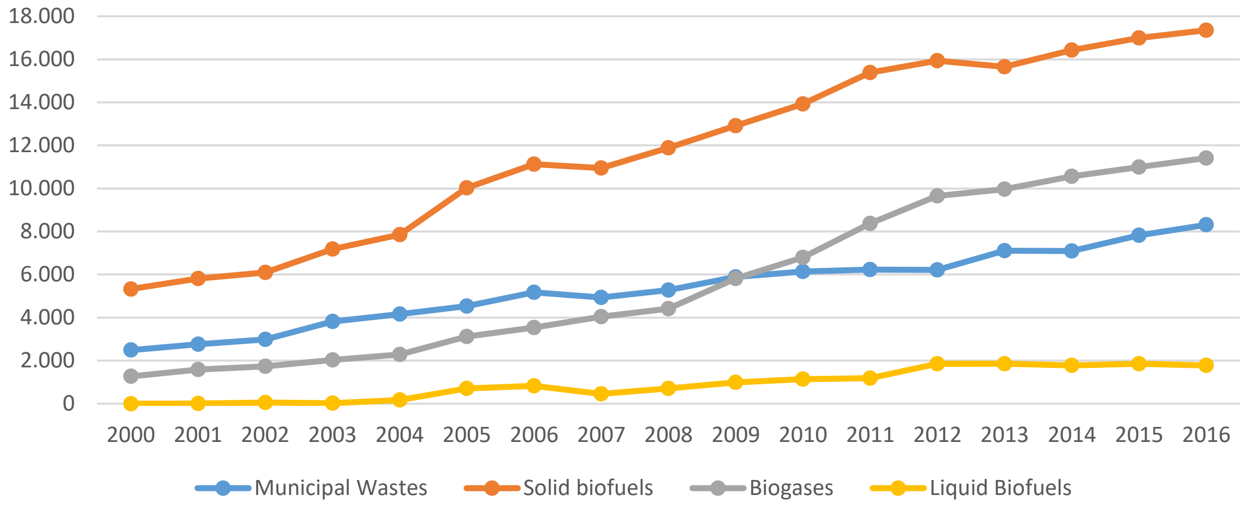
	Renewables	Hydro	Wind	Bioelectricity	Solar photovoltaic	Solar thermal	Geothermal	Tide, wave and ocean
EU28	84.394	32.690	26.044	15.519	9.047	480	571	43
AT	4.631	3.690	450	396	94	0	0	0
BE	1.315	128	467	454	265	0	0	0
BG	665	393	123	30	119	0	0	0
CY	36	0	19	5	13	0	0	0
CZ	910	275	43	409	183	0	0	0
DE	16.675	2.247	6.758	4.379	3.276	0	15	0
DK	1.588	2	1.099	423	64	0	0	0
EE	130	3	51	76	0	0	0	0
EL	1.282	479	443	24	338	0	0	0
ES	9.296	3.428	4.205	489	694	480	0	0
FI	2.615	1.359	264	991	2	0	0	0
FR	8.778	5.580	1.840	613	702	0	0	43
HR	737	607	87	37	6	0	0	0
HU	277	22	59	178	17	0	0	0
IE	671	84	529	59	0	0	0	0
IT	9.445	3.805	1.521	1.677	1.901	0	541	0
LT	230	90	98	37	6	0	0	0
LU	161	131	9	12	9	0	0	0
LV	299	218	11	71	0	0	0	0
MT	12	0	0	1	11	0	0	0
NL	1.267	9	703	422	134	0	0	0
PL	2.003	226	1.082	684	11	0	0	0
PT	2.876	1.454	1.073	264	71	0	15	0
RO	2.363	1.594	567	46	157	0	0	0
SE	7.674	5.343	1.331	988	12	0	0	0
SI	459	411	1	24	23	0	0	0
SK	591	396	1	149	46	0	0	0
UK	7.411	718	3.213	2.583	896	0	0	0

Source: Eurostat

The top 5 EU-28 countries (DE, UK, IT, FI, SE) in biopower represent 68% of the total EU bioelectricity generation. This makes the bioelectricity market even more concentrated than the bioheat market. Among the following top 5, led by Germany (28.2%) and the UK (16.6%), different approaches exist: While in Germany and Italy, the majority of bioelectricity is produced in a high number of small or medium size biogas plants, the UK operates a small number of large installations that convert woody biomass to electricity.

5.2 Bioelectricity in Europe

Figure 5.7 Evolution of electrical capacity from biomass plants by type in EU28 (MW)



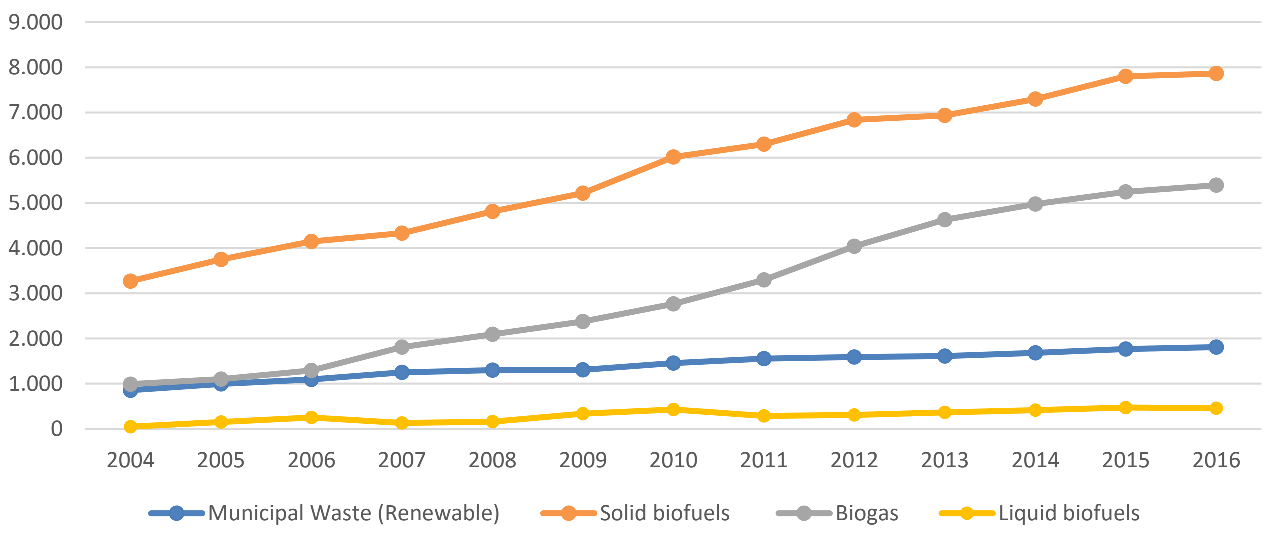
Source: Eurostat

Bioelectricity capacity has increased significantly over the last decade. In particular, capacity for electrical generation from biogas and from solid biomass grew rapidly after the adoption of the first Renewable Energy Directive. It remains to be seen in the coming years to what extent the recast of the Renewable Energy Directive will lead to similar results in terms of growth rates.

With fast changing legislation at European, but also national level, investment certainty has diminished -on the liquid biofuels producint an stagnations of the sector in the last years.

In the framework of the legislative development for related to the period from 2020 to 2030, Bioenergy Europe has consistently advocated the establishment of a stable policy framework, to be reviewed after 2030 along with full harmonisation of the criteria at EU level. However, legislators have decided to allow Member States to set additional national criteria. This makes it possible for Member States to develop new criteria whenever they choose. It is now in the hands of Member States to ensure a stable and secure legislative framework to attract investments.

Figure 5.8 Evolution of the gross electricity generation from biomass by type in the EU28 (ktoe)



Source: Eurostat

Table 5.3 Electrical capacity from biomass plants by type in EU28 Member States in 2016 (MW)

	Municipal wastes	Wood, wood waste and other solid wastes	Biogas	Liquid biofuels
EU28	8.309	17.352	11.413	1.776
AT	542	917	202	1
BE	249	561	186	36
BG	0	19	38	0
CY	0	0	10	0
CZ	55	376	369	0
DE	1.957	1.600	5.839	231
DK	334	1.030	110	0
EE	210	165	11	0
EL	0	2	56	0
ES	234	677	224	0
FI	0	1.748	0	0
FR	859	548	353	4
HR	0	26	37	0
HU	58	322	76	0
IE	22	5	53	0
IT	818	685	1.352	989
LT	15	39	25	0
LU	17	4	12	0
LV	0	81	62	0
MT	0	0	5	0
NL	649	294	221	0
PL	44	727	225	0
PT	83	477	68	0
RO	0	107	16	0
SE	1.127	3.769	2	515
SI	0	30	29	0
SK	19	150	93	0
UK	1.017	2.993	1.739	0

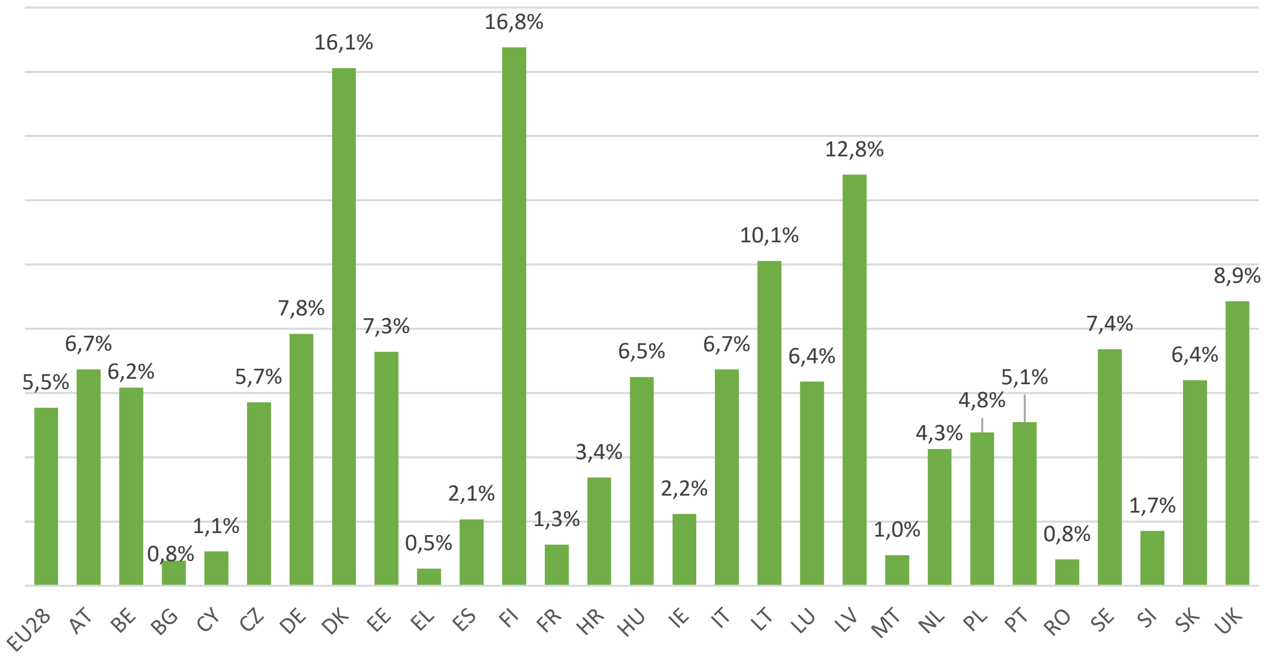
Source: Eurostat

Table 5.4 Gross electricity generation from biomass in EU28 Member States in 2016 (ktoe)

	Total	Renewable municipal waste	Solid biomass excl. Charcoal	Biogas	Biofuel
EU28	15.518,9	1.809,5	7.862,3	5.391,8	455,3
Share (%)	100%	11,66%	50,66%	34,74%	2,93%
AT	396	23	317	56	0
BE	454	75	292	85	3
BG	30	0	14	16	0
CY	5	0	0	5	0
CZ	409	9	178	223	0
DE	4.379	510	928	2.898	43
DK	423	74	299	49	0
EE	76	0	72	4	0
EL	24	0	0	23	0
ES	489	63	348	78	0
FI	991	45	912	34	0
FR	613	186	264	163	0
HR	37	0	17	20	0
HU	178	21	128	29	0
IE	59	7	34	18	0
IT	1.677	208	355	710	405
LT	37	4	23	11	0
LU	12	4	2	6	0
LV	71	0	37	34	0
MT	1	0	0	1	0
NL	422	172	164	85	0
PL	684	1	594	88	0
PT	264	26	213	25	0
RO	46	0	40	6	0
SE	988	145	838	1	4
SI	24	0	12	12	0
SK	149	2	97	50	0
UK	2.583	236	1.685	663	0

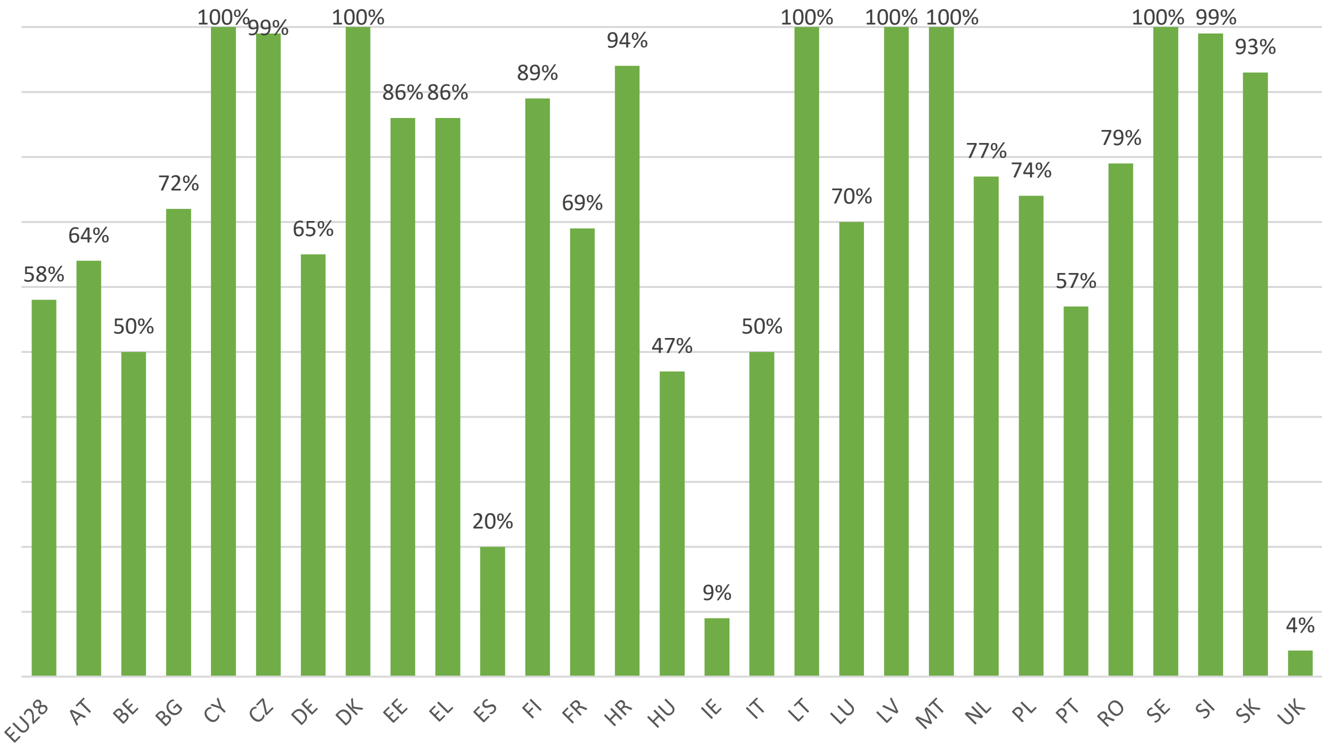
Source: Eurostat

Figure 5.9 Share of bioelectricity generation out of total gross electricity generation in EU28 Member States in 2016 (%)



Source: Eurostat

Figure 5.10 Bioelectricity generated from CHP out of total bioelectricity in EU28 Member States in 2016 (ktoe)



Source: Eurostat

Table 5.5 Evolution of bioelectricity 2000-2016 in EU28 Member States (ktoe)

	Total bioelectricity			Bioelectricity from CHP plants			Bioelectricity from electricity only plants		
	2000	2010	2016	2000	2010	2016	2000	2010	2016
EU28	2.929	10.668	15.519	1.750	6.526	9.021	1.179	4.143	6.498
AT	132	384	396	95	216	252	37	167	144
BE	49	373	454	16	142	228	33	231	226
BG	0	3	30	0	3	22	0	0	9
CY	0	3	5	0	3	5	0	0	0
CZ	45	186	409	31	130	403	14	56	6
DE	372	2.950	4.379	0	1.937	2.856	372	1.013	1.522
DK	112	395	423	112	395	423	0	0	0
EE	1	64	76	1	44	65	0	20	11
EL	0	16	24	0	3	20	0	14	3
ES	128	345	489	58	113	96	70	232	394
FI	743	944	991	687	798	882	56	146	109
FR	213	382	613	125	185	424	88	197	190
HR	0	3	37	0	3	35	0	0	2
HU	6	198	178	6	28	84	0	170	94
IE	8	27	59	0	4	5	8	23	53
IT	120	812	1.677	56	280	834	64	532	844
LT	0	13	37	0	13	37	0	0	0
LU	2	7	12	0	5	8	2	2	4
LV	0	6	71	0	5	71	0	1	0
MT	0	0	1	0	0	1	0	0	0
NL	171	605	422	65	350	323	107	255	99
PL	19	542	684	16	521	508	3	21	176
PT	112	225	264	89	135	150	23	90	115
RO	0	10	46	0	6	36	0	4	10
SE	352	1.048	988	352	1.048	988	0	0	0
SI	6	19	24	6	18	24	0	1	0
SK	0	57	149	0	57	139	0	0	10
UK	338	1.055	2.583	35	86	106	304	969	2.477

Source: Eurostat

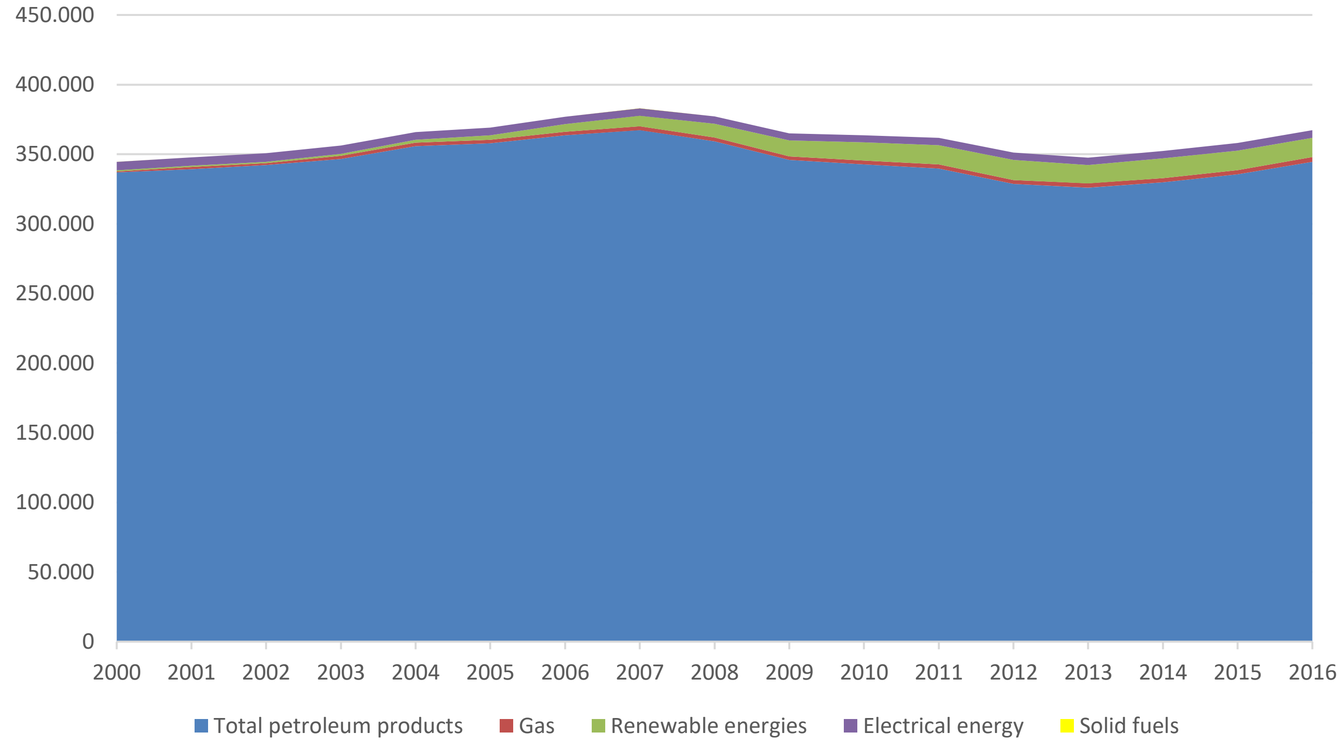
Bioelectricity generation increased significantly between 2000 and 2010. This is mainly due to the entry into force of the Renewable Energy Directive, which introduced a binding renewable energy target of 20% RES share by 2020. This objective reflects the importance of political support and the role of supportive policies for bioenergy deployment. Bioenergy and biopower should continue to grow and play an important role in the future, despite the lower ambition agreed for the period 2020-2030 (32% binding at EU level, no binding target at national level).

6

BIOFUELS FOR TRANSPORT

6.1 Transport sector in Europe

Figure 6.1 Evolution of the final energy consumption by energy type in the transport sector in EU28 (ktoe)



Note: Renewable electricity in transport not included in the “Renewable energy” category
Source: Eurostat

Final energy consumption in transport accounted for 367.272 ktoe in 2016, out of which 93,8% was from oil. According to Eurostat, the contribution of renewables to the transport sector (RES-T) is 13.840 ktoe (see table 6.1). It should be noted that this figure only includes statistics for biogas and liquid biofuels and excludes renewable electricity used for transport.

Table 6.1 Final energy consumption in the transport sector in EU28 in 2016 (ktoe)

	All products	Solid fuels	Total petroleum products	Gas	Electricity	Biofuels	Biogas	Bioethanol	Biodiesel	Bioliquids
Total	367.272	12	344.648	3.284	5.488	13.840	132	2.620	11.083	5
Rail	6.410	12	1.941	0	4.424	33	0	0	33	0
Road	300.157	0	284.494	1.744	123	13.796	131	2.619	11.041	5
International aviation	47.482	0	47.482	0	0	0	0	0	0	0
Domestic aviation	5.849	0	5.849	0	0	0	0	0	0	0
Domestic Navigation	4.575	0	4.570	0	0	5	0	1	4	0
Consumption in Pipeline transport	1.662	0	1	1.505	156	0	0	0	0	0
Non-specified (Transport)	1.138	0	312	35	785	7	1	0	6	0

Source: Eurostat

Table 6.2 Final energy consumption of the different fuels used in the transport sector in 2016 in EU28 Member States (ktoe)

	All products	Total petroleum products	Gas	Electrical energy	Biofuels
EU28	367.272	344.648	3.284	5.488	13.840
AT	9.187	8.128	257	269	533
BE	10.514	9.895	38	140	441
BG	3.492	3.068	230	30	163
CY	931	922	0	0	9
CZ	6.734	6.236	55	141	301
DE	65.173	61.146	446	1.009	2.572
DK	5.110	4.835	3	36	236
EE	811	801	4	4	3
EL	6.789	6.592	19	28	149
ES	34.966	33.069	345	463	1.088
FI	4.956	4.710	8	61	177
FR	49.616	45.591	68	927	3.030
HR	2.163	2.137	4	22	1
HU	4.536	4.199	48	101	187
IE	4.948	4.826	0	4	118
IT	39.110	36.004	1.106	960	1.041
LT	1.961	1.866	31	6	57
LU	2.422	2.319	0	13	90
LV	1.158	1.136	0	9	13
MT	322	315	0	0	6
NL	14.295	13.850	43	161	242
PL	19.240	18.118	383	283	457
PT	6.775	6.458	19	33	265
RO	6.029	5.680	1	90	257
SE	9.051	7.488	33	229	1.301
SI	1.904	1.869	3	14	18
SK	2.480	2.146	142	52	140
UK	52.601	51.243	0	402	946

Source: Eurostat

6.2 Renewables in transport: towards the 2020 targets

To compile with the 2020 targets, Article 3(4) of the RES Directive defines a methodology for calculation of % RES-T that includes some multipliers which alter the real figure. According to this methodology RES contribution in the transport sector is the sum of the following:

-Liquid and gaseous biofuels for all modes of transport compliant with Articles 17 and 18 of Directive 2009/28/EC., where a multiplier of 2 is applied for biofuels produced from wastes, residues, non-food cellulosic materials and ligno-cellulosic materials as defined in Article 21(2).

-Renewable electricity, calculated by applying the national or European renewable electricity share (RES-E) to the total electricity consumption in transport, on the basis of the quantity of renewable electricity supplied to the power grid, with a multiplier of 2.5 for electricity used for rail transport and 5 for road transport, as defined in Article 3(4)(c). The RES-E share of year n-2 is applied ('… as measured two years before …').

-Hydrogen of renewable origin in all modes of transport.

-Other forms of renewable energy used in the transport sector.

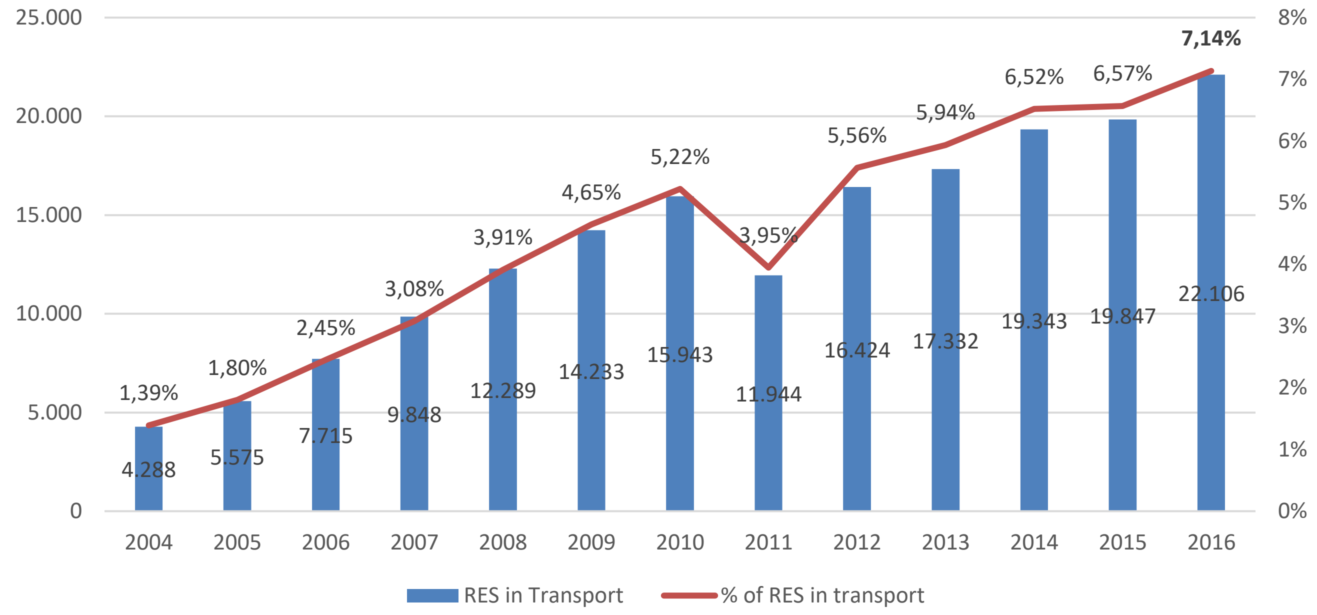
For the purpose of this calculation, the denominator 'energy consumed in transport' is defined as the sum of the following elements: Petrol in all modes of transport (motor gasoline plus aviation gasoline); diesel in all modes of transport (non-bio gas/diesel oil; All biofuels (compliant and non-compliant) in road and rail transport (including respective quantities with multiplier as defined in the paragraph above) and electricity in all modes of transport (including respective quantities with multiplier).

The multiplication factors create **virtual renewable energy**, which are counted for the target but non-existing in reality. This virtual energy does not contribute to reduction of GHG emissions in the transport sector or to replacement of fossil fuels. Moreover, the recent changes to the RES Directive to include indirect land use change (ILUC) concerns will produce a stronger incentive for renewable electricity in transport.

The following three figures (6.2, 6.3, 6.4) and table 6.3 present the contribution of renewables in transport as determined using the %-RES-T calculation described above according to Directive 2009/28/EC. It should be noted that the dataset used for this chapter was not produced from the database of Eurostat, so the results may differ slightly from the biofuel statistics displayed in the other chapters of this report, which are based on Eurostat data.

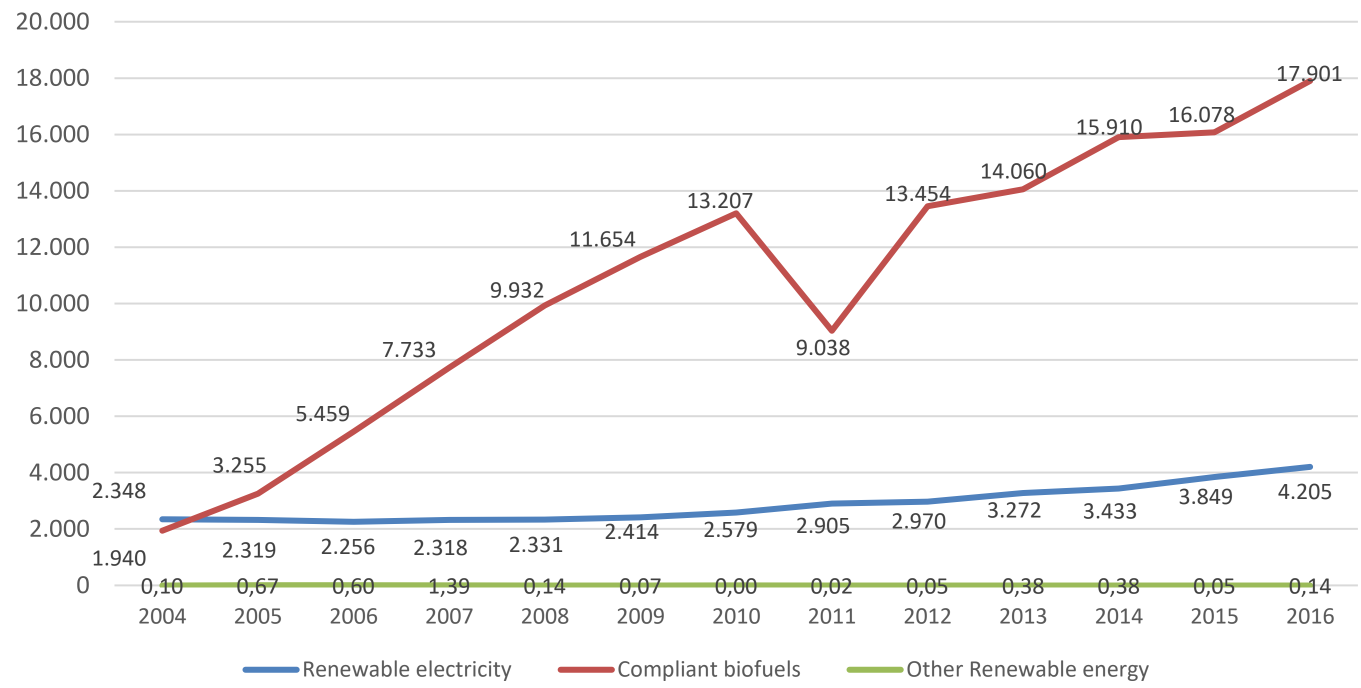
Referring to figures 6.2 and 6.3, the significant but temporary decrease in renewable energy consumption in 2011 is due to the implementation of sustainability legislation that altered the reporting requirements for biofuels. From then on, the statistics only account for biofuels that are demonstrated to be compliant with Articles 17 and 18 of Directive 2009/28/EC. .

Figure 6.2 Evolution of renewable energy consumption in the transport sector* in EU28 (ktoe and %)



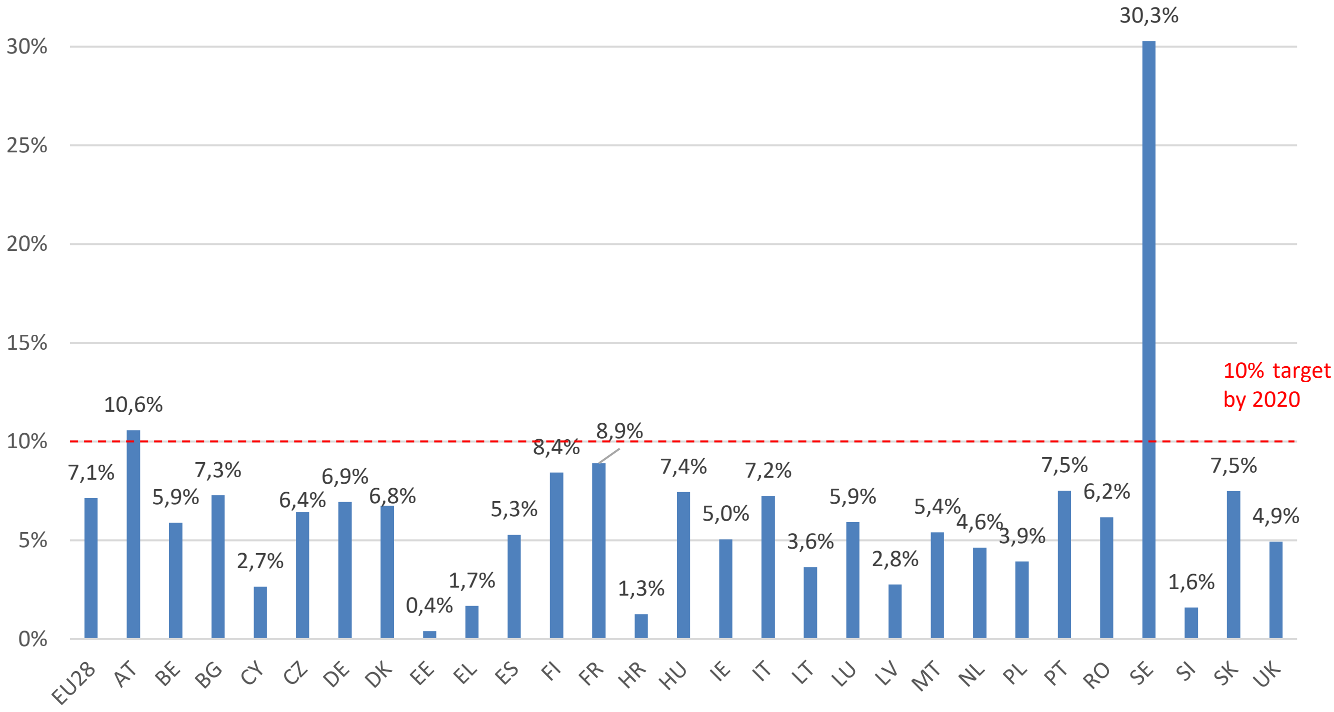
*Multipliers applied
Source: Eurostat, SHARE 2016

Figure 6.3 Evolution of renewable energy consumption in the transport sector* by fuel type in EU28 (ktoe)



*Multipliers applied
Source: Eurostat, SHARE 2016

Figure 6.4 Status towards fulfilling the 2020 targets for renewable energies in the transport sector in EU28 Member States in 2016 (%)



*Multipliers applied
Source: Eurostat, SHARE 2016

When the multipliers of the RES directive are applied, it appears that the transport sector consumed 22.106 ktoe of renewable energy. Without applying multipliers, the figure becomes 15.917 ktoe. Table 6.3 shows the true consumption of renewables in transport, in ktoe and the percent of the total energy consumption in the transport sector, as well as the same figures with the multipliers applied.

Table 6.3 Share of renewables in the transport sector in EU28 Member States in 2016 with and without application of multipliers (ktoe)

	RES in transport according to European commission methodology		RES in transport without multipliers		
	RES in transport (ktoe)	Contribution RES-T (%)	RES in transport (ktoe)	Contribution RES-T (%)	Difference
EU28	22.106	7,14%	15.917	5,24%	1,89%
AT	894	10,58%	704	8,52%	2,06%
BE	534	5,89%	470	5,22%	0,67%
BG	186	7,27%	172	6,73%	0,55%
CY	17	2,65%	9	1,36%	1,29%
CZ	400	6,42%	339	5,49%	0,93%
DE	3.890	6,94%	2.832	5,15%	1,79%
DK	279	6,76%	253	6,16%	0,59%
EE	3	0,40%	1	0,14%	0,26%
EL	86	1,68%	57	1,13%	0,55%
ES	1.497	5,28%	1.334	4,73%	0,55%
FI	371	8,43%	197	4,67%	3,77%
FR	3.871	8,90%	3.370	7,84%	1,06%
HR	24	1,26%	11	0,56%	0,70%
HU	323	7,44%	214	5,04%	2,40%
IE	207	5,05%	120	2,98%	2,07%
IT	2.377	7,24%	1.360	4,27%	2,97%
LT	62	3,63%	58	3,42%	0,22%
LU	115	5,92%	91	4,71%	1,21%
LV	27	2,76%	15	1,54%	1,22%
MT	11	5,41%	6	3,15%	2,26%
NL	478	4,63%	276	2,73%	1,90%
PL	642	3,92%	535	3,29%	0,63%
PT	410	7,51%	277	5,20%	2,31%
RO	353	6,17%	295	5,20%	0,97%
SE	2.814	30,29%	1.622	20,02%	10,27%
SI	30	1,60%	23	1,23%	0,37%
SK	172	7,50%	151	6,66%	0,84%
UK	2.031	4,94%	1.126	2,80%	2,14%

Source: Eurostat, SHARE 2016

6.3 Liquid biofuels for transport

Table 6.4 Biofuels capacity by EU28 Member States in 2016 (1000 tonnes)

	Bioethanol	Biodiesel	Bioliquids
EU28	6.972	21.314	4.772
AT	220	646	646
BE	408	450	71
BG	27	160	0
CY	0	5	0
CZ	160	420	0
DE	790	4.125	3.828
DK	0	0	0
EE	0	0	0
EL	0	994	0
ES	464	4.237	0
FI	40	480	50
FR	1.615	2.305	40
HR	0	41	0
HU	500	157	0
IE	0	30	0
IT	332	2.212	0
LT	20	140	0
LU	0	0	0
LV	19	173	0
MT	0	1	0
NL	421	1.927	0
PL	858	1.151	0
PT	0	721	52
RO	80	200	0
SE	178	132	86
SI	0	0	0
SK	118	125	0
UK	723	481	0

Source: Eurostat

Table 6.5 Primary production and net imports of liquid biofuels in EU28 Member States in 2016 (ktoe)

	Total biofuels			Bioethanol		Biodiesel		Bioliquids	
	Primary production	Net import	Biofuel import dependency	Primary production	Net import	Primary production	Net import	Primary production	Net import
EU 28	13.771	1.215	8%	2.254	431	10.762	357	756	427
AT	395	181	32%	139	-81	255	262	1	0
BE	375	75	17%	160	-117	212	190	3	2
BG	74	90	55%	17	15	56	74	0	0
CY	0	8	94%	0	0	0	8	0	0
CZ	206	97	32%	75	-21	132	118	0	0
DE	3.374	-566	-20%	443	302	2.795	-868	137	0
DK	7	225	92%	0	0	0	225	7	0
EE	0	3	100%	0	3	0	0	0	0
EL	138	35	21%	0	0	138	35	0	0
ES	1.370	-395	-35%	168	-37	1.202	-358	0	0
FI	161	72	31%	0	72	109	0	52	0
FR	2.406	709	23%	386	87	2.019	622	1	0
HR	1	-1	-56%	0	0	1	-1	0	0
HU	411	-235	-124%	270	-211	140	-23	0	0
IE	24	95	83%	0	34	24	61	0	0
IT	1.002	947	49%	15	17	509	505	478	425
LT	100	-42	-73%	9	-1	91	-40	0	0
LU	0	90	100%	0	9	0	81	0	0
LV	43	-32	-266%	3	5	40	-37	0	0
MT	1	8	127%	0	0	1	8	0	0
NL	1.292	-1.021	-486%	0	128	1.292	-1.150	0	0
PL	922	-455	-99%	126	43	794	-497	2	0
PT	298	-24	-9%	0	23	296	-47	2	0
RO	187	77	30%	36	45	151	32	0	0
SE	281	896	76%	110	2	97	894	74	0
SI	0	19	100%	0	4	0	15	0	0
SK	162	-18	-12%	59	-43	104	25	0	0
UK	543	375	40%	238	151	304	224	0	0

* Import dependency is calculated as net imports divided by the gross inland consumption. Energy dependency may be negative in the case of net exporter countries.
Source: Eurostat

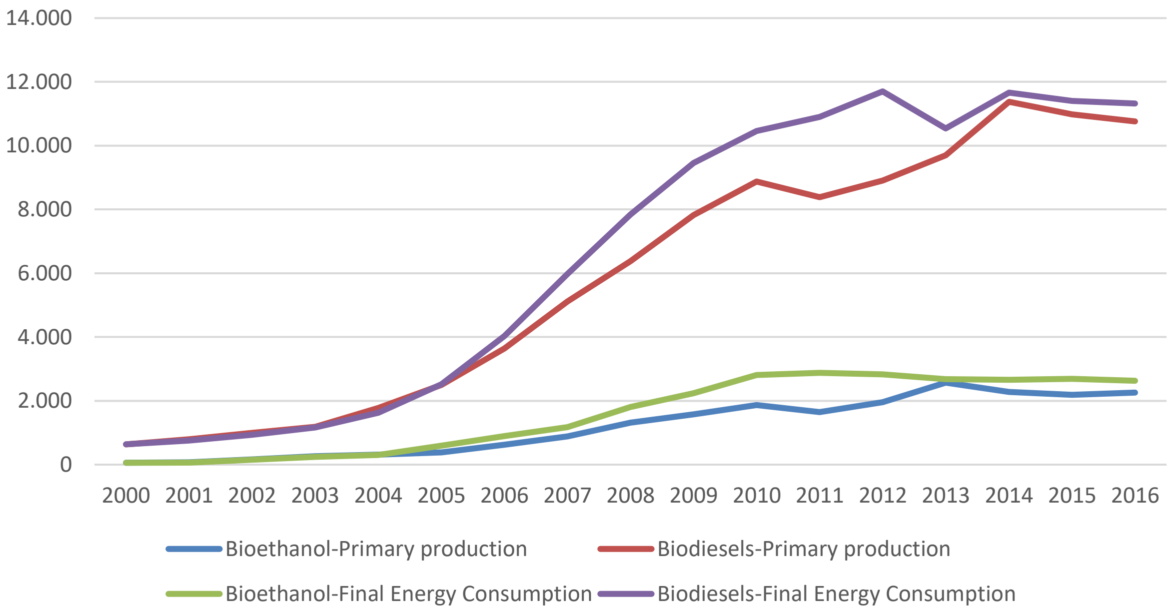
With around 80% of the market share, biodiesel is the most widely used biofuel in Europe, with more than 11 million tonnes of biodiesel blended into the European transport energy mix. These include around 3 million tonnes of waste-based biodiesel, reinforcing the industry's efforts to use different raw materials and contribute to the circular economy. This sustainable biodiesel delivers significant GHG emissions savings, mitigates the need for the EU to import additional animal feed and avoids the need to import even more fossil fuels from third countries.

For biodiesel to maintain its role in the decarbonization of the EU economy, in particular for freight transport where electrification is not an option, full traceability of all raw materials is essential to ensure that the European industry only uses sustainable feedstocks to produce its renewable energy. To this end, alongside the 14% target for renewables in the transport sector, the EU-wide traceability database recently agreed in the frame of the post-2020 EU Renewable Energy Directive is a positive step, as it can avoid any concerns with potential fraudulent and eliminate any worries about sustainability of biofuels and their raw materials.

Raffaello Garofalo
Secretary General
European Biodiesel Board

EBB
EUROPEAN BIODIESEL BOARD

Figure 6.5 Evolution of primary production and final energy consumption of biodiesel and bioethanol in EU28 (ktoe)



Source: Eurostat

Table 6.6 Share of the total use of biofuels in the transport sector by type in 2016 (ktoe, %)

	Consumption indicator	Energy (in ktoe)	Share use in transport sector (in %)
Bioethanol	Final energy consumption	2.668	
	Final energy consumption in transport	2.620	98,2%
Biodiesel	Final energy consumption	11.222	
	Final energy consumption in transport	11.083	98,8%
Bioliquids	Final energy consumption	1.183	
	Final energy consumption in transport	5	0,4%
Total	Final energy consumption	15.072	
	Final energy consumption in transport	13.708	91,0%

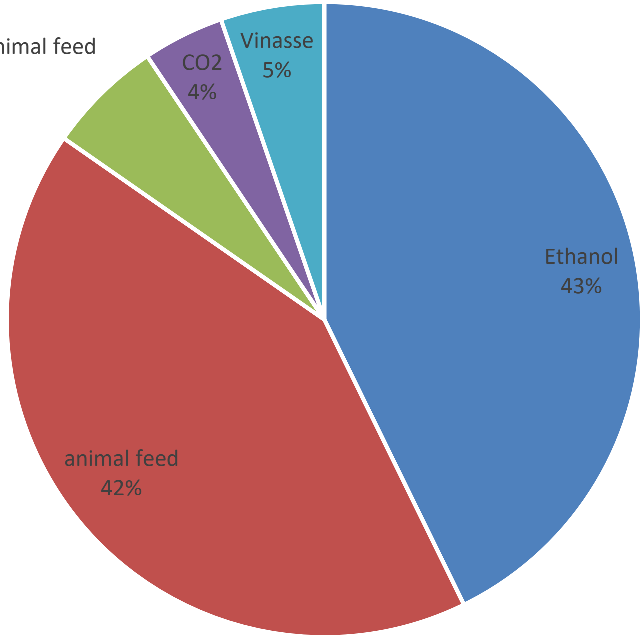
Source: Eurostat

Table 6.7 Final energy consumption of biofuels in the transport sector in EU28 Member States in 2016 (ktoe)

	Biogasoline	Biodiesel
EU28	2.620	11.083
AT	57	475
BE	43	398
BG	33	130
CY	0	9
CZ	48	253
DE	746	1.792
DK	0	236
EE	3	0
EL	0	149
ES	133	955
FI	68	109
FR	447	2.582
HR	0	1
HU	44	143
IE	32	86
IT	33	1.008
LT	6	50
LU	9	81
LV	8	4
MT	0	6
NL	121	121
PL	168	290
PT	26	236
RO	81	176
SE	109	1.093
SI	4	14
SK	16	125
UK	386	560

Source: Eurostat

Figure 6.6 Share of mass output of Epure members' Ethanol plant in Europe in 2016 (in %)



Source: ePURE

European renewable ethanol continued to improve its greenhouse-gas-reducing performance in 2017, with an average savings of more than 70% over fossil fuels – a record high. For the sixth year in a row, ethanol increased its GHG-reduction score, confirming its value as a sustainable biofuel contributing to the achievement of EU climate goals.

Other audited industry statistics from 2017 highlight the importance of European ethanol production and use. Members of ePURE, the European renewable ethanol association, produced 5.84 billion liters of ethanol (from an installed capacity of 6.84 billion liters) and 5.71 million tonnes of beneficial co-products. Some 81% of the renewable ethanol produced in 2017 was for fuel use, with 10% for industrial use and 9% for food and beverage.

Co-products from European ethanol production included 4.32 tonnes of high-protein animal feed and 0.77 million tonnes of captured CO_2. Virtually all of the feedstock used by ePURE members to produce ethanol was sourced from Europe. This included 11.41 million tonnes of cereals, 1.81 million tonnes of sugars and 0.41 million tonnes of ligno-cellulosic, other RED Annex IX-A and other feedstocks.

Emmanuel Desplechin
Secretary General
ePURE

ePURE european renewable ethanol

7

BIOGAS

7.1 Biogas sector in Europe

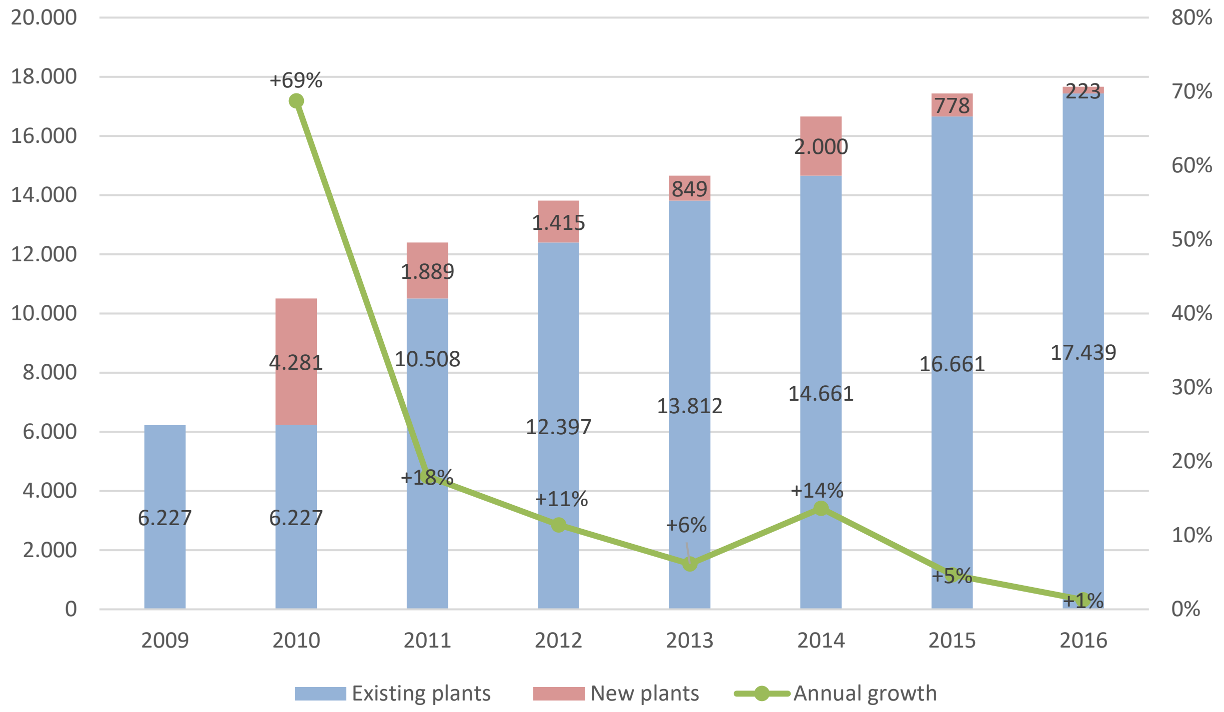
Six countries have currently achieved their biogas target for 2020 under the National Renewable Energy Action Plans (NREAPs): Austria, Germany, Italy, Portugal Sweden and the United Kingdom.

Table 7.1 Primary energy production of biogas by type in EU28 Member states in 2016 and 2020 NREAPs targets (in ktoe)

	Biogas	Landfill Gas	Sewage Sludge Gas	Other biogases from anaerobic fermentation	NREAPs targets
EU28	16.600	2.677	1.455	12.388	20.820
BE	227	22	26	179	162
BG	60	0	0	60	418
CZ	601	25	42	534	111
DK	218	5	25	189	35
DE	8.095	84	464	7.547	902
EE	11	7	4	0	7.748
IE	56	40	9	8	807
EL	102	73	17	13	0
ES	245	139	62	21	220
FR	760	286	72	402	761
HR	47	5	4	38	137
IT	1.875	366	53	1.450	1.562
CY	12	0	1	11	0
LV	90	8	3	80	222
LT	32	9	8	16	117
LU	20	0	2	18	1.796
HU	89	18	23	47	160
MT	2	0	0	2	51
NL	319	16	58	245	201
AT	313	4	13	296	0
PL	261	58	120	84	1.485
PT	80	68	3	9	1.520
RO	18	0	0	18	50
SI	30	4	2	24	233
SK	152	12	11	129	26
FI	112	23	15	25	90
SE	174	7	76	91	282
UK	2.601	1.401	345	855	1.724

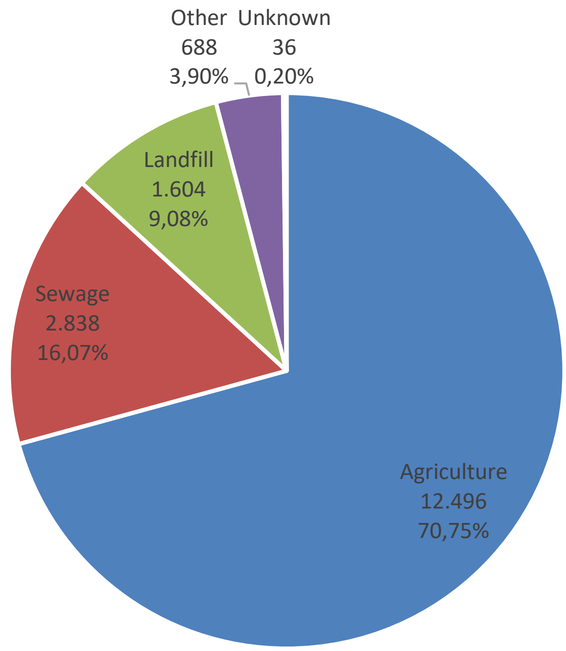
Source: Eurostat

Figure 7.1 Evolution of the number of biogas plant in the EU28



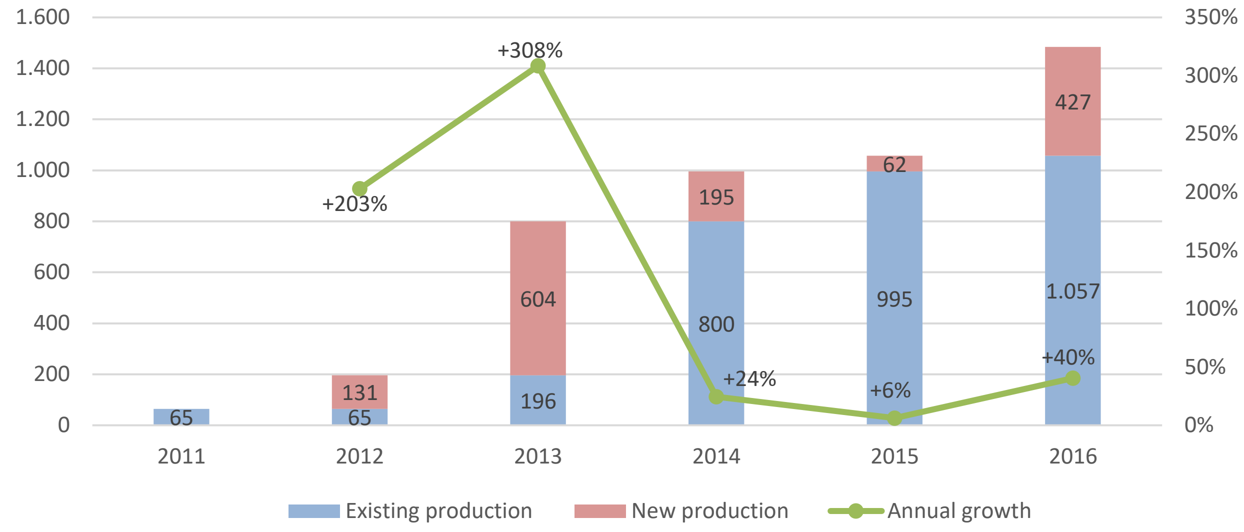
Source: EBA

Figure 7.2 Distribution of biogas plants by substrate in the Europe* in 2016 (number of plants)



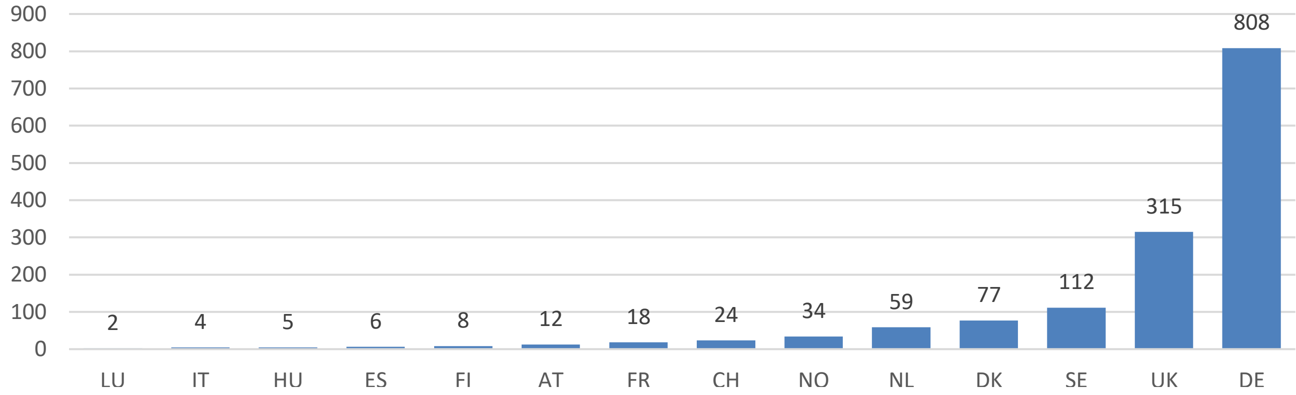
*EU28 + Switzerland + Norway
Source: EBA

Figure 7.3 Evolution of the production of biomethane in Europe* (in ktoe, %)



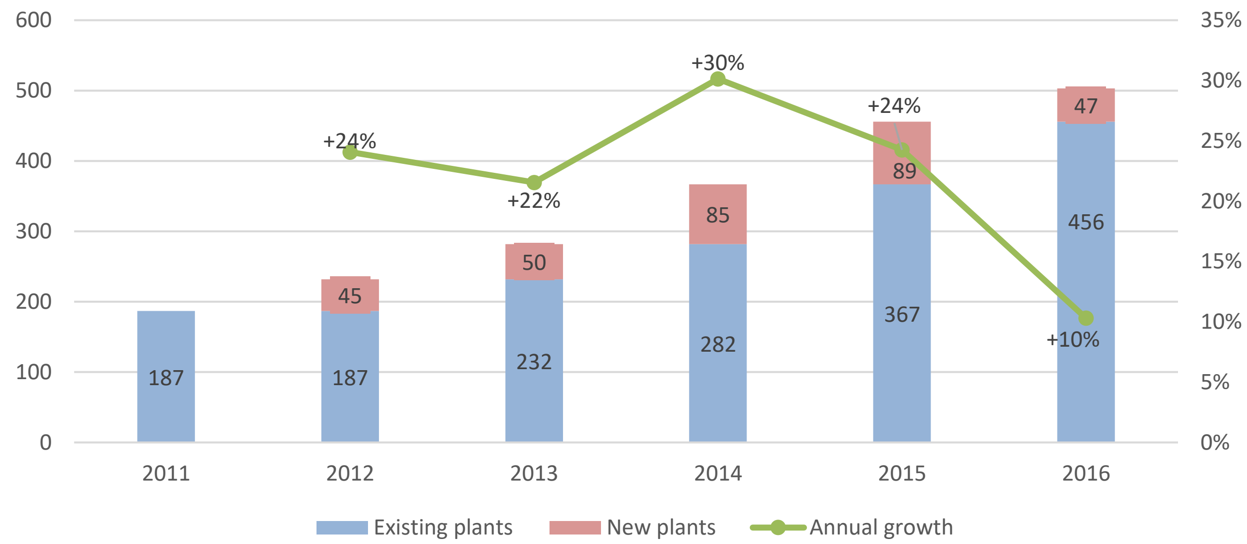
*EU28 + Switzerland + Norway   Source: EBA

Figure 7.4 Production of biomethane in European countries in 2016 (in ktoe)



Source: EBA

Figure 7.5 Evolution of the number of biomethane plants in Europe*



Source: EBA

The biogas sector has grown to a total of 17,662 biogas plant producing 63 TWh of electricity at the end of 2016, equating to an installed electric capacity of roughly 10 GW. The renewable gas sector has made strides over the last two years thanks to renewable gas production from anaerobic digestion and emergent technologies like biomass gasification and power-to-methane. The biogas sector is also concentrating on increased efficiency and increased mitigation of GHG emission through the production of renewable energy, organic fertiliser and renewable gas.

Growth has been particularly strong in the biomethane sector, with a total of 503 biomethane plants in operation and a production increase of 16,512 GWh over the past 5 years, reaching 17,264 GWh in 2016. This increase in production was produced mainly in three countries: Germany, with 900 GWh of increased production, France with 133 GWh, and Sweden with 78 GWh. Biomethane provides the end user with several advantages, including freedom to choose a renewable product, energy security, flexibility, and easy transportation and storage.

Changes to the legal framework will create new economic conditions for the next decades: the Waste Framework Directive finally addresses waste separation, which has been insufficient. Better waste separation will accelerate the production of biogas and the implementation of a truly circular economy. The recast of the Renewable Energy Directive has initiated the creation of a common European market for biomethane by extending guarantees of origin to renewable gas, and harmonising critical elements like sustainability criteria. Soon, the Gas Package will re-design the gas market, paving the way for a green gas grid.

It is the flag-ship project of both the European Biogas Association (EBA) and the young European Renewable Gas Registry (ERGaR) to ensure that renewable gas can fulfil its crucial role in ensuring a cost-effective energy transition in Europe. ERGaR is an international non-governmental non-profit organisation whose mission is to establish a European biomethane market by removing non-technical barriers. ERGaR's main goal is to boost the European biomethane market by establishing suitable pre-conditions, market strategies and business models focused on enabling European biomethane trade. ERGaR is working to pave the way for an integrated biomethane market, allowing trade along the European gas grid.

Stefanie Königsberger
Technical and Project Officer
European Biogas Association

EBA
European Biogas Association

8

PELLETS

FOREWORD

Recovery, dynamism and variety!

After several years of disappointing demand in Europe, the pellet market began to recover in late 2016. Both on the industrial and residential/domestic markets, the recovery has allowed the industry to clear out its stocks and brought market conditions back to normal, with a positive impact on prices.

Growth in EU28 pellet production has slowed somewhat, but nonetheless there are promising signs in countries all over Europe, including France, Spain, and Poland despite differences in the character of their domestic markets. The Balkans are a recent success story - altogether the region produced more than 1 million tonnes of pellets in 2017, out of the 16 million tonnes produced across Europe. Moreover, those pellets are produced in relatively small plants, demonstrating the versatility of the pellet market, where large, centralised production facilities are not always the best business model. There has also been sustained growth in countries peripheral to the EU28, notably Russia.

New routes to feed the European markets have emerged around the globe. South America is probably the best example, recently witnessing a steady growth in production even though the total volume remains limited. Production in Southeast Asia is also booming, in response to a tremendous increase in consumption occurring in South Korea and Japan.

Favourable weather conditions and increases in the price of heating oil have brought new dynamism to the European residential and commercial heating markets. Furthermore, a sharp increase in sales of pellet heating appliances has caused many traditional exporters to quickly transform into net importers. The commercial heating sector, while remaining a sleeping giant, has shown encouraging signs, recording a higher growth rate than the residential market.

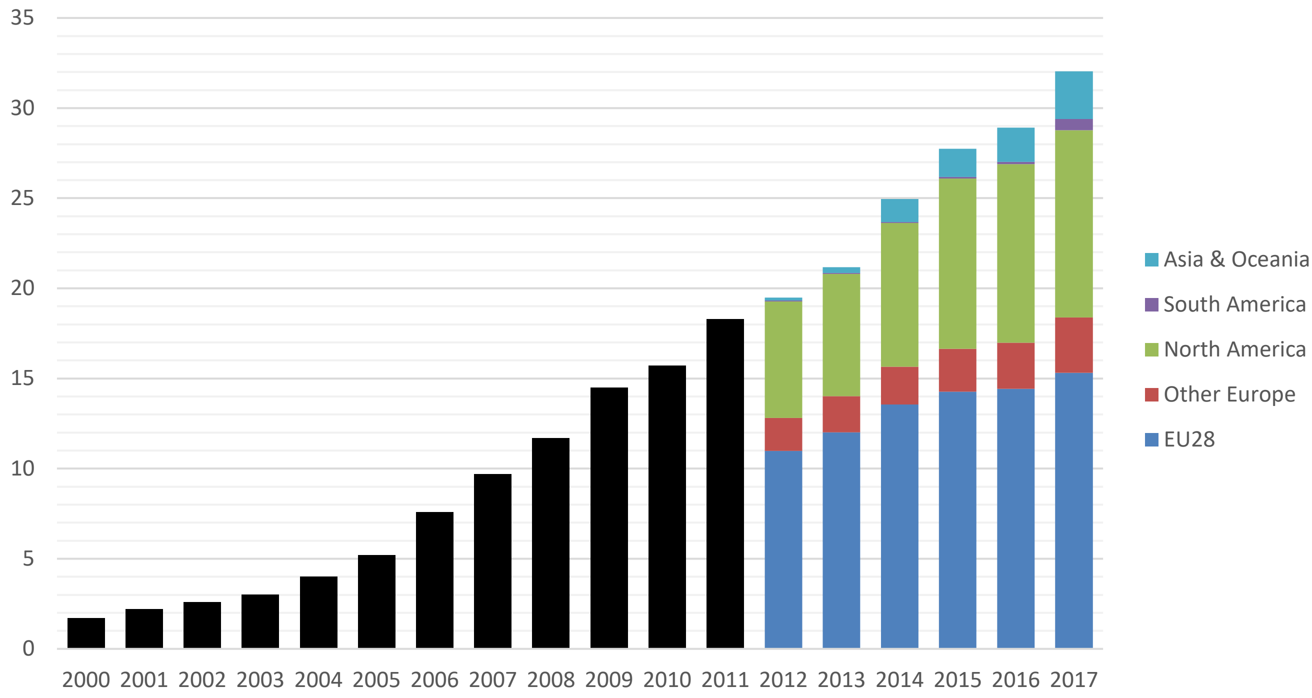
After a quiet period, the European industrial pellet industry has also shown new life thanks to the growth in Denmark and United Kingdom. Observers are also looking to The Netherlands where more than 3 million tonnes of pellets could be used in the near future, depending on the policy framework.

Dynamism in the pellet market doesn't come without some tension. Sudden rises in consumption or unexpectedly cold weather can lead to momentary shortages of supply. To ensure against these shocks, it is essential that the industry enhances its flexibility on the market. One way to do this is by standardising the products using recognisable trademarks like EN*plus*®. It is also important to recognize the value of collaboration – the industry as a whole will benefit from sharing expertise with other pellet stakeholders. And what better option to do so than Bioenergy Europe!

8.1 OVERVIEW OF WORLD PELLET SECTOR

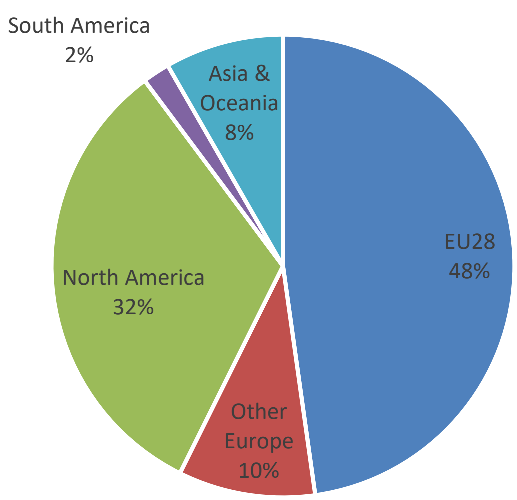
8.1.1 WORLD PELLET PRODUCTION

Figure 8.1 Evolution of pellet production in the World (million tonnes)



Note: IE, JP, NZ, UA: 2017 production is a replication of 2016; BE: 2017 production estimated by EPC; RO: production estimated by EPC.
Source: EPC survey 2018; FAO; Future Metrics

Figure 8.2 Distribution of world pellet production in 2017 (%)



Note: IE, JP, NZ, UA: 2017 production is a replication of 2016; BE: 2017 production estimated by EPC; RO: production estimated by EPC.
Source: EPC survey 2018; FAO; Future Metrics

Table 8.1 displays worldwide pellet production statistics. In this table, it can be seen that production rebounded after a relatively tepid 2016, growing 11% in 2017 (+3.133.023 tonnes). Growth was especially strong in developing markets, including South America, Asia and Oceania and Europe outside of the EU 28.

South American production has displayed astonishing growth, especially in Brazil and Chile, where production grew by +385% in 2017. Due to a dearth of statistics, production in other South American countries could not be estimated, and was therefore excluded from these figures.

Across Asia and Oceania, pellet production volume increased by +40% in 2017, led by Vietnam and Malaysia. The increase in production volume in Asia and Oceania was also the second largest increase in absolute terms, representing +24% of the increase of the world production in 2017. Reliable statistics were not available for the Chinese production market. Consequently, no statistics are displayed for China's pellet production.

In relative terms, production in the EU28 countries was healthy but not exceptional. However, in absolute terms, the EU registered the most significant increase in production. Other European countries (including AL, BA, BY, CH, ME, NO, RS, RU, UA), grew more quickly than EU28.

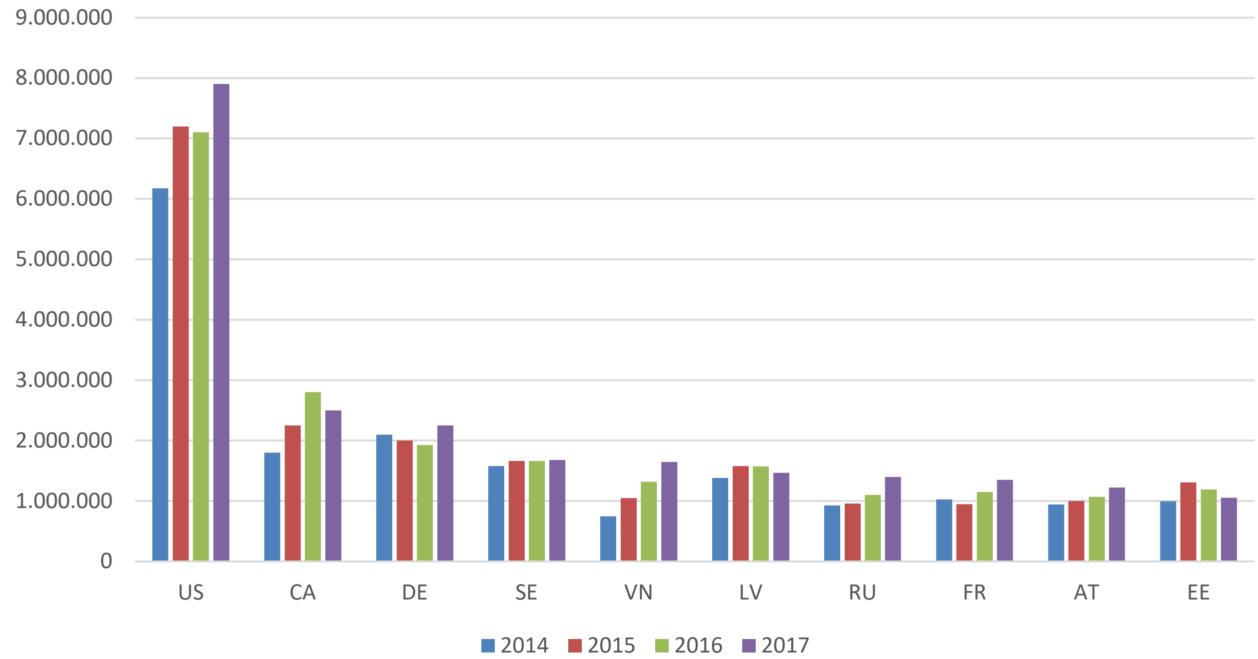
In North America, growth remained tepid, despite substantial growth in US production (see figure 8.4). The lacklustre production statistics are due to a decrease in Canadian production. Although it remains the second largest producer in the world, Canada produced 300.000 tonnes of pellets less than it did in 2016.

Table 8.1 Evolution of pellet production in the World by regions (tonnes)

	2012	2013	2014	2015	2016	2017	Growth 2016-2017
EU28	10.978.087	12.011.594	13.558.541	14.263.427	14.421.208	15.310.461	**6%**
Other Europe	1.835.100	2.003.128	2.084.366	2.384.124	2.568.352	3.069.225	**20%**
North America	6.456.500	6.781.000	7.978.000	9.450.000	9.900.000	10.400.000	**5%**
South America	56.580	61.500	49.390	75.000	125.350	608.300	**385%**
Asia & Oceania	152.853	309.177	1.281.977	1.567.796	1.900.483	2.660.430	**40%**
Total	19.479.120	21.166.399	24.952.274	27.740.347	28.915.393	32.048.416	**11%**

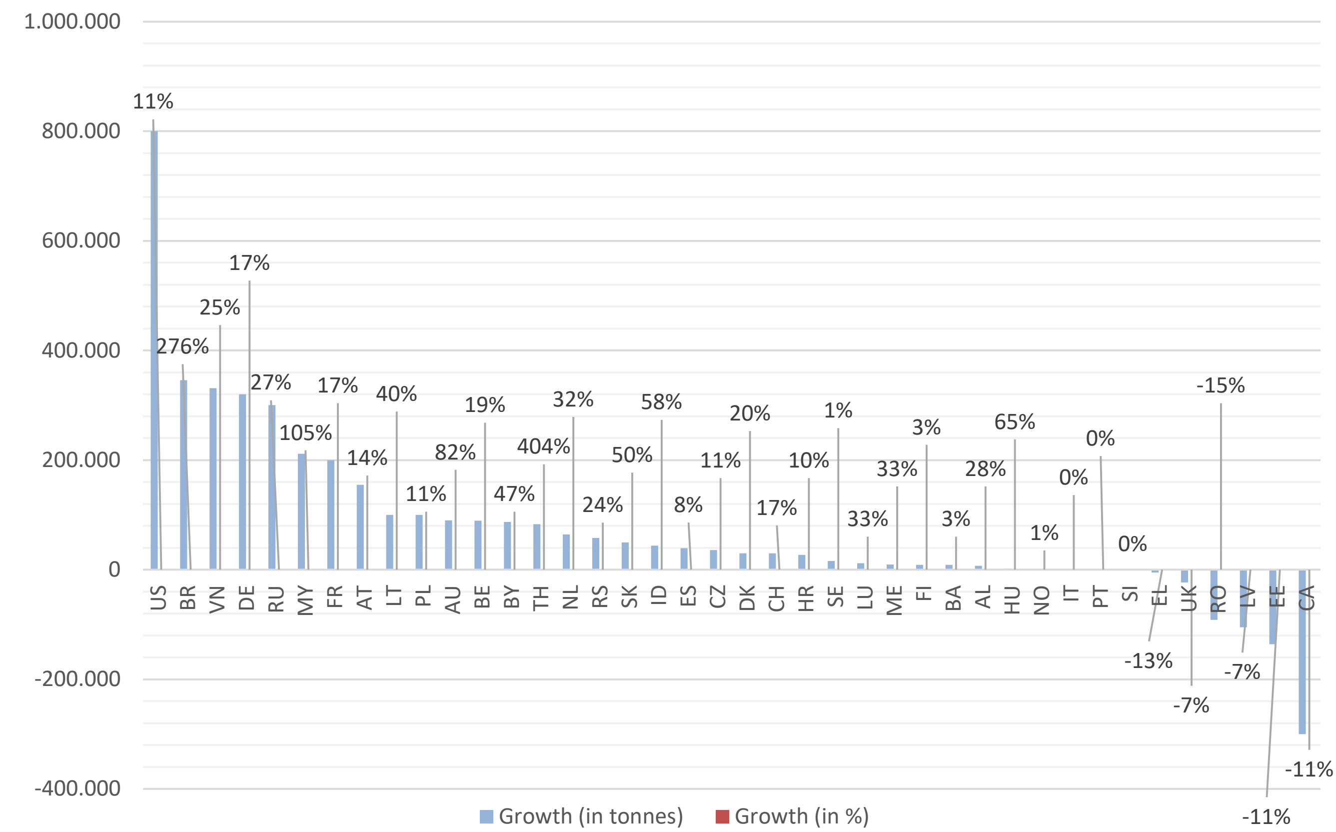
Note: IE, JP, NZ, UA: 2017 production is a replication of 2016; BE: 2017 production estimated by EPC; RO: production estimated by EPC.
Source: EPC survey 2018; FAO; Future Metrics

Figure 8.3 Evolution of pellet production of the TOP 10 of 2017 producers (tonnes)



Source: EPC survey 2018; FAO; Future Metrics

Figure 8.4 Growth in pellet production by countries between 2016-2017 (tonnes and %)



BE: 2017 production estimated by EPC; RO: production estimated by EPC.
Source: Source: EPC survey 2018; FAO; Future Metrics

Table 8.2 World pellet production in 2016 and 2017

	2016			2017		
	Number of operating production plants	Production capacity (tonnes)	Actual production (tonnes)	Number of operating production plants	Production capacity (tonnes)	Actual production (tonnes)
EU28	637	21.949.115	14.421.208	656	22.775.771	15.310.461
Other Europe	520	3.332.000	2.568.352	538	3.555.000	3.069.225
Total Europe	**1.157**	**25.281.115**	**16.989.560**	**1.194**	**25.982.150**	**18.379.686**
North America	**184**	**16.891.000**	**9.900.000**	**185**	**15.638.864**	**10.400.000**
South America	**12**	**265.000**	**125.350**	**33**	**846.800**	**608.300**
Asia & Oceania	**67**	**2.565.000**	**1.900.483**	**67**	**2.745.000**	**2.660.430**
Total	**1.420**	**45.002.115**	**28.915.393**	**1.479**	**45.561.435**	**32.048.416**

Note: IE, JP, NZ, UA: 2017 production is a replication of 2016; BE: 2017 production estimated by EPC; RO: production estimated by EPC, BG, HU, NL, RO, ID, MY, TH: 2017 capacity and number of plants are a replication of 2016; UK capacity: Estimated by EPC
Source: EPC survey 2018; FAO; Future Metrics

North American pellet production increased in the US with the coming on stream of several new plants in the South and declined slightly in Canada with the closure of some start-ups. Most of the production is for export to Europe and Asia, with local demand growing, but at a much slower pace than the export opportunities.

The new and mostly large capacity industrial plants (> 200.000 t/a) are located in the US South and Western Canada with several projects under advanced planning or construction in Eastern Canada also. The new installations tend to be in areas where the sawmill residuals are under-utilized, providing the local sawmill industry relief of their residual products in the wake of reduced continental demand for pulp wood and other uses. Pellet production should therefore continue to expand.

Operators are increasingly working under certification schemes for both sustainability and quality, responding to demands for such by their markets.

Residential pellet production continues to grow slowly, with the winter temperatures of 2017 having been average for the producers from both Canada and the US, maintaining inventories at relatively high levels following a mild winter in 2016. With excess capacity therefore available, a few producers contracted to export small volumes to Europe and should continue to expand those volumes in the coming years with forecasts of continued strong demand.

John W. Arsenault
Director | Market access and promotion
Wood Pellet Association of Canada

WOOD PELLET
ASSOCIATION OF CANADA

Table 8.3 Detailed production table of non-European countries in 2016 and 2017

	2016			2017		
	Number of operating production plants	Production capacity (tonnes)	Actual production (tonnes)	Number of operating production plants	Production capacity (tonnes)	Actual production (tonnes)
North America	**184**	**16.891.000**	**9.900.000**	**185**	**15.638.864**	**10.400.000**
CA	39	3.900.000	2.800.000	40	3.800.000	2.500.000
US	145	12.991.000	7.100.000	145	11.838.864	7.900.000
South America	**12**	**265.000**	**125.350**	**33**	**846.800**	**608.300**
BR	12	265.000	125.350	16	846.800	470.900
CL	n.a.	n.a.	n.a.	17	n.a.	137.400
Asia & Oceania	**67**	**2.565.000**	**1.900.483**	**67**	**2.745.000**	**2.660.430**
AU	9	120.000	110.000	9	300.000	200.000
CN	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
ID	8	355.000	75.853	8	355.000	119.561
JP	6	138.000	126.000	6	138.000	126.000
KR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MY	25	850.000	200.623	25	850.000	412.114
NZ	3	270.000	50.000	3	270.000	50.000
TH	16	832.000	20.611	16	832.000	103.894
VN	n.a.	n.a.	1.317.396	n.a.	n.a.	1.648.861

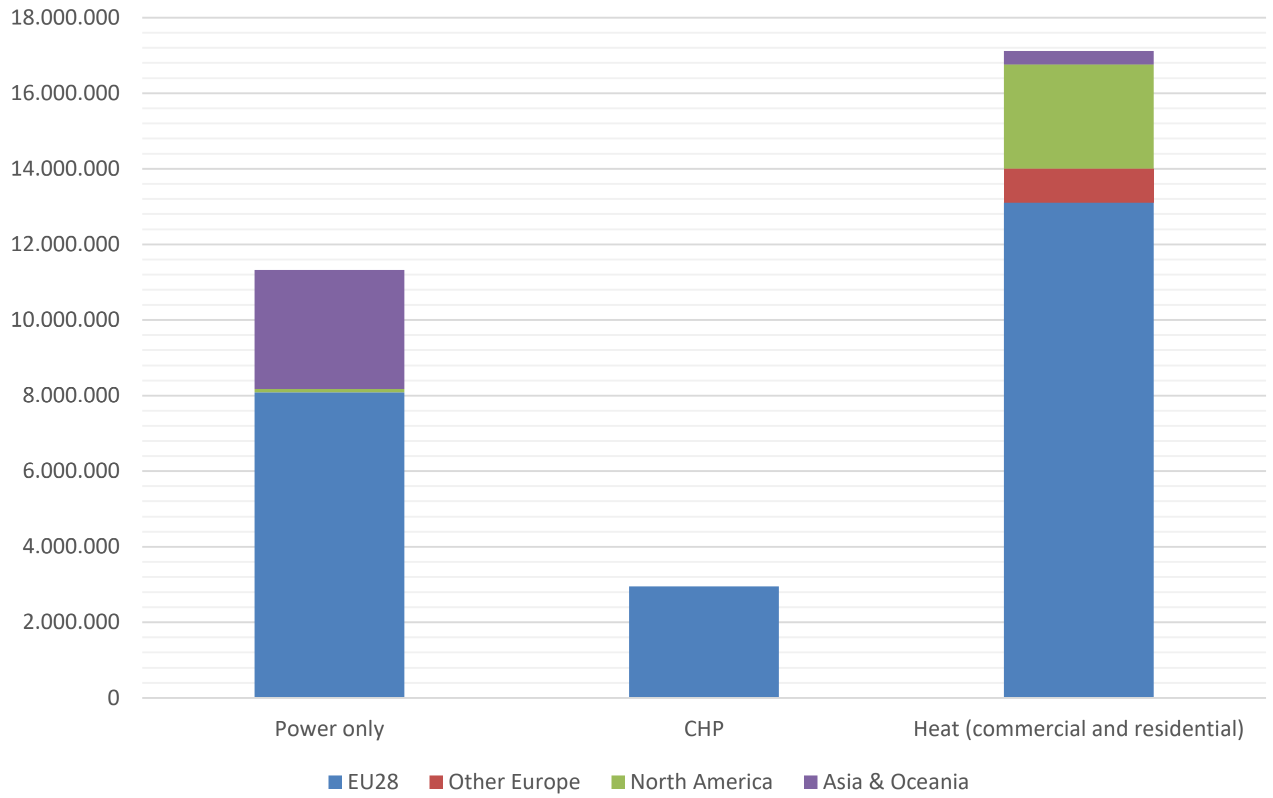
Note: JP, NZ: 2017 production, capacity and number of plants are a replication of 2016; ID, MY, TH: 2017 capacity and number of plants are a replication of 2016.
Source: EPC survey 2018; FAO; Future Metrics

8.1.2 WORLD PELLET CONSUMPTION

World pellet consumption has increased to 31.385.202 tonnes in 2017 or +13% compare to its level of 2016. Industrial pellet consumption increased 2.096.122 tonnes, while residential & commercial consumption increased 1.486.841 tonnes. Notably only two countries, Latvia and Sweden, reported a decrease in consumption in 2017.
5 countries represented 74% of the total increase in consumption (KR, DK, UK, FR, IT) in 2017, while the 10 biggest consumers represented 86% of the world consumption.

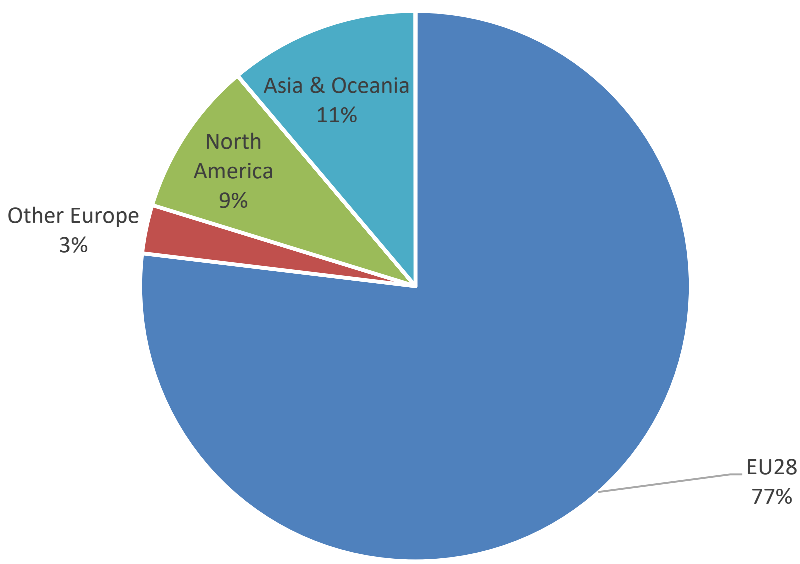
As can be seen in Figure 8.6, the EU28 remains by far the largest consumer of pellets. In Table 8.4, which displays consumption around the world, it can be seen that EU 28 consumption grew by almost 2,3 million tonnes in 2017. Already the largest single consumer of pellets, the UK is expected to continue increasing its pellet consumption as more biomass power plants begin to be put online. For instance, Drax has announced a fourth unit converted to biomass in 2018 and other power plants that are to be put online.
A significant increase in consumption was also observed in Denmark, due to the CHP plants operating in the country, which consumed 2.300.000 tonnes of pellets in 2017 (+46% in CHP consumption). Denmark also has the highest rate of pellet consumption per inhabitant for the residential sector.
European countries outside of the EU28 also displayed robust growth in consumption, although total consumption volume remains relatively small.
Outside of Europe, the most significant growth in consumption occurred in East Asia. South Korea and Japan have lived up to expectations, with an increase of more than 40%, almost exclusively coming from industrial consumption. Together, these two countries account for almost all pellet consumption in Asia and Oceania.

Figure 8.5 World pellet consumption in 2017 by type of end-use (tonnes)



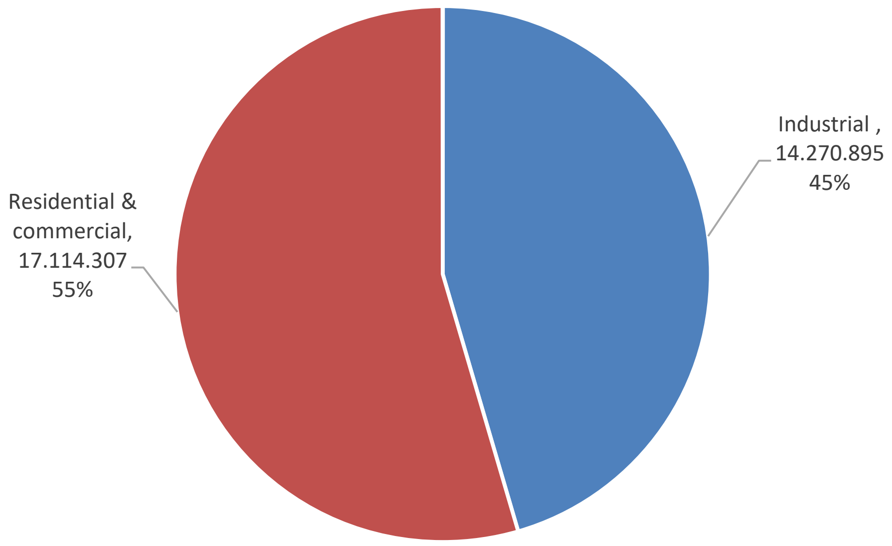
Note: EE, LT, NL, NZ: Consumption 2017 is a replication of 2016; KR, JP: Residential and commercial consumption are a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Sources: EPC survey 2018, Hawkins Wright

Figure 8.6 Distribution of world pellet consumption in 2017 (%)



Note: EE, LT, NL, NZ: Consumption 2017 is a replication of 2016; KR, JP: Residential and commercial consumption are a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Sources: EPC survey 2018, Hawkins Wright

Figure 8.7 World pellet consumption by type of end use in 2017 (tonnes and %)



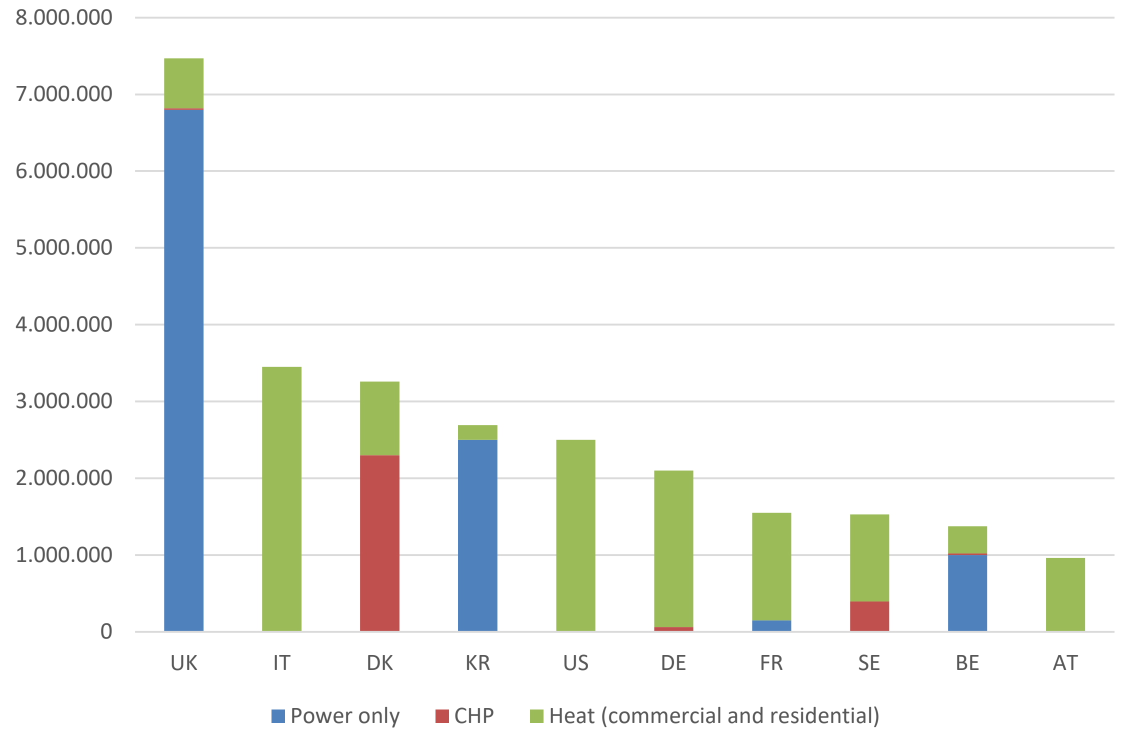
Note: EE, LT, NL, NZ: Consumption 2017 is a replication of 2016; KR, JP: Residential and commercial consumption are a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Sources: EPC survey 2018, Hawkins Wright

Table 8.4 Evolution of pellet consumption in the world by region (tonnes)

	2013	2014	2015	2016	2017	Growth 2016-2017
EU28	16.990.804	17.984.077	21.020.161	21.834.545	24.137.466	11%
Other Europe	325.079	569.134	598.730	704.194	892.236	27%
North America	2.506.000	2.875.000	2.902.000	2.760.000	2.850.000	3%
South America	0	58.000	90.000	n.a.	n.a.	n.a.
Asia & Oceania	168.941	218.551	1.828.500	2.503.500	3.505.500	40%
Total	19.990.824	21.704.762	26.439.391	27.802.239	31.385.202	13%

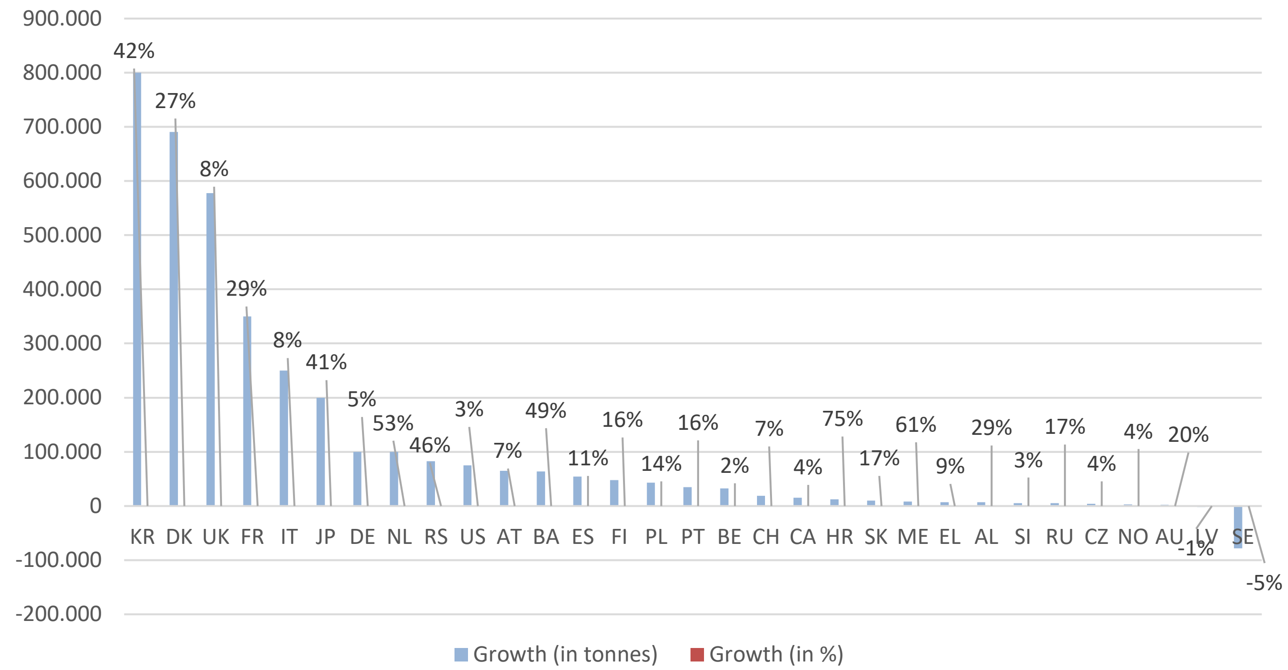
Note: EE, LT, NL, NZ: Consumption 2017 is a replication of 2016; KR, JP: Residential and commercial consumption are a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Sources: EPC survey 2018, Hawkins Wright

Figure 8.8 Top 10 pellet consuming countries by end-use in 2017 (tonnes)



Note: BE: Residential and commercial consumption estimated by EPC.
Sources: EPC survey, 2017; Hawkins Wright

Figure 8.9 Growth in pellet consumption by countries between 2016-2017 (tonnes and %)



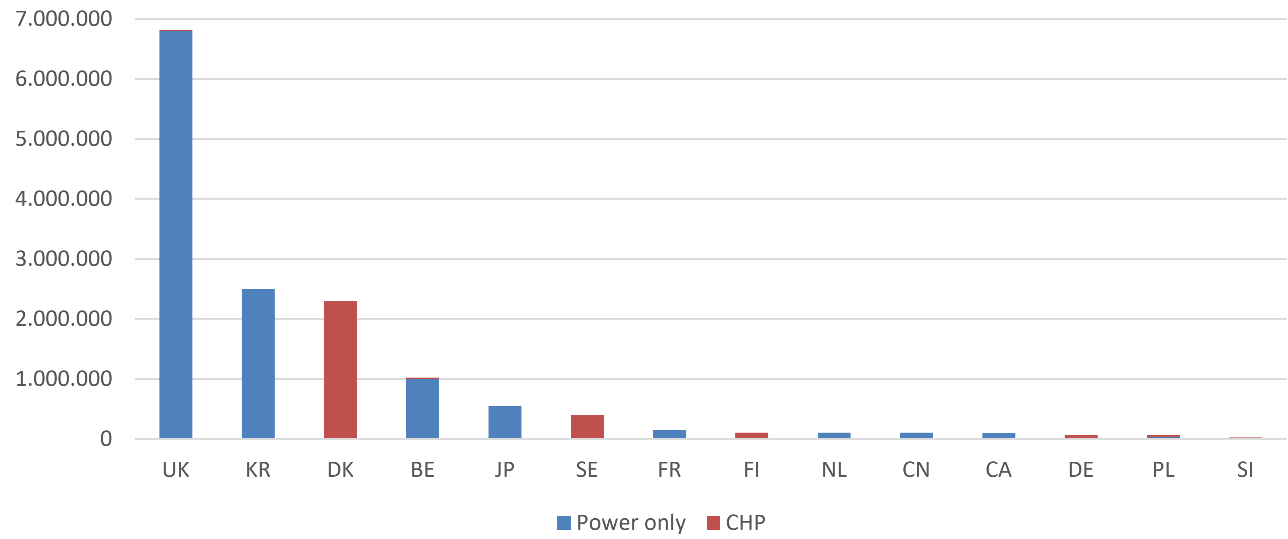
Note: EE, LT, NL, NZ: Consumption 2017 is a replication of 2016; KR, JP: Residential and commercial consumption are a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Sources: EPC survey, 2018; Hawkins Wright

The biggest development in the industrial market in 2017 came in South Korea, where KOEN successfully converted its 125 MW Yeongdong Unit 1 from coal to wood pellets. The station consumed roughly 500.000 tonnes in 2017. Three cofiring plants also contributed to industrial demand growth in Korea in 2017. Hanwha began cofiring at its 222 MW Gunsan plant, OCI at its 303 MW Saemangeum CHP plant and eTEC increased consumption at its 250 MW Gunjang Energy plant.

Although a large number of biomass power projects are under development in Japan, industrial pellet demand rose by a modest 100.000 tonnes in 2017. However Japanese demand is expected to increase significantly between 2020 and 2022, once new power plants in the pipeline come to fruition.

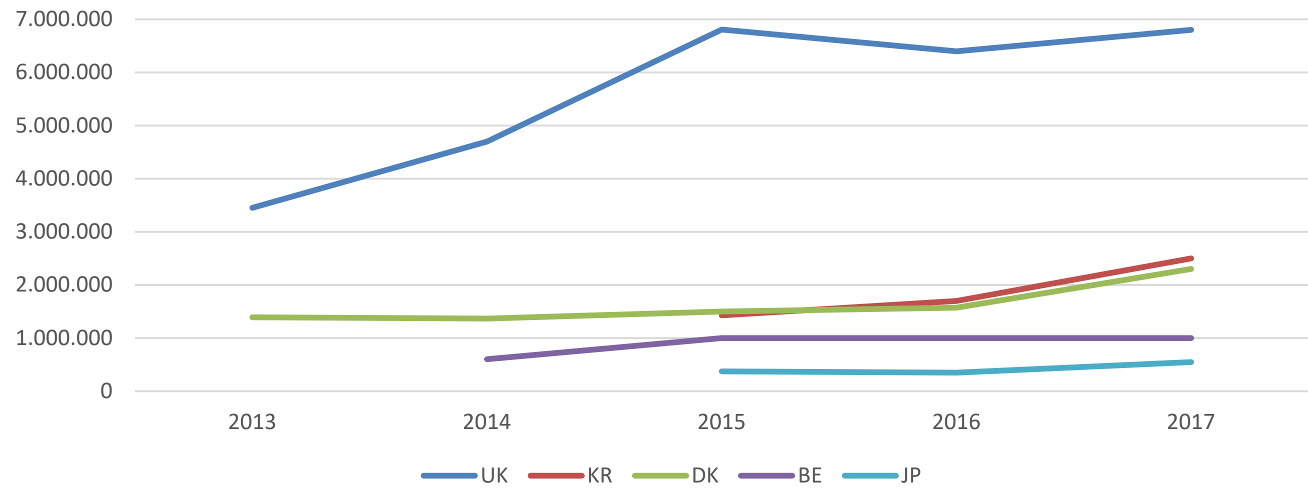
Fiona Matthews
Research Manager
Hawkins Wright

Figure 8.10 World industrial pellet consumption by country in 2017 (tonnes)



Sources: EPC survey 2018, Hawkins Wright

Figure 8.11 Evolution of industrial pellet consumption in top 5 countries in the world (tonnes)



Sources: EPC survey 2018, Hawkins Wright

Table 8.5 World pellet consumption (detailed) in 2016 and 2017 (tonnes)

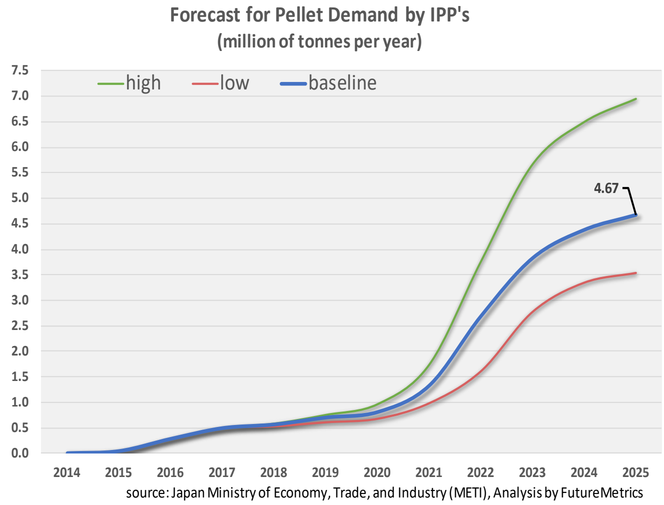
	2016					2017				
	Residential	Commercial	CHP	Power Only	Total	Residential	Commercial	CHP	Power Only	Total
EU28	**9.002.790**	**2.906.982**	**2.399.773**	**7.525.000**	**21.834.545**	**9.741.416**	**3.370.155**	**2.945.895**	**8.080.000**	**24.137.466**
Other Europe	**552.606**	**151.588**	**0**	**0**	**704.194**	**714.470**	**177.766**	**0**	**0**	**892.236**
Total Europe	**9.555.396**	**3.058.570**	**2.399.773**	**7.525.000**	**22.538.739**	**10.455.886**	**3.547.921**	**2.945.895**	**8.080.000**	**25.029.702**
North america	**2.605.000**	**55.000**	**0**	**100.000**	**2.760.000**	**2.690.000**	**65.000**	**0**	**95.000**	**2.850.000**
South america	**n.a.**	**n.a.**	**0**	**0**	**n.a.**	**n.a.**	**n.a.**	**0**	**0**	**n.a.**
Asia & Oceania	**353.500**	**0**	**0**	**2.150.000**	**2.503.500**	**355.500**	**0**	**0**	**3.150.000**	**3.505.500**
Total	**12.513.896**	**3.113.570**	**2.399.773**	**9.775.000**	**27.802.239**	**13.501.386**	**3.612.921**	**2.945.895**	**11.325.000**	**31.385.202**

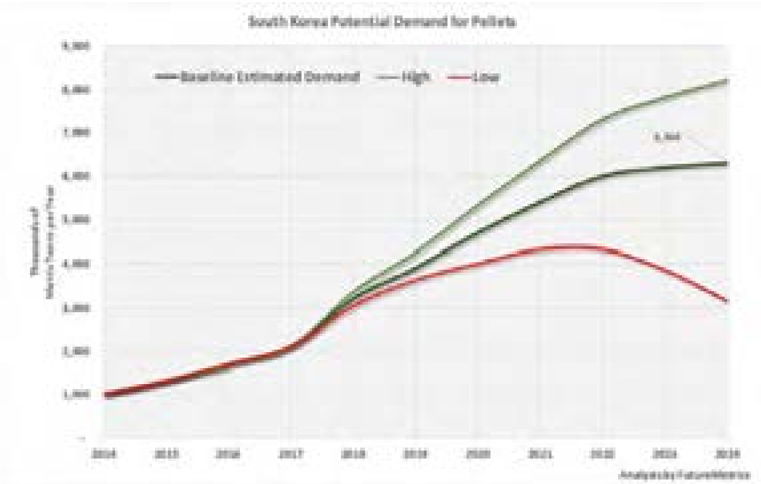
Note: EE, LT, NL, NZ: Consumption 2017 is a replication of 2016; KR, JP: Residential and commercial consumption are a replication of 2016; BE: Residential and commercial consumption estimated by EPC; CH & NO: Split residential and commercial consumption estimated by EPC.
Sources: EPC survey, 2018; Hawkins Wright

Table 8.6 Detailed consumption table of non-European countries in 2016 and 2017 (tonnes)

	2016					2017				
	Residential	Commercial	CHP	Power only	Total	Residential	Commercial	CHP	Power only	Total
North america	2.605.000	55.000	0	100.000	2.760.000	2.690.000	65.000	0	95.000	2.850.000
CA	210.000	25.000	0	100.000	335.000	225.000	30.000	0	95.000	350.000
US	2.395.000	30.000	0	0	2.425.000	2.465.000	35.000	0	0	2.500.000
South america	0	0	0	0	0	0	0	0	0	0
BR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CL	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Asia & Oceania	353.500	0	0	2.150.000	2.503.500	355.500	0	0	3.150.000	3.505.500
AU	10.000	0	0	0	10.000	12.000	0	0	0	12.000
CN	n.a.	n.a.	n.a.	100.000	100.000	n.a.	n.a.	n.a.	100.000	100.000
ID	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
JP	136.000	0	0	350.000	486.000	136.000	0	0	550.000	686.000
KR	190.000	0	0	1.700.000	1.890.000	190.000	0	0	2.500.000	2.690.000
MY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NZ	17.500	0	0	0	17.500	17.500	0	0	0	17.500
TH	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VN	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Note: NZ: Consumption 2017 is a replication of 2016; KR, JP: Residential and commercial consumption are a replication of 2016.
Sources: EPC survey, 2018; Hawkins Wright





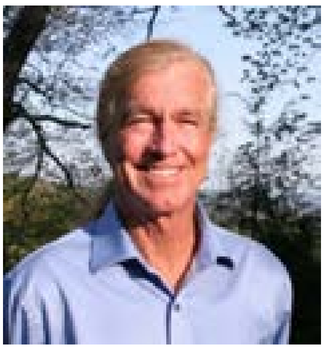
Europe and the UK have led the growth in the industrial wood pellet sector. But, under current policies, by 2022 we expect demand growth in Western Europe and the UK to flatten. Just opposite is expected for Japan and South Korea. The Japanese feed-in-tariff (Fit) and the South Korean renewable portfolio standards (RPS) are underpinning current and expected future rapid growth in those two markets.
The RPS's market-based pricing for renewable energy certificates (RECs) and a history of policy tweaks in South Korea makes forecasting future demand in South Korea challenging. However, we forecast expected demand to be about 6,3 million metric tonnes by 2024. As the chart illustrates, there is a potential for demand to fall if REC prices collapse.

Demand for industrial wood pellets in Japan, at least from the independent power producers (IPPs) who have qualified for the FiT, is more certain. The chart below is based on analysis of about 150 IPP projects by FutureMetrics.

Demand by the major utilities in Japan for co-firing is also likely. Between 2,3 and 11,6 million tonnes per year could be used by major power plants due to a combination of compliance with carbon mitigation targets and minimum efficiency requirements.
In summary, between Japan and South Korea it is likely that annual demand for industrial wood pellets will be at least 10 million tonnes per year by 2025. Japan and South Korea will in some ways mirror (and possibly exceed) the growth in demand from 2012 to 2018 by Western Europe and the UK.

William Strauss, PhD
President
FutureMetrics

FutureMetrics LLC



8.1.3 WORLD PELLET TRADE

Two regions are net importer of pellet in the world: the EU28 and Asia. Figure 8.12 confirms the current hegemony of the EU28 concerning pellet consumption.

The EU imports most of its pellet from the USA and Canada, as well as from peripheral European countries. Demand for pellets is driven in large part by the industrial consumption in the UK, Denmark and Belgium. The trade within Europe (import and export) is detailed later in this report.

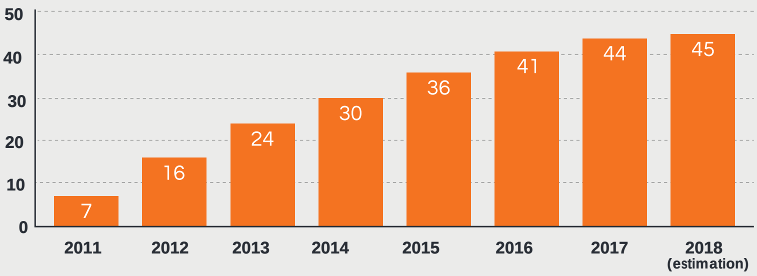
South Korea and Japan are almost exclusively importing their pellets. While South Korea is mainly sourcing its pellets from Vietnam (around 1.5 million tonnes or 62 % of its import in 2017) and Malaysia (around 0.4 million tonnes or 17% of its import in 2017). Japan, setting stronger requirements in term of sustainability, quality and reliability of supply, is sourcing its pellet principally from Canada (around 0.4 million tonnes or 76% of its import in 2017).

Canada, the USA and Russia do not show any sign of strengthening their internal consumption in the future and are likely to remain net exporters. However, some other net exporting regions like the Balkans have displayed strengthening in their domestic markets driven by residential pellet consumption. This may disturb their role as suppliers of the EU28 in the future.

Figure 8.12 World pellet map and trade flow in 2017 (million tonnes)

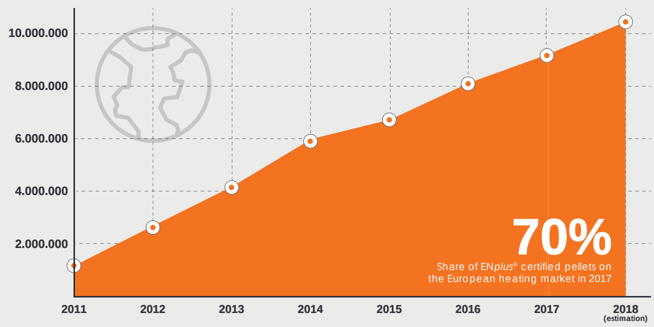
Note: IE, JP, NZ, UA: 2017 production is a replication of 2016; BE: 2017 production estimated by EPC; RO: production estimated by EPC.
Source: EPC survey 2018; FAO; Future Metrics, Hawkins Wright, UNComtrade

Countries with ENplus® certified producers
(from 2011 to 2018, number of countries)



Worldwide ENplus® certified pellet production plants
(in 2017)

Worldwide ENplus® certified pellet production
(from 2011 to 2018, tonnes)



8.2 SITUATION IN EUROPE

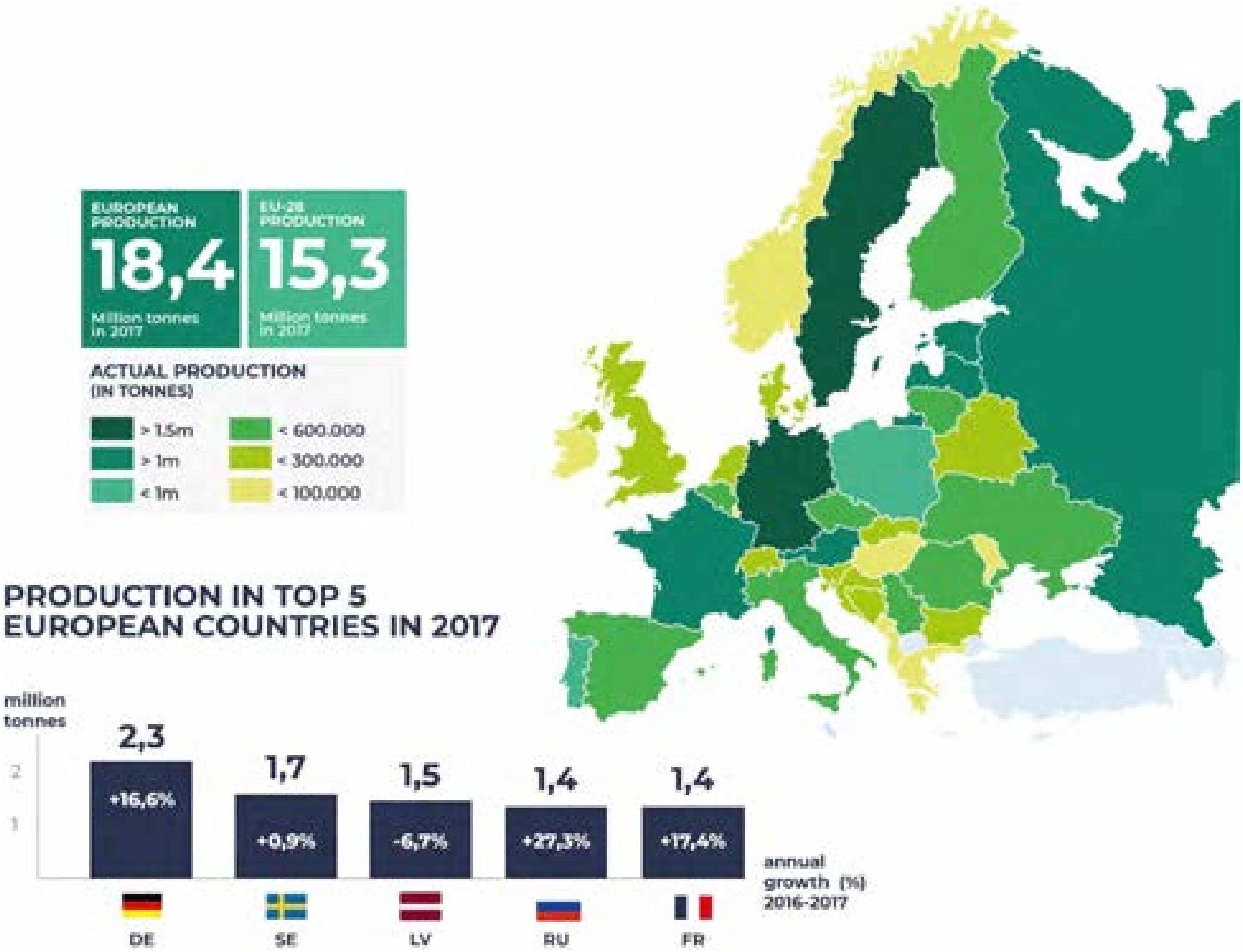
8.2.1 EUROPEAN PELLET PRODUCTION

Europe as a whole registered 8% growth reaching 18,4 million tonnes of production in 2017. Production has set a new record in 2017 after a disappointing year in 2016 (2% growth in 2016).

Weather during the summer and autumn of 2017 adversely affected the pellet industry in northeast Europe, specifically Estonia and Latvia. In August 2017, flooding happened in the Baltic region. Furthermore, the winter came late leaving the ground damped for extended period, delaying the access to the forest for the harvesting. This impacted the supply of wood products. The result was a sharp rise in the price of raw materials and diminished supply of wood for pellet producers.

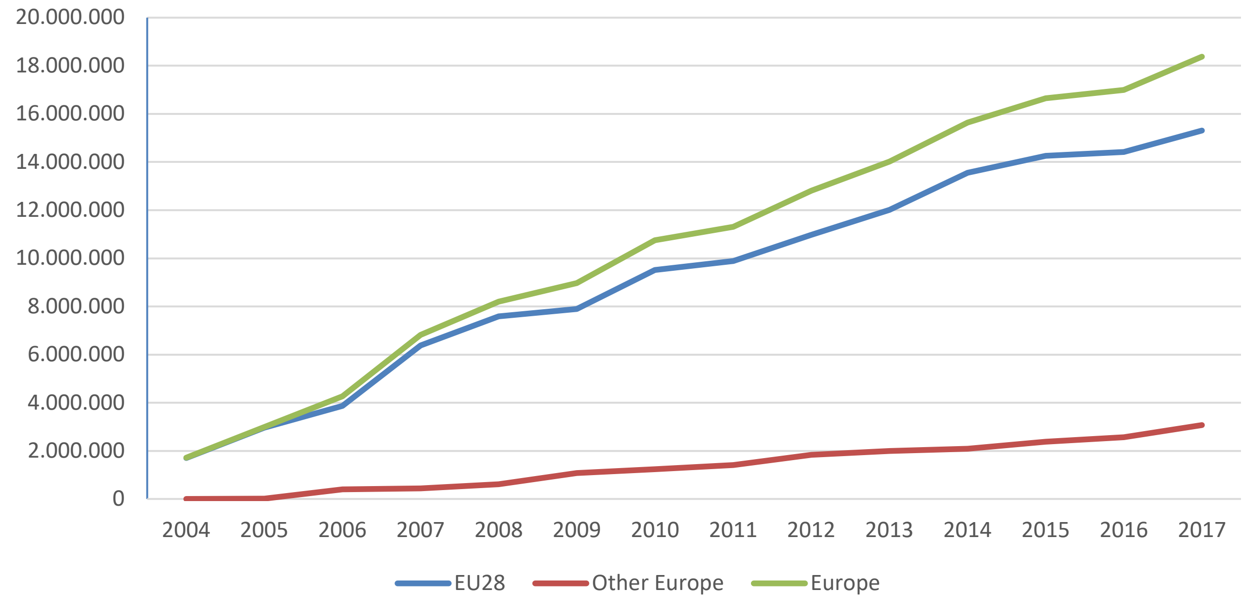
In contrast to the difficulties experienced in the Baltic States, other big European producers registered solid growth: Germany, Russia, France, Austria, and the Balkans all registered double-digit growth rates. Europe remained unchallenged as the world leader of pellet production. Despite this robust growth, however, European demand for pellets still grew faster than production in 2017.

Figure 8.13 Map of European pellet production in 2017



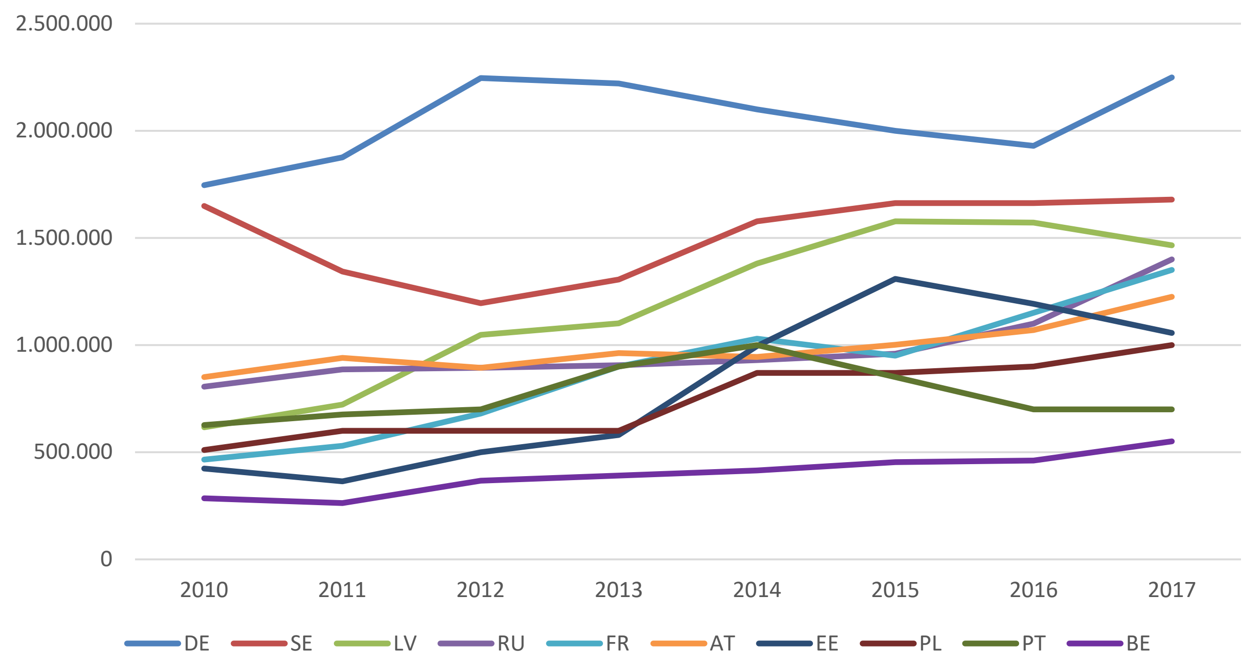
Note: IE, UA: 2017 production is a replication of 2016; BE: 2017 production estimated by EPC; RO: production estimated by EPC.
Source: EPC survey, 2018, FAO

Figure 8.14 Evolution of European pellet production by region (tonnes)



Note: IE, UA: 2017 production is a replication of 2016; BE: 2017 production estimated by EPC; RO: production estimated by EPC.
Source: EPC survey 2018, FAO

Figure 8.15 Evolution of pellet production in the top 10 largest European producers (tonnes)



Note: BE: 2017 production has been estimated by EPC.
Source: EPC survey 2018

Germany: Germany has grown to be the biggest EU pellet producer, based mainly on a strong domestic heating market. The German market was disrupted in 2016 by the bankruptcy of the biggest producer "German Pellets" and disappointing internal consumption, but there was a strong recovery in 2017 allowing the country to exceed its previous record of production, set in 2012.

Sweden: Despite a drop in production in 2011 and 2012, Sweden has seen a gradual recovery, returning to its 2010 production level in 2017. Swedish production is almost exclusively high-quality A1-class pellets.

Latvia: Due to raw material shortages total pellet production was lower in 2017 than in the two previous years. Warm winter weather meant that the ground did not freeze, and forestry equipment could not cross the boggy terrain to harvest wood. As of summer 2018, pellet producers and raw material traders still reported raw material shortages. The market remains unpredictable, but most pellet producers and industry experts expect a production at least as great as in 2017. Despite disturbances to pellet production, production of A1-quality pellets has slightly increased, probably driven by high demand in the European residential market.

Russia: Production has grown 27% in 2017, up to 1.400.000 tonnes total production, likely in response to strong demand in Europe, as well as because of subsidies for pellet exports. Domestic demand for pellets remains lacklustre. Leading exports destinations for Russian wood include Denmark, Belgium, Sweden, the United Kingdom and South Korea.

France: Production has grown 17% in 2017 after being hindered by three consecutive seasons of mild winters and low fossil fuel prices.

Austria: Production grew 14 %, driven by high demand in Austria, Italy and across Europe and plentiful supply of raw materials. Spoliation due to bark beetle infestation created a significant stream of cheap raw material for wood pellets. In 2018, production is still expected to grow, fed by oversupply of raw material. It is estimated that another million cubic meters of wood will be spoiled by bark beetle infestation, which is exacerbated hot and dry summers that encourage the spread of the insect.

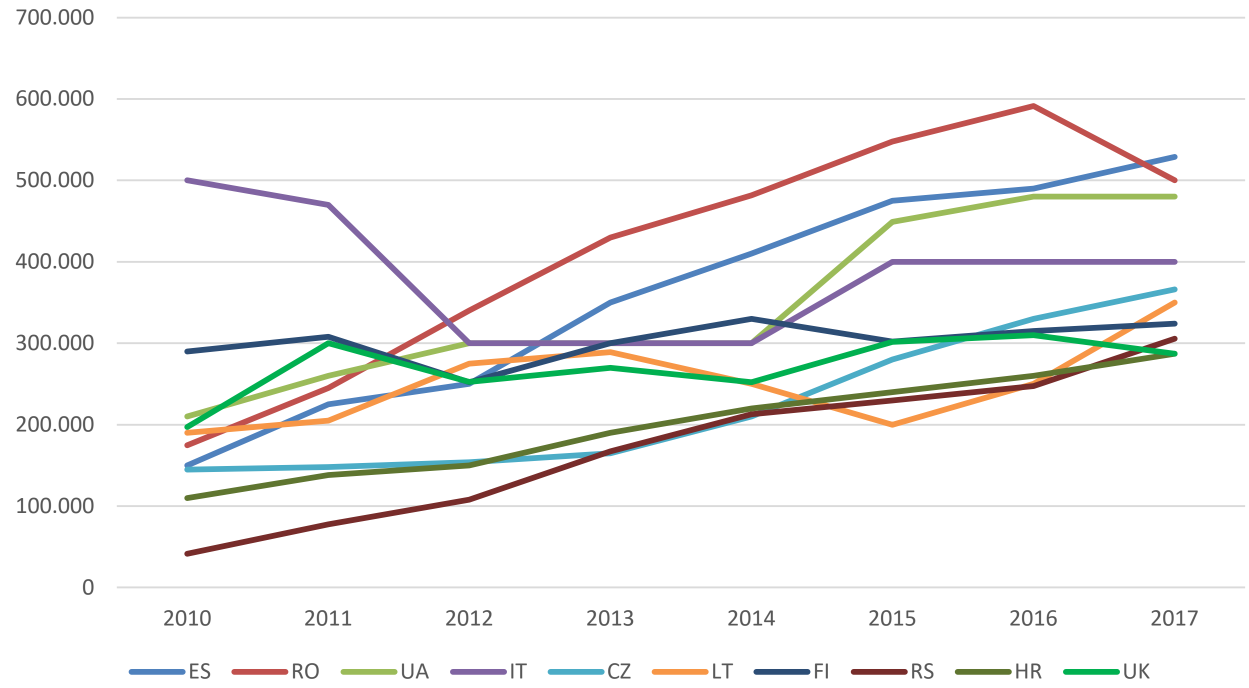
Estonia: Estonia's production decreased by 11% in 2017, the second consecutive year of decreased production, due to the problems that have affected the entire Baltic region.

Poland: In 2016 and 2017 the market has changed radically. Amid growing demand for pellets, mainly for export to Italy and Austria, some pellets plants had problems getting sufficient supply of raw materials. Prices of raw material has rapidly increased. The season 2017/2018 was additionally influenced by local demand which is rapidly growing due to subsidies for modern boilers investments.

Portugal: Portuguese production grew continuously from 2010 to 2014, but then contracted due to limited availability of raw material. The industry was also disrupted by the forest fires that ravaged Portugal in 2017. The fires not only destroyed around 520.000 hectares of forest but also several wood processing mills, including 2 pellet plants. The future of the forest industry remains uncertain, although pellets mills may be more resilient than other wood processing industries due to their ability to process a wider variety of raw materials.

Belgium: Production capacity in Belgium, which had grown well in the period from 2007 to 2012, has since remained relatively constant. Currently, Belgian industrial users rely almost exclusively on imported pellets, and consequently the Belgian pellet production suffers from an overcapacity. Domestic production is therefore principally for the local heating market, while the rest are exported. Belgian production has nonetheless increased due to recent cold weather and the increased export demand.

Figure 8.16 Evolution of pellet production in the top 11-20 European producers (tonnes)



Note: RO: production has been estimated by EPC.
Source: EPC survey 2018

Spain: Since 2010, Spain has registered solid, steady growth. Recently, the Spanish pellet market has been hindered by diminished Portuguese pellet imports, and by the closure of several plants due to financial problems. Nonetheless, the Spanish pellet market registered modest growth. Although there were relatively few new producers, some of the existing producers increased their capacity. Continued growth is expected for 2018, as several large plants are expected to begin operating in the last quarter of 2018, or the first quarter 2019. This will inevitably affect the internal market even if a large percentage of their production will be exported. Despite the increased capacity the next season may be complicated by shortages, since producers only began restocking their stores in June.

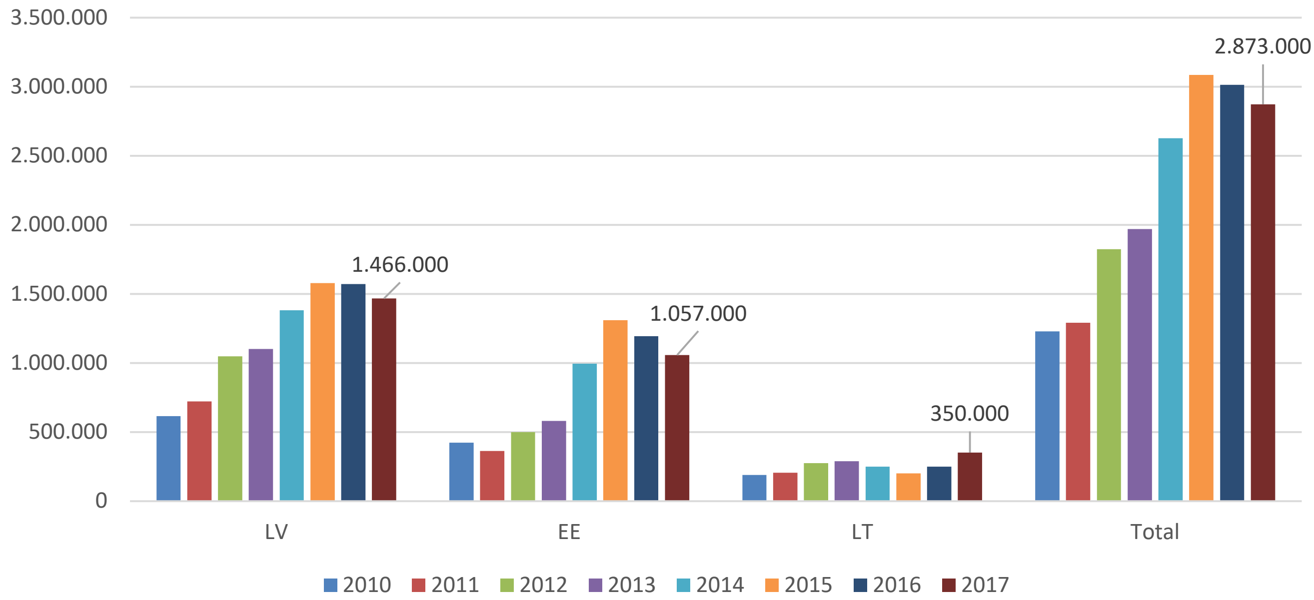
Italy: Italy remains the world's biggest residential pellet user. Italian pellet production has most likely reached its peak, due to insufficient access to raw material. Although Italy has abundant forests, extraction is complicated by the limited accessibility of this wood, making any future growth in pellet production unlikely. Some regions in Italy have banned the use of A2 pellets for air emissions reasons, which precipitated a conversion of pellet plants to exclusive A1 production. If this tendency were to spread in Italy, this could have a significant impact on the market since 25% of the pellet used in Italy is estimated to be of A2 quality.

Lithuania: Despite the adverse conditions experienced along the Baltic, Lithuanian production has grown. Demand for pellets was high, and the entire domestic pellet stock was consumed while Lithuanian mills were operating at almost 90% of their capacity.

Serbia: The number of pellet producers has rapidly increased in the last ten years, from 2 producers in 2006 to 61 in 2017. By the end of 2017, total installed capacity for pellet production in Serbia had reached 525.000 tonnes, and the actual production was 306.000 tonnes. This rapid increase was precipitated by demand for pellets both domestically and for export. Raw material shortages prevent Serbian producers from operating at full capacity. Pressure on forest resources is strong and the competition among the participants on the woody biomass market is increasingly tough.

Croatia: Since 2010, Croatia has registered sustained growth in pellet production. All market conditions are favourable (raw material availability, local and foreign demand), allowing the production to thrive.

Figure 8.17 Evolution of pellet production in the Baltics countries (tonnes)



Source: EPC survey 2018

During the last twenty years Estonia, Latvia and Lithuania have become some of the most important producers of sorts of fiber products. They have also become a robust and reliable supplier for wood pellets. Their success against traditional forest countries is due chiefly to their technically well-developed industry and better understanding of customer orientation.

After a number of good years the past few seasons have taken the breath out of the producers. Pellet prices hit rock bottom, inventories of raw materials got flooded, new applications for wood fibre increased the competition. All of this, held back the development of the Baltic wood pellet sector.

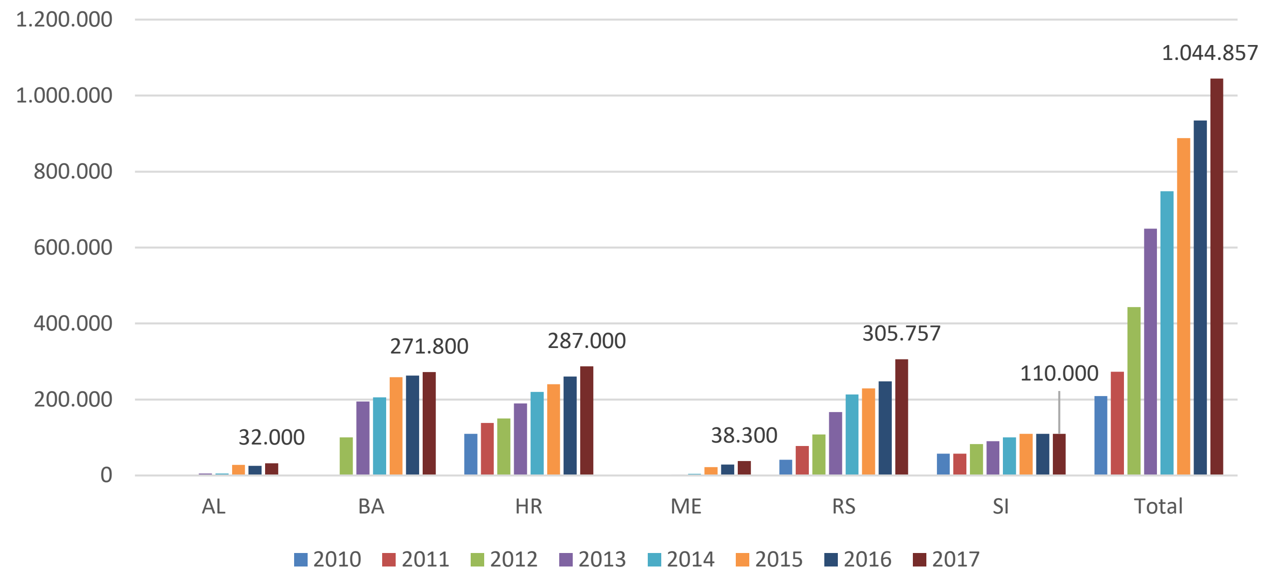
However, strong demand at the end of the previous season has brought new life to the sector. Profitability has increased on the export market, where pellets are traditionally sold, as well as in the domestic market, which as surged of late. On the long run, increased demand on raw materials might drive up prices and long-term profitability.

We are sure to have good years ahead, so long as we do not lose sight of our focus on customers.

Peter Granborn
Scandbio
CEO

SCANDBIO

Figure 8.18 Evolution of pellet production in the Balkans countries (tonnes)



Source: EPC survey 2018

The Balkans region has its own unique approach to wood pellet production and consumption showing that a lot of very small producers together can make a significant volume. Most pellet production is in very small factories using the locally available raw material. I would estimate the average production unit at less than 6.000 tonne per year, but when all the production is collated the figure is very impressive at more than a million tonnes.

This figure is relatively easy to verify by checking import and export customs data. It is always more difficult to get a true feel for the local consumption. Imports into the Balkans from both the EU and non EU countries would seem to suggest that consumption is higher than previously estimated and still growing at such a pace that many producers will certainly stop exporting and concentrate on local sales.

There is a very healthy trade between the Balkans countries showing that the EU market is no longer the main driving force behind pellet production. Some of the Balkans countries are now clearly importing more wood pellets than they produce.
Take Slovenia as an example, imports are higher than total production volumes. With non-EU imports (Russia, Belarus, Ukraine and others) at 90.000 tonnes whilst imports from the EU totalled 130.000 tonnes. Meaning that imports of wood pellets are now much larger than the local production which was 140.000 tonnes.

This is a trend that is being repeated all over the Balkans and it is becoming very clear that not only will exports from the Balkans slow down, but the Balkans will be a rival destination to the established EU markets.

Arnold Dale
Vice President Bioenergy
Ekman

Ekman

Table 8.7 European pellet production in 2017 compared to 2016

	2016			2017		
	Number of operating production plants	Production capacity (tonnes)	Actual production (tonnes)	Number of operating production plants	Production capacity (tonnes)	Actual production (tonnes)
EU28	**637**	**21.949.115**	**14.421.208**	**656**	**22.775.771**	**15.310.461**
AT	38	1.496.000	1.070.000	43	1.600.000	1.225.000
BE	12	760.000	460.500	12	760.000	550.000
BG	5	200.000	149.334	5	200.000	149.334
CY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CZ	25	400.000	330.000	26	450.000	366.000
DE	55	3.200.000	1.930.000	55	3.400.000	2.250.000
DK	5	300.000	150.000	5	300.000	180.000
EE	19	1.500.000	1.193.000	23	1.612.000	1.057.000
EL	16	140.000	40.000	18	130.000	35.000
ES	82	1.600.000	490.000	89	1.747.000	529.000
FI	29	623.500	315.000	29	630.000	324.000
FR	52	1.800.000	1.150.000	52	1.800.000	1.350.000
HR	18	340.000	260.000	18	352.000	287.000
HU	3	122.000	3.139	3	122.000	5.191
IE	1	40.000	48.100	1	40.000	48.100
IT	30	450.000	400.000	30	450.000	400.000
LT	14	360.000	250.000	17	400.000	350.000
LU	1	50.000	36.602	1	50.000	48.650
LV	28	1.850.000	1.571.000	27	1.950.000	1.466.000
MT	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NL	4	350.000	200.000	4	350.000	264.300
PL	52	1.100.000	900.000	55	1.200.000	1.000.000
PT	25	1.159.000	700.000	23	1.159.000	700.000
RO	22	1.030.150	591.335	22	1.030.150	500.000
SE	65	2.361.850	1.663.198	64	2.300.000	1.678.929
SI	18	140.000	110.000	17	145.000	110.000
SK	10	200.000	100.000	10	250.000	150.000
UK	8	376.615	310.000	7	348.621	286.957
Other Europe	**520**	**3.332.000**	**2.568.352**	**538**	**3.555.000**	**3.069.225**
AL	7	30.000	25.000	10	45.000	32.000
BA	31	350.000	263.000	32	360.000	271.800
BY	n.a.	n.a.	187.000	n.a.	n.a.	274.000
CH	24	280.000	180.000	24	280.000	210.000
ME	4	55.000	28.900	7	65.000	38.300
NO	4	105.000	56.892	4	105.000	57.368
RS	52	387.000	247.560	61	525.000	305.757
RU	85	2.125.000	1.100.000	87	2.175.000	1.400.000
UA	313	n.a.	480.000	313	n.a.	480.000

Note: IE, UA: 2017 production is a replication of 2016; BE: 2017 production estimated by EPC; RO: production estimated by EPC; BG, HU, NL, RO: 2017 capacity and number of plants are a replication of 2016; UK capacity: Estimated by EPC
Source: EPC survey 2018

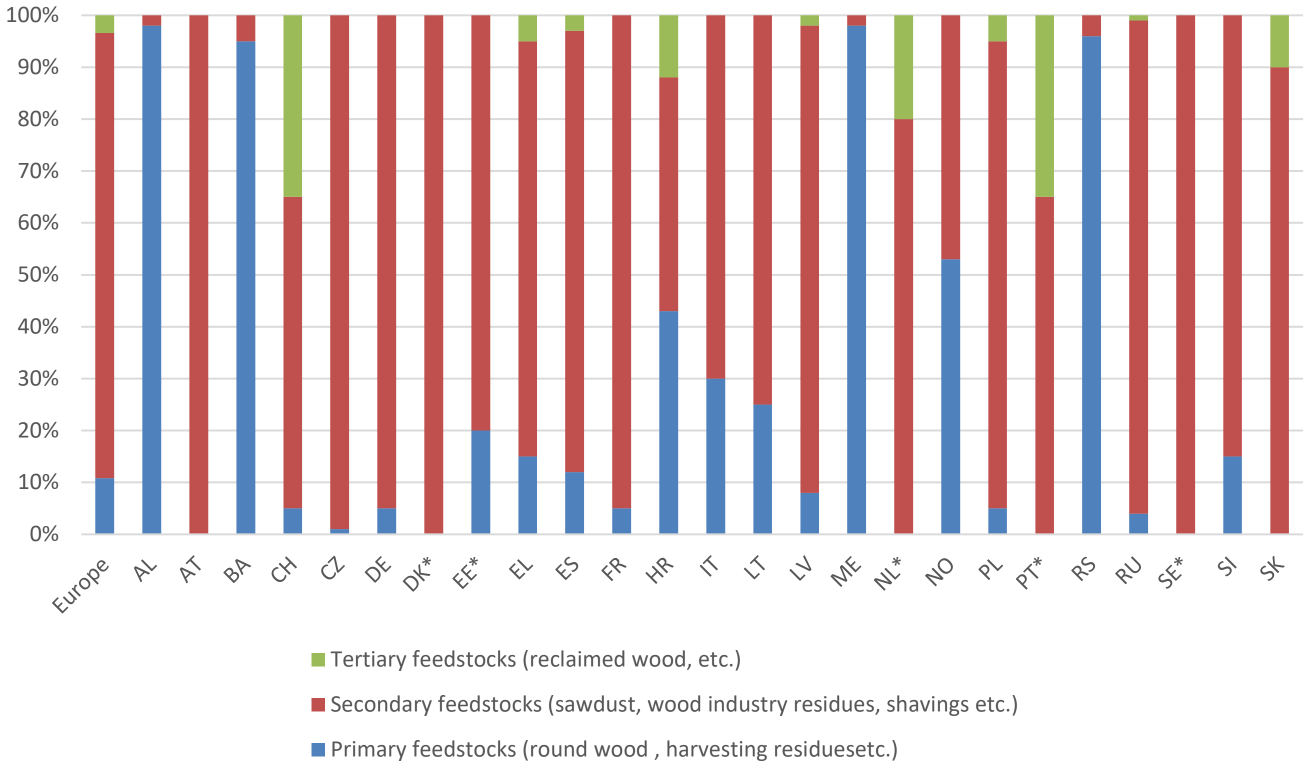
8.2.2 RAW MATERIALS FOR EUROPEAN WOOD PELLET PRODUCTION

Within the data collection run by EPC, our partners[1] have identified the main raw materials used for pellets production in Europe.

Three categories have been defined:

- Primary feedstock = Roundwood and harvesting residues (i.e. wood extracted for pellet production.)
- Secondary feedstock = any by-products from wood industry e.g. sawdust, shavings, etc.
- Tertiary feedstock = any used wood (reclaimed wood, waste wood

Figure 8.19 Estimate of the shares of raw materials used in local pellet production in Europe in 2017 (%)

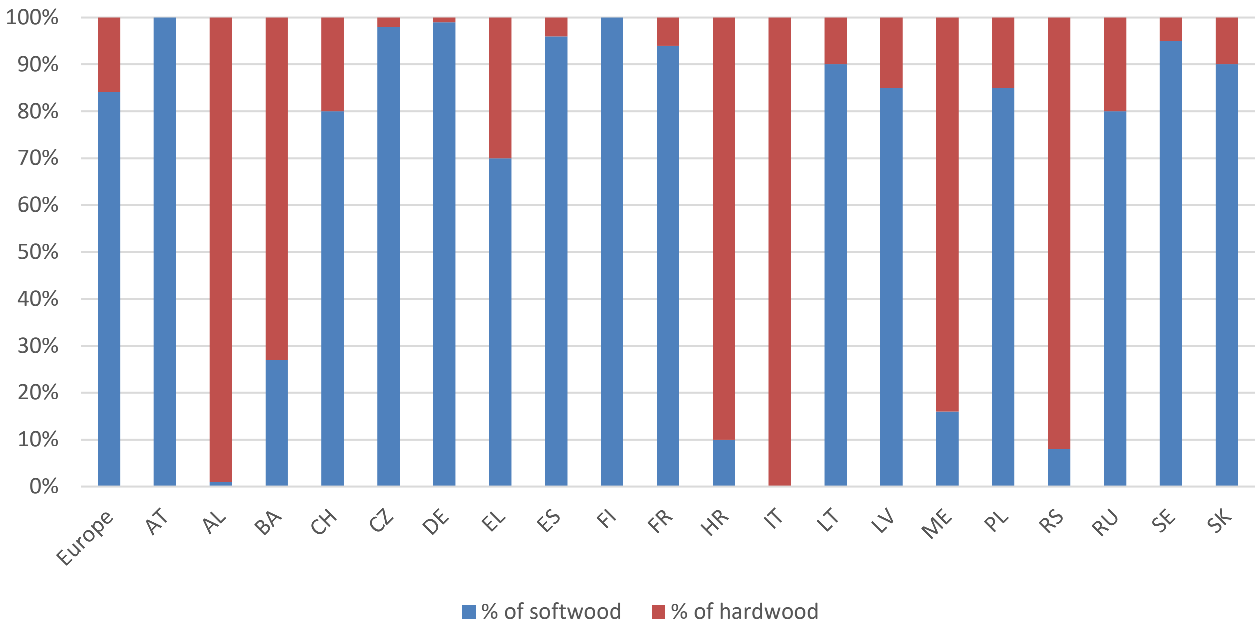


*2016 data
Source: EPC survey 2018

[1] For this survey, only the national pellet associations were consulted. Not all of them have consulted their local producers.

Our partners have also reported on the use of hard wood and soft wood use for their local pellet production.

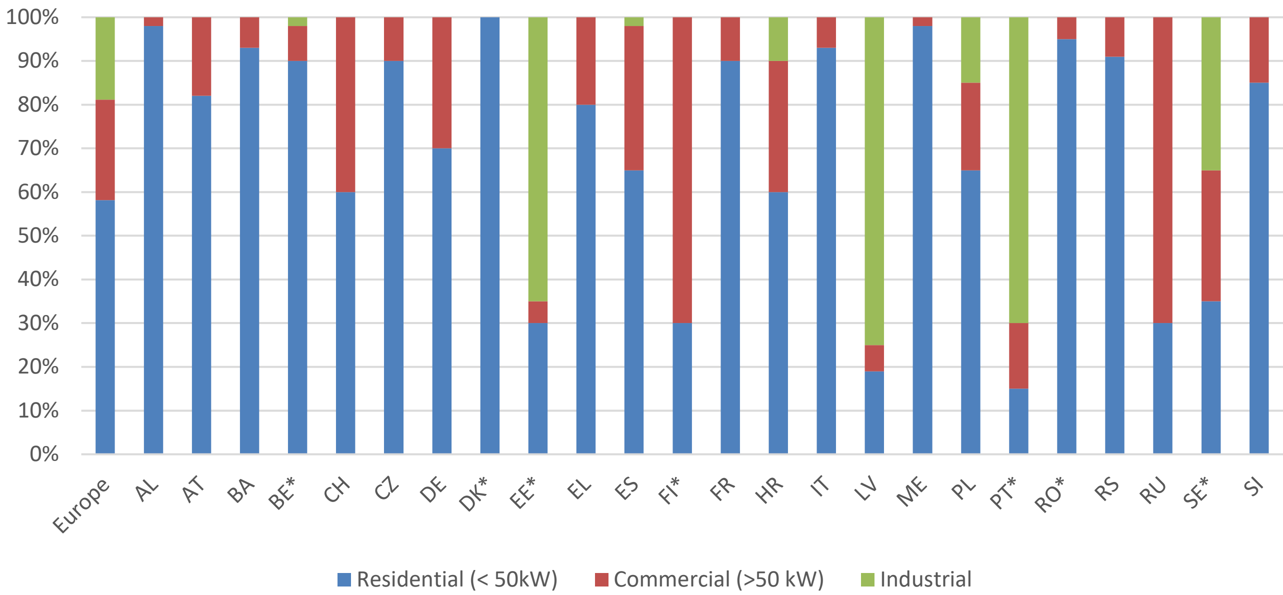
Figure 8.20 Estimate of the shares of hard wood and soft wood as raw material for local pellet production in Europe in 2017 (%)



Source: EPC survey 2018

A consultation was carried out with our partners[2] to identify the main markets for the pellets produced in each European country. Two main categories were identified: countries mainly producing pellets for the heating market (residential and commercial), and countries mainly producing pellets for industrial use. Latvia, Estonia and Portugal are the only countries mainly producing for industrial use.

Figure 8.21 Estimate of European pellet producers' main markets by end-use in 2017 (%)



*2016 data
Source: EPC survey 2018

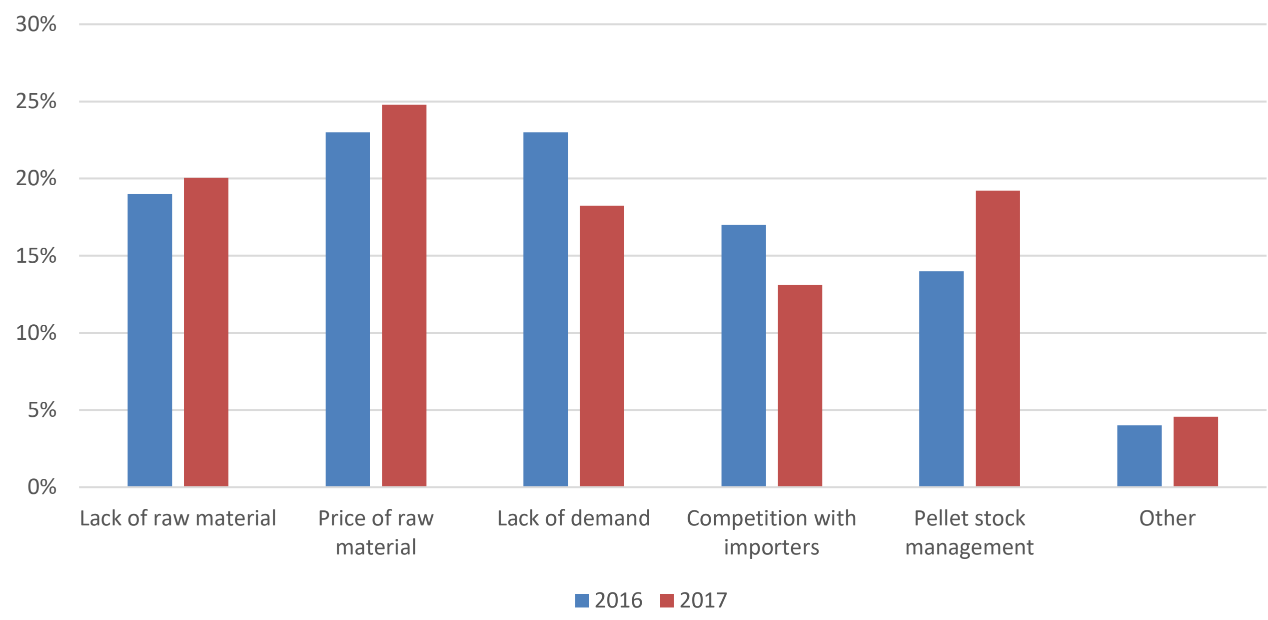
[2] For this survey, only the national pellet associations were consulted. Not all of them have consulted their local producers.

The **main concerns** of EU pellet producers[3] have been registered by national pellet associations every year since 2013. As of 2017, the methodology for recording these concerns has changed. Consequently, Figure 8.22 displays only the results from 2016 and 2017.

In 2017, European pellet production grew by 1.4 million tonnes while consumption increased by 2.5 million tonnes. This is reflected in the responses of pellet producers, whose concerns about demand decreased while prices, supply of raw materials and stock management all registered a rise.

Lack of demand may remain a problem in some markets, like as Finland, where the other residential RES are competitive heating options, Czech Republic where coal remain a cheap heating solution.

Figure 8.22 Evolution of European pellet producers' perception of the main difficulties 2016-2017 (%)

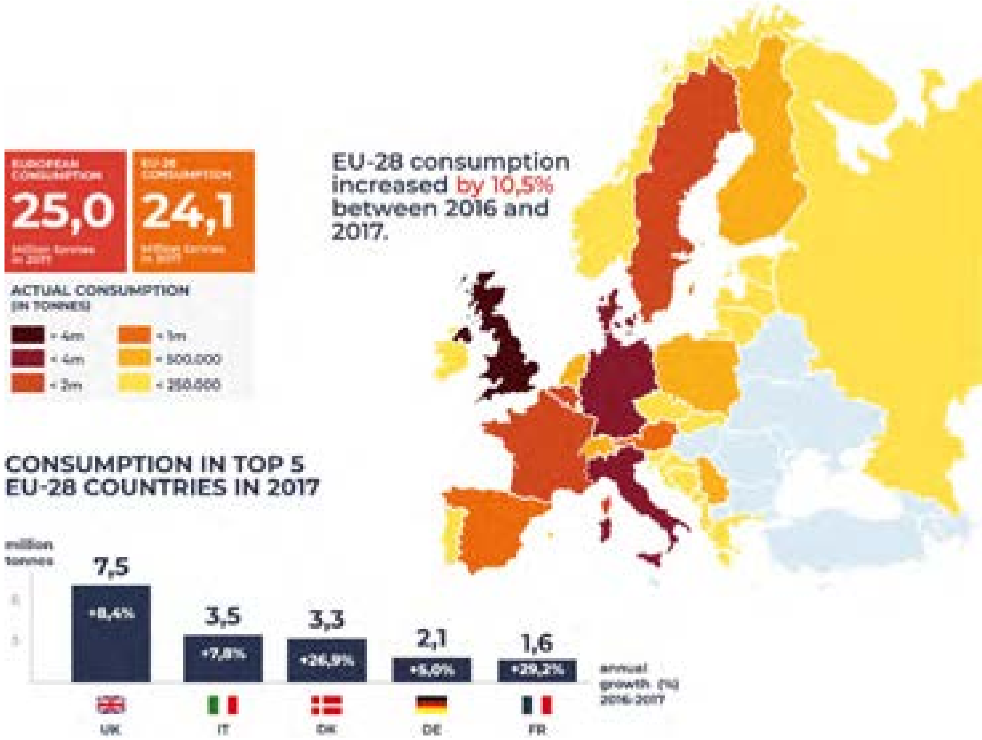


Source: EPC survey 2018
Note: Indicators weighted by the production of each country.

[3] For this survey, only the national pellet associations were consulted. Not all of them have consulted the local producers.

8.2.3 EUROPEAN WOOD PELLET CONSUMPTION

Figure 8.23 Map of pellet consumption in Europe in 2017



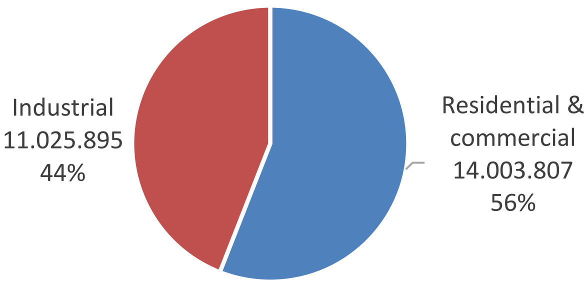
Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Source: EPC survey 2018, Hawkins Wright

In 2017, European pellet demand experienced an impressive increase of 2,5 million tonnes, representing a growth of 11%, significantly outstripping the 4% growth in demand that was observed in 2016. Demand increased in both the industrial and residential/commercial markets by around 11% during 2017. Growth in industrial consumption of pellets was almost exclusively due to increases in consumption in the United Kingdom and Denmark.

The residential/commercial market realise impressive growth in most European countries. France has registered the biggest increase in residential/commercial pellet consumption and is promising to do even better in the future with sustained sales of pellet appliances happening in the country. Italy keeps a steady growth with a +8% increase, leaving it the biggest consumer of residential pellet in Europe. Nevertheless, the additional demand did not come without its problems, as shortages happened in many country and pellet stocks becoming an increased concern for pellet producers.

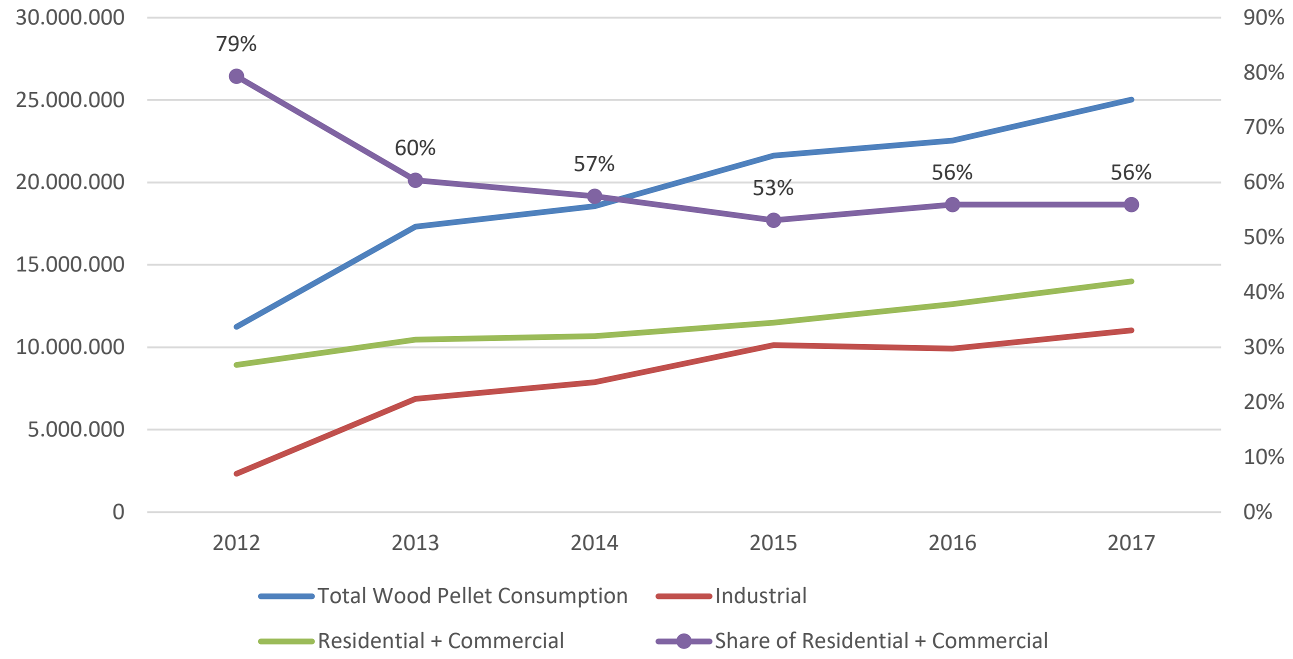
Despite significant change on the market compare to 2016, no significant price change occurred between 2016 and 2017.

Figure 8.24 European pellet consumption by type of end use in 2017 (tonnes and %)



Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Source: EPC survey 2018, Hawkins Wright

Figure 8.25 Evolution of pellet consumption in Europe by type (tonne and %)



Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Source: EPC survey 2018, Hawkins Wright

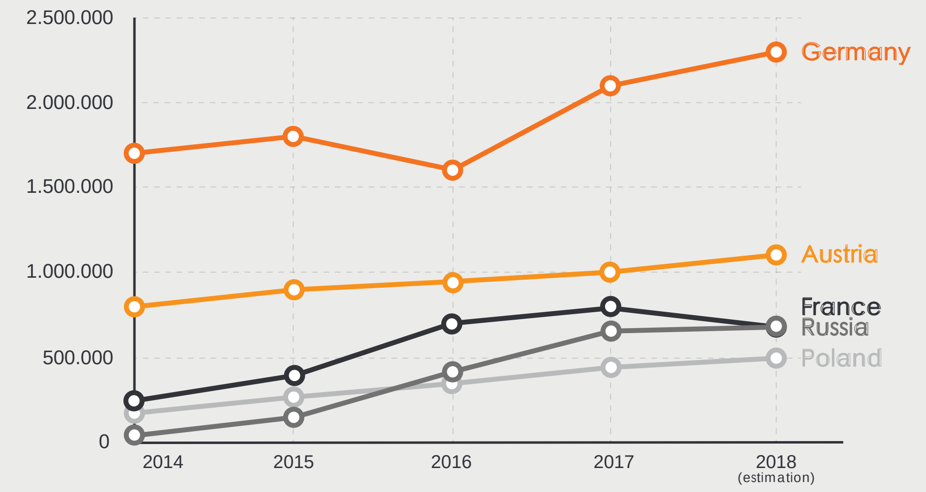
After 3 difficult seasons mainly due to mild winters together with low prices of fossil fuels, the French market registered an increasing pellet demand in 2017. Producers and traders have been able to come back to a sustainable level of stock. Decrease of stock is explaining why production in 2017 was slightly lower than consumption: a little bit less than 1,4 million tons against a consumption of 1,45 million tonnes.

In parallel, stoves installation has grown by 30% compared to 2016 to reach a volume of sales of 140.000 stoves. For boilers, after 3 years of decrease, sales came back to a positive trend with an increase from 25% on 2016 figures. This improvement is clearly due to an increase of fossils' price and also to colder winter which force customers to think about their heating installation. A more dynamic construction market may have also been an advantage.
2018 seems to follow the same route and maybe even better thanks to the carbon tax which got more visibility after its growth acceleration given by new government.
This situation may continue in the next years as pellets will continue to have a more attractive and stable price on the long run compare to fossils.

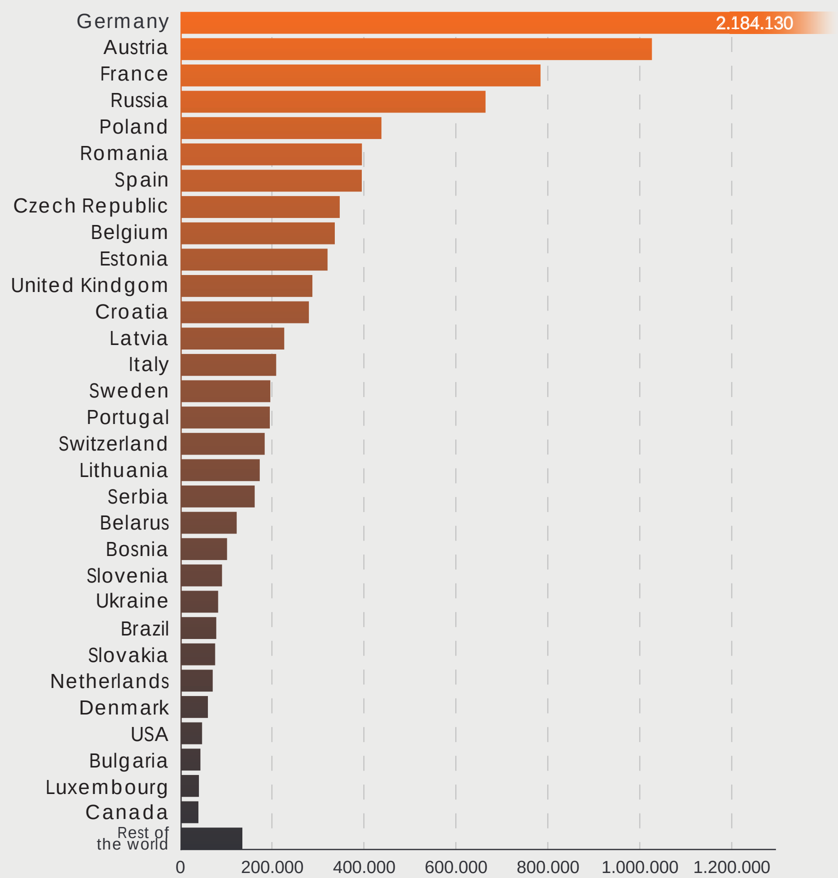
Production capacity is still higher than consumption and thanks to the development of sawmills' production and capacity, this situation will continue. Co-product from forest management may also grow if actual promotion of wood use in construction and industry is successful.

Eric Vial
Secretary General
Propellet France

Volumes of ENplus® certified pellets produced in the top 5 countries
(from 2014 to 2018, tonnes)

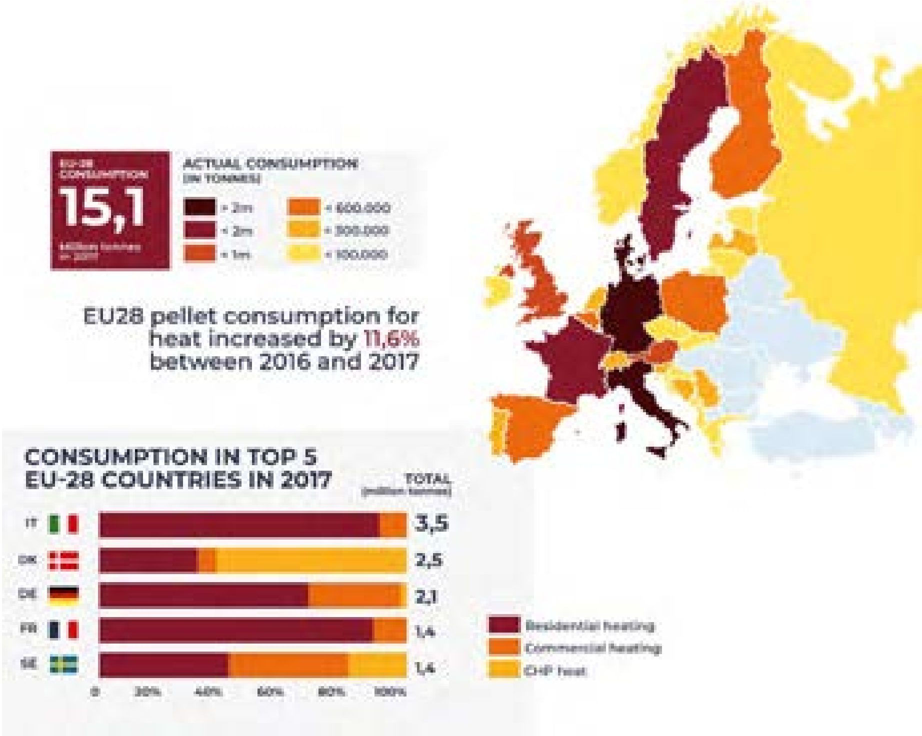


Volumes of ENplus® certified pellets produced per country
(in 2017, tonnes)



8.2.3.1 PELLET CONSUMPTION FOR HEATING

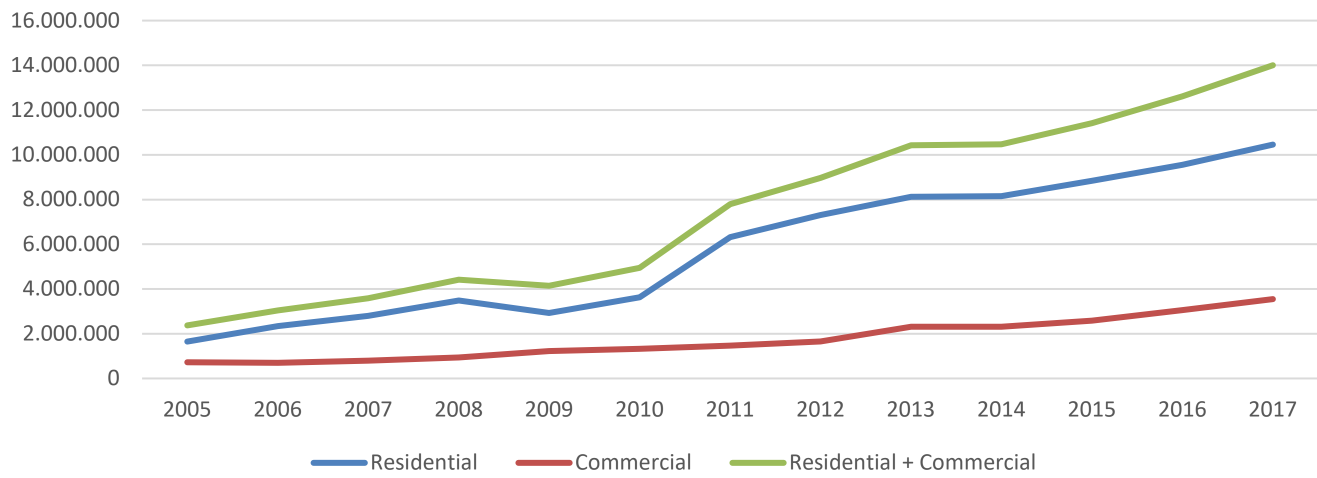
Figure 8.26 Map of pellet consumption for heating in Europe in 2017



Note: Include residential, commercial and 2/3 of CHP consumption
Note 2: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Source: EPC survey 2018

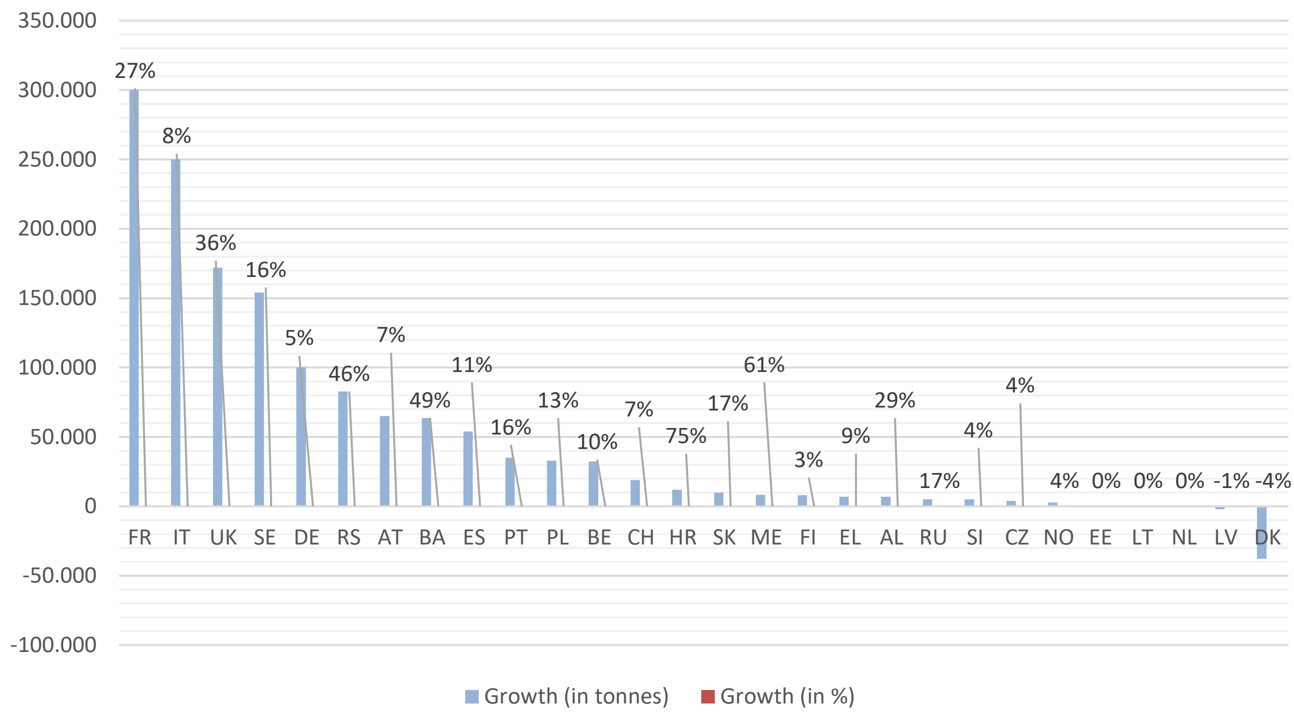
Demand in the residential/commercial sector has grown steadily over the last 3 years. In 2017, it increased by 1,4 million tonnes. 75% of pellets used in these two segments are consumed by residential users. Commercial pellet demand grew at a faster rate (+16% in 2017) than the residential one (+9% in 2017). The opposite is true in absolute terms: +900.490 tonnes for residential use, +489.351 tonnes for commercial use.

Figure 8.27 Evolution of European pellet consumption for residential (<50kW) and commercial (>50kW) heat excluding CHP (tonnes)



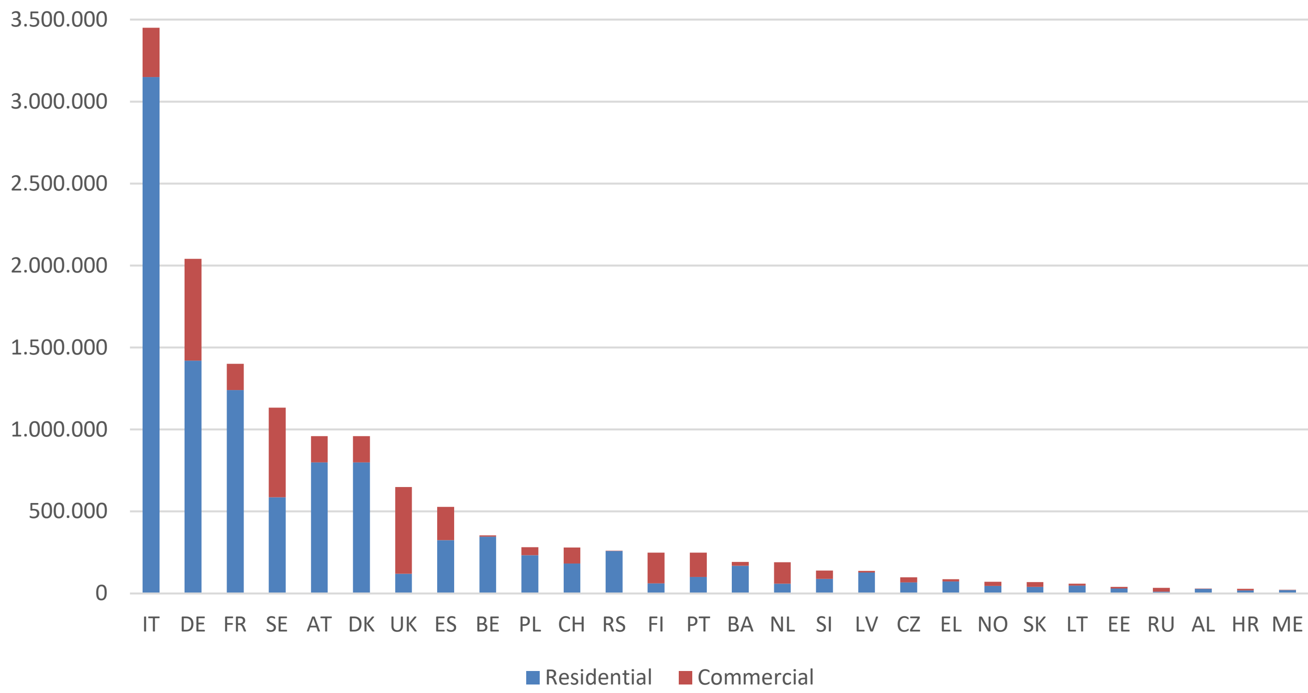
Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Source: EPC survey 2018

Figure 8.28 Growth of European pellet consumption for residential (<50kW) and commercial (>50kW) heat excluding CHP by countries between 2016-2017 (tonnes & %)



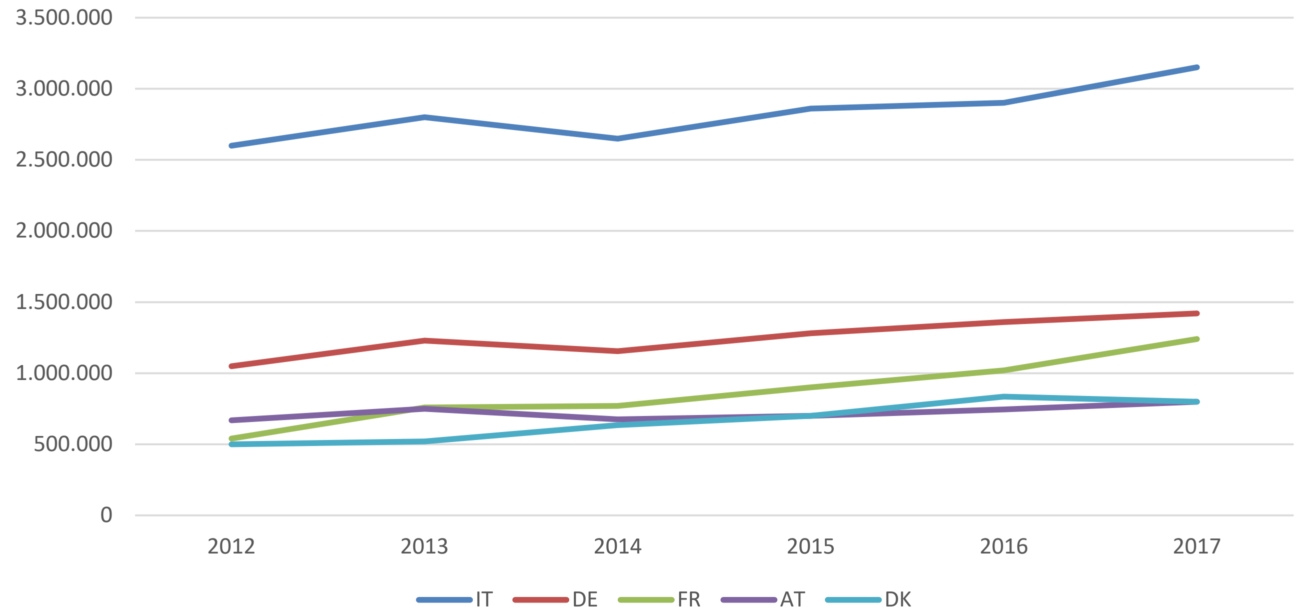
Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC.
Source: EPC survey 2018

Figure 8.29 European pellet consumption for residential (< 50kW) and commercial (> 50kW) heat in 2017 (tonnes)



Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC; CH & NO: Split residential and commercial consumption estimated by EPC.
Source: EPC survey 2018

Figure 8.30 Evolution of Europe's top 5 counties for residential (<50kW) pellet consumption in Europe (tonnes)



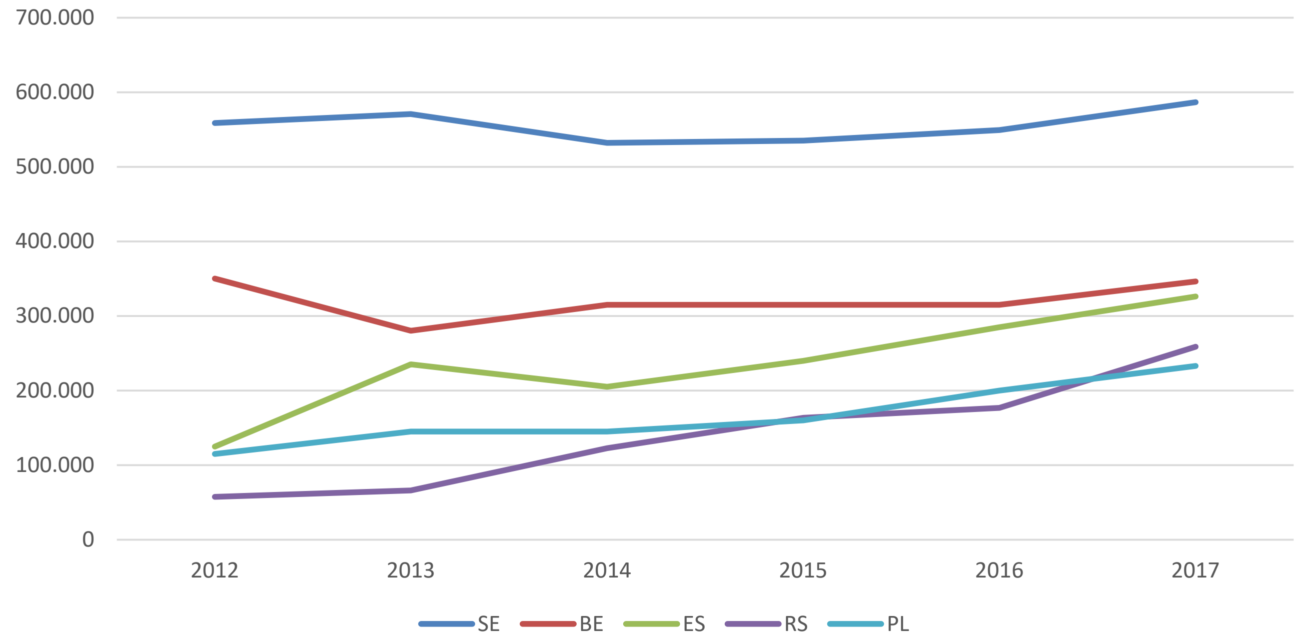
Source: EPC survey 2018

Italy: Cooler weather conditions and new pellet appliance installations have contributed to an increase in consumption.

France: France consumption of pellets resulted in the biggest increase in Europe with 300.00 tonnes. Consumption originates in the residential market where sales are booming.

Austria: The main driver for consumption in Austria is the climate. The winter of 2016-2017 was colder than previous winters, which increased the pellet consumption by +7,3%.

Figure 8.31 Evolution of Europe's top 6-10 counties for residential (<50kW) pellet consumption in Europe (tonnes)

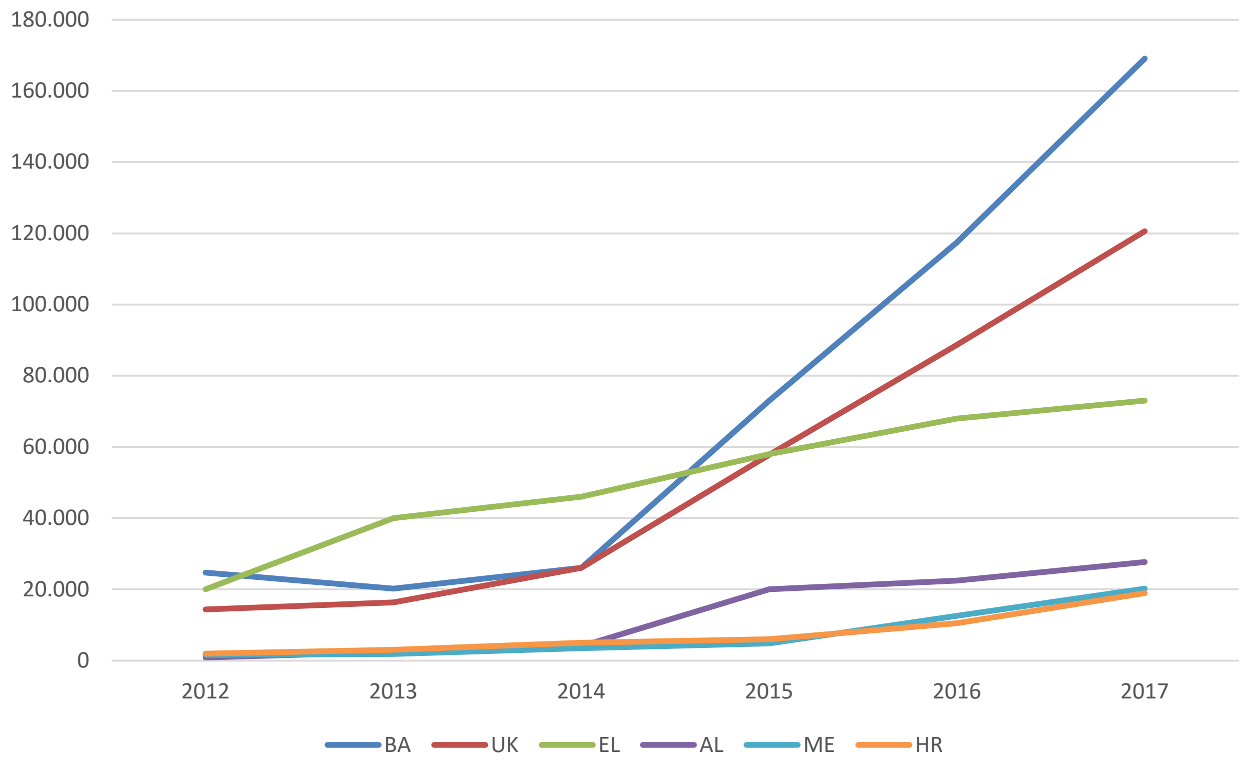


Note: BE: Residential and commercial consumption estimated by EPC.
Source: EPC survey 2018

Spain: In Spain consumption increased, roughly matching domestic production levels. The demand exceeded previous years due to the severity and length of the winter, along with higher fossil fuel prices and growth of installed devices. As a result of the busy season, problems in stock management was experienced. It is expected that consumption will still grow in 2018, based on sales of heating devices and government support for heating devices that was foreseen before the summer, but was delayed by a change of government.

Poland: Consumption of pellets in Poland has grown since 2014. Government subsidies drove an increase in new appliances, which in turn precipitated an increase in pellet consumption. The effect of these subsidies should continue to be felt for years to come.

Figure 8.32 Evolution of Europe's top 5 fastest growing markets (between 2012-2017) residential (<50kW) pellet consumption in Europe (tonnes)



Source: EPC survey 2018

Countries represented in the figure above have been the fastest growing markets in relative terms between 2012-2017.

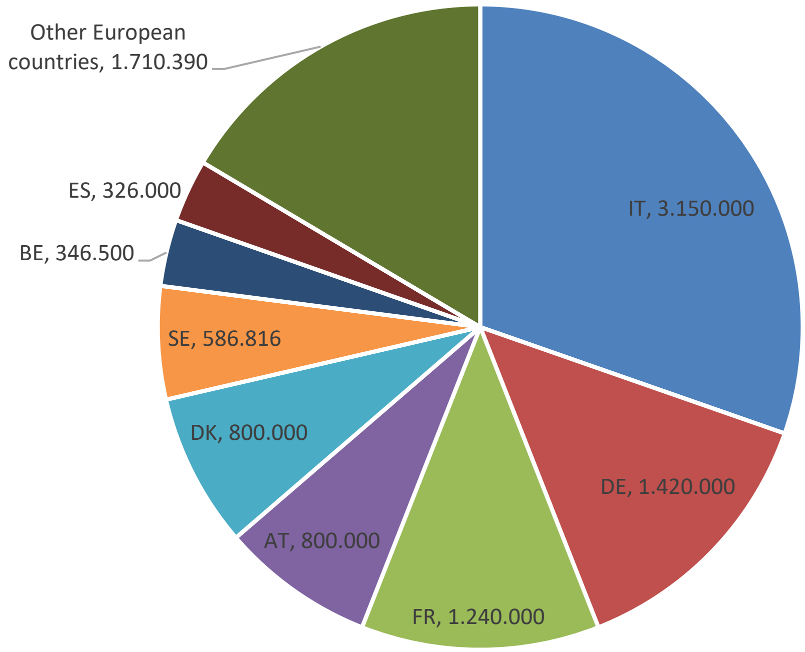
Bosnia and Herzegovina & Serbia: Pellet consumption increased steeply in 2017 in both countries. However, growth was hindered by a pellet shortage in the middle of January 2017. Pellets had been consumed at a faster rate than expected as a result of the number of days with temperatures below -15ºC. The increased heating demand led to premature exhaustion of winter stocks. The shortage lasted almost a month, during which prices peaked substantially, to over 300 €/tonne.

Table 8.8 European pellet consumption for heating in 2017 compared to 2016 (tonnes)

	2016				2017			
	Residential	Commercial	2/3 CHP	Total	Residential	Commercial	2/3 CHP	Total
EU28	9.002.790	2.906.982	1.599.849	13.509.621	9.741.416	3.370.155	1.963.930	15.075.501
AT	745.000	150.000	0	895.000	800.000	160.000	0	960.000
BE	315.000	8.000	13.333	336.333	346.500	8.800	13.333	368.633
BG	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CZ	64.000	30.000	0	94.000	68.000	30.000	0	98.000
DE	1.360.000	580.000	40.000	1.980.000	1.420.000	620.000	40.000	2.080.000
DK	834.762	162.979	1.047.944	2.045.685	800.000	160.000	1.533.333	2.493.333
EE	30.000	10.000	0	40.000	30.000	10.000	0	40.000
EL	68.000	13.000	0	81.000	73.000	15.000	0	88.000
ES	285.000	190.000	0	475.000	326.000	203.000	0	529.000
FI	58.000	184.000	40.000	282.000	62.000	188.000	66.667	316.667
FR	1.020.000	80.000	0	1.100.000	1.240.000	160.000	0	1.400.000
HR	10.500	5.500	0	16.000	19.000	9.000	0	28.000
HU	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IE	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IT	2.900.000	300.000	0	3.200.000	3.150.000	300.000	0	3.450.000
LT	47.500	12.500	0	60.000	47.500	12.500	n.a.	60.000
LU	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
LV	132.000	8.000	0	140.000	129.000	9.000	0	138.000
MT	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NL	60.000	130.000	0	190.000	60.000	130.000	0	190.000
PL	200.000	50.000	16.667	266.667	233.000	50.000	20.000	303.000
PT	115.000	100.000	0	215.000	100.000	150.000	0	250.000
RO	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SE	549.370	428.894	418.721	1.396.985	586.816	545.555	263.863	1.396.234
SI	85.000	50.000	13.333	148.333	90.000	50.000	13.333	153.333
SK	35.000	25.000	0	60.000	40.000	30.000	0	70.000
UK	88.658	389.109	9.851	487.618	120.600	529.300	13.400	663.300
Other Europe	**552.606**	**151.588**	**0**	**704.194**	**714.470**	**177.766**	**0**	**892.236**
AL	22.500	1.200	0	23.700	27.700	2.800	0	30.500
BA	117.500	11.000	0	128.500	169.090	23.000	0	192.090
BY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CH	169.650	91.350	0	261.000	182.000	98.000	0	280.000
ME	12.600	1.000	0	13.600	20.200	1.700	0	21.900
NO	44.456	23.938	0	68.394	46.180	24.866	0	71.046
RS	176.900	2.100	0	179.000	258.800	2.900	0	261.700
RU	9.000	21.000	0	30.000	10.500	24.500	0	35.000
UA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

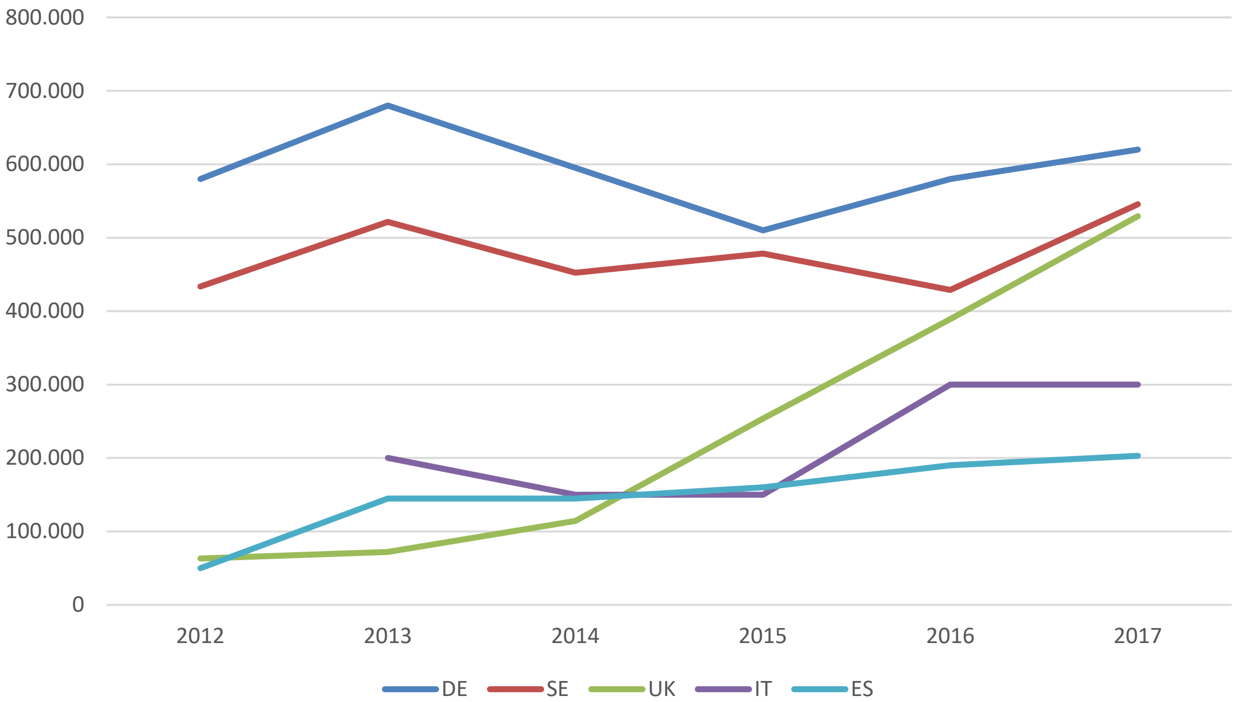
Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC; CH & NO: Split residential and commercial consumption estimated by EPC.
Source: EPC survey 2018

Figure 8.33 Share of European residential (<50kW) pellet consumption by country in 2017 (tonnes)



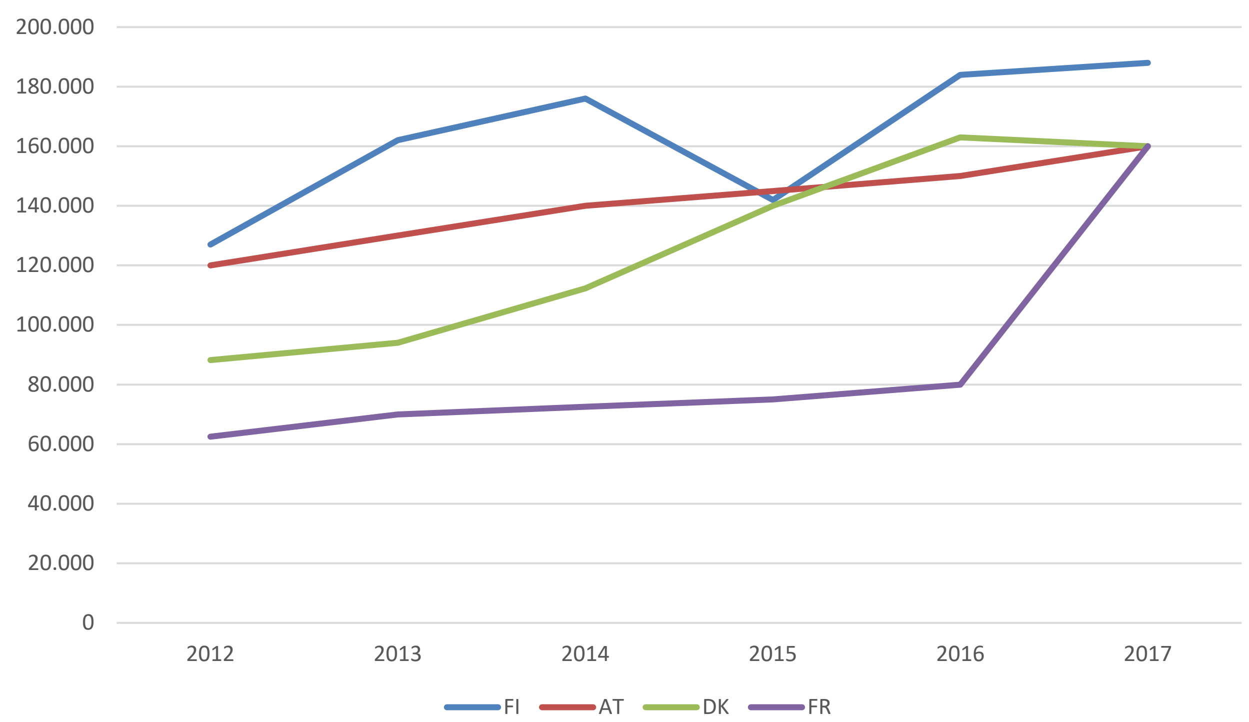
Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC; CH & NO: Split residential and commercial consumption estimated by EPC.
Source: EPC survey 2018

Figure 8.34 Evolution of Europe's top 5 counties commercial (>50kW) pellet consumption in EU (tonnes)



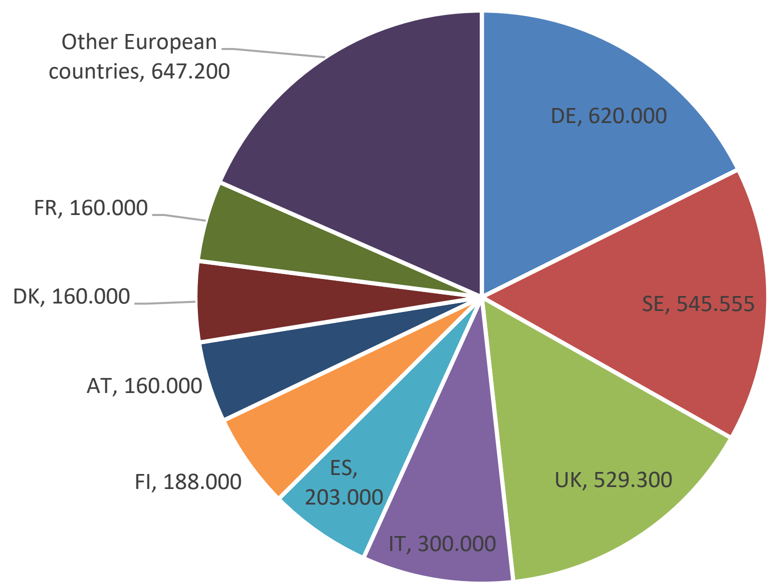
Source: EPC survey 2018

Figure 8.35 Evolution of Europe's top 5-9 countries commercial (>50kW) pellet consumption in EU (tonnes)



Source: EPC survey 2018

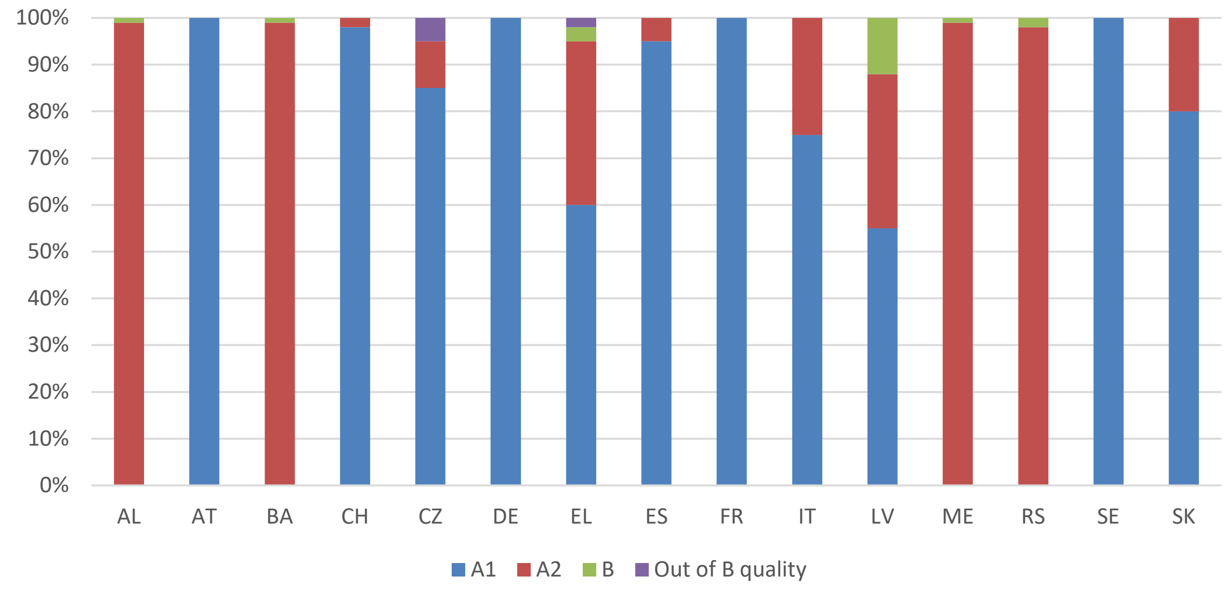
Figure 8.36 Share of European commercial (>50kW) pellet consumption by country in 2017 (tonnes)



Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC; CH & NO: Split residential and commercial consumption estimated by EPC.
Source: EPC survey 2018

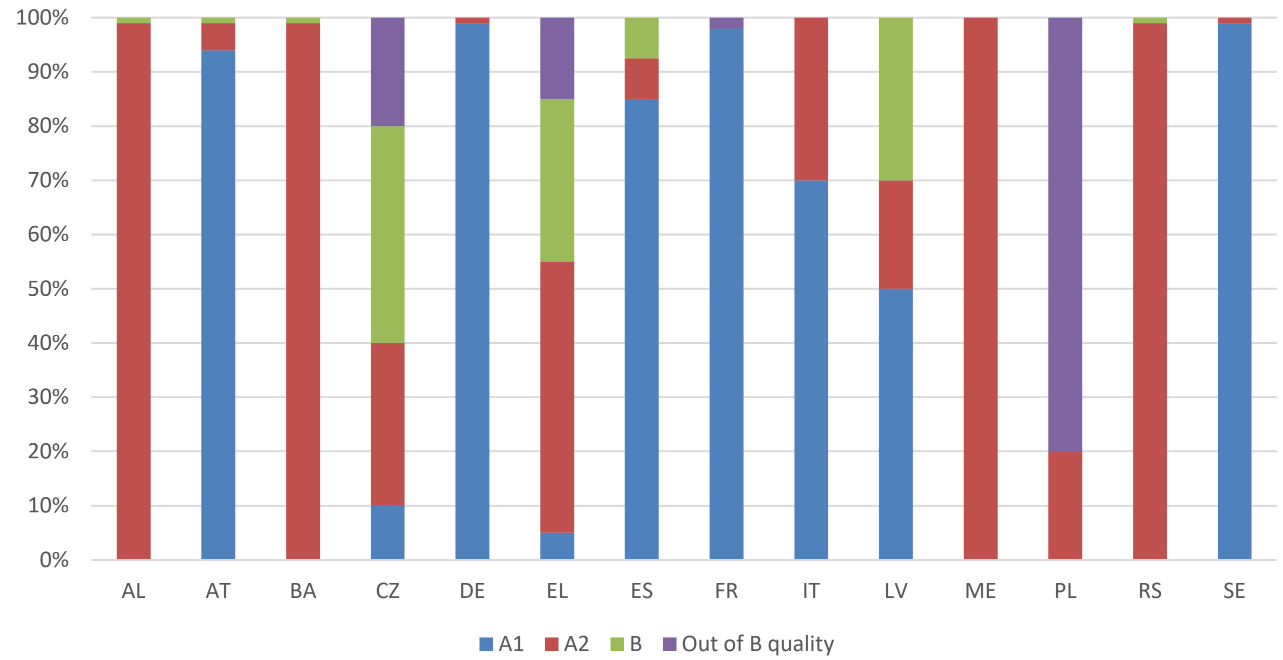
EPC held a consultation with pellet industry stakeholders[4] to identify the pellet quality classes most used in the residential heat market and commercial heat market for each European country. The results are shown in figures 8.37 and 8.38, below. The consultation demonstrated that, while some countries are mainly or even exclusively using premium quality both for the residential and commercial markets, many other countries use lower quality pellets in the commercial sector, and some countries even use lower quality pellets in the residential market.

Figure 8.37 Estimate of pellet quality class shares for residential heat market in European country in 2017(%)



Source: EPC survey 2018

Figure 8.38 Estimate of pellet quality class shares for commercial heat market in European country in 2017 (%)

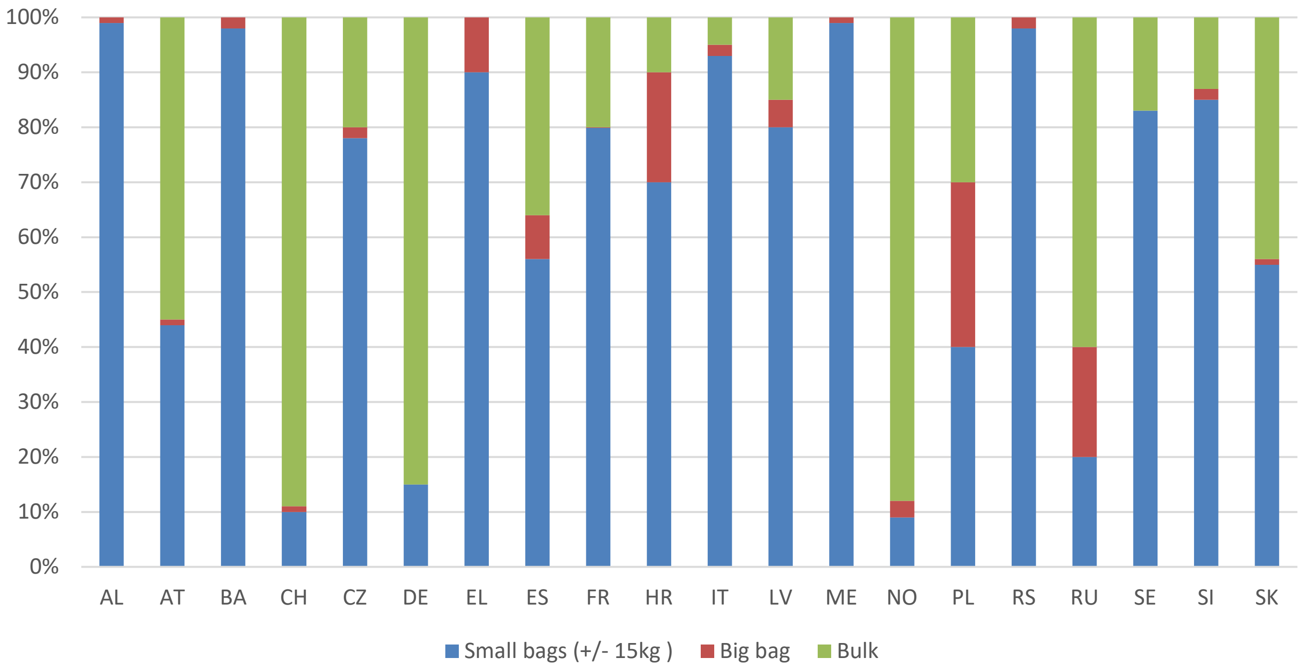


Source: EPC survey 2018

[4] For this survey, only the national pellet associations were consulted. Not all of them have consulted the local producers.

Another consultation was carried out to identify how pellets are delivered to users in the residential heat markets of each European country. **Germany**, **Austria** and **Switzerland** each have heat markets where consumers operate boilers fed from a silo having a multi-tonne capacity. This explains why these markets are mainly consuming bulk pellets. Outside of these countries, consumers mainly buy bagged pellets, either because residential appliances are typically stoves with lower power output (e.g. Italy) or because the boiler operators are not fed from a dedicated high-capacity storage room.

Figure 8.39 Forms of delivery used in the residential heat market in European countries in 2017 (%)

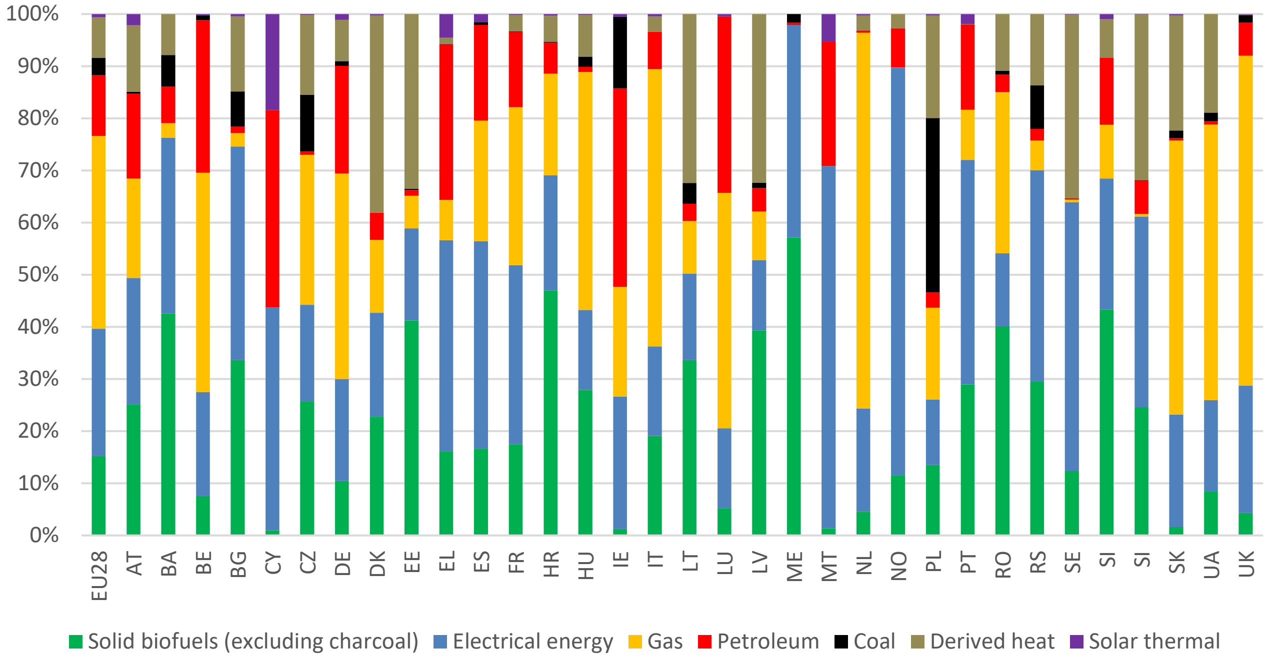


Source: EPC survey 2018

8.2.4 EUROPEAN HEATING APPLIANCES MARKET

Figure 8.40 presents the breakdown of energy sources by fuel type in the residential sector in European countries. The purpose of this graph is to understand the market share of each heating technologies in the residential sector. The graph can help to identify which European markets are the most promising market for pellets.

Figure 8.40 Share of energy used in the residential sector by European countries in 2016 (%)



Note: Electrical energy is also used for non-heat purposes.
Source: Eurostat

8.2.4.1 EUROPEAN STOVE MARKET

In 2014, 2015 and early 2016 sales of stoves was slow through most EU 28 countries, mainly due to the mild winters and the low price of heating oil. But the purchase of a stove is seen much less as an investment, having to rapidly pay off, than is that of a boiler for the customer. As a consequence, the better heating season 2016-2017 allowed the market to recover in some countries.

Italy: Despite the slowing market in 2015 and 2016, stove sales remained higher than in any other country in Europe, and even slightly increased in 2017. A support scheme called “Conto Termico”, implemented in 2012, began a second iteration in May 2016. Italy also has the highest number of installed pellet stoves in Europe with 2,6 million units in place, more than three times as many appliances as the next-largest market, France.

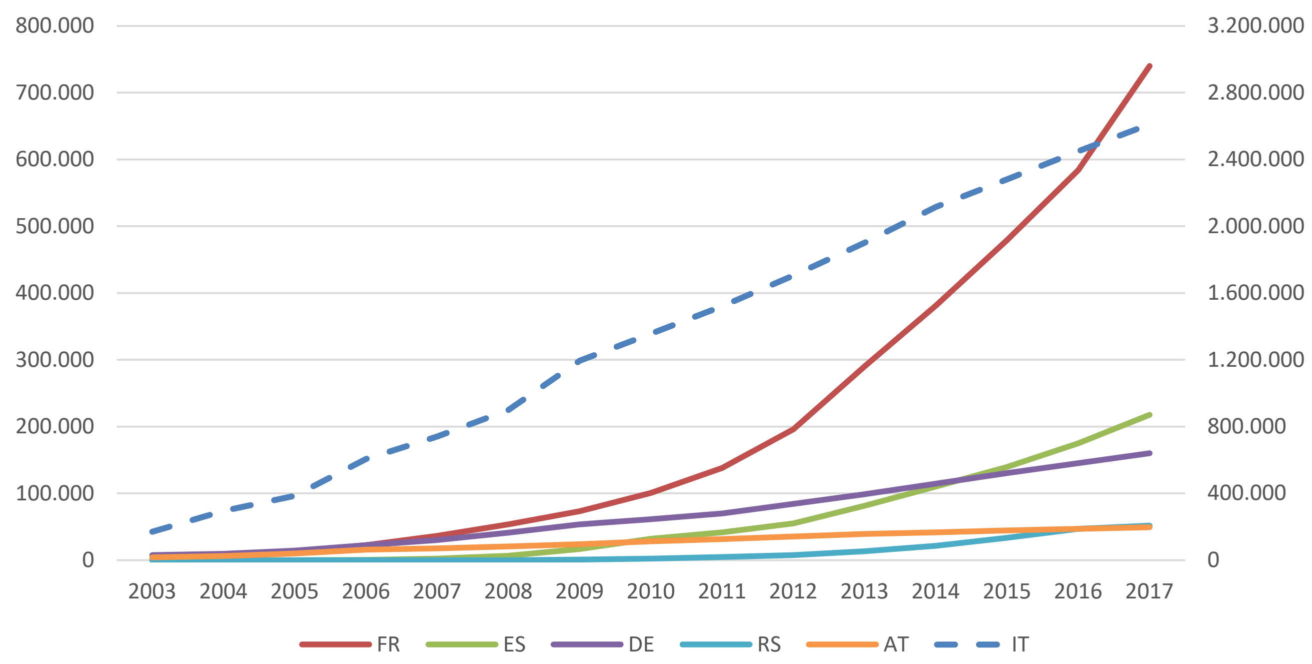
France: Stove sales have increased steadily since 2014, almost reaching the rate of sales in the Italian market in 2017. Pellets should become increasingly competitive against their fossil counterpart in the future as the French carbon tax progressively increases from 22€/tonne of CO_2eq in 2017 to 86,2€ tonne of CO_2eq in 2022, and as credits for fossil fuel appliances cease.

Germany: Rising prices for heating oil and improved subsidies for new pellet installations did not lead to any substantial growth in sales. Despite new policy framework, renewable heat still lacks political support.

Serbia: Because of a shortage of pellet during January 2017, followed by a steep increase in prices. Consumers lost trust in pellets in the residential and commercial sector. The result was a sharp drop in the sales of pellet appliances.

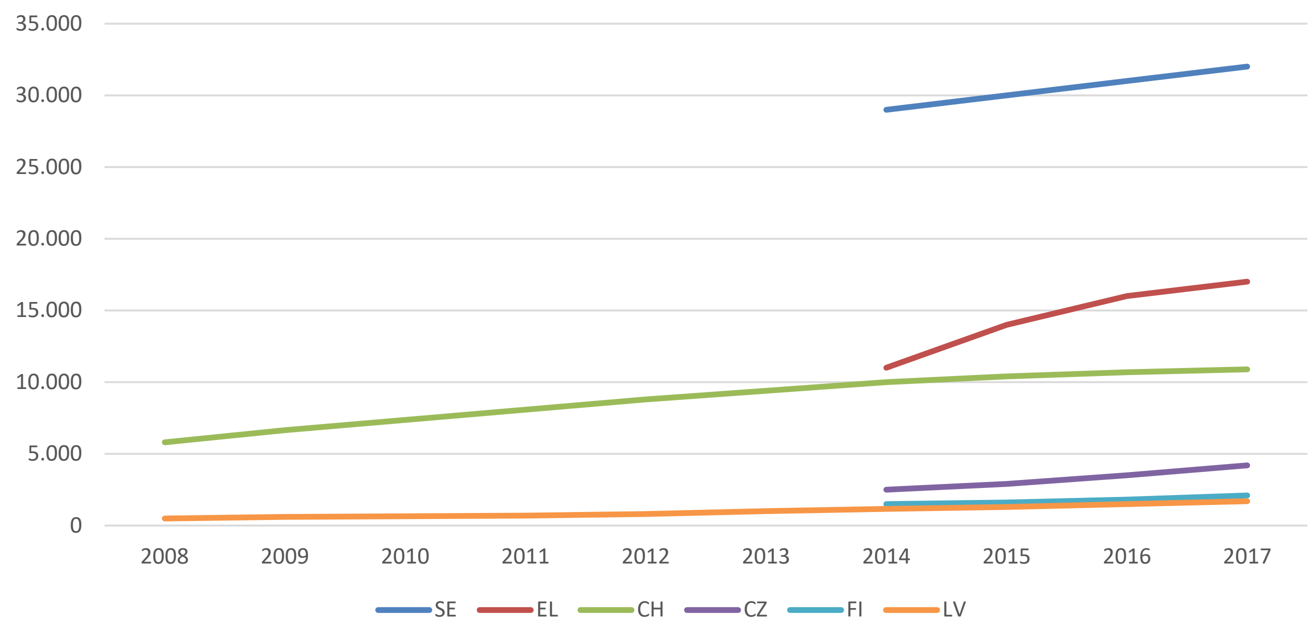
Finland: The market for pellet appliances has been relatively unsuccessful for years. However, increased oil prices may bring some interest to the market.

Figure 8.41 Evolution of the installed stock of pellet stoves in some major European markets (n° of units; Italy in secondary axis)



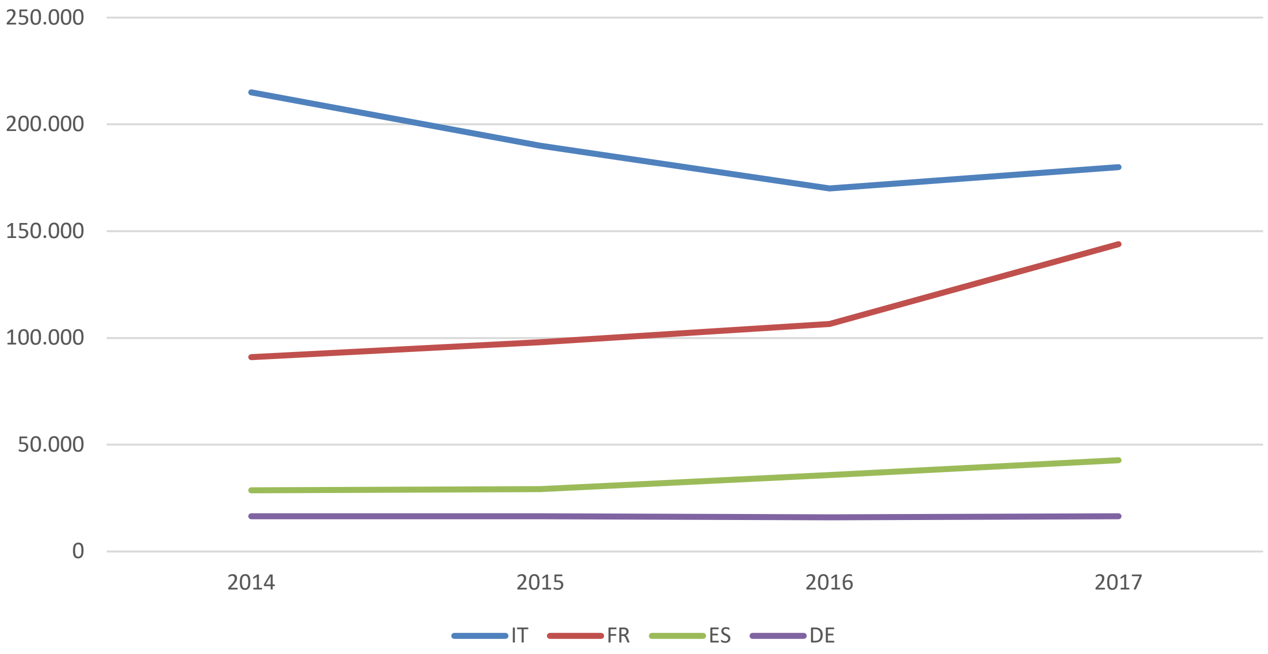
Source: EPC survey 2018

Figure 8.42 Evolution of the installed stock of pellet stoves in some minor European markets (n° of units)



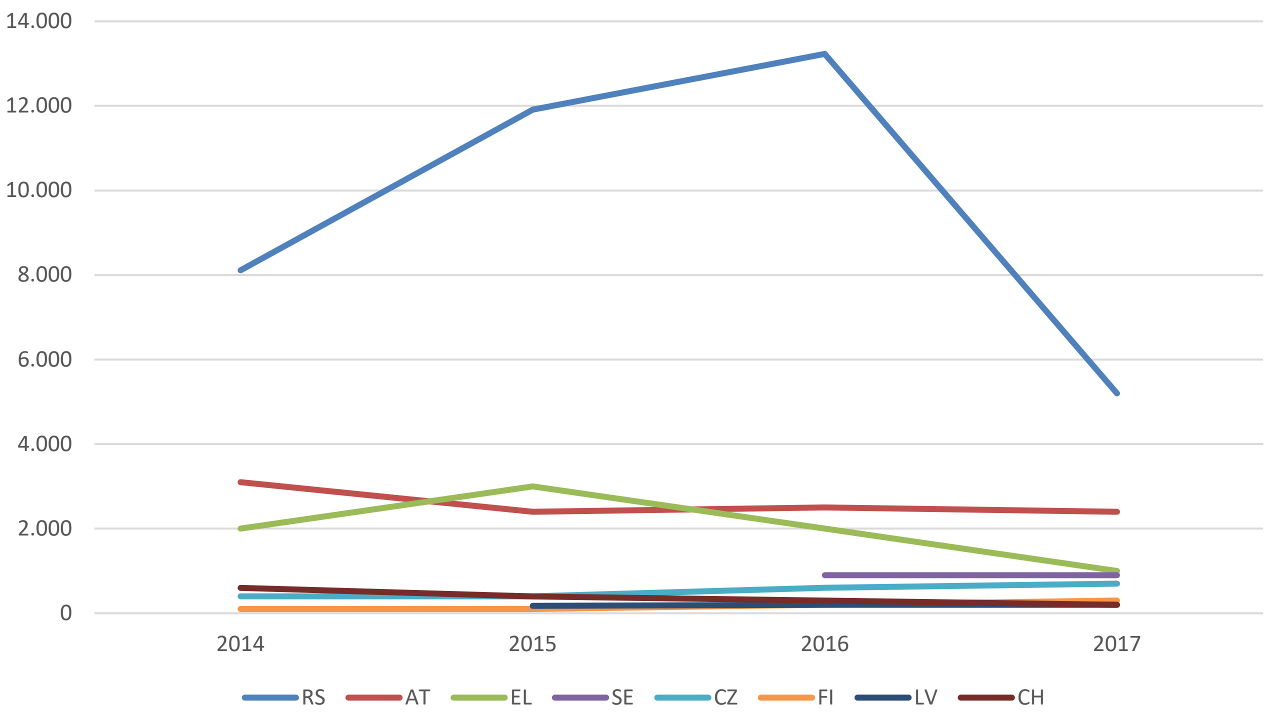
Source: EPC survey 2018

Figure 8.43 Evolution of the annual sales of pellet stoves in some major European markets (n° of units)



Source: EPC survey 2018

Figure 8.44 Evolution of the annual sales of pellet stoves in some minor European markets (n° of units)



Source: EPC survey 2018

8.2.4.2 EUROPEAN RESIDENTIAL BOILER MARKET

Germany: Germany owns the biggest stock of installed residential pellet boilers in Europe. The numbers of boilers is higher than the number of pellet stoves, which shows the specificity of this market.

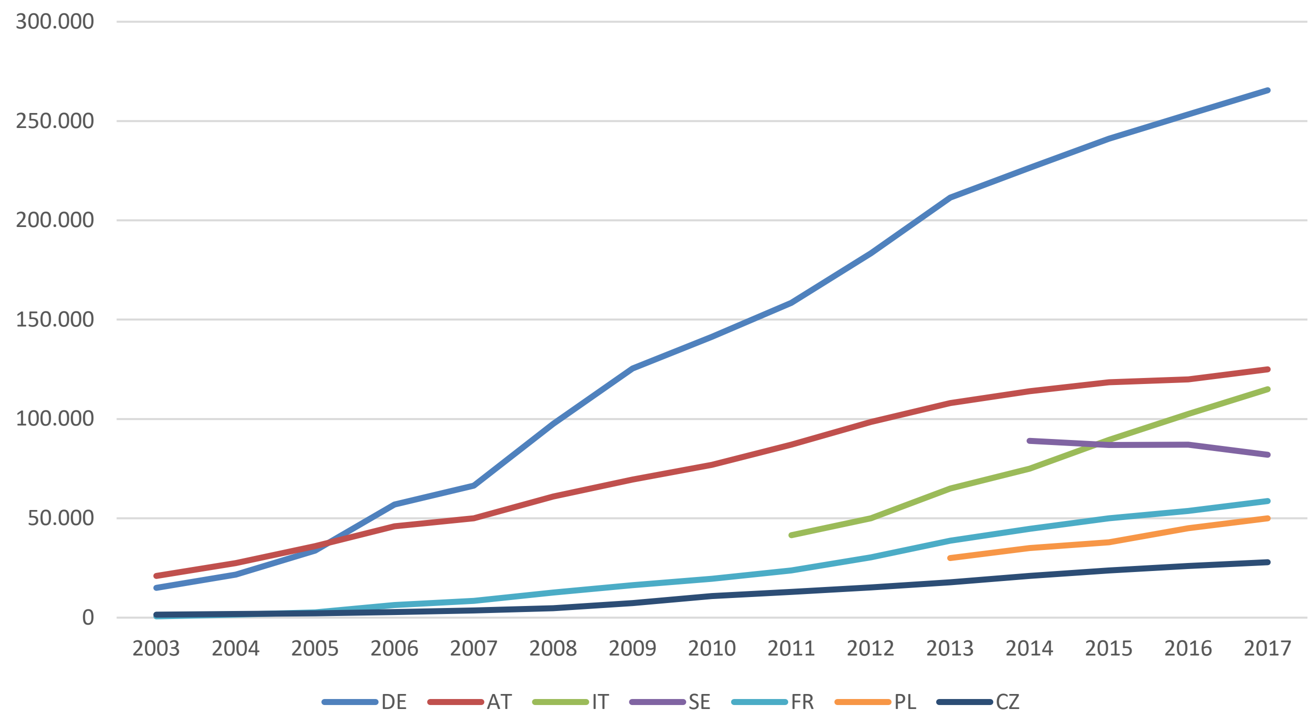
Austria: Residential pellet boilers have long been popular in Austria, but sales have slowed down since 2013. In 2017, sales increased substantially (27% from 2016), and in May-June 2018 two support programs were launched to replace existing fossil fuel appliances. Despite this, sales are expected to be down 10% in 2018.

Italy: Although the market is dominated by pellet stoves, sales of residential pellet boilers are the second highest in Europe, almost equalling Germany.

Poland: After a promising year in 2014, the Polish market stagnated between 2016 and 2017. Due to air quality issues, the country is working to replace inefficient solid fuel appliances. The country remain Europe's biggest user of coal in the residential sector. Government incentives, are expected to drive sales of modern pellet stoves and boilers.

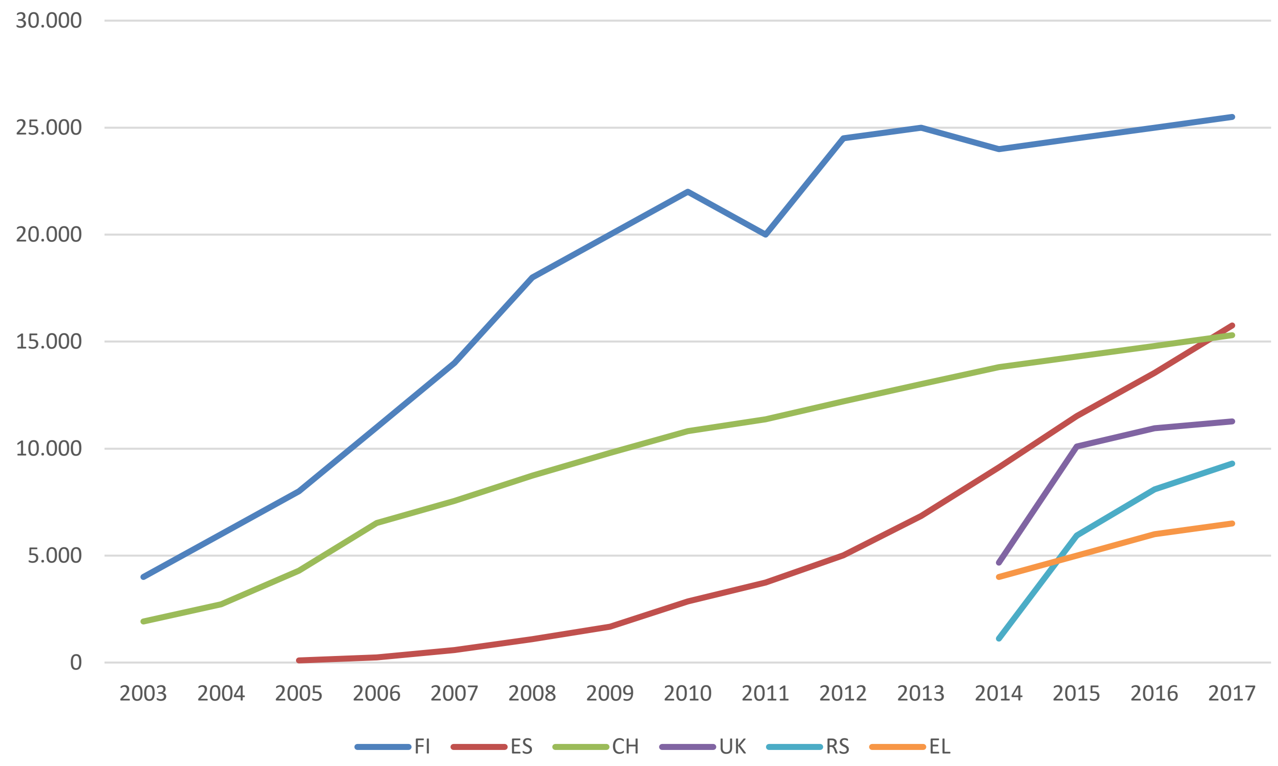
United Kingdom: The Renewable Heat Incentive (RHI) scheme has helped residential pellet boiler sales to skyrocket in the UK. However, the program is a victim of its own success, and the government has now decided to significantly reduce tariff payments to the owners of biomass installations. This led to a boom in sales in 2015 followed almost immediately by a steep drop-off in sales in 2016 and 2017.

Figure 8.45 Evolution of the installed stock of residential pellet boilers (<50kW) in some major European markets <50kW (n° of units)



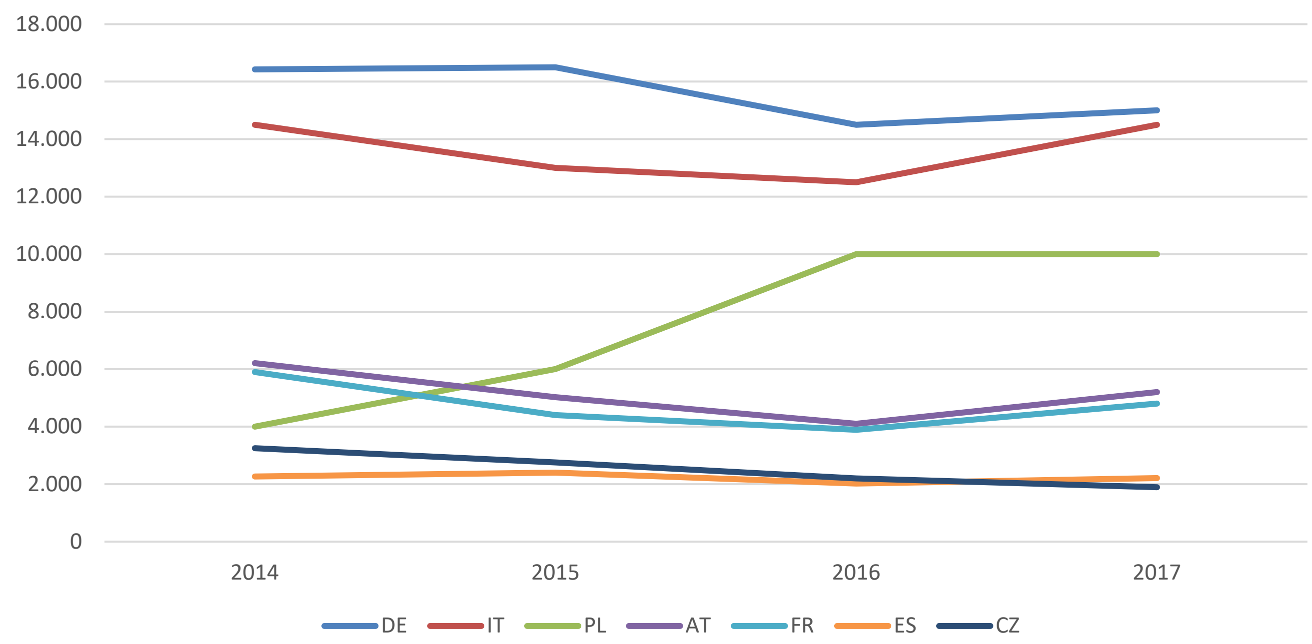
Source: EPC survey 2018

Figure 8.46 Evolution of the installed stock of residential pellet boilers (<50kW) in some major European markets (n° of units)



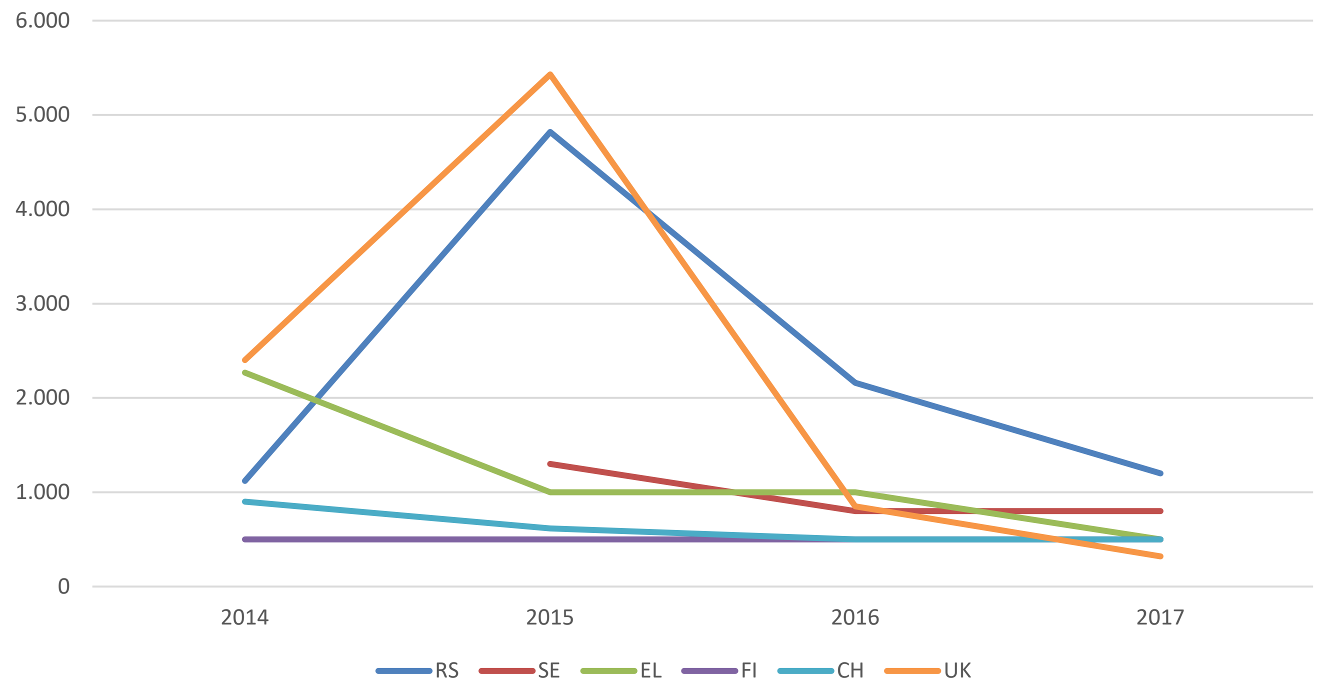
Source: EPC survey 2018

Figure 8.47 Evolution of the annual sales of residential pellet boilers (<50kW) in some major European markets (n° of units)



Source: EPC survey 2018

Figure 8.48 Evolution of the annual sales of residential pellet boilers (<50kW) in some minor European markets (n° of units)



Source: EPC survey 2018

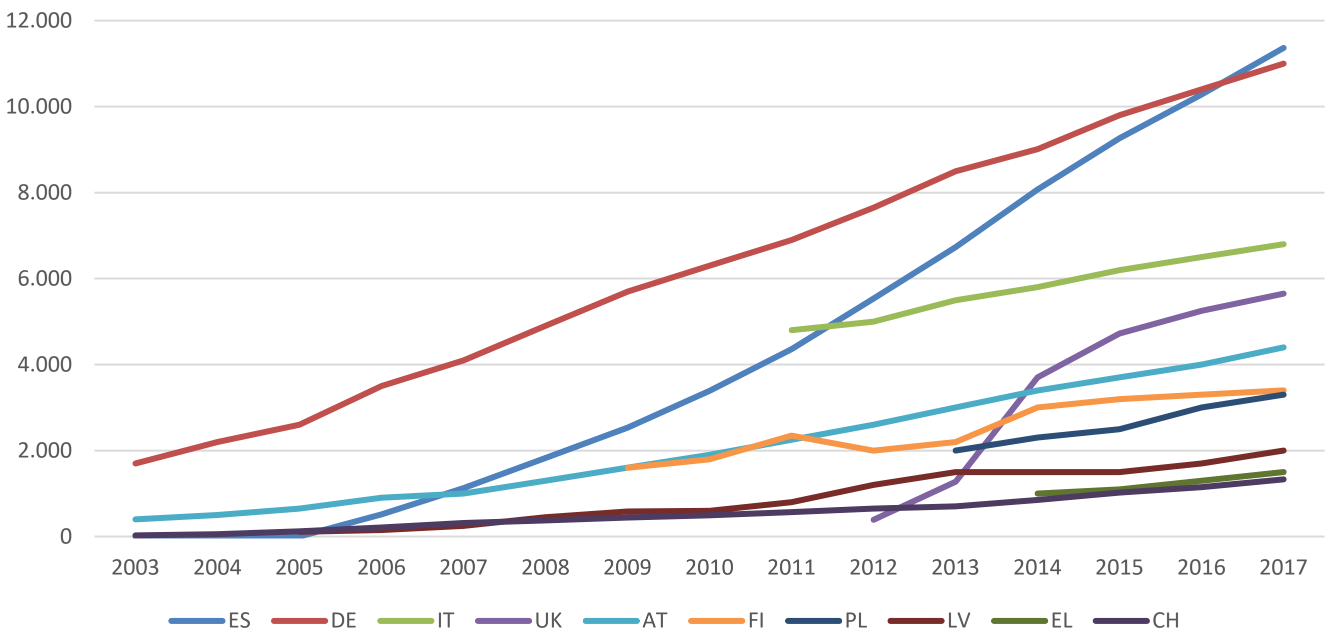
8.2.4.3 EUROPEAN COMMERCIAL BOILER MARKET

Pellets for commercial heating (defined as dedicated-heat boilers with at least 50 kilowatts of output used in residential buildings, public buildings, services, industry, etc.) remains a niche market in most of Europe, but has been identified by several observers as the key for establishing pellet use in the long run. Indeed, the commercial heating market is today growing at a faster growth rate than the residential sector

Data on Spanish commercial boilers includes multi-fuel boilers capable of using pellets. While these boilers tend to use cheaper biomass sources like olive stones, pine nut shells or almond shells, they are capable of consuming pellets when cheaper biomass is not available.

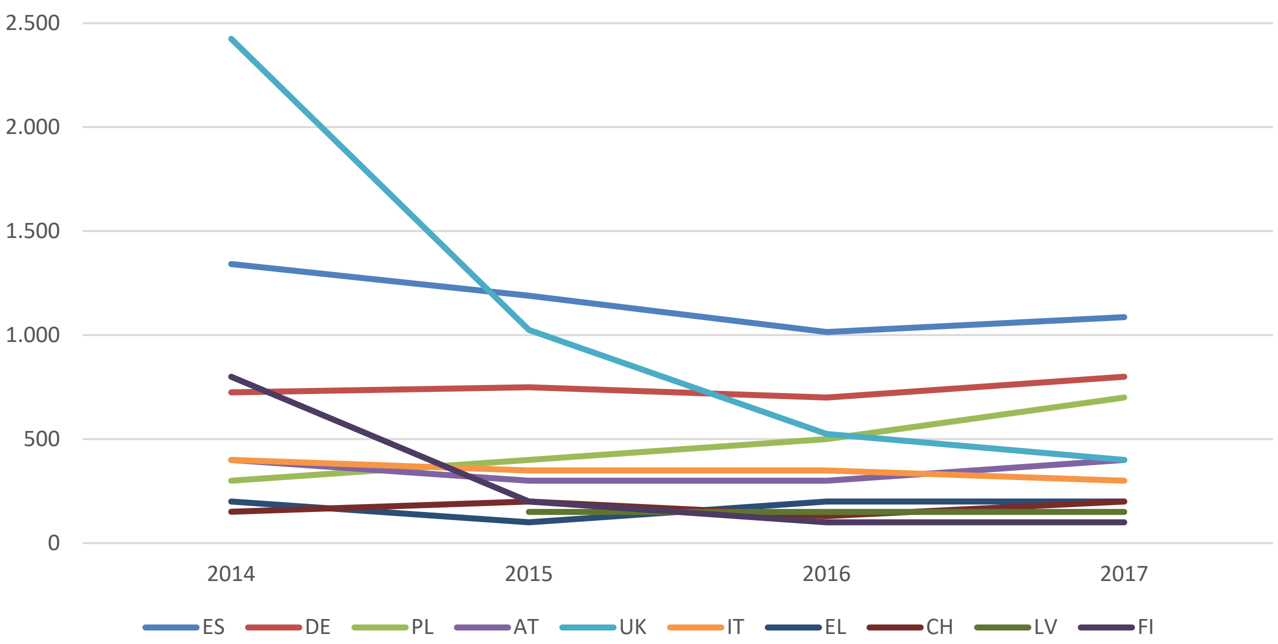
United Kingdom: The Renewable Heat Incentive (RHI) has helped residential pellet boiler sales to skyrocket in the UK. However, the program is a victim of its own success, and the government has now decided to significantly reduce tariff payments to the owners of biomass installations. This led to a boom in sales in 2015 followed almost immediately by a steep drop-off in sales in 2016 and 2017.

Figure 8.49 Evolution of the installed stock of commercial pellet boilers (>50kW) in some European countries (n° of units)



Note: Commercial boilers in Spain includes multi-fuel boilers.
Source: EPC survey 2018

Figure 8.50 Evolution of the annual sales of commercial pellet boilers (>50kW) in some European countries (n° of units)



Source: EPC survey 2018

Table 8.9 Annual sales of boilers and stoves in Europe in 2016 and 2017 (n° of units)

	Stoves		Residential boilers (<50kW)		Commercial boilers (>50kW)	
	2016	2017	2016	2017	2016	2017
AT	2.500	2.400	4.100	5.200	300	400
CH	300	200	500	500	130	200
CZ	600	700	2.200	1.893	n.a.	n.a.
DE	16.000	16.500	14.500	15.000	700	800
EL	2.000	1.000	1.000	500	200	200
ES	35.815	42.732	2.021	2.212	1.015	1.086
FI	200	300	500	500	100	100
FR	106.550	143.900	3.890	4.800	n.a.	n.a.
IT	170.000	180.000	12.500	14.500	350	300
LV	200	200	400	400	150	150
PL	n.a.	n.a.	10.000	10.000	500	700
RS	13.230	5.200	2.160	1.200	33	24
SE	900	900	800	800	100	200
UK	n.a.	n.a.	850	320	525	400

Note: Commercial boilers in Spain includes multi-fuel boilers.
Source: EPC survey 2018

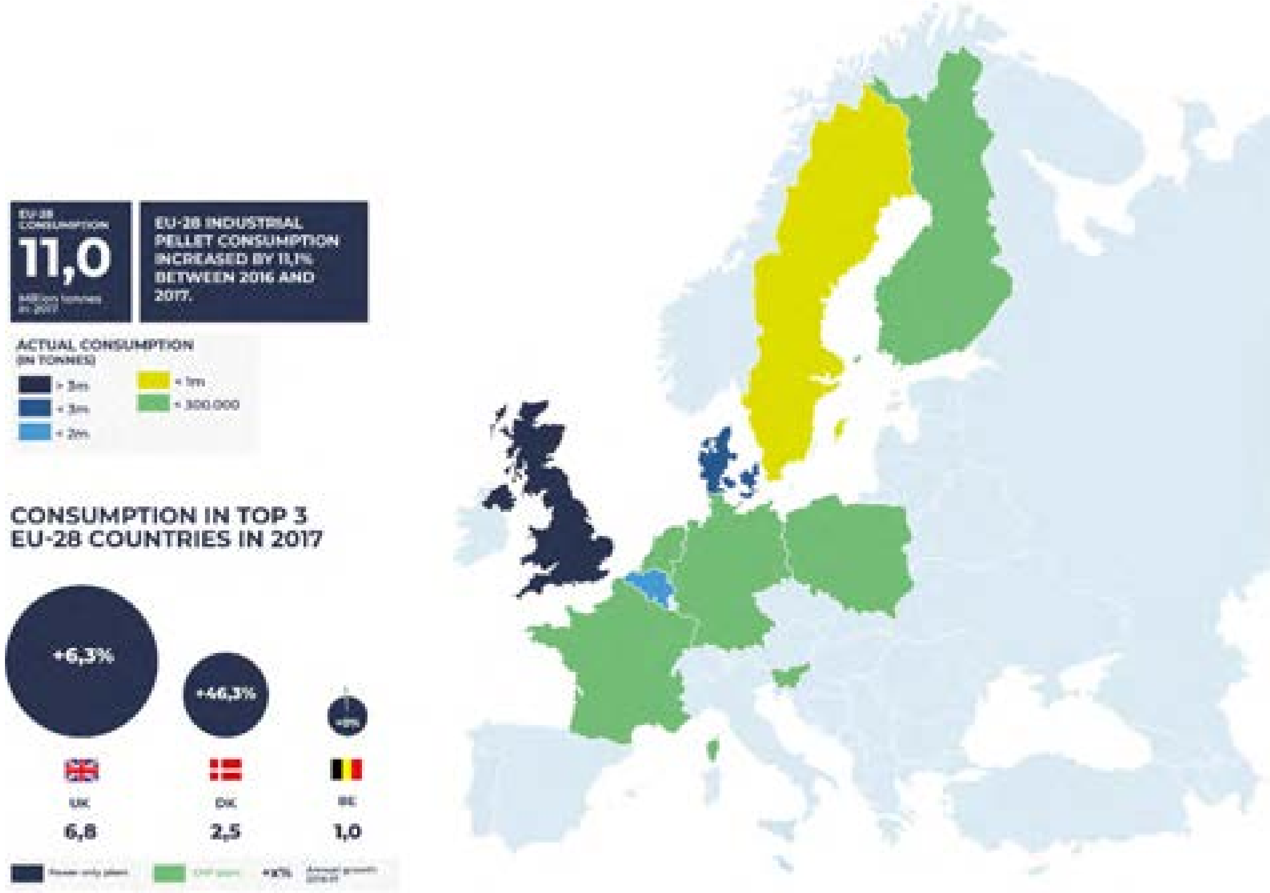
Table 8.10 Installed stock of pellet boilers and stoves in Europe in 2016 and 2017 (n° of units)

	Stoves		Residential boilers (<50kW)		Commercial boilers (>50kW)	
	2016	2017	2016	2017	2016	2017
AT	47.000	49.500	120.000	125.000	4.000	4.400
CH	10.700	10.900	14.800	15.300	1.150	1.330
CZ	3.500	4.200	26.007	27.900	n.a.	n.a.
DE	145.100	160.300	253.300	265.500	10.400	11.000
EL	16.000	17.000	6.000	6.500	1.300	1.500
ES	175.065	217.797	13.542	15.754	10.280	11.366
FI	1.800	2.100	25.000	25.500	3.300	3.400
FR	584.000	740.000	53.700	58.700	n.a.	n.a.
IT	2.450.000	2.610.000	102.500	115.000	6.500	6.800
LV	1.500	1.700	8.000	10.000	1.700	2.000
PL	n.a.	n.a.	45.000	50.000	3.000	3.300
RS	46.720	51.920	8.100	9.300	70	94
SE	31.000	32.000	87.000	82.000	n.a.	1.800
UK	n.a.	n.a.	10.950	11.270	5.250	5.650

Note: Commercial boilers in Spain includes multi-fuel boilers.
Source: EPC survey 2018

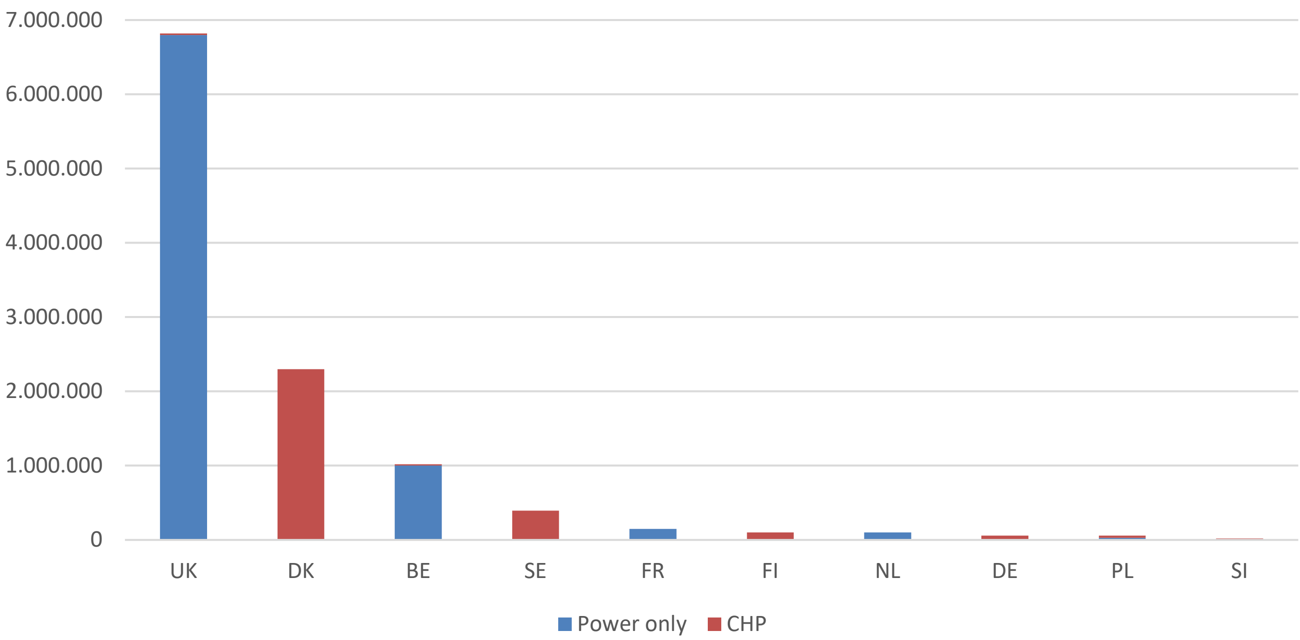
8.2.4.4 INDUSTRIAL PELLET CONSUMPTION

Figure 8.51 European map of industrial pellet consumption in 2017



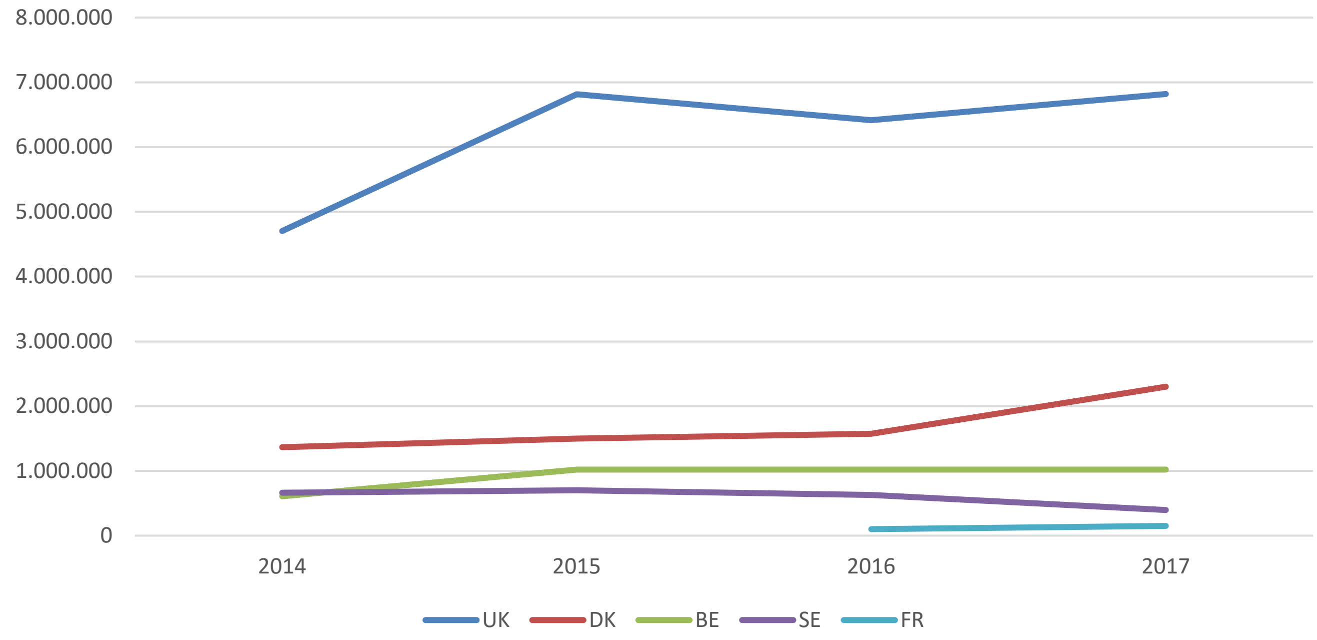
Source: EPC survey 2018, Hawkins Wright

Figure 8.52 European industrial pellet consumption by country in 2017 (tonnes)



Source: EPC survey 2018, Hawkins Wright

Figure 8.53 Evolution of industrial pellet consumption of Europe's biggest consumers (tonnes)



Source: EPC survey 2018, Hawkins Wright

Global industrial wood pellet demand increased by 2Mt in 2017, to approximately 15Mt. This growth was split evenly between Europe and Asia, with a number of new pellet-consuming power projects becoming operational in both continents.

In the UK, EPH's 400MW Lynemouth power station was converted from coal to wood pellets and began modest test burns at the end of 2017. Once fully operational the station's wood pellet demand will be 1.6Mt/y, but technical issues caused the plant's conversion to be significantly delayed, and therefore consumption at the station was much lower than expected in 2017. Technical challenges also caused delays in the commissioning of RWE's 600MW Amer 9 unit in the Netherlands, which was due to begin burning pellets in Q4 2017.

In Denmark, pellet demand from Ørsted's three converted CHP plants increased by around 500kt in 2017. This caused industrial pellet consumption in the country to reach ~2Mt.

Fiona Matthews
Research Manager
Hawkins Wright

HAWKINS WRIGHT

Table 8.11 European pellet consumption in 2017 compared to 2016 (tonnes)

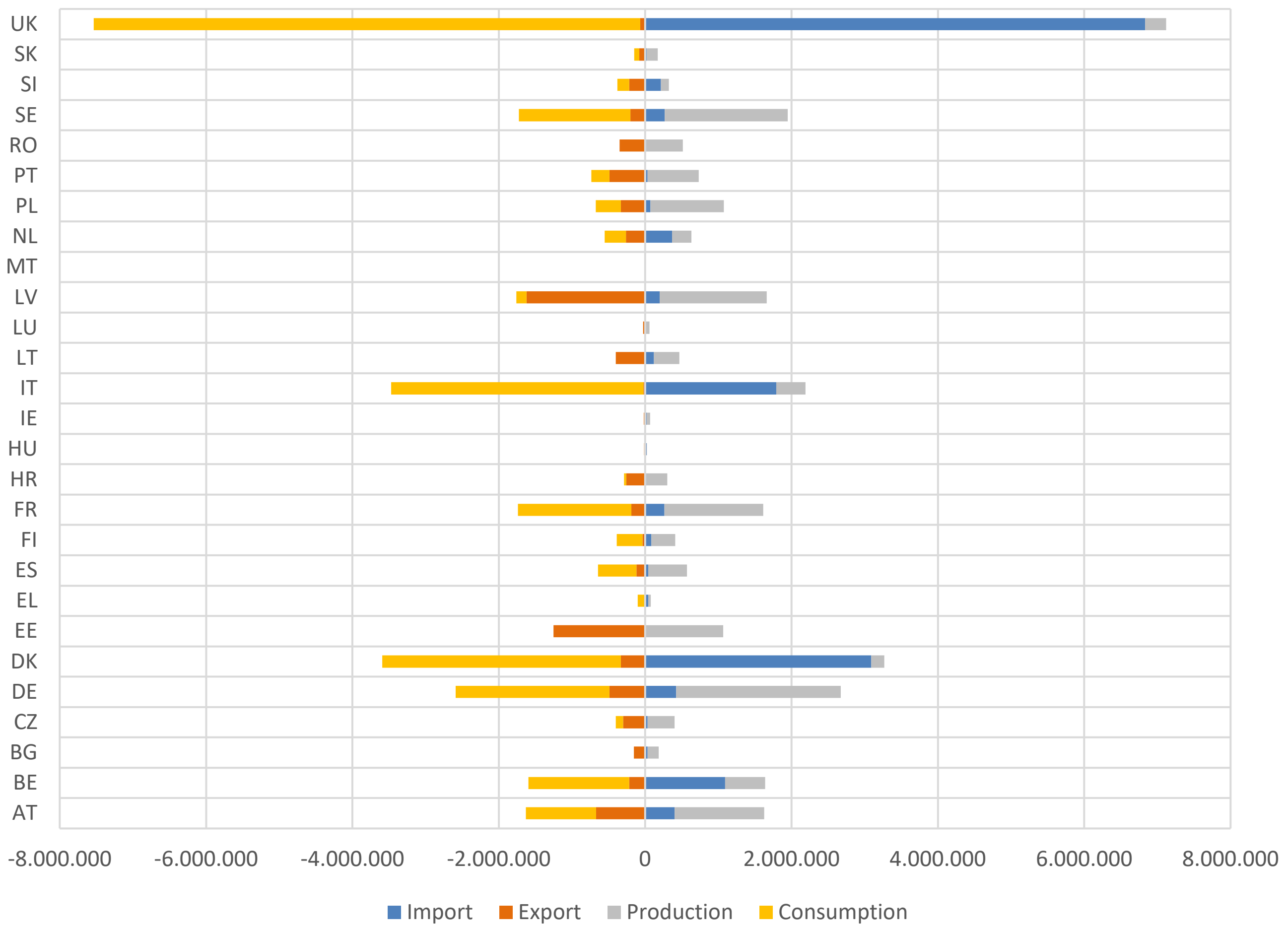
	2016					2017				
	Residential	Commercial	CHP	Power only	Total	Residential	Commercial	CHP	Power only	Total
EU28	9.002.790	2.906.982	2.399.773	7.525.000	21.834.545	9.741.416	3.370.155	2.945.895	8.080.000	24.137.466
AT	745.000	150.000	0	0	895.000	800.000	160.000	0	0	960.000
BE	315.000	8.000	20.000	1.000.000	1.343.000	346.500	8.800	20.000	1.000.000	1.375.300
BG	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CZ	64.000	30.000	0	0	94.000	68.000	30.000	0	0	98.000
DE	1.360.000	580.000	60.000	0	2.000.000	1.420.000	620.000	60.000	0	2.100.000
DK	834.762	162.979	1.571.916	0	2.569.657	800.000	160.000	2.300.000	0	3.260.000
EE	30.000	10.000	0	0	40.000	30.000	10.000	0	0	40.000
EL	68.000	13.000	0	0	81.000	73.000	15.000	0	0	88.000
ES	285.000	190.000	0	0	475.000	326.000	203.000	0	0	529.000
FI	58.000	184.000	60.000	0	302.000	62.000	188.000	100.000	0	350.000
FR	1.020.000	80.000	0	100.000	1.200.000	1.240.000	160.000	0	150.000	1.550.000
HR	10.500	5.500	0	0	16.000	19.000	9.000	0	0	28.000
HU	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IE	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IT	2.900.000	300.000	0	0	3.200.000	3.150.000	300.000	0	0	3.450.000
LT	47.500	12.500	0	0	60.000	47.500	12.500	n.a.	n.a.	60.000
LU	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
LV	132.000	8.000	0	0	140.000	129.000	9.000	0	0	138.000
MT	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NL	60.000	130.000	0	0	190.000	60.000	130.000	0	100.000	290.000
PL	200.000	50.000	25.000	25.000	300.000	233.000	50.000	30.000	30.000	343.000
PT	115.000	100.000	0	0	215.000	100.000	150.000	0	0	250.000
RO	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SE	549.370	428.894	628.081	0	1.606.345	586.816	545.555	395.795	0	1.528.166
SI	85.000	50.000	20.000	0	155.000	90.000	50.000	20.000	0	160.000
SK	35.000	25.000	0	0	60.000	40.000	30.000	0	0	70.000
UK	88.658	389.109	14.776	6.400.000	6.892.543	120.600	529.300	20.100	6.800.000	7.470.000
Other Europe	552.606	151.588	0	0	704.194	714.470	177.766	0	0	892.236
AL	22.500	1.200	0	0	23.700	27.700	2.800	0	0	30.500
BA	117.500	11.000	0	0	128.500	169.090	23.000	0	0	192.090
BY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CH	169.650	91.350	0	0	261.000	182.000	98.000	0	0	280.000
ME	12.600	1.000	0	0	13.600	20.200	1.700	0	0	21.900
NO	44.456	23.938	0	0	68.394	46.180	24.866	0	0	71.046
RS	176.900	2.100	0	0	179.000	258.800	2.900	0	0	261.700
RU	9.000	21.000	0	0	30.000	10.500	24.500	0	0	35.000
UA	n.a.	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.	n.a.	0

Note: EE, LT, NL: Consumption 2017 is a replication of 2016; BE: Residential and commercial consumption estimated by EPC; BE: Residential and commercial consumption estimated by EPC; CH & NO: Split residential and commercial consumption estimated by EPC.
Sources: EPC survey 2018; Hawkins Wright

8.2.5 EUROPEAN TRADE OF WOOD PELLET

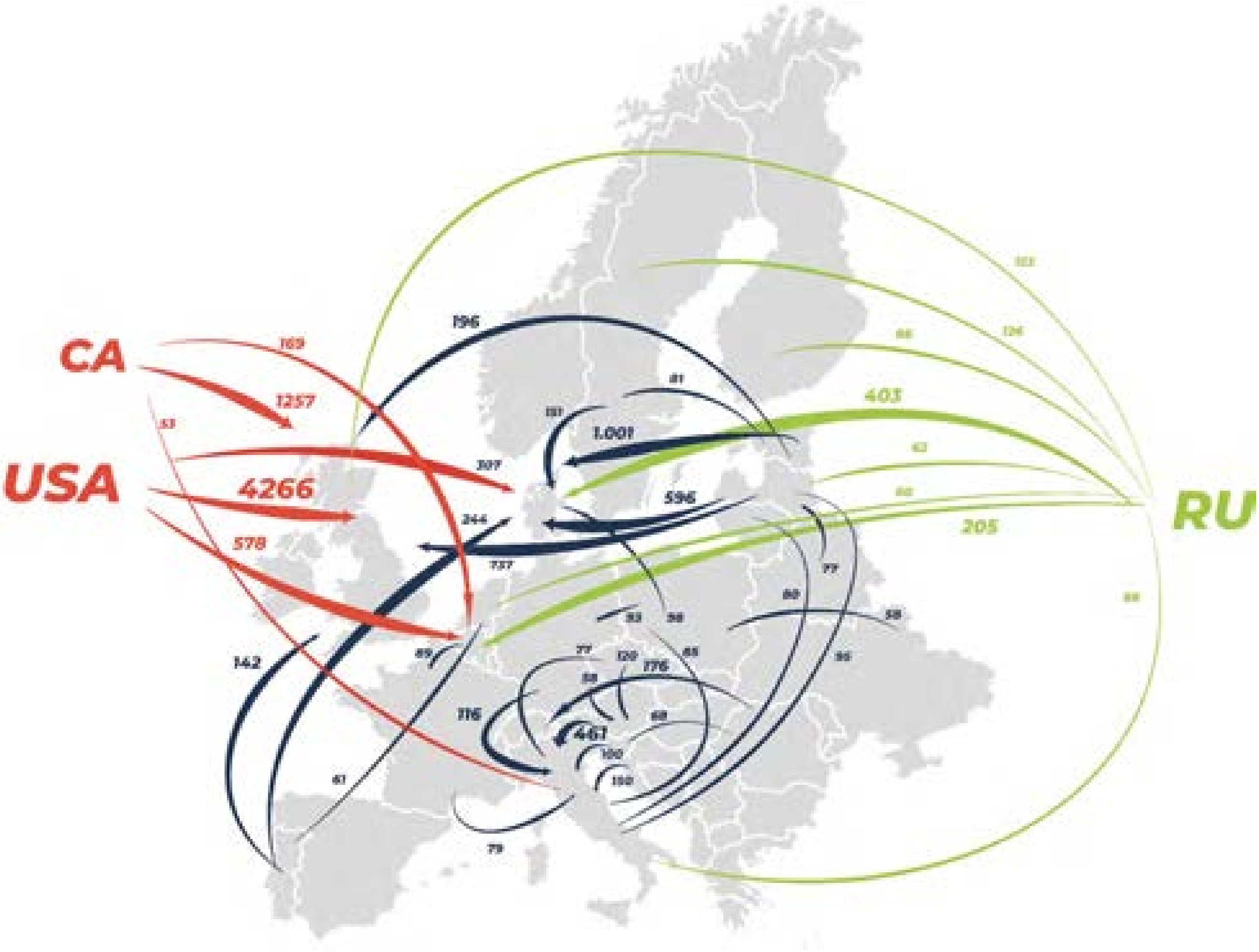
The data provided in this section are delivered by Eurostat. Their accuracy vary between countries. However, these numbers still reflect the big trends in import-export in Europe.

Figure 8.54 EU28 Member States pellet balance by country in 2017 - production, consumption, export, import (tonnes)



Source: EPC survey 2018, Hawkins Wright, Eurostat, FAO

Figure 8.55 Net European pellet trade stream and net North American export toward Europe in 2017 (>50 ktonne), (ktonnes)



Source: Eurostat

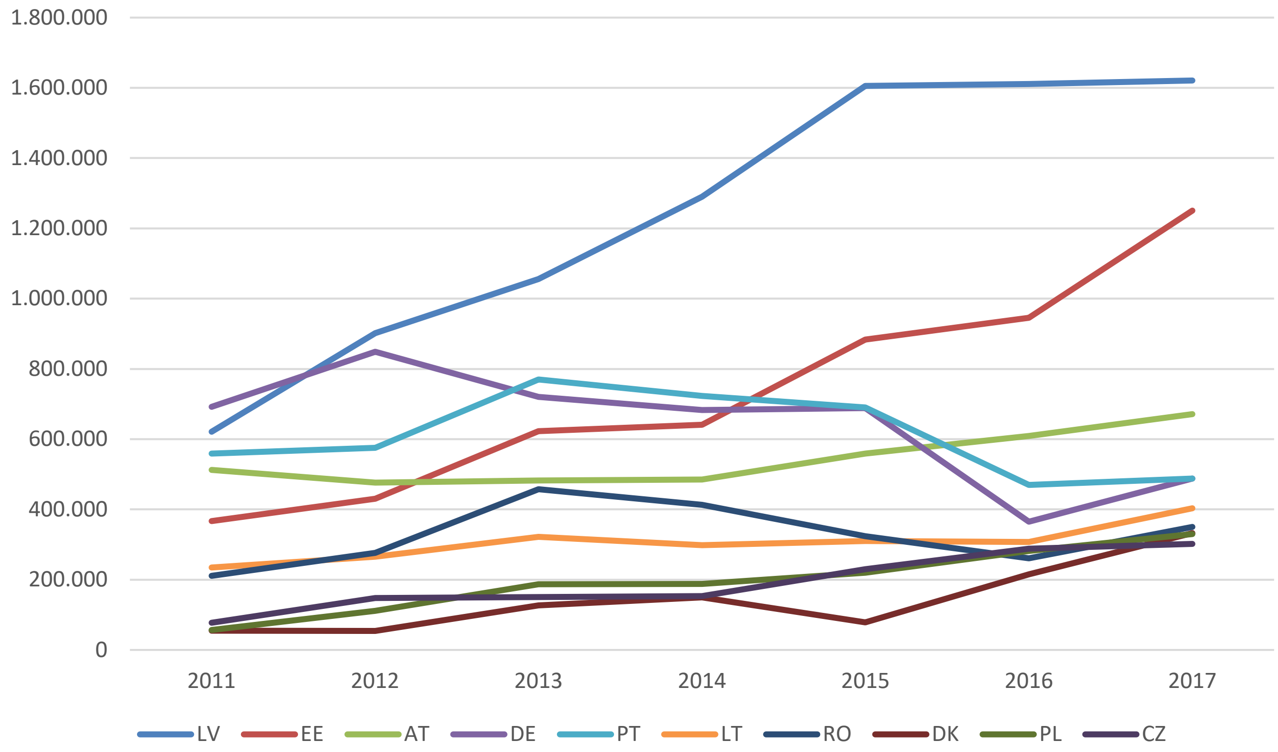
8.2.5.1 EU28 EXPORTING COUNTRIES

Latvia & Estonia: Both countries are major exporters of industrial pellets in Europe. Almost all their production is exported due to weak internal consumption. The numbers displayed for 2017 are unlikely to be exact since both countries have reported lower pellet production than the data on exported volumes.

Austria: Austria remains a major exporter in Europe, mainly in the Italian market. Austrian production is principally A1 quality and is recognised as such abroad.

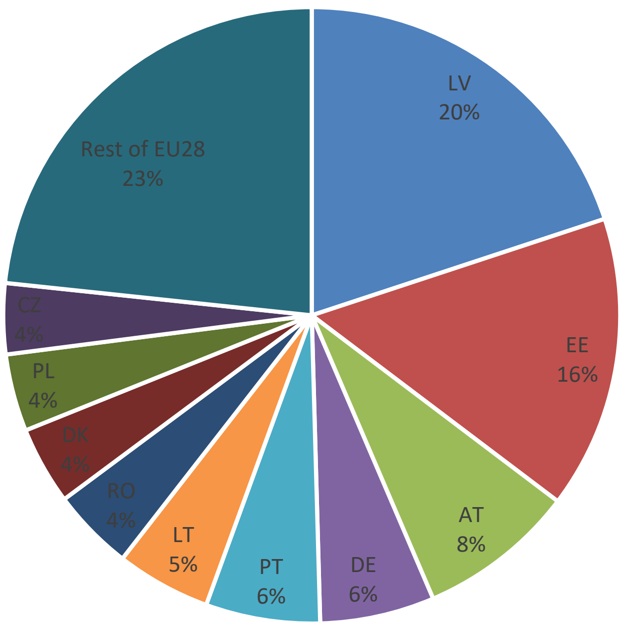
Portugal: Portugal is historically an exporter of industrial pellets, but its exports have declined the latest year due to production problems and a growing internal consumption.

Figure 8.56 Evolution of the exports of pellets in the top 10 EU28 exporting countries (tonnes)



Source: Eurostat

Figure 8.57 Share of total EU28 pellet exports in 2017 (%)



Source: Eurostat

Table 8.12 Export to top 3 destinations of top 10 pellet exporting countries in EU28 between 2013 and 2017 (tonnes)

	2013		2014		2015		2016		2017	
LV	DK	504.857	DK	493.195	DK	537.619	EE	634.804	EE	715.336
	EE	179.940	UK	308.086	EE	487.150	DK	572.750	DK	604.498
	UK	161.703	EE	306.500	UK	419.512	UK	294.369	UK	139.568
	Rest of EU28	209.181	Rest of EU28	182.208	Rest of EU28	160.453	Rest of EU28	108.863	Rest of EU28	160.830
	Rest of the world	250	Rest of the world	458	Rest of the world	621	Rest of the world	647	Rest of the world	721
EE	DK	375.956	DK	423.156	DK	506.484	AT	493.870	DK	725.473
	SE	119.640	IT	56.223	UK	234.417	DK	213.778	UK	219.188
	IT	43.735	SE	55.104	NL	59.178	UK	116.589	SE	69.839
	Rest of EU28	83.821	Rest of EU28	106.284	Rest of EU28	83.227	Rest of EU28	121.501	Rest of EU28	235.888
	Rest of the world	23	Rest of the world	72	Rest of the world	84	Rest of the world	115	Rest of the world	209
AT	IT	429.268	IT	440.114	IT	486.604	IT	550.796	IT	589.511
	DE	36.494	DE	28.575	DE	29.368	DE	21.584	CH	23.552
	CH	8.119	CH	7.266	CH	20.046	SI	17.102	DE	22.898
	Rest of EU28	7.498	Rest of EU28	8.021	Rest of EU28	20.766	Rest of EU28	7.371	Rest of EU28	31.673
	Rest of the world	1.420	Rest of the world	1.396	Rest of the world	2.344	Rest of the world	12.694	Rest of the world	3.606
DE	AT	167.421	AT	212.409	AT	141.294	IT	120.113	IT	144.553
	DK	121.539	IT	170.714	IT	136.486	AT	83.812	FR	108.201
	IT	112.408	FR	90.181	FR	49.312	FR	57.501	AT	97.940
	Rest of EU28	243.452	Rest of EU28	166.517	Rest of EU28	308.792	Rest of EU28	55.971	Rest of EU28	88.403
	Rest of the world	75.408	Rest of the world	42.979	Rest of the world	52.400	Rest of the world	47.672	Rest of the world	48.816
PT	UK	277.251	UK	477.851	NL	502.271	UK	208.772	DK	199.261
	DK	252.076	DK	133.796	UK	109.458	DK	146.396	UK	126.762
	NL	70.059	ES	60.512	DK	59.288	ES	62.376	ES	95.064
	Rest of EU28	170.504	Rest of EU28	50.913	Rest of EU28	19.187	Rest of EU28	51.936	Rest of EU28	66.671
	Rest of the world	7	Rest of the world	43	Rest of the world	127	Rest of the world	236	Rest of the world	21

Source: Eurostat

8.2.5.2 EU28 IMPORTING COUNTRIES

United Kingdom: The UK is the largest pellet importer in the EU, with most of its pellets being sourced from North America, due to the continuous increase of pellet use in its power plants coupled with limited local production.

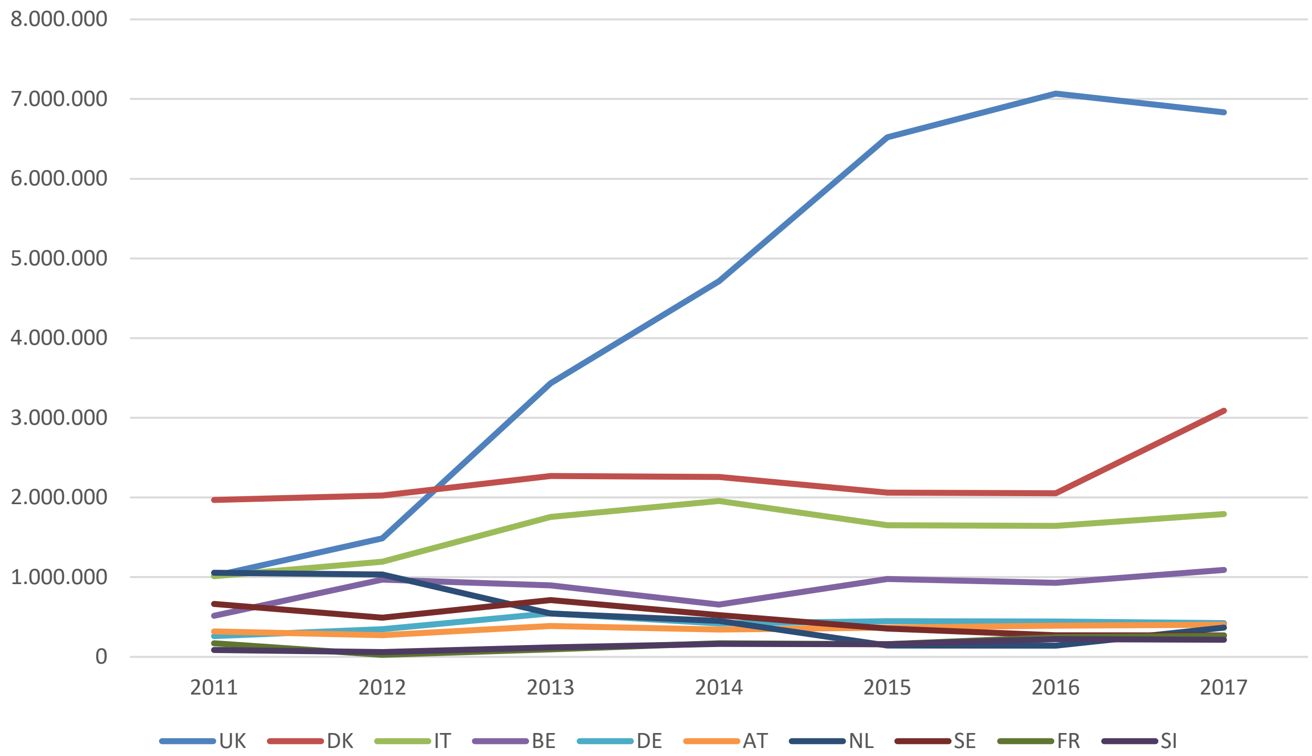
Denmark: Denmark is the second largest pellet importer, mainly sourcing pellets from Latvia, Estonia and Russia. The imported volumes increased by 150% in 2017 to supply a substantial increase in industrial pellet consumption.

Italy: Italy is the third largest importer of pellets. With a production of 400.000 tonnes and a consumption of 3.450.000 tonnes, the numbers delivered by Eurostat are likely to be one million tonnes too low. Italy is therefore probably closer to 3 million tonnes of import in 2017.

Belgium: The import of industrial pellets have been constant over the years due to internal consumption for electricity production.

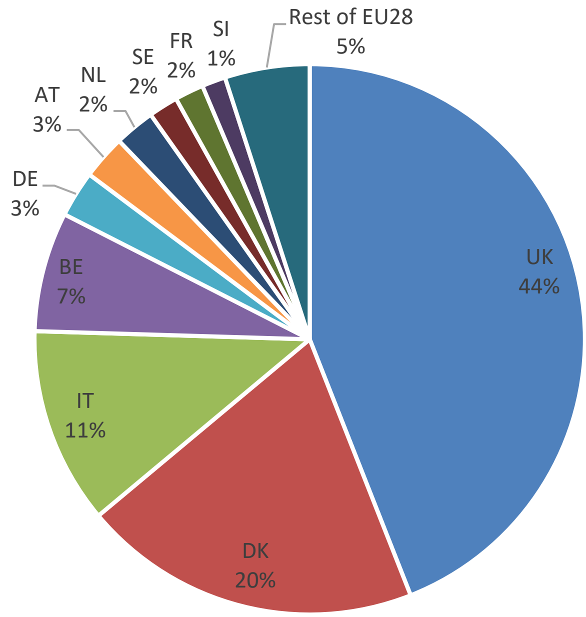
These 4 countries represent 82% of imports in Europe. This numbers is likely to be higher due to Italy's imports been likely under estimated in Eurostat data.

Figure 8.58 Evolution of the imports of pellets in the top 10 EU28 importing countries (tonnes)



Source: Eurostat

Figure 8.59 Share of total EU28 pellet imports in 2017 (%)



Source: Eurostat

Table 8.13 Import to top 3 destinations of top 10 pellet importing countries in EU28 between 2013 and 2017 (tonnes)

	2013		2014		2015		2016		2017	
EU28	US	2.775.929	US	3.889.833	US	4.277.626	US	4.901.682	US	5.205.397
	CA	1.963.270	CA	1.258.832	CA	1.474.785	CA	1.685.203	CA	1.478.403
	RU	701.722	RU	826.185	RU	786.214	RU	837.190	RU	1.267.703
	Other non EU28	330.908	Other non EU28	279.191	Other non EU28	317.292	Other non EU28	321.540	Other non EU28	449.461
UK	US	1.573.493	US	2.894.916	US	3.527.986	US	4.127.578	US	4.265.670
	CA	1.466.782	CA	889.353	CA	1.161.425	CA	1.384.774	CA	1.256.756
	LV	165.190	LV	402.046	LV	995.125	LV	936.256	LV	737.190
	Rest of EU28	225.654	Rest of EU28	524.315	Rest of EU28	789.599	Rest of EU28	461.449	Rest of EU28	398.814
	Rest of the world	1.068	Rest of the world	4.460	Rest of the world	44.746	Rest of the world	158.595	Rest of the world	174.442
DK	LV	695.180	LV	636.693	LV	599.074	EE	595.199	EE	1.010.268
	EE	357.688	EE	464.212	EE	542.787	LV	548.760	LV	606.075
	RU	333.964	RU	388.704	RU	333.086	RU	257.655	RU	402.574
	Rest of EU28	714.583	Rest of EU28	662.240	Rest of EU28	546.877	Rest of EU28	522.023	Rest of EU28	714.455
	Rest of the world	166.779	Rest of the world	104.211	Rest of the world	37.562	Rest of the world	128.260	Rest of the world	356.040
IT	AT	349.491	AT	400.299	AT	406.808	AT	449.627	AT	461.870
	CA	186.001	CA	229.180	HR	128.115	HR	144.113	HR	150.297
	HR	129.338	US	179.966	DE	108.882	SI	109.139	DE	116.175
	Rest of EU28	705.622	Rest of EU28	837.930	Rest of EU28	591.862	Rest of EU28	617.280	Rest of EU28	708.688
	Rest of the world	864.338	Rest of the world	406.528	Rest of the world	417.936	Rest of the world	472.389	Rest of the world	355.517
BE	US	587.619	US	422.774	US	619.970	US	533.133	US	578.407
	CA	160.151	CA	107.238	CA	227.940	CA	237.359	RU	205.057
	NL	78.160	NL	72.833	NL	63.251	RU	85.835	CA	168.552
	Rest of EU28	67.144	Rest of EU28	49.005	Rest of EU28	24.980	Rest of EU28	71.374	Rest of EU28	122.986
	Rest of the world	3.115	Rest of the world	4.590	Rest of the world	40.720	Rest of the world	1.035	Rest of the world	15.854
DE	DK	109.292	NL	88.086	RU	74.931	PL	111.545	PL	102.212
	NL	97.826	DK	54.257	PL	69.910	BE	72.773	DK	87.752
	BE	54.861	AT	53.490	DK	63.475	RU	53.538	BE	56.695
	Rest of EU28	210.258	Rest of EU28	153.806	Rest of EU28	209.186	Rest of EU28	177.521	Rest of EU28	103.900
	Rest of the world	74.386	Rest of the world	69.740	Rest of the world	28.286	Rest of the world	27.720	Rest of the world	71.537

Source: Eurostat

8.2.6 EUROPEAN WOOD PELLET PRICE

Limitation of liability: Under no circumstance shall EPC and its contributors be liable for the exactitude or the use made of the price information available in this section.

8.2.6.1 EUROPEAN PRICE DEVELOPMENT OF RESIDENTIAL PELLETS

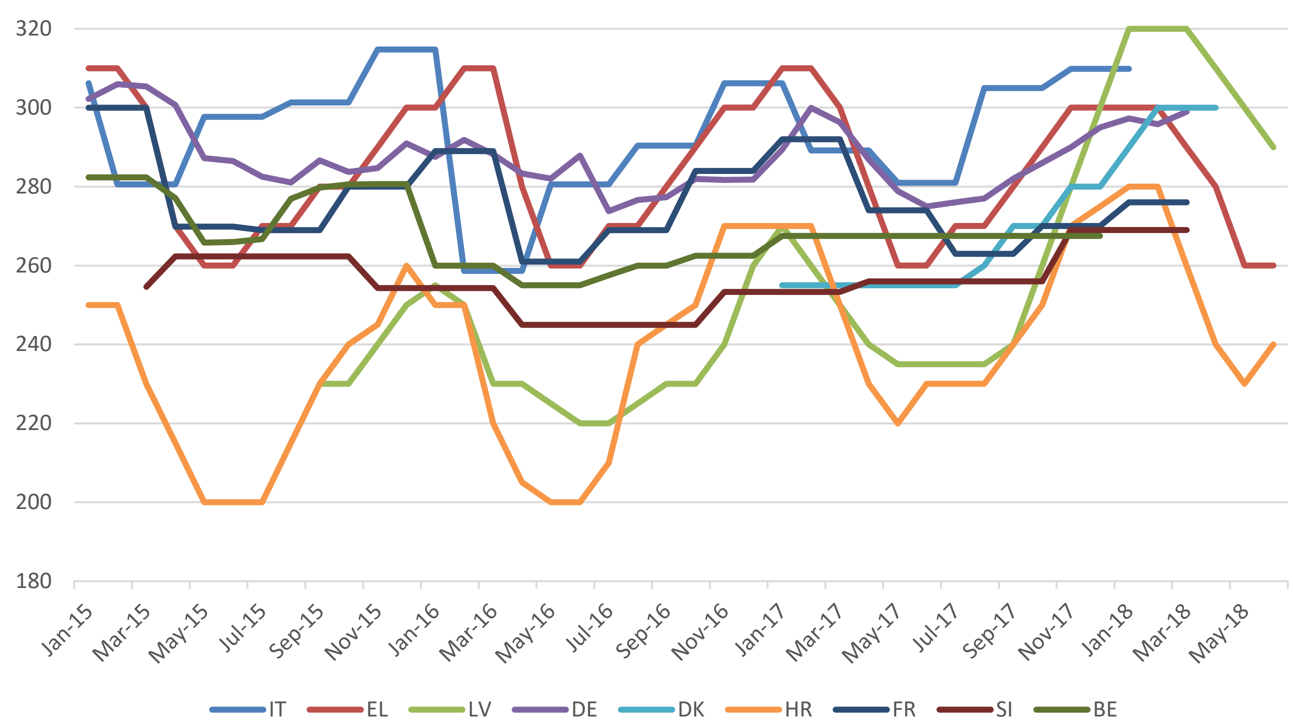
Despite growing demand and supply difficulties in some European countries, pellet prices followed the same trend as previous years. Major differences in pellet prices occur in Europe and prices difference can go to simple to double between countries. Some countries show large seasonal price variation (e.g. the Balkans) while others are relatively stable (e.g. AT, SE, ES).

Latvia: Due to a difficult season and low production, Latvia's pellet producers have prioritized the export market to fulfil their contracts with industrial consumers. The internal market has suffered from it, as prices rose steeply during the winter 2017-2018.

Bosnia and Herzegovina & Serbia: Pellet consumption increased steeply in 2017 in both countries. However, growth was hindered by a pellet shortage in the middle of January 2017. Pellets had been consumed at a faster rate than expected as a result of the number of days with temperatures below -15ºC. The increased heating demand led to premature exhaustion of winter stock in many households. The shortage lasted almost a month, during which prices peaked substantially, to over 300 €/tonne.

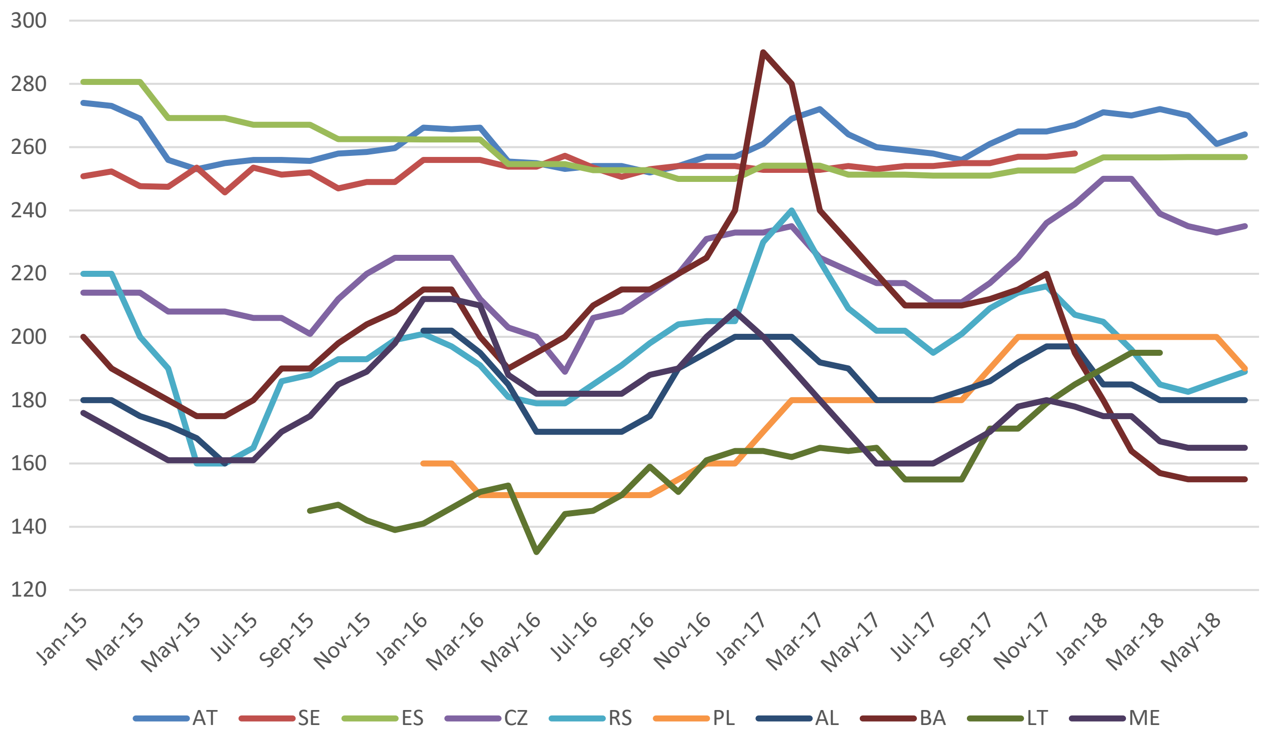
Bagged pellet prices

Figure 8.60 Estimation of bagged pellet prices in European countries with highest prices between January 2015 and June 2018 (retail price, 1 pallet in €/tonne VAT incl.)



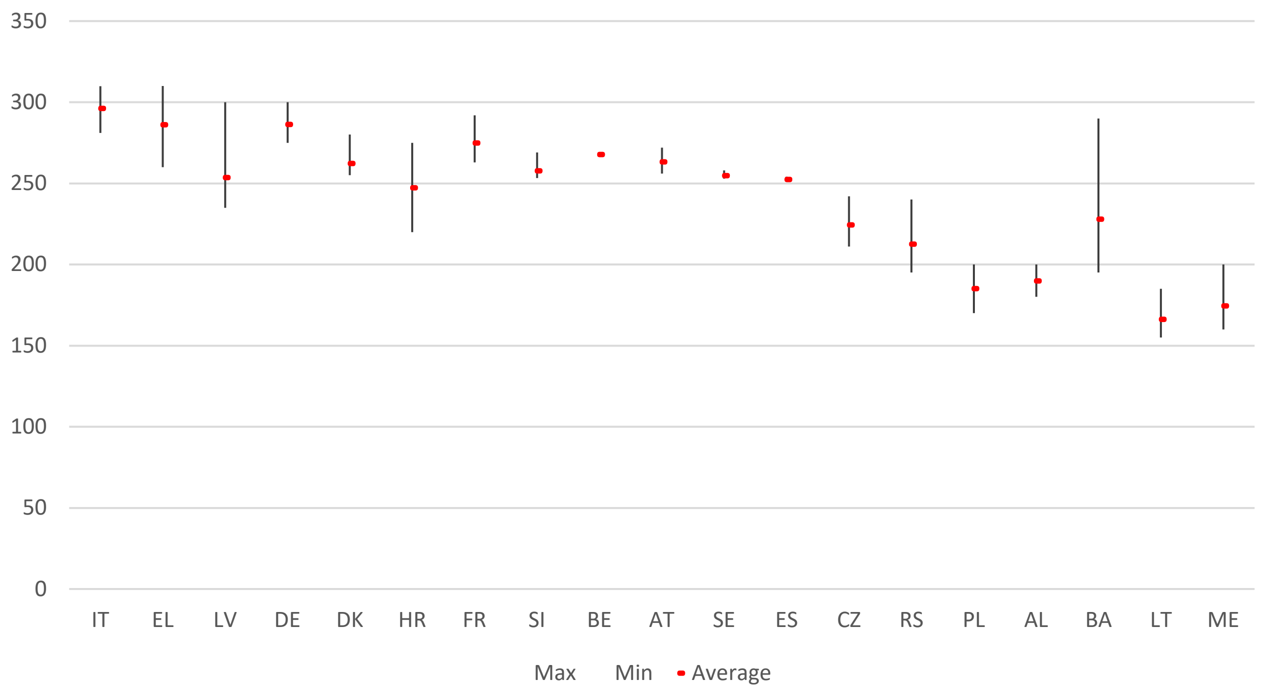
Source: EPC survey 2018

Figure 8.61 Estimation of bagged pellet prices in European countries with lowest prices between January 2015 and June 2018 (retail price, 1 pallet in €/tonne VAT incl.)



Source: EPC survey 2018

Figure 8.62 Variation and average of bagged pellet prices between January 2017 and December 2017 by country (retail price, 1 pallet in €/tonne VAT incl.)



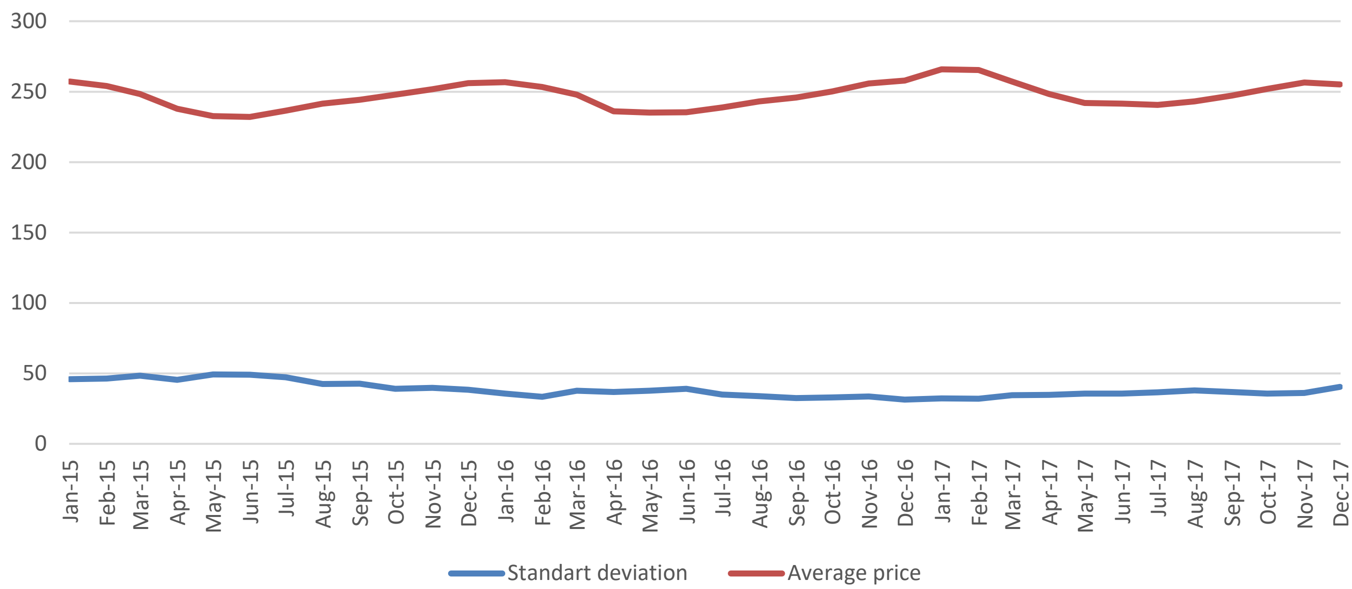
Source: EPC survey 2018

Table 8.14 Estimation of bagged pellet prices between January 2017 and December 2017 in Europe (retail price, 1 pallet in €/tonne VAT incl.)

	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18
AL	200	200	192	190	180	180	180	183	186	192	197	197	185	185	180	180	180
AT	261	269	272	264	260	259	258	256	261	265	265	267	271	270	272	270	261
BA	290	280	240	230	220	210	210	210	212	215	220	195	180	164	157	155	155
BE	268	268	268	268	268	268	268	268	268	268	268	268	n.a.	n.a.	n.a.	n.a.	n.a.
CZ	233	235	225	221	217	217	211	211	217	225	236	242	250	250	239	235	233
DE	289	300	296	287	279	275	276	277	282	286	290	295	297	296	299	n.a.	n.a.
DK	255	255	255	255	255	255	255	260	270	270	280	280	290	300	300	300	0
EL	310	310	300	280	260	260	270	270	280	290	300	300	300	300	290	280	260
ES	254	254	254	251	251	251	251	251	251	253	253	253	257	257	257	n.a.	n.a.
FR	292	292	292	274	274	274	263	263	263	270	270	270	276	276	276	n.a.	n.a.
HR	270	270	250	230	220	230	230	230	240	250	270	275	280	280	260	240	230
IT	306	289	289	289	281	281	281	305	305	305	310	310	310	n.a.	n.a.	n.a.	n.a.
LT	164	162	165	164	165	155	n.a.	n.a.	171	171	179	185	190	195	195	n.a.	n.a.
LV	270	260	250	240	235	235	235	235	240	260	280	300	320	320	320	310	300
ME	200	190	180	170	160	160	160	165	170	178	180	178	175	175	167	165	165
PL	170	180	180	180	180	180	180	180	190	200	200	200	200	200	200	200	200
RS	230	240	224	209	202	202	195	201	209	214	216	207	205	196	185	183	186
SE	253	253	253	254	253	254	254	255	255	257	257	258	n.a.	n.a.	n.a.	n.a.	n.a.

Source: EPC survey, 2018

Figure 8.63 Average and standard deviation of European prices of bagged pellets between January 2015 and December 2017 (retail price, 1 pallet in €/tonne VAT incl.)



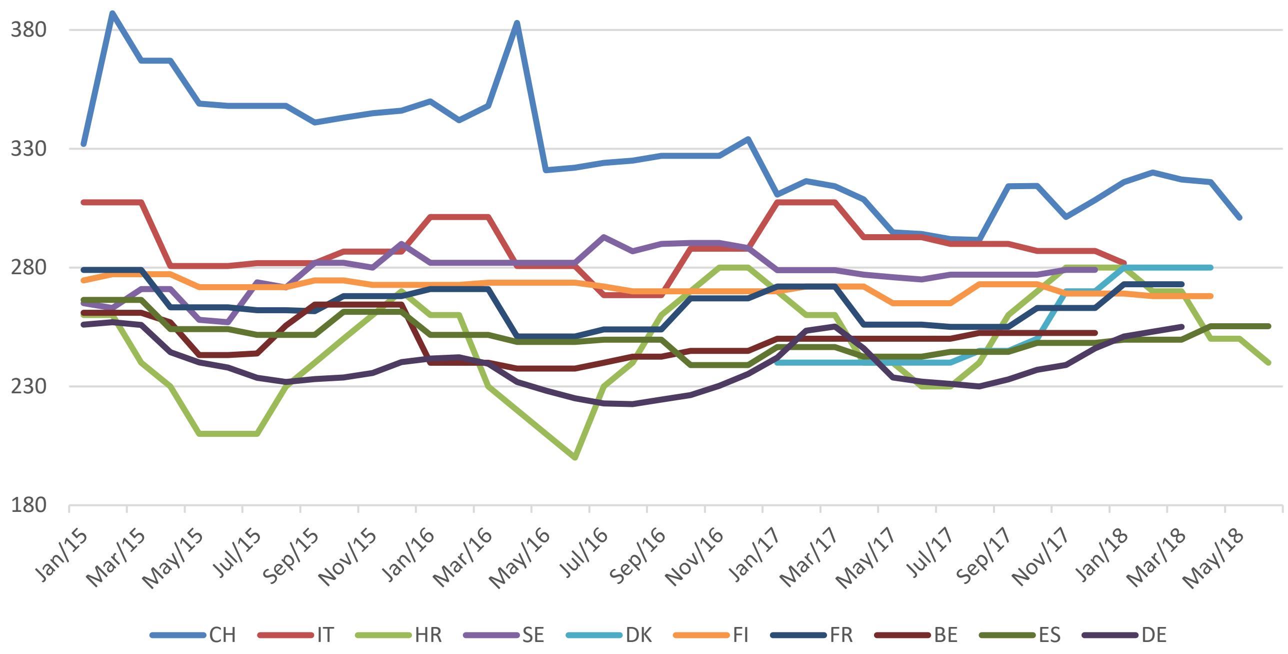
Note: Only the countries with complete data for the analysed period have been taken into account: AT, BA, BE, CZ, DE, EL, ES, FR, HR, IT, ME, RS, SE.

Note 2: The standard deviation is a measure that is used to quantify the amount of variation or dispersion of a set of data values.

Source: EPC survey, 2018

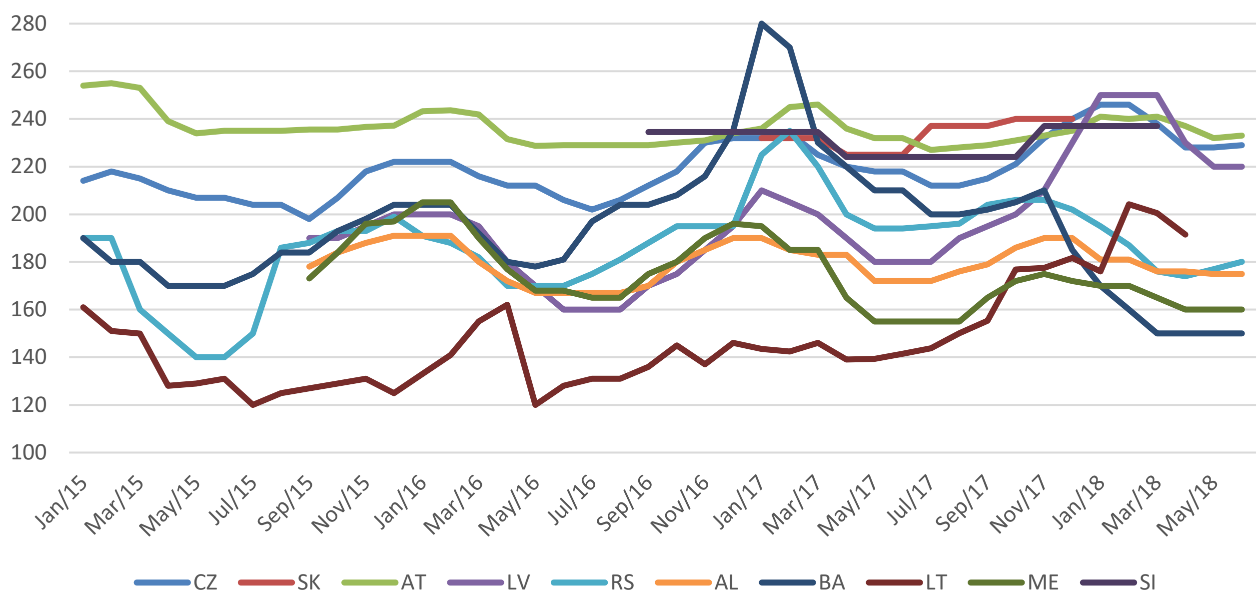
Bulk pellet prices

Figure 8.64 Estimation of bulk pellet prices in European countries with highest prices between January 2015 and June 2018 (delivered 6t, distance 100 km, delivery fees included. In €/tonne VAT incl.)



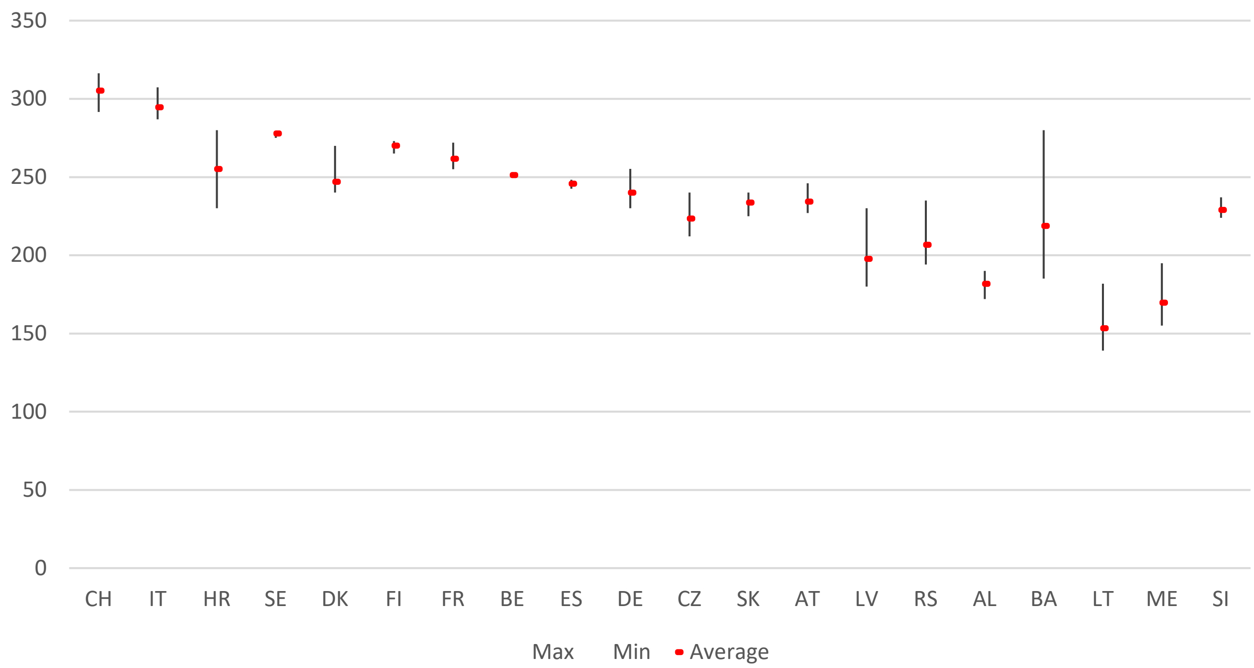
Source: EPC survey 2018

Figure 8.65 Estimation of bulk pellet prices in European countries with lowest prices between January 2015 and June 2018 (delivered 6t, distance 100 km, delivery fees included. In €/tonne VAT incl.)



Source: EPC survey, 2018

Figure 8.66 Variation and average of bulk pellet prices between January 2017 and December 2017 by country (delivered 6t, distance 100 km, delivery fees included. In €/tonne VAT incl.)



Source: EPC survey, 2018

Table 8.15 Estimation of bulk pellet prices between January 2017 and December 2017 (delivered 6t, distance 100 km, delivery fees included. In €/tonne VAT incl.)

	Jan -17	Feb -17	Mar -17	Apr -17	May -17	Jun -17	Jul-17	Aug -17	Sep -17	Oct -17	Nov -17	Dec -17	Jan -18	Feb -18	Mar -18	Apr -18	May -18
AL	190	185	183	183	172	172	172	176	179	186	190	190	181	181	176	176	175
AT	236	245	246	236	232	232	227	228	229	231	233	235	241	240	241	237	232
BA	280	270	230	220	210	210	200	200	202	205	210	185	170	160	150	150	150
BE	250	250	250	250	250	250	250	253	253	253	253	253	n.a.	n.a.	n.a.	n.a.	n.a.
CH	311	316	314	309	295	294	292	292	314	314	301	308	316	320	317	316	301
CZ	232	234	225	220	218	218	212	212	215	221	232	240	246	246	238	228	228
DE	242	253	255	246	234	232	231	230	233	237	239	246	251	253	255	n.a.	n.a.
DK	240	240	240	240	240	240	240	245	245	250	270	270	280	280	280	280	n.a.
ES	247	247	247	243	243	243	244	244	244	248	248	248	250	250	250	n.a.	n.a.
FI	270	272	272	272	265	265	265	273	273	273	269	269	269	268	268	268	n.a.
FR	272	272	272	256	256	256	255	255	255	263	263	263	273	273	273	0	n.a.
HR	270	260	260	240	240	230	230	240	260	270	280	280	280	270	270	250	250
IT	307	293	293	293	290	290	290	287	287	287	282	282	282	n.a.	n.a.	n.a.	n.a.
LT	144	142	146	139	139	142	144	150	155	177	177	182	176	204	200	192	n.a.
LV	210	205	200	190	180	180	180	190	195	200	210	230	250	250	250	230	220
ME	195	185	185	165	155	155	155	155	165	172	175	172	170	170	165	160	160
RS	225	235	220	200	194	194	195	196	204	206	206	202	195	187	176	174	177
SE	279	279	279	277	276	275	277	277	277	277	279	279	n.a.	n.a.	n.a.	n.a.	n.a.
SK	232	232	232	225	225	225	237	237	237	240	240	240	n.a.	n.a.	n.a.	n.a.	n.a.

Source: EPC survey, 2018

Some countries are implementing a reduced **VAT rate** for pellets (red font in the table below).

Table 8.16 VAT rate for pellets compared with general VAT rate applied in European countries in 2017 (%)

	VAT pellet	VAT
AT	13	20
BE	6	21
CZ	15	21
DE	7	19
EE	20	20
EL	24	24
ES	21	21
FI	24	24
FR	10	20
IT	22	22
LT	21	21
LV	12	21
PL	23	23
SE	25	25
SI	22	22
SK	20	20
AL	20	20
BA	17	17
CH	8	8
ME	21	21
NO	25	25
RS	10	20

Source: EPC survey, 2018

8.2.6.2 PRICE DEVELOPMENT OF INDUSTRIAL PELLETS

Argus renamed its wood pellet cif ARA index as the wood pellet cif Northwest Europe index this year, and at the end of August the index reached its highest point since December 2014.

After several years of oversupply and weak demand, the tide turned in February 2017 and the colder-than average winter 2017-2018 supported prices further. New winter demand in Denmark coincided with less spot supply, following forest fires in Portugal and flooding in the Baltics and infrastructure problems for some US suppliers.

Most producers in both North America and Europe are sold out for the coming winter too, which has helped support summer spot prices.
Further demand is expected in UK from EPH's commissioning Lynemouth facility and Drax's recently-converted fourth unit. In the Netherlands, RWE's Amer 9 co-firing plant is commissioning and Uniper plans to start co-firing at its MPP3 facility by the end of this year.

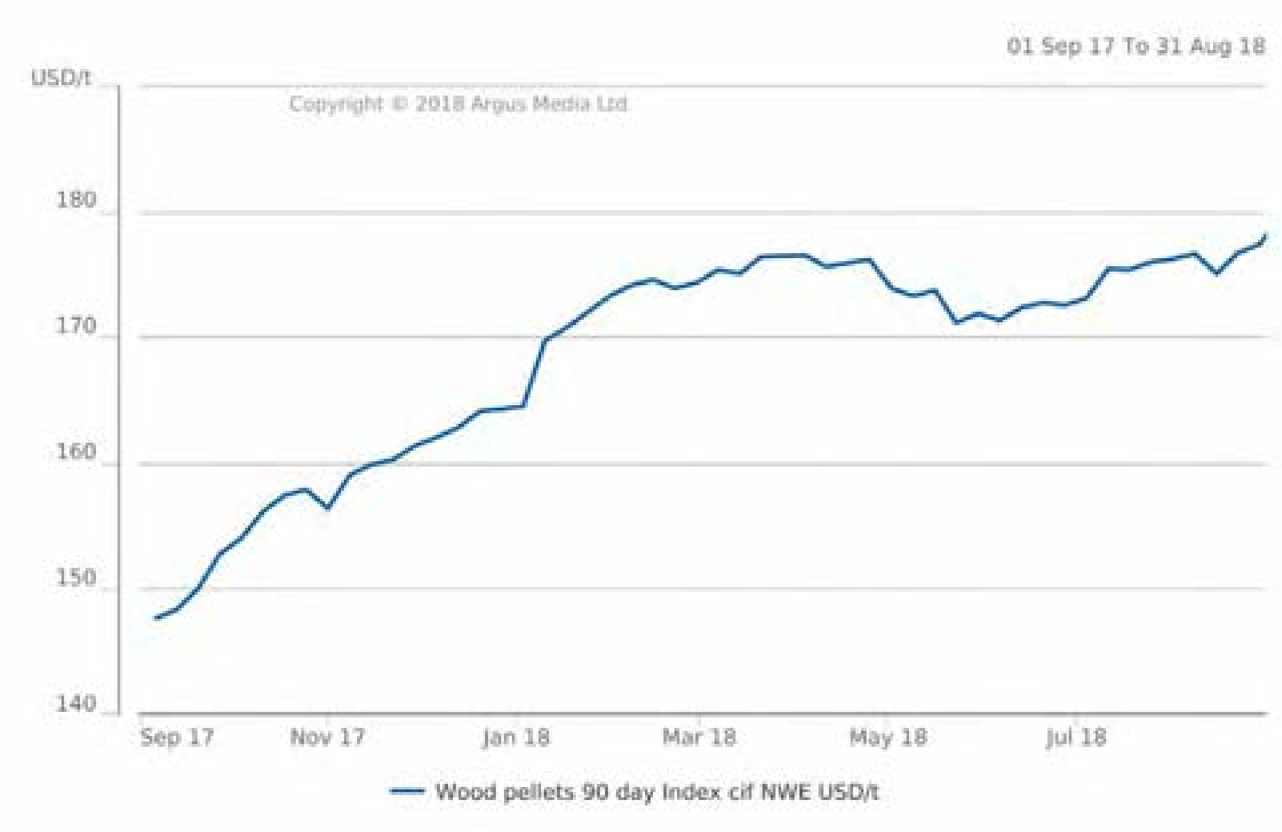
Attention has increasingly turned to emerging northeast Asian markets, particularly Japan. North American pellet producers have signed long-term supply contracts with Japanese buyers, as has Engie. Most of these contracts are not due to start until 2021-2022 but the growing Asian demand is pointing the way towards increased cross-basin competition for wood pellet supply.

Forward cif Northwest Europe prices have also climbed since the start of the year because of expected stronger demand both in Europe and Asia, and the strengthening US dollar against both sterling and the euro since the start of this year.

Laura Tovey Fall
Editor Biomass Markets
Argus Media

argus

Figure 8.67 Development of Argus cif ARA pellet index (Sep 2017- August 2018)



Source: Argus Media

9 ANNEXES

9.1 Reference tables

GENERAL COUNTRY INFORMATION

Table 9.1 Country codes

EU28	**European Union (28 members)**
AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovak Republic
UK	United Kingdom

AL	Albania
AU	Australia
BA	Bosnia Herzegovina
BR	Brazil
BY	Belarus
CA	Canada
CH	Switzerland
CL	Chile
CN	China
ID	Indonesia
JP	Japan
KR	South Korea
ME	Montenegro
MY	Malaysia
NO	Norway
NZ	New Zealand
RS	Republic of Serbia
RU	Russia
TH	Thailand
UA	Ukraine
US	United states of America
VN	Vietnam

SYMBOLS AND ABBREVIATIONS AND DECIMAL PREFIXES

Table 9.2 Symbols and abbreviations

Symbol	Meaning
,	Decimal separator
.	Thousand
- / n.a.	Data not available

Table 9.3 Table decimal prefixes

10^{1}	**Deca (da)**	10^{-1}	**Deci (d)**
10^{2}	**Hecto (h)**	10^{-2}	**Centi (c)**
10^{3}	**Kilo (k)**	10^{-3}	**Milli (m)**
10^{6}	**Mega (M)**	10^{-6}	**Micro (µ)**
10^{9}	**Giga (G)**	10^{-9}	**Nano (n)**
10^{12}	**Tera (T)**	10^{-12}	**Pico (p)**
10^{15}	**Peta (P)**	10^{-15}	**Femto (f)**
10^{18}	**Exa (E)**	10^{-18}	**Atto (a)**

Table 9.4 Table general conversion factor for energy

to from	1 MJ	1kWh	1 kg oe	Mcal
1 MJ	1	0.278	0.024	0.239
1 kWh	3.6	1	0.086	0.86
1 kg oe	41.868	11.63	1	10
1 Mcal	4.187	1.163	0.1	1

ENERGY CONTENT, CALORIFIC VALUE, SPECIFIC WEIGHT

LIQUIDS

Table 9.5 Average net calorific value, energy content of liquid fuels

	NCV (GJ/m³)	Density (t/m³)	NCV (GJ/t)	1 m³ = x toe	1 t = x toe
toe			41,868		
Diesel	35,4	0,83	42,7	0,85	1,02
Biodiesel*	32,8	0,88	37,3	0,78	0,89
Rape oil	34,3	0,915	37,5	0,82	0,9
Gasoline	31,9	0,748	42,7	0,76	1,02
Ethanol	21,2	0,794	26,7	0,51	0,64

*also called RME for rapeseed methyl ester or FAME for fatty acid methyl ester. Calorific value can change according to raw material used for biodiesel production

Source: M. Kaltschmitt,H. Hartmann, Energy aus Biomasse, Springer 2001

SOLID FUELS

Table 9.6 Net calorific value, moisture content and energy density for different biomass fuels

Fuel	Net calorific value, dry content kWh/kg (moisture content 0%) ($q_{p,net,d}$)	Moisture content w-% (Mar)	Net calorific value, as received=actual value kWh/kg ($q_{p,net,ar}$)	Bulk density kg/loose m³	Energy density (MWh/loose m³)	Ash content, dry, %
Sawdust	5,28-5,33	45-60	0,60-2,77	250-350	0,45-0,70	0,4-0,5
Bark, birch	5,83-6,39	45-55	2,22-3,06	300-400	0,60-0,90	1-3
Bark, coniferous	5,14-5,56	50-65	1,38-2,50	250-350	0,50-0,70	1-3
Plywood chips	5,28-5,33	5-15	4,44-5,00	200-300	0,9-1,1	0,4-0,8
Wood pellets	5,26-5,42	7-8	4,60-4,90	550-650	2,6-3,3	0,2-0,5
Steam wood chips	5,14-5,56	40-55	1,94-3,06	250-350	0,7-0,9	0,5-2,0
Log wood (oven-ready)	5,14-5,28	20-25	3,72-4,03	240-320	1,35-1,95	
Logging residue chips	5,14-5,56	50-60	1,67-2,50	250-400	0,7-0,9	1,0-3,0
Whole tree chips	5,14-5,56	45-55	1,94-2,78	250-350	0,7-0,9	1,0-2,0

Reed canary grass (spring harvested)	4,78-5,17	8-20	3,70-4,70	70	0,3-0,4	1,0-10,0
Reed canary grass (autumn harvested)	4,64-4,92	20-30	3,06-3,81	80	0,2-0,3	5,1-7,1
Grain	4,8	11	4,30	600	2,6	2
Straw, chopped	4,83	12-20	3,80-4,20	80	0,3-0,4	5
Miscanthus, chopped	5,0	8-20	3,86-4,06	110-140	1,72-2,19	2,0-3,5
Straw pellets	4,83	8-10	4,30-4,40	550-650	2,4-2,8	5
Olive cake (olive pomace)	4,9-5,3	55-70	1,00-3,10	800-900	1,46-1,64	2-7
Olive cake (olive marc)	4,9-5,3	<10	4,30-4,70	600-650	2,6-2,9	2-7

1kWh/kg = 1 MWh/ton = 3.6 GJ/ton

Source: EUBIONET "Biomass fuel supply chains for solid biofuels"

Calculation of net calorific value as received (CEN/TS 15234)

The net calorific value (at constant pressure) as received (net calorific value of the moist biomass fuel) is calculated according to equation:

$$q_{p,net,ar} = q_{p,net,d} \times [(100 - M_{ar})/100] - 0,02443 \times M_{ar}$$

$q_{p,net,ar}$ is the net calorific value (at constant pressure) as received [MJ/kg]
$q_{p,net,d}$ is the net calorific value (at constant pressure) in dry matter [MJ/kg] (net calorific value of dry fuel)
M_{ar} is the moisture content as received [w-%, wet basis]
0,02443 is the correction factor of the enthalpy of vaporization (constant pressure) for water (moisture) at 25°C [MJ/kg per 1 w-% of moisture)

Table 9.7 Typical moisture content of biomass fuels and corresponding calorific values as received

		GCV			NCV		
	Moisture content (%)	**kWh/kg**	**GJ/t**	**toe/t**	**kWh/kg**	**GJ/t**	**toe/t**
Green wood direct from the forest, freshly harvested	60%	2	7,2	0,17	1,6	5,76	0,14
Chips from short rotation coppices after harvest	50-55%	2,5	9	0,21	2,1	7,56	0,18
Recently harvested wood	50%	2,6	9,36	0,22	2,2	7,92	0,19
Saw mill residues, chips etc	40%	3,1	11,16	0,27	2,9	10,44	0,25
Wood, dried one summer in open air, demolition timber	30%				3,4	12,24	0,29
Wood, dried several years in open air	20%				4	14,4	0,34
Pellets	8-9%				4,7	16,92	0,4
Wood, dry matter	0%				5,2	18,72	0,45
Cereals as stored after harvest, straw, hay, miscanthus after harvest	13-15%				4	14,4	0,34
Silomaize	30%						
Rape seed	9%				7,1	25,6	0,61
Chicken litter as received	68%				2,6	9,6	0,22
To compare with:							
Hard coal					8,06	29	0,69
Brown coal					4,17	15	0,36
Peat					2,8	10	0,24

Source: M. Kaltschmitt,H. Hartmann, Energie aus Biomasse, Springer 2001; AEBIOM

The energy content of one ton of wood depends primarily upon the moisture content and not on the wood species. This is not true on volume basis. The energy content of 1 m³ wood depends upon the species, the water content and the form of the wood (logs, fire wood pieces, chips etc.).

In the practical use the NCV is of greater importance than the GCV, because normally the energy needed to evaporate the water is not used. This energy needed to evaporate 1 kg of moisture is around 2,44 MJ (0,68 kWh). The GCV is only of importance in combustion plants, where the vapour is condensed and therefore this energy can be used. The NCV of a given biomass fuel depends mainly on the mass, measured in units such as tons or kg and the moisture content.
The moisture content is defined as follows:

m: total weight of a given biomass

d: weight of the dry matter of this biomass (after completely drying)

Moisture content, m.c. in % = (100 – d/m) x 100

Table 9.8 Examples for weight and energy content (NCV) for 1 m³ wood at different water contents, species and shape of the wood

Species	Shape	m.c. in %	t/m³	GJ/m³	kWh/m³
Spruce	Solid wood	0	0,41	7,7	2.130
Spruce	Solid wood	40	0,64	6,6	1.828
Spruce	Stapled wood	25	0,33	4,5	1.245
Spruce	Chips	40	0,22	2,3	640
Beech	Solid wood	0	0,68	12,6	3.500
	Solid wood	40	0,96	9,2	2.547
Beech	Stapled wood	25	0,5	6,3	1.739
Beech	Chips	40	0,34	3,2	892
	Pellets	9	0,69	10,8	3.300
Average figures					
Average figures for different species	Solid wood	35	0,75	7,2	2.000
Average figures for different species	Chips	35	0,3	2,9	800

Source: M. Kaltschmitt,H. Hartmann, Energie aus Biomasse, Springer 2001

GASEOUS FUELS

Table 9.9 Net Calorific value and density of gaseous fuels

	NCV	NCV	NVC	Density	NCV
	kWh/Nm³	MJ/m³	toe/1000m³	kg/Nm³	kWh/kg
Natural gas	9,9	36	0,86	0,73	13,6
Biogas (60% methane)	6	21,6	0,52		
Biomethane (upgraded biogas)	9,5	36	0,86	0,73	13

TRANSFORMATION COEFFICIENTS, AVERAGE YIELDS

Transformation coefficients from biomass to final energy

The following coefficients describe the quantity of final energy in terms of toe that can be produced on the basis of one ton of different forms of biomass and different conversion technologies.

Biodiesel:

conversion technology: transesterification

1 t rape seed → 0,4 t rape seed oil → 0,4 t biodiesel→ 0,45 m³ RME = 0,35 toe

These figures are valid for big installations.

Ethanol :

conversion technology: alcoholic fermentation

1 t corn (14% m.c.) → 0,382 m³ ethanol = 0,194 toe

1 t wheat (14% m.c.) → 0,378 m³ ethanol = 0,192 toe

1 t sugar beet (16% sugar content) → 0,107 m³ ethanol = 0,054 toe

1 t sugar cane (14% sugar content) → 0,085 m³ ethanol = 0,043 toe

Biogas:

conversion technology: anaerobic fermentation

1 t silo maize (30% dry matter) → 180 m³ biogas → 110 m³ biomethane = 0,088 toe

25% of this biogas is needed as energy source for the fermentation

1 t sugar beet (23% organic dry matter) → 170 m³ biogas→ 100 m³ biomethane = 0,08 toe

1 t cattle manure (8-11% org. dry matter) 25 m³ biogas→ 15 m³ biomethane = 0,012 toe

1 t pig manure (7% organic dry matter) → 20 m³ biogas → 12 m³ biomethane = 0,01 toe

1 t poultry manure. (32 % organ. dry matter) → 80 m³ biogas → 48 m³ biomethane = 0,04 toe

1 t organic waste from households → 90m³ biogas → 55 m³ biomethane = 0,05 toe

1 t glycerine (100% organic dry matter) → 840 m³ biogas → 500 m³ biomethane = 0,4 toe

Advanced biofuels:

1 t wood (dry matter) = 0,2 t BTL = 0.2 toe

1 t wood (dry matter) = 0,2 t ethanol

EMMISION FACTORS

Table 9.10 Emission factors for fossil fuels and main fertilizers

Emission factors		Net GHG emitted [g CO_2 eq/MJ]	CO_2 [g/MJ]	CH_4 [g/MJ]	N_2O [g/MJ]
Natural gas	Supply	16,67	11,38	0,21	3,61E-04
	Combustion	55,08	55,08		
	Total	71,7	66,45	0,21	3,61E-04
EU el. Mix (LV)	Supply	208,84	189,90	0,68	6,86E-03
	Use	0,0	0,0	0,00	0,00
	Total	208,8	189,90	0,68	6,86E-03
EU el. Mix (MV)	Supply	196,35	178,45	0,64	6,44E-03
	Use	0,0	0,0	0,00	0,00
	Total	196,3	178,45	0,64	6,44E-03
Hard coal	Supply	16,21	6,50	0,39	2,50E-04
	Combustion	96,11	96,11		
	Total	112,3	102,62	0,39	2,50E-04
Lignite	Supply	1,73	1,68	1,44E-03	5,56E-05
	Combustion	115,0	115,0		
	Total	116,7	116,68	1,44E-03	5,56E-05
Heavy fuel oil	Supply	12,70	-	-	-
	Combustion	80,60	80,60	0	0,00
	Total	93,3	-	0,00	0,00
Diesel	Supply	20,70	-	-	-
	Combustion	73,25	73,25	0,00	0,00
	Total	93,9	-	0,00	0,00

Source: JRC 2014 ” Solid and gaseous bioenergy pathways: input values and GHG emissions”
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259

Typical and default values for solid biomass pathways

Table 9.11 Typical and default GHG emission values for forest systems producing wood chips

Values of emissions are provided at plant gate (excl. final conversion efficiency) and based on a MJ of wood chips delivered at the plant. No land use emissions are included in these results nor are CO2 emissions from the combustion of biomass or other indirect effects.

	Forest biomass production system	Transport distance	TYPICAL [gCO_2eq/MJ]	DEFAULT [gCO_2eq/MJ]
Woodchips	**Forest residues**	1-500 km	5	6
		500-2500 km	7	8
		2500-10000 km	13	14
		Above 10000	21	25
	SRC (Eucalyptus)	2500-10000 km	24	26
	SRC (Poplar- fertilized)	1-500 km	8	9
		500-2500 km	10	11
		2500-10000 km	15	17
		Above 10000	24	28
	SRC (Poplar- Not fertilized)	1-500 km	6	7
		500-2500 km	8	9
		2500-10000 km	13	15
		Above 10000	22	26
	Stemwood	1-500 km	5	6
		500-2500 km	7	8
		2500-10000 km	12	14
		Above 10000	21	25
	Wood industry residues	1-500 km	4	4
		500-2500 km	6	7
		2500-10000 km	10	13
		Above 10000	20	24

Source: JRC 2014 ” Solid and gaseous bioenergy pathways: input values and GHG emissions”
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259

Table 9.12 Typical and default GHG emission values for forest systems producing wood pellets or briquettes

Values of emissions are provided at plant gate (excl. final conversion efficiency) and based on a MJ of wood pellets delivered at the plant. No land use emissions are included in these results nor are CO_2 emissions from the combustion of biomass or other indirect effects.

	Forest biomass production system		Transport distance	TYPICAL [gCO_2eq/MJ]	DEFAULT [gCO_2eq/MJ]
Wood pellets or briquettes	Forest residues	Case 1	1-500 km	30	36
			500-2500 km	30	36
			2500-10000 km	32	38
			Above 10000 km	35	42
		Case 2a	1-500 km	16	19
			500-2500 km	16	19
			2500-10000 km	17	21
			Above 10000	21	25
		Case 3a	1-500 km	+	7
			500-2500 km	6	7
			2500-10000 km	8	8
			Above 10000 km	11	13
	SRC (Eucalyptus)	Case 1	2500-10000 km	42	48
		Case 2a	2500-10000 km	31	34
		Case 3a	2500-10000 km	21	22
	SRC Poplar (fertilized)	Case 1	1-500 km	32	38
			500-10000km	34	40
			Above 10000 km	37	44
		Case 2a	1-500 km	18	21
			500-10000km	20	23
			Above 10000 km	23	27
		Case 3a	1-500 km	8	9
			500-10000km	10	11
			Above 10000 km	13	15
	SRC Poplar (No fertilized)	Case 1	1-500 km	31	36
			500-10000km	32	38
			Above 10000 km	36	42
		Case 2a	1-500 km	17	19
			500-10000km	18	21
			Above 10000 km	22	25
		Case 3a	1-500 km	6	7
			500-10000km	8	9
			Above 10000 km	11	13
	Stemwood	Case 1	1-500 km	30	36
			500-2500km	30	36
			2500-10000km	31	38
			Above 10000 km	35	42
		Case 2a	1-500 km	16	19
			500-2500km	16	18
			2500-10000km	17	20
			Above 10000 km	21	25
		Case 3a	1-500 km	5	6
			500-2500km	5	6

			2500-10000km	7	8
			Above 10000 km	10	12
	Wood Industry residues	**Case 1**	1-500 km	18	22
			500-2500km	18	21
			2500-10000km	19	23
			Above 10000 km	23	27
		Case 2a	1-500 km	9	11
			500-2500km	9	11
			2500-10000km	11	13
			Above 10000 km	14	17
		Case 3a	1-500 km	3	4
			500-2500km	3	4
			2500-10000km	5	6
			Above 10000 km	8	10

Source: JRC 2014 " Solid and gaseous bioenergy pathways: input values and GHG emissions"
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259
Case 1 refers to pathways in which a natural gas boiler is used to provide the process heat to the pellet mill. Process electricity is purchased from the grid.
Case 2a refers to pathways in which a boiler fuelled with pre-dried wood chips is used to provide the process heat to the pellet mill. Process electricity is purchased from the grid.
Case 3a refers to pathways in which a CHP, fuelled with pre-dried wood chips, is used to provide heat and power to the pellet mill.

Table 9.13 Typical and default values for agricultural biomass production systems

Values of emissions are provided at plant gate (excl. final conversion efficiency) and based on a MJ of biomass delivered at the plant. No land use emissions are included in these results nor are CO_2 emissions from the combustion of biomass or other indirect effects.

	Agriculture biomass production system	Transport distance	TYPICAL [gCO_2eq/MJ]	DEFAULT [gCO_2eq/MJ]
Agricultural systems	**Agricultural Residues with density <0.2 t/m3[1]**	1-500 km	4	4
		500-2500 km	7	9
		2500-10000 km	14	17
		Above 10000	27	32
	Agricultural Residues with density <0.2 t/m3[2]	1-500 km	4	4
		500-2500 km	5	6
		2500-10000 km	8	9
		Above 10000	14	17
	Straw pellets	1-500 km	8	10
		500-10000 km	10	12
		Above 10000	14	16
	Bagasse briquettes	500-10000 km	5	6
		Above 10000 km	9	10
	Palm Kernel Meal	Above 10000 km	55	61
	Palm Kernel Meal (no CH4 emissions from oil mill)	Above 10000 km	37	40

[1] This group of materials includes agricultural residues with a low bulk density and it comprises materials such as straw bales, oat hulls, rice husks and sugar cane bagasse bales (not exhaustive list).
[2] The group of agricultural residues with higher bulk density includes materials such as corn cobs, nut shells, soybean hulls, palm kernel shells (not exhaustive list).
Source: JRC 2014 " Solid and gaseous bioenergy pathways: input values and GHG emissions"
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259

GHG savings for solid biomass pathways

The use of 'GHG savings' as a metric to assess climate change mitigation effects of bioenergy pathways compared to fossil fuels has been designed and defined by the EU in several legislative documents (RED, FQD, COM(2010) 11). While this may have merits of simplicity and clarity for regulatory purposes, it should be remembered that: "*analyses that report climate-mitigation effects based on Attributional LCA generally have assumed away all indirect and scale effects on CO2-eq emission factors and on activity within and beyond the targeted sector. Unfortunately, there is no theoretical or empirical basis for treating indirect and scale effects as negligible*." (Plevin et al., 2013)

Table 9.14 GHG savings for forest systems producing wood chips

GHG savings are calculated according to the COM(2010) 11 and the SWD(2014) 259. Standard electrical efficiency of 25% and standard thermal efficiency of 85% are applied for biomass pathways. GHG savings are calculated relative to the FFC reported in SWD(2014) 259 (also listed in section 7.1 of this report). No land use emissions are included in these results nor are CO2 emissions from the combustion of biomass or other indirect effects.

	Forest biomass production system	Transport distance	TYPICAL [%]		DEFAULT [%]	
			Heat	Electricity	Heat	Electricity
Woodchips	Forest residues	1-500 km	93	89	91	87
		500-2500 km	90	85	88	82
		2500-10000 km	83	75	79	70
		Above 10000	69	55	63	46
	SRC (Eucalyptus)	2500-10000 km	64	48	61	43
	SRC (Poplar- fertilized)	1-500 km	89	83	87	82
		500-2500 km	86	79	84	77
		2500-10000 km	79	69	76	64
		Above 10000	65	49	59	40
	SRC (Poplar- Not fertilized)	1-500 km	91	87	90	85
		500-2500 km	88	83	87	80
		2500-10000 km	81	82	78	68
		Above 10000	67	52	62	44
	Stemwood	1-500 km	93	90	92	88
		500-2500 km	90	86	88	83
		2500-10000 km	83	75	80	71
		Above 10000	69	55	64	47
	Wood industry residues	1-500 km	95	92	93	90
		500-2500 km	92	88	90	86
		2500-10000 km	85	77	82	83
		Above 10000	71	58	65	49

Source: JRC 2014 " Solid and gaseous bioenergy pathways: input values and GHG emissions"
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259

Table 9.15 GHG savings for forest systems producing wood pellets or briquettes

GHG savings are calculated according to the COM(2010) 11 and the SWD(2014) 259. Standard electrical efficiency of 25% and thermal efficiency of 85% are applied. GHG savings are calculated relative to the FFC reported in SWD(2014) 259 (also listed in section 7.1 of this report). No land use emissions are included in these results nor are CO2 emissions from the combustion of biomass or other indirect effects.

	Forest biomass production system		Transport distance	TYPICAL [%]		DEFAULT [%]	
				Heat	Electricity	Heat	Electricity
Wood pellets or briquettes – GHG Savings	Forest residues	Case 1	1-500 km	56	35	47	22
			500-2500 km	56	35	47	22
			2500-10000 km	54	32	44	18
			Above 10000 km	48	24	38	9
		Case 2a	1-500 km	77	66	72	59
			500-2500 km	77	66	72	59
			2500-10000 km	75	63	69	55
			Above 10000	69	55	63	46
		Case 3a	1-500 km	92	88	90	86
			500-2500 km	92	88	90	86
			2500-10000 km	90	85	88	82
			Above 10000 km	84	77	81	72
	SRC (Eucalyptus)	Case 1	2500-10000 km	38	9	29	-4
		Case 2a	2500-10000 km	54	33	50	27
		Case 3a	2500-10000 km	69	54	67	52
	SRC Poplar (fertilized)	Case 1	1-500 km	53	31	44	18
			500-10000km	51	28	42	15
			Above 10000 km	45	20	36	6
		Case 2a	1-500 km	73	60	69	54
			500-10000km	71	57	66	51
			Above 10000 km	66	50	60	41
		Case 3a	1-500 km	88	82	87	81
			500-10000km	86	79	84	77
			Above 10000 km	80	71	78	68
	SRC Poplar (No fertilized)	Case 1	1-500 km	55	34	46	22
			500-10000km	53	31	44	18
			Above 10000 km	48	23	38	9
		Case 2a	1-500 km	76	64	72	58
			500-10000km	74	61	69	55
			Above 10000 km	68	54	63	45
		Case 3a	1-500 km	91	87	90	85
			500-10000km	89	84	87	81
			Above 10000 km	83	76	81	72
	Stemwood	Case 1	1-500 km	56	35	47	23
			500-2500km	56	36	47	23
			2500-10000km	54	32	45	19
			Above 10000 km	48	25	38	10
		Case 2a	1-500 km	77	66	73	60
			500-2500km	77	66	73	60
			2500-10000km	75	63	70	56
			Above 10000 km	69	55	64	47
		Case 3a	1-500 km	92	88	91	87

			500-2500km	92	89	91	87
			2500-10000km	90	85	88	83
			Above 10000 km	85	77	82	74
	Wood Industry residues	**Case 1**	1-500 km	74	61	68	54
			500-2500km	74	62	68	54
			2500-10000km	71	58	66	50
			Above 10000 km	66	51	60	41
		Case 2a	1-500 km	87	80	84	77
			500-2500km	87	81	84	77
			2500-10000km	85	77	81	73
			Above 10000 km	79	70	75	64
		Case 3a	1-500 km	95	93	94	92
			500-2500km	95	93	94	92
			2500-10000km	93	90	92	88
			Above 10000 km	88	82	86	79

Source: JRC 2014 " Solid and gaseous bioenergy pathways: input values and GHG emissions"
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259

Table 9.16 GHG savings for agricultural biomass systems

GHG savings are calculated according to the COM(2010) 11 and the SWD(2014) 259. Standard electrical efficiency of 25% and thermal efficiency of 85% are applied. GHG savings are calculated relative to the FFC reported in SWD(2014) 259 (also listed in section 7.1 of this report). No land use emissions are included in these results nor are CO2 emissions from the combustion of biomass or other indirect effects. Negative values indicate that the bioenergy pathway emits more than the fossil comparator.

	Agriculture biomass production system	Transport distance	TYPICAL [%]		DEFAULT [%]	
			Heat	Electricity	Heat	Electricity
Agricultural systems – GHG Savings	**Agricultural Residues with density <0.2 t/m3[1]**	1-500 km	95	92	93	90
		500-2500 km	89	85	87	82
		2500-10000 km	79	70	75	64
		Above 10000	61	42	53	31
	Agricultural Residues with density <0.2 t/m3[2]	1-500 km	95	92	93	90
		500-2500 km	93	90	92	88
		2500-10000 km	88	83	86	80
		Above 10000	79	70	75	64
	Straw pellets	1-500 km	88	82	85	79
		500-10000 km	86	79	83	75
		Above 10000	80	71	76	65
	Bagasse briquettes	500-10000 km	93	89	91	87
		Above 10000 km	87	81	85	78
	Palm Kernel Meal	Above 10000 km	20	-17	10	-31
	Palm Kernel Meal (no CH4 emissions from oil mill)	Above 10000 km	46	21	41	14

Source: JRC 2014 " Solid and gaseous bioenergy pathways: input values and GHG emissions"
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259

Absolute GHG emissions for biogas pathways

Table 9.17 Typical and default GHG emission values for non-upgraded biogas

Values of emissions are provided at plant gate (excl. final conversion efficiency) and based on a MJ of biogas produced. No land use emissions are included in these results nor are CO2 emissions from the combustion of biomass or other indirect effects. Negative values indicate bioenergy pathways that save GHG emissions compared to the alternative in which the biomass is not used for bioenergy production (i.e. credits for improved manure management higher than the biogas supply chain emissions).

	Biogas production system		Technological option	TYPICAL [gCO_2eq/MJ]	DEFAULT [gCO_2eq/MJ]
Biogas for electricity – GHG emissions	Wet manure[3]	Case 1	Open digestate[1]	-28	3
			Close digestate[2]	-88	-84
		Case 2	Open digestate	-22	12
			Close digestate	-82	-76
		Case 3	Open digestate	-26	12
			Close digestate	-92	-86
	Maize whole plant[4]	Case 1	Open digestate	38	47
			Close digestate	24	28
		Case 2	Open digestate	45	57
			Close digestate	31	38
		Case 3	Open digestate	50	62
			Close digestate	34	40
	Biowaste	Case 1	Open digestate	31	44
			Close digestate	9	13
		Case 2	Open digestate	40	55
			Close digestate	18	24
		Case 3	Open digestate	43	60
			Close digestate	18	26

[1] Open storage of digestate accounts for additional emissions of methane and N2O. The magnitude of these emissions changes with ambient conditions, substrate types and the digestion efficiency (see chapter 5 for more details).
[2] Close storage means that the digestate resulting from the digestion process is stored in a gas-tight tank and the additional biogas released during storage is considered to be recovered for production of additional electricity or biomethane. No emissions of GHG are included in this process.
[3]The values for biogas production from manure include negative emissions for emissions saved from raw manure management. The value of esca considered is equal to -45 gCO2eq./MJ manure used in anaerobic digestion (see section 5.2.1 for more details).
[4] Maize whole plant should be interpreted as maize harvested as fodder and ensiled for preservation.
Source: JRC 2014 " Solid and gaseous bioenergy pathways: input values and GHG emissions"
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259

Case 1 refers to pathways in which power and heat required in the process are supplied by the CHP engine itself.
Case 2 refers to pathways in which the electricity required in the process is taken from the grid and the process heat is supplied by the CHP engine itself. In some Member States, operators are not allowed to claim the gross production for subsidies and Case 1 is the more likely configuration.
Case 3 refers to pathways in which the electricity required in the process is taken from the grid and the process heat is supplied by a biogas boiler. This case applies to some installations in which the CHP engine is not on-site and biogas is sold (but not upgraded to biomethane).

Table 9.18 Typical and default GHG emission values for biogas upgraded to bio methane and injected into the natural gas grid

Values of emissions are provided at the grid outlet (excl. final conversion efficiency, the grid is considered to be neutral to the GHG emissions) and based on a MJ of biomethane produced. Negative values indicate bioenergy pathways that save GHG emissions compared to the alternative in which the biomass is not used for bioenergy production (i.e. credits for improved manure management higher than the biogas supply chain emissions).

	Biogas production system	Technological option		TYPICAL [gCO_2eq/MJ]	DEFAULT [gCO_2eq/MJ]
Biomethane– GHG emissions	Wet manure	Open digestate	No off-gas combustion[1]	-17	26
			off-gas combustion[2]	-32	5
		Close digestate	No off-gas combustion	-85	-75
			off-gas combustion	-100	-96
	Maize whole plant	Open digestate	No off-gas combustion	61	78
			off-gas combustion	46	57
		Close digestate	No off-gas combustion	45	56
			off-gas combustion	30	35
	Biowaste	Open digestate	No off-gas combustion	54	76
			off-gas combustion	39	55
		Close digestate	No off-gas combustion	29	40
			off-gas combustion	14	19

[1]This group includes the following categories of technologies for biogas upgrading to biomethane: Pressure Swing Absorption (PSA), Pressure Water Scrubbing (PWS), Membranes, Cryogenic, and Organic Physical Scrubbing (OPS). It includes an emission of 0.03 MJCH4/MJbiomethane for the emission of methane in the off-gases.
[2]This group includes the following categories of technologies for biogas upgrading to biomethane: Pressure Water Scrubbing (PWS) when water is recycled, Pressure Swing Absorption (PSA), Chemical Scrubbing, Organic Physical Scrubbing (OPS), Membranes and Cryogenic upgrading. No methane emissions are considered for this category (the methane in the off gas, if any, is combusted and fully oxidized).
Source: JRC 2014 " Solid and gaseous bioenergy pathways: input values and GHG emissions"
Calculated according to the methodology set in COM(2010) 11 and SWD(2014) 259

LOWER HEATING VALUES (LHV'S)

Diesel	43,1	MJ/kg (0% water)
Gasoline	43,2	MJ/kg (0% water)
Heavy fuel oil (HFO) for marine transport	40,5	MJ/kg (0% water)
Ethanol	26,81	MJ/kg (0% water)
Methanol	19,9	MJ/kg (0% water)
FAME	37,2	MJ/kg (0% water)
Syn diesel (BtL)	44,0	MJ/kg (0% water)
Hydrotreated Vegetable Oil (HVO)	44,0	MJ/kg (0% water)
Pure Vegetable Oils (PVO)	36,0	MJ/kg (0% water)
n-Hexane	45,1	MJ/kg (0% water)
Hard coal	26,5	MJ/kg (0% water)
Lignite	9,2	MJ/kg (0% water)
Corn	18,5	MJ/kg (0% water)
Rapeseed	26,4	MJ/kg (0% water)
Soybeans	23,5	MJ/kg (0% water)
Sugar beet	16,3	MJ/kg (0% water)
Sugar cane	19,6	MJ/kg (0% water)
Sunflowerseed	26,4	MJ/kg (0% water)
Wheat	17,0	MJ/kg (0% water)
Animal fat	37,1	MJ/kg (0% water)
Biooils (by-products FAME from waste oil)	21,8	MJ/kg (0% water)
Crude vegetable oil	36,0	MJ/kg (0% water)
Dried Distillers Grains with Solubles (DDGS),10 wt% moisture	16,0	MJ/kg (10% water)
Glycerol	16,0	MJ/kg (0% water)
Palm kernel meal	17,0	MJ/kg (0% water)
Palm oil	37,0	MJ/kg (0% water)
Rapeseed meal	18,7	MJ/kg (0% water)
Soybean oil	36,6	MJ/kg (0% water)
Sugar beet pulp	15,6	MJ/kg (0% water)
Sugar beet slops	15,6	MJ/kg (0% water)

TRANSPORT EFFICIENCIES

Truck for dry product (Diesel)	**0,94**	**MJ/ton,km**
Truck for liquids (Diesel)	1,01	MJ/ton,km
Truck for FFB transport (Diesel)	2,01	MJ/ton,km
Tanker truck MB2218 for vinasse (Diesel)	2,16	MJ/ton,km
Tanker truck with water cannons for vinasse (Diesel)	0,94	MJ/ton,km
Dumpster truck MB2213 for filter mud (Diesel)	3,60	MJ/ton,km
Ocean bulk carrier (Fuel oil)	0,20	MJ/ton,km
Ship /product tanker 50kt (Fuel oil)	0,12	MJ/ton,km
Rail (Electric, MV)	0,21	MJ/ton,km

Source: BioGrace project

9.2 Pellets chapter reference tables

Conventions to geographic regions:
EU28: European Union member states. In the case when a new country has joined the EU, the country will be added also to previous years as a member of EU.
Other Europe: Albania, Bosnia Herzegovina, Belarus, Switzerland, Montenegro, Norway, Serbia, Ukraine, Russia
Balkan countries: Bosnia Herzegovina, Croatia, Republic of Serbia, Bulgaria, Slovenia, Montenegro, Albania
Baltic countries: Lithuania, Latvia, Estonia
Asia: Japan, South Korea, Thailand, Vietnam, Myanmar, Indonesia, Malaysia, China

Table 9.19 ENplus requirements for wood pellets

Property	Unit	EN*plus* A1	EN*plus* A2	EN*plus* B	Testing standard 11)
Diameter	mm	6 ± 1 or 8 ± 1			ISO 17829
Length	mm	3,15 < L ≤ 40 4)			ISO 17829
Moisture	w-% 2)	≤ 10			ISO 18134
Ash	w-% 3)	≤ 0,7	≤ 1,2	≤ 2,0	ISO 18122
Mechanical Durability	w-% 2)	≥ 98,0 5)	≥ 97,5 5)		ISO 17831-1
Fines (< 3,15 mm)	w-% 2)	≤ 1,0 6) (≤ 0,5 7))			ISO 18846
Temperature of pellets	°C	≤ 40 8)			
Net Calorific Value	kWh/kg 2)	≥ 4,6 9)			ISO 18125
Bulk Density	kg/m3 2)	600 ≤ BD ≤ 750			ISO 17828
Additives	w-% 2)	≤ 2 10)			-
Nitrogen	w-% 3)	≤ 0,3	≤ 0,5	≤ 1,0	ISO 16948
Sulfur	w-% 3)	≤ 0,04	≤ 0,05		ISO 16994
Chlorine	w-% 3)	≤ 0,02		≤0,03	ISO 16994
Ash Deformation Temperature1)	°C	≥ 1200	≥ 1100		CEN/TC 15370-1
Arsenic	mg/kg 3)	≤1			ISO 16968
Cadmium	mg/kg 3)	≤ 0,5			ISO 16968
Chromium	mg/kg 3)	≤10			ISO 16968
Copper	mg/kg 3)	≤10			ISO 16968
Lead	mg/kg 3)	≤10			ISO 16968
Mercury	mg/kg 3)	≤ 0,1			ISO 16968
Nickel	mg/kg 3)	≤10			ISO 16968
Zinc	mg/kg 3)	≤100			ISO 16968

1) ash is produced at 815 °C
2) as received
3) dry basis
4) a maximum of 1% of the pellets may be longer than 40mm, no pellets longer than 45mm are allowed.
5) at the loading point of the transport unit (truck, vessel) at the production site
6) at factory gate or when loading truck for deliveries to end-users (*Part Load Delivery* and *Full Load Delivery*)
7) at factory gate, when filling pellet bags or sealed *Big Bags*.
8) at the last loading point for truck deliveries to end-users (*Part Load Delivery* and *Full Load Delivery*)
9) equal ≥ 16,5 MJ/kg as received
10) the amount of additives in production shall be limited to 1,8 w-%, the amount of post-production additives (e.g. coating oils) shall be limited to 0,2 w-% of the pellets.
11) As long as the mentioned ISO standards are not published, analyses shall be performed according to related CEN standards
Source: EN*plus* Handbook

9.3 Glossary

Arable land	Land worked regularly, generally under a system of crop rotation, which includes fallow land.
Balkan countries	In the pellet chapter, it refers to: Bosnia Herzegovina, Croatia, Serbian Republic, Slovenia, Montenegro, Albania
Baltic countries	Lithuania, Latvia, Estonia
Biodiesels	This category includes biodiesel (a methyl–ester produced from vegetable or animal oil, of diesel quality), biodimethylether (dimethylether produced from biomass), Fischer Trophy (Fischer tropic produced from biomass), cold pressed biooil (oil produced from oil seed through mechanical processing only) and all other liquid biofuels which are added to, blended with Gas/diesel oil.
Biofuels	In this report 'Biofuels' refer biomass use for energy in the transport sector including as bioethanol, biodiesels and to lesser extend biogas and bioliquids.
Biogas	Biogas is a gas containing 50-70% biomethane. It is produced by micro-organisms under anaerobic conditions from different sources of wet biomass such as manure, fresh crops, and organic waste. The process of biogas production takes place in landfill sites and also in swamps and other places in the nature, where organic matter is stored under anaerobic conditions.
Bioheat	Bioheat comprises biomass for heat and derived heat.
Bioliquids	Refers to liquid biofuels used for other purposes than transport fuels, mainly heat and electricity.
Biomass	The biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste.
Biomass for heat	Biomass for heat refers to the biomass delivered to the final costumer and used for heat production. Sectors consuming biomass for heat production are: industrial, residential, services and other sectors (fishing, agriculture, forestry and other non-specified).
Black liquor	Black liquor is a recycled by-product formed during the process of chemical pulping of wood in the papermaking industry. In this process, lignin is separated from cellulose, with the latter forming the paper fibres. Black liquor is the combination of the lignin residue with water and the chemicals used for the extraction. It plays an important role as bioenergy carrier in the paper and pulp industry.
CHP heat pellets consumption/use	Volume of pellets used for the heat production within a combined heat and power appliance (CHP) corresponding to 2/3 of the total volume of pellets used in the CHP.
CHP electricity pellets consumption/use	Volume of pellets used for electricity production within a combined heat and power appliance (CHP) corresponding to 1/3 of the total volume of pellets used in the CHP.
Combine Heat and Power (CHP)	Or cogeneration, integrates the production of usable heat and power (electricity), in one single, highly efficient process.

Commercial heating pellets consumption/use	Volume of pellets used in dedicated heat boilers with a capacity greater than 50 kW. This class includes dedicated heat boilers used in residential buildings, public buildings, services, industry and excludes combined heat and power appliances (CHP).
CO2eq (Carbon Dioxide Equivalent)	Carbon dioxide equivalent is the standard unit for comparing the global warming potential of any greenhouse gas over a specified period of time. In this way, the relative severity of all greenhouse gas emissions can be evaluated in terms of one agreed reference point.
Derived heat (DH)	According to Eurostat, derived heat covers the total heat production in heating plants and in combined heat and power plants. It includes the heat used by the auxiliaries of the installation which use hot fluid and losses in the installation/network heat exchanges. For autoproducing entities (= entities generating electricity and/or heat wholly or partially for their own use as an activity which supports their primary activity) the heat used by the undertaking for its own processes is not included.
Dedicated power pellets consumption/use	Volume of pellets used for electricity production in a plant only producing electricity without recovering the heat generated during the process.
Direct jobs	Direct jobs are those directly derived from RES manufacturing, equipment and component supply, or onsite installation and O&M.
Effort sharing decision	Established binding annual GHG emission targets for member states for the period 2013-2020 and forms part of a set of policies and measures on climate change and energy known as the climate and energy package that will help move Europe towards a low-carbon economy and increase its energy security.
Electricity and heat generation- Main activity and autoproducers	The electricity and heat generation are further divided into Electricity-only plants, Combined heat and power plants (CHP) and Heat-only plants. These types of plants may be operated by enterprises which are producing the electricity and/or heat for sale as their main business or by enterprises which are not producing the energy as their main business but primarily for their own consumption. The enterprises of the first group are called public or main power producers (MPPs) and those in the second group autogenerators or autoproducers.
Energy dependency	Energy dependency is calculated as net imports divided by the sum of gross inland energy consumption and maritime bunkers. Hence, it describes the extent to which an economy relies on imports to meet its energy needs.
Fallow land	Arable land not under rotation that is set at rest for a period of time ranging from one to five years before it is cultivated again, or land usually under permanent crops, meadows or pastures, which is not being used for that purpose for a period of at least one year. Arable land which is normally used for the cultivation of temporary crops, but which is temporarily used for grazing is included.
Fellings	Average annual standing volume of all trees, living or dead, measured overbark to a minimum diameter of 0 cm at diameter breast height (d.b.h.) that are felled during the given reference period, including the volume of trees or parts of trees that are not removed from the forest, other wooded land or other felling site. Includes: silvicultural and pre-commercial thinnings and cleanings left in the forest; and natural losses that are recovered (harvested)
Final energy consumption	Final energy consumption cover energy supplied to the final consumer´s door for all energy uses. Is the sum of the final energy consumed in the transport, industrial, agricultural/forestry, fishing, services, household and other unspecified sector It excludes deliveries to the energy transformation sector and to the energy industries themselves.

Forest available for wood supply	Forests available for wood supply are forests where no legal, economic, or environmental restrictions have a bearing on the supply of wood; it is here that large volumes of commercial wood are generally harvested.
Forest Stewardship Council (FSC)	An international non-profit, multi-stakeholder organization established in 1993 to promote responsible management of the world's forests. The FSC does this by setting standards on forest products, along with certifying and labelling them as eco-friendly.
Fugitive emissions	emissions of gases or vapors from pressurized equipment due to leaks and other unintended or irregular releases of gases, mostly from industrial activities.
Gross Electricity Generation	The gross electricity generation is measured at the outlet of the main transformers, i.e. the consumption of electricity in the plant auxiliaries and in transformers is included.
Gross final energy consumption	Final energy consumption + consumption of electricity and heat by the energy branch for electricity and heat generation (own use by plant) + losses of electricity and heat in transmission and distribution.
Gross inland consumption	Gross inland consumption is the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration. It is calculated using the following formula: primary production + recovered products + imports +stock changes – exports – bunkers. International Marine Bunkers are quantities of fuels delivered to ships of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways, and in coastal waters.
Indirect jobs	Indirect jobs are those that result from activity in sectors that supply the materials or components used, but not exclusively so, by the renewables sectors (such as jobs in copper smelting plants part of whose production may be used for manufacturing solar thermal equipment, but may also be destined for appliances in totally unconnected fields).
Industrial use of wood	Sawlogs, veneerlogs, Pulpwood and other industrial wood
Industrial pellet consumption	Pellet consumed in large scale CHP and Power plant
Industry	Final energy consumption – industry covers the consumption in all industrial sectors with the exception of the "Energy sector" . This refers to fuel quantities consumed by the industrial undertaking in support of its primary activities.
Kyoto basket	Included carbon dioxide, methane, nitrous oxide and the so-called F-gases (hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride (NF3) and sulphur hexafluoride (SF6)). These gases are aggregated into a single unit using gas-specific global warming potential (GWP) factors. The aggregated greenhouse gas emissions are expressed in units of CO2 equivalents. The indicator does not include emissions and removals related to land use, land-use change and forestry (LULUCF); nor does it include emissions from international maritime transport. Greenhouse gas emissions from international aviation are not included in the data which is indexed to the Kyoto base year because these emissions are not covered by the Kyoto Protocol. However, they are included in the data indexed to 1990.
Natura2000	Natura 2000 is a network of nature protection areas in the territory of the European Union. It is made up of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) designated respectively under the Habitats Directive and Birds Directive.
Other European countries	In the pellet chapter, "Other European countries" refers to the European countries outside the EU28 that have participated to the EPC survey 2018. Respectively: AL, BA, BY, CH, ME, NO, RS, RU, UA

Other sectors	Final energy consumption – Other sectors covers quantities consumed by sectors not specifically mentioned or not belonging to residential, industry or transport (services, agriculture/forestry and fisheries).
Other wooded land	Land either with a tree crown cover (or equivalent stocking level) of 5-10 % of trees that will reach a height of 5 m at maturity in situ; or a crown cover (or equivalent stocking level) of more than 10 percent of trees that will not reach a height of 5 m at maturity in situ (e.g. dwarf or stunted trees) and shrub or bush cover.
Pellet consumption for electricity production	Without a specific note this corresponds to the total volume of pellets used in dedicated power plants and 1/3 of the total volume of pellets used in combined heat and power plants (CHP)
Pellet consumption for heat production	Without a specific note this corresponds to the volume of pellets used for residential heating, commercial heating and 2/3 of the total volume of pellets used in combined heat and power plants (CHP)
Permanent crops	This signifies land used for crops occupying it for a long period of time and which do not have to be planted for several years after each harvest. Land under trees and shrubs producing flowers, such as roses and jasmine, is so classified, as are nurseries (except those for forest trees, which should be classified under "forests and other wooded land"). Permanent meadows and pastures are excluded.
Permanent grassland	Land used permanently (for five years or more) to grow herbaceous forage crops, through cultivation (sown) or naturally (self-seeded), and that is not included in the crop rotation on the holding. The land can be used for grazing or mown for silage, hay or used for renewable energy production.
Primary energy production	Primary energy refers to the indigenous production, that is any kind of extraction of energy products from natural sources to a usable form. Primary production takes place when the natural sources are exploited, for example in coal mines, crude oil fields, hydro power plants or fabrication of biofuels. Transformation of energy from one form to another, such as electricity or heat generation in thermal power plants is not included in primary production.
Program for the endorsement of forest certification (PEFC)	world's leading forest certification organization. An international non-profit, non-governmental organization dedicated to promoting sustainable forest management, the Programme for the Endorsement of Forest Certification is the certification system of choice for small forest owners.
Pulpwood	Roundwood that will be used for the production of pulp, particleboard or fibreboard. It includes: roundwood (with or without bark) that will be used for these purposes in its round form or as splitwood or wood chips made directly (i.e. in the forest) from roundwood.
Removals	a synonym for roundwood production. This comprises of all quantities of wood removed from forests and other wooded land or other felling sites during a given period; it is reported in cubic meters (m^3) under bark (in other words, excluding bark).

Residential	Final energy consumption – Residential covers quantities consumed by all households including "households with employed persons" (NACE Divisions 97 and 98). Household means a person living alone or a group of people who live together in the same private dwelling and sharing expenditures including the joint provision of the essentials of living. The household sector, also known as the residential (or domestic) sector is therefore, a collective pool of all households in a country. Collective residences which can be permanent (e.g. prisons) or temporary (e.g. hospitals) are excluded as these are covered in consumption in the service sector. Energy used in all transport activities are reported in the transport sector and not in the household sector.
Residential heating pellets consumption/use	Volume of pellets used in domestic's stoves and dedicated heat boilers with a capacity below 50 kW
Sawlogs and veneer logs	Roundwood that will be sawn (or chipped) lengthways for the manufacture of sawnwood or railway sleepers (ties) or used for the production of veneer (mainly by peeling or slicing). It includes roundwood (whether or not it is roughly squared) that will be used for these purposes; shingle bolts and stave bolts; match billets and other special types of roundwood (e.g. burls and roots, etc.) used for veneer production.
Services	Final energy consumption – Services consists of fuels consumed by business and offices in the public and private sectors.
Solid biomass	Covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation. It comprises: - Charcoal: Covers the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material. - Wood, wood wastes, other solid wastes: Covers purpose-grown energy crops (poplar, willow, etc.), a multitude of woody materials generated by an industrial process (wood/paper industry in particular) or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, black liquor, etc.) as well as wastes such as straw, rice husks, nut shells, poultry litter, crushed grape dregs, etc. Combustion is the preferred technology for these solid wastes. The quantity of fuel used should be reported on a net calorific value basis.
Solid fossil fuel	Solid fossil fuels such as coal product defined in the regulation (EC) N° 1099/2008 of the European parliament and of the council.
Stock of forests	The living tree component of the standing volume excluding smaller branches, twigs, foliage and roots. It is measured in cubic meters (m^3) over bark.
Stock of forests available for wood supply	The forests where no legal, economic, or environmental restrictions have a bearing on the supply of wood; it is here the large volumes of commercial wood are generally harvested
Ton of oil equivalent	Tonne(s) of oil equivalent, abbreviated as toe, is a normalized unit of energy. By convention it is equivalent to the approximate amount of energy that can be extracted from one tonne of crude oil. It is a standardized unit, assigned a net calorific value of 41 868 kilojoules/kg and may be used to compare the energy from different sources.
Utilised agricultural area (UAA)	The Utilized Agricultural Area means the total area used for crop production, which is exhaustively described as: Arable land including temporary grassing and fallow and green manure, permanent grassland, land under permanent crops (e.g. fruit and grapes), crops under glass and other utilized agricultural areas.
Utilized arable land	Land worked regularly, generally under a system of crop rotation, which excludes fallow land.

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 such as logs and wood chips) and wood that will be used for the production of charcoal (e.g. in pit kilns and portable ovens), wood pellets and other agglomerates.
CHP heat pellets consumption/use	Volume of pellets used for the heat production within a combined heat and power appliance (CHP) corresponding to 2/3 of the total volume of pellets used in the CHP.
CHP electricity pellets consumption/use	Volume of pellets used for electricity production within a combined heat and power appliance (CHP) corresponding to 1/3 of the total volume of pellets used in the CHP.
Commercial heating pellets consumption/use	Volume of pellets used in dedicated heat boilers with a capacity greater than 50 kW. This class includes dedicated heat boilers used in residential buildings, public buildings, services, industry and excludes combined heat and power appliances (CHP).
Dedicated power pellets consumption/use	Volume of pellets used for electricity production in a plant only producing electricity without recovering the heat generated during the process.
Pellet consumption for electricity production	Without a specific note this corresponds to the total volume of pellets used in dedicated power plants and 1/3 of the total volume of pellets used in combined heat and power plants (CHP)
Pellet consumption for heat production	Without a specific note this corresponds to the volume of pellets used for residential heating, commercial heating and 2/3 of the total volume of pellets used in combined heat and power plants (CHP)
Residential heating pellets consumption/use	Volume of pellets used in domestic’s stoves and dedicated heat boilers with a capacity below 50 kW

9.1 List of figures

9.2 List of tables

10 Erratum

A mistake can be found in Chapter 8: Wood pellet.

France shows a pellet consumption for power only in 2016 and 2017 which is wrong.

Therefore, this number should be ignored in any aggregate, tables and figures.

Data used in the report:

	2016					2017				
	Residential	Commercial	CHP	**Power only**	**Total**	Residential	Commercial	CHP	**Power only**	**Total**
FR	1.020.000	80.000	0	**100.000**	**1.200.000**	1.240.000	160.000	0	**150.000**	**1.550.000**

Correction:

	2016					2017				
	Residential	Commercial	CHP	**Power only**	**Total**	Residential	Commercial	CHP	**Power only**	**Total**
FR	1.020.000	80.000	0	**0**	**1.100.000**	1.240.000	160.000	0	**0**	**1.400.000**

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