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AEBIOM Statistical Report

About & Timeline

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

The AEBIOM 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.

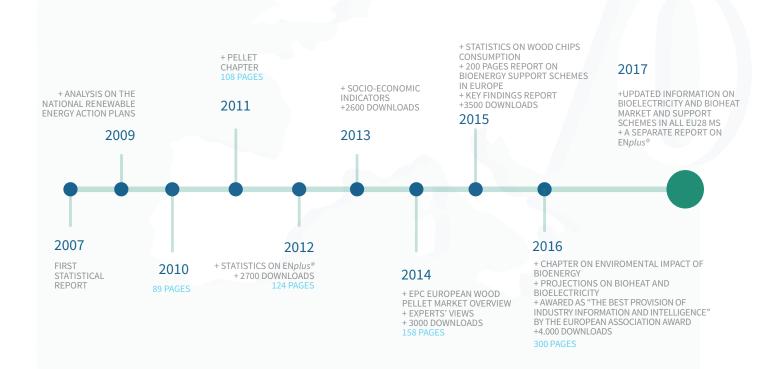
AEBIOM is therefore able to develop a detailed report that helps industry leaders, decision makers, investors and all bioenergy professionals to understand the situation of bioenergy in Europe.

With more than 150 graphs and figures, readers of AEBIOM's Statistical Report can get accurate and upto-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.

This 300-page report was further enriched in 2016 with an exhaustive analysis of the support schemes in place for biomass for heating, electricity and transport, covering all EU-28 countries and market forecasts based on past trends and the existing reality. Key data have been reviewed by key national experts in order to give the most accurate visions of how European bioenergy markets will evolve in the coming years.

In 2017, AEBIOM statictical 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.





About the

European Biomass Association



The European Biomass Association (AEBIOM) is the common voice of the bioenergy sector with the aim to develop a sustainable bioenergy market based on fair business conditions.

AEBIOM 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.aebiom.org



Academics











Associations

























































































About the

European Biomass Association



Companies













































































































































































AEBIOM's

Networks



The European Pellet Council (EPC) is an umbrella organisation of the European Biomass Association (AEBIOM) 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.

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 ENplus® quality certification.

For more information on the European Pellet Council >>> www.epc.aebiom.org

For more information on the ENplus® certification >>> www.enplus-pellets.eu

The International Biomass Torrefaction Council (IBTC) is an umbrella organisation of AEBIOM 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.

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.

For more information on the International Biomass Torrefaction Council >>> www.biomasstorrefaction.org





Sponsors 2017















Biomasa Partner

Biomasa Partner Group is a leading and preferred manufacturer supplying annually 80 000 tons of certified wooden pellet and briquette. All of the products are made from the highest quality saw dust and wood chips supplied by our biomass department. We deliver annually 150 000 tons of saw dust together with paper, saw mill and forest wooden chips. Our organization guarantees the highest quality products and services to all of our partners. Additionally our logistics and forwarding departments provide deliveries by trucks, trains, sea containers and ships all over Europe.

>>> www.biomasapartner.pl

BioCurve

BioCurve is a biomass boiler manufacturer, leading the design of condensing boilers. Its pioneering portfolio includes pellet condensing boilers from 25 kW to 150 kW, with efficiencies up to 105,7% and emissions well below the strictest limits. The quality of the most powerful boilers of its kind has been endorsed by twelve international awards and satisfied clients in six countries. BioCurve has recently received the Expobiomasa 2017 Innovation Award for the first woodchip condensing boiler without need of heat recovers, which will be available from 2018.

>>> www.biocurve-heating.com

STUV

Based in Bois-de-Villers, in the Namur province (Belgium), Stûv designs, produces and markets individual wood, gas and pellet heating solutions. Our stoves, fires, inserts and fireplaces are designed with incredible care, offering customer satisfaction in terms of energy performance, enjoyment and durability.

>>> www.stuv.com

Africa-EU Renewable Energy Cooperation Programme

The Africa-EU Renewable Energy Cooperation Programme (RECP) is a multi-donor programme that supports the development of markets for renewable energy in Africa. It was launched by more than 35 African and European Ministers and Commissioners under the Africa-EU Energy Partnership (AEEP).

>>> www.africa-eu-renewables.org

Scandbio

Scandbio is Sweden's largest company within solid processed wood fuels. We sell $100\,\%$ renewable energy in the form of pellets, briquettes, logs and powder.

>>> www.scandbio.com

Badger Pellets - François Group

BADGER Pellets are wood fuel pellets formed from sawdust from wood sawing in our regions. The sawdust, without bark, is made into pellets in this form through the combined action of high pressure and lignin, a natural constituent of wood which gives a gloss on the surface of our pellets. BADGER Pellets, no glue or chemical additive is used. It is a 100% natural fuel! They are produced on totally integrated bio-sites in Virton (Recybois) and Thimister (Woodenergy) in Belgium and in Bissen (KIOWATT – www.kiowatt.lu) in Luxembourg. They are real centres of excellence in circular economy. In fact, at BADGER Pellets, nothing is wasted. Wood is used in all its forms with the aim of giving it maximum value at each stage.

>>> www.badgerpellets.com

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A Word from AEBIOM President





I BELIEVE THAT THE EUROPEAN BIOENERGY SECTOR HAS THE POTENTIAL AND THE BIOMASS RESOURCES AVAILABILITY TO DO EVEN BETTER IN THE COMING YEARS.

Didzis Palejs,
President
EUROPEAN BIOMASS ASSOCIATION

I am particularly proud to present this latest edition of the AEBIOM Statistical Report, as 2017 marks a milestone for our organisation with this publication achieving its 10th edition.

Celebrating a decade of data collection on bioenergy is a good occasion to step back and consider the progress that has been made. Bioenergy has largely contributed to the doubling of the consumption of renewables over the decade (from 8,46% in 2004 to 16,66% in 2015). In the same period, bioenergy experienced a growth of 72% and reached 112.374ktoe in 2015. How many economic sectors in Europe can currently boast of such growth? Bioenergy is too often the unsung hero of the European energy transition in the media. I hope that the clarity of this publication will contribute to a better understanding of the key role that bioenergy has actually played over the past decade.

As bioenergy is currently high on the EU-28 policy agenda, it is also important to understand its its central contribution for many industrial and residential actors eager to cure their dependency on fossil fuels. Looking at the figures displayed in the report, it is clear that bioenergy remains among the most effective solutions to achieve the decarbonisation of the heating and cooling sector, which represent about 50% of our needs

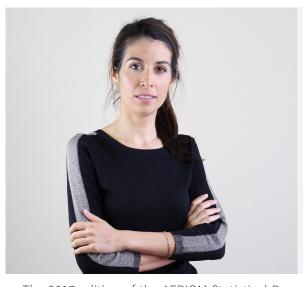
for energy. Indeed, 80% of the renewable energy in this sector is supplied by biomass. Replacing aging stoves and developing the use of CHP to supply the industrial sectors and district heating plants are a few of many solutions that biomass offers.

One could think that we are heading down the right path. However, much remains to be done and the EU-28 political strategy cannot rest upon its past accomplishments. The adoption of the Renewable Energy Directive in 2009 was a major push for bioenergy and other renewables. The Clean Energy package needs to confirm these initial ambitions, by proposing the highest renewable energy target possible to encourage citizens and businesses to invest in clean energy for the decades to come.

Indeed, a final lesson from this report is that the European bioenergy sector has the potential and the biomass resources available to do even better in the coming years.

I hope that the AEBIOM Statistical Report will help both market stakeholders and policy makers to make informed decisions that contribute to the sustainable development of the European energy industry.

Foreword



THE NUMBERS ARE LOUD AND CLEAR, BIOENERGY IS THE LEADING RENEWABLE ENERGY IN THE EU28 REPRESENTING ALMOST 60% OF ALL RENEWABLES IN 2015. WITH 16.7% OF THE ENERGY CONSUMED IN THE EU-28 BEING PROVIDED BY RENEWABLE ENERGY.

Cristina Calderón, Market Intelligence Director

EUROPEAN BIOMASS ASSOCIATION

The 2017 edition of the AEBIOM Statistical Report reveals that the transition towards renewables in Europe is well under way. The numbers are loud and clear, bioenergy is the leading renewable energy in the EU28, representing almost 60% of all renewables in 2015. With 16.7% of the energy consumed in the EU-28 being provided by renewable energy. The above mentioned growth of renewables and bioenergy are good news and pave the way towards a decarbonized energy system.

Nevertheless, despite the general positive trends, there is a long way to go: The EU-28 energy system is still largely dominated by fossil fuels (more than 83% of final energy consumption). As the majority of these fossil fuels are imported, Europe's energy dependency is 54%, so in other words, more than half of the energy that we consumed was imported. Besides having favorable market conditions and a well-developed technology, policy is essential in supporting the energy transition to renewables.

In the past few years policy support for renewables has focused on power generation, while more than half of our energy consumption goes to the heating and cooling sector, 82% still powered by fossil fuels - a share that remains almost unchanged when compared with 2014.

Bioenergy represents 88% of the contribution of renewables in this sector, and there is a large potential for further growth, along with other

sources of renewable energy, to meet domestic and industrial heating needs.

This is why AEBIOM is very active in the current post-2020 framework discussions, proposing ambitious targets and measures to develop the renewable heating sector, as a follow up to the EU Strategy on Heating and Cooling.

74% of the final consumption of bioenergy is in the heating sector, however biomass is also an important source of renewable energy in the electricity and transport sector. It is difficult to cover all the complexity of bioenergy with statistics, with diverse raw material uses, multiple technologies and uses in all the sectors, but AEBIOM can proudly say that our Statistical publication is one of the most accurate sources of information in this regard. The prize as the "Best provision of Industry Information and Intelligence" won by the previous edition of our Report shows this.

This is the result of a collective effort by the whole AEBIOM team, not only those collecting statistics but also the communication and policy departments, as well as an established network of experts that collectively shares their insights and knowledge. Finally, the contribution of the sponsors makes it possible to finance all the work load needed to produce this unique piece of information.

On behalf of the AEBIOM Secretariat, I would like to thank all those who have contributed to the successful production of this year's report.



Export

575.809

39.047

399.235

93.985

0

9.453

34.056

28

1.1 Energy breakdown

Table 1.1 EU28 energy balance in 2015 - key components (ktoe)*

Primary production	766.583
Solid fossil fuels	144.874
Total petroleum products	74.842
Gas	107.588
Nuclear heat*	221.202
Renewable energies	205.043
Electrical energy	0
Waste (non-renewable)	13.033
Transactions	Imports
All products	1.477.933
Solid fuels	151.490
Total petroleum products	934.110
Gas	341.278
Nuclear heat	0
Renewable energies	15.470
Electrical energy	35.283
Waste (non-renewable)	296
Gross inland consumption	1.627.475
Solid fuels	262.682
Total petroleum products	560.106
Gas	357.909
Nuclear heat	221.202
Renewable energies	211.046
Electrical energy	1.226
Waste (non-renewable)	13.302
Energy Available for Final Consumption	1.182.392
Final Non-energy Consumption	96.820
Final Energy Consumption	1.083.957

Final Energy Consumption 1.083.957 ktoe

Stock Changes

-3.737

4.827

-11.279

2.729

0

-15

0

1

By fuel / product				
Solid fossil fuels	46.284			
Oil	429.569			
Gases	236.254			
Renewable energies	86.846			
Electricity	235.665			
Derived heat	45.883			
Wastes, non-	3.456			
renewable	3.430			
By sector				
Industry	274.737			
Transport	358.629			
Household	275.155			
Services	146.924			
Other sectors	28.512			

^{*} According to AEBIOM, 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.

Table 1.2 Primary energy production by fuel in EU28 Member States in 2015 (ktoe)

	All products	Solid fossil fuels	Total petroleum products	Gas	Nuclear heat	Renewable energies	Biomass*	Waste (non- renewable)
EU28	766.583	144.874	74.842	107.588	221.202	205.043	130.201	13.033
AT	11.932	0	866	1.038	0	9.303	5.401	726
BE	10.367	0	0	0	6.733	2.959	2.163	675
BG	11.986	5.832	24	85	3.983	2.033	1.247	30
CY	121	0	0	0	0	118	19	3
CZ	28.756	16.843	207	205	6.945	4.279	3.863	277
DE	119.770	43.004	3.616	6.335	23.677	38.886	26.229	4.252
DK	15.709	0	7.654	4.144	0	3.528	2.222	382
EE	5.554	4.200	0	0	0	1.286	1.222	67
EL	8.473	5.675	63	5	0	2.641	1.178	89
ES	33.441	1.246	233	54	14.782	16.874	7.009	252
FI	17.538	838	71	0	5.996	10.394	8.749	239
FR	136.699	0	1.081	19	112.836	21.417	13.931	1.345
HR	4.393	0	685	1.471	0	2.228	1.584	9
HU	11.188	1.518	850	1.369	4.104	3.240	3.034	107
IE	1.912	762	0	107	0	981	333	62
IT	36.134	51	5.824	5.546	0	23.564	10.740	1.149
LT	1.585	21	75	0	0	1.466	1.359	23
LU	147	0	0	0	0	113	85	34
LV	2.338	0	0	0	0	2.330	2.158	8
MT	15	0	0	0	0	15	2	0
NL	47.593	0	2.040	39.003	1.052	4.810	3.971	688
PL	67.347	53.590	915	3.683	0	8.635	7.473	524
PT	5.304	0	0	0	0	5.182	3.104	122
RO	26.656	4.712	4.148	8.785	3.003	5.935	3.698	74
SE	33.643	110	0	0	14.535	18.375	10.481	624
SI	3.391	862	0	3	1.457	1.026	620	43
SK	6.320	495	12	78	3.954	1.592	1.203	190
UK	118.274	5.115	46.479	35.659	18.146	11.835	7.126	1.041

^{*}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.

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

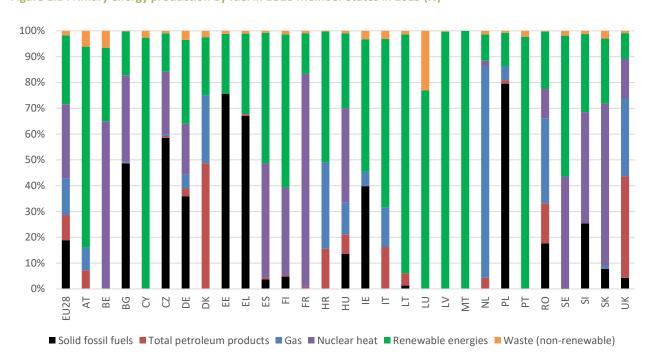


Figure 1.1 Primary energy production by fuel in EU28 Member States in 2015 (%)

Total primary energy production in the EU28 declined between 2000 and 2015 from 942,3 Mtoe to 766,6 Mtoe. On the contrary renewable energy production has a steady growth from 97,9 Mtoe in 2000 to more than 205 Mtoe in 2015, overtaking the indigenous production of all fossil fuels.

300.000 250.000 200.000 150.000 100.000 50.000 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 Solid fossil fuels Total petroleum products ─Waste (non-renewable) ——Renewable energies Nuclear heat

Figure 1.2 Evolution of primary energy production by fuel in EU28 (ktoe)

Biomass

Table 1.3 Total imports by fuel in 2015 by EU28 Member States (ktoe)

	All products	Solid fossil fuels	Total petroleum products	Gas	Waste (non- renewable)	Renewable energies
EU28	1.477.933	151.490	934.110	341.278	296	15.470
AT	29.473	2.755	13.814	9.431	0	948
BE	81.502	3.155	60.191	15.318	2	797
BG	12.513	756	8.732	2.519	0	140
CY	2.476	4	2.439	0	6	27
CZ	21.944	2.814	11.210	6.164	0	366
DE	255.760	37.452	128.164	85.919	0	1.043
DK	18.565	1.518	13.803	591	45	1.260
EE	2.589	5	1.709	391	0	16
EL	35.286	159	31.362	2.674	0	139
ES	124.531	10.963	83.582	28.182	0	518
FI	23.121	2.553	16.349	2.237	0	137
FR	149.670	8.703	100.053	39.450	0	608
HR	7.162	624	4.511	868	0	28
HU	17.875	1.107	9.151	5.677	25	202
IE	14.583	1.481	9.240	3.621	0	90
IT	151.070	12.583	81.133	50.177	0	2.805
LT	14.370	167	11.184	2.141	0	196
LU	4.199	49	2.622	769	0	113
LV	4.504	41	2.760	1.083	47	123
MT	2.761	:	2.665	0	0	5
NL	220.509	34.270	155.868	27.153	137	437
PL	48.930	5.065	31.740	9.992	0	890
PT	26.070	3.208	17.924	4.065	34	144
RO	11.635	1.096	9.800	162	0	191
SE	32.551	2.009	28.111	724	0	908
SI	5.757	203	4.084	662	0	31
SK	15.344	2.829	7.435	3.688	1	101
UK	143.184	15.924	84.474	37.624	0	3.209

Note: Waste trade statistics are likely to be incomplete

Table 1.4 Total exports by fuel in 2015 by EU28 Member States (ktoe)

	All products	Solid fossil fuels	Total petroleum products	Gas	Waste (non- renewable)	Renewable energies
EU28	575.809	39.047	399.235	93.985	28	9.453
AT	9.259	49	2.566	4.442	0	542
BE	30.876	60	29.016	1.445	0	122
BG	5.928	15	4.481	2	0	155
CY	24	0	24	0	0	0
CZ	8.400	3.105	2.456	0	0	372
DE	59.745	1.286	22.305	27.243	0	1.575
DK	16.264	50	13.384	1.967	0	26
EE	2.106	16	1.155	0	0	387
EL	16.474	0	16.339	0	0	8
ES	30.103	601	22.882	4.407	0	915
FI	7.461	91	6.886	0	0	43
FR	32.827	18	21.401	4.865	0	178
HR	3.045	0	1.896	304	0	298
HU	4.421	304	2.699	458	0	422
IE	1.867	19	1.755	0	0	0
IT	29.240	259	28.303	181	0	113
LT	8.888	3	8.492	80	0	250
LU	192	0	6	0	0	22
LV	2.134	1	971	0	0	867
MT	531	:	531	0	0	0
NL	173.725	21.970	111.699	36.522	28	1.614
PL	20.909	10.671	8.393	45	0	528
PT	7.770	0	6.919	0	0	351
RO	6.093	67	4.910	1	0	151
SE	18.310	55	15.431	0	0	82
SI	2.524	0	1.742	0	0	0
SK	5.702	57	4.445	0	0	116
UK	70.990	352	58.146	12.024	0	315

Note: Waste trade statistics are likely to be incomplete

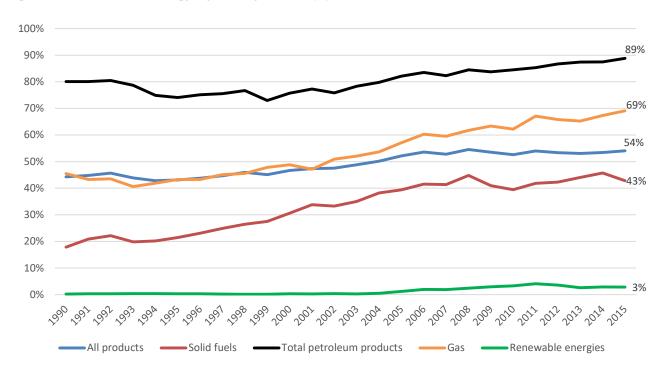


Figure 1.3 Evolution of the energy dependency* in EU28 (%)

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

Source: Eurostat

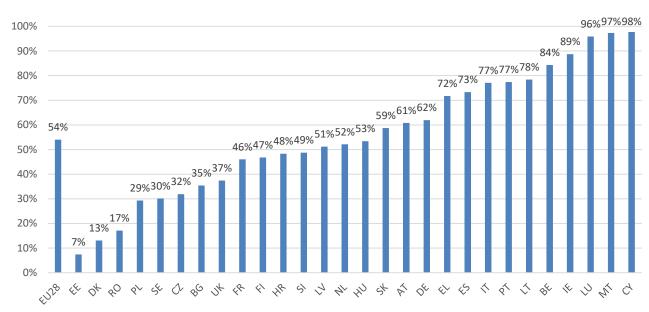


Figure 1.4 Energy dependency in EU28 Member States in 2015 (%)

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

^{*} 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

Table 1.5 Gross inland consumption by fuel in EU28 Member States in 2015 (ktoe)

	All products	Solid fossil fuels	Total petroleum products	Gas	Nuclear heat	Renewable energies	Out of which: Bioenergy	Electrical energy	Waste (non- renewable)
EU28	1.627.475	262.682	560.106	357.909	221.202	211.046	136.204	1.226	13.302
Share (in %)	100%	16,14%	34,42%	21,99%	13,59%	12,97%	8,37%	0,08%	0,82%
AT	33.250	3.176	11.955	6.877	0	9.651	5.749	865	726
BE	54.217	3.183	24.218	13.967	6.733	3.633	2.838	1.806	677
BG	18.511	6.619	4.201	2.595	3.983	1.992	1.207	-909	30
CY	2.272	4	2.110	0	0	147	47	0	12
CZ	42.442	16.580	8.955	6.483	6.945	4.279	3.863	-1.076	277
DE	314.203	79.515	107.406	65.154	23.677	38.354	25.697	-4.152	4.252
DK	16.766	1.727	6.472	2.867	0	4.762	3.456	508	427
EE	6.255	3.851	1.120	391	0	906	842	-80	67
EL	24.449	5.606	12.476	2.677	0	2.775	1.311	826	89
ES	121.418	13.238	52.002	24.538	14.782	16.619	6.754	-11	252
FI	33.155	4.025	8.759	2.243	5.996	10.488	8.844	1.405	239
FR	252.615	8.827	78.256	35.047	112.836	21.814	14.327	-5.508	1.345
HR	8.525	605	3.283	2.082	0	1.962	1.318	584	9
HU	25.200	2.363	6.920	7.491	4.104	3.014	2.808	1.177	132
IE	14.178	2.191	7.044	3.752	0	1.071	423	58	62
IT	156.169	12.301	57.160	55.302	0	26.269	13.445	3.988	1.149
LT	6.913	188	2.597	2.068	0	1.419	1.311	620	23
LU	4.177	49	2.634	774	0	205	177	482	34
LV	4.380	47	1.486	1.098	0	1.537	1.365	157	55
MT	756	:	645	0	0	20	8	91	0
NL	77.557	10.943	31.198	29.176	1.052	3.639	2.800	752	797
PL	95.434	48.256	23.921	13.776	0	8.987	7.825	-29	524
PT	22.997	3.208	10.400	4.074	0	4.966	2.887	195	155
RO	32.414	5.914	9.104	8.925	3.003	5.974	3.736	-579	72
SE	45.474	2.116	10.219	731	14.535	19.193	11.298	-1.943	624
SI	6.579	1.074	2.289	664	1.457	1.056	651	-4	43
SK	16.426	3.275	3.343	3.879	3.954	1.576	1.187	205	191
UK	190.745	23.803	69.935	61.280	18.146	14.740	10.032	1.800	1.041

800000 700000 600000 500000 400000 300000 200000 100000 0 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 Solid fuels Total petroleum products ——Gas Nuclear heat Renewable energies Electrical energy ──Waste (non-renewable) — Bioenergy

Figure 1.5 Evolution of the gross inland consumption in EU28 (ktoe)

Table 1.6 Gross final energy consumption by fuel in EU28 Member States in 2015 (ktoe)

	Total	Solid fossil fuels	Petroleum products	Gas	Electricity	Out of which: Electricity generated from RES	Derived Heat	Out of which: Derived heat generated from RES	RES*	Waste Non- Renewable
EU28	1.083.957	46.284	429.569	236.254	235.665	85.635	45.883	13.506	86.846	3.456
Share (%)	100%	4,3%	39,6%	21,8%	21,7%		4,2%		8,0%	0,3%
AT	27.370	1.456	9.843	4.879	5.229	4.670	1.828	903	3.831	305
BE	35.780	1.607	15.719	9.195	7.026	1.433	512	49	1.576	144
BG	9.508	333	3.371	1.314	2.436	838	818	12	1.207	30
CY	1.660	4	1.183	0	352	34	1	1	108	12
CZ	24.187	2.329	6.715	5.428	4.684	1.030	2.081	207	2.729	222
DE	212.124	10.399	81.119	51.764	44.259	17.129	9.594	1.547	13.962	1.026
DK	13.946	118	5.837	1.467	2.640	1.630	2.415	1.468	1.448	21
EE	2.765	37	990	222	589	129	431	218	484	12
EL	16.502	224	9.391	969	4.367	1.286	50	0	1.436	65
ES	80.461	1.306	40.465	13.449	19.952	8.903	0	0	5.287	2
FI	24.181	603	6.716	843	6.747	2.625	3.833	1.859	5.391	49
FR	144.123	4.113	61.132	28.323	36.537	8.536	2.348	1.153	11.542	129
HR	6.587	81	2.746	978	1.319	674	212	20	1.242	9
HU	17.309	425	5.125	5.448	3.112	276	966	163	2.174	59
IE	11.214	506	6.468	1.718	2.156	725	0	0	330	37
IT	116.444	1.720	44.338	33.182	24.719	9.611	3.851	905	8.365	269
LT	4.869	184	1.867	519	803	260	798	458	697	0
LU	3.988	49	2.604	603	535	283	51	15	133	14
LV	3.788	43	1.373	317	556	239	504	222	941	55
MT	572	:	380	0	182	9	0	0	11	0
NL	48.505	1.532	17.204	17.174	8.866	1.177	2.463	312	1.230	36
PL	62.251	11.688	19.193	8.977	10.991	2.054	5.462	308	5.454	486
PT	16.038	12	7.959	1.643	3.939	2.292	244	0	2.185	56
RO	21.893	838	7.008	5.468	3.700	2.317	1.273	79	3.533	72
SE	31.759	1.036	8.515	750	10.736	8.830	4.193	3.423	6.529	0
SI	4.689	38	2.167	558	1.100	423	169	35	622	35
SK	10.077	1.323	2.124	3.093	2.096	566	632	133	635	175
UK	131.370	4.281	58.019	37.975	26.040	7.655	1.152	19	3.766	138

^{*}It doesn't include electricity from RES and Derived Heat from RES.

1.2 Renewables in Europe

Table 1.7 Primary production of renewable energy in EU28 Member States in 2015 (ktoe)

	Renewable energies	Hydro power	Wind power	Solar thermal	Solar photovoltaic	Tide, Wave and Ocean	Geothermal Energy	Biomass
EU28	205.043	29.327	25.956	4.252	8.799	42	6.466	130.200
Share (%)	100%	14,30%	12,66%	2,07%	4,29%	0,02%	3,15%	63,50%
AT	9.303	3.186	416	185	81	0	35	5.401
BE	2.959	27	479	22	264	0	3	2.163
BG	2.033	487	125	22	119	0	33	1.247
CY	118	0	19	68	11	0	2	19
CZ	4.279	154	49	18	195	0	0	3.863
DE	38.886	1.632	6.811	671	3.330	0	214	26.229
DK	3.528	2	1.215	34	52	0	3	2.222
EE	1.286	2	62	0	0	0	0	1.222
EL	2.641	524	397	196	335	0	10	1.178
ES	16.874	2.420	4.241	2.474	711	0	19	7.009
FI	10.394	1.442	200	2	1	0	0	8.749
FR	21.417	4.681	1.827	99	624	42	213	13.931
HR	2.228	550	68	10	5	0	11	1.584
HU	3.240	20	60	11	11	0	105	3.034
IE	981	69	565	13	0	0	0	333
IT	23.564	3.916	1.276	190	1.973	0	5.470	10.740
LT	1.466	30	70	0	6	0	2	1.359
LU	113	9	9	2	9	0	0	85
LV	2.330	160	13	0	0	0	0	2.158
MT	15	0	0	4	8	0	0	2
NL	4.810	8	649	27	96	0	59	3.971
PL	8.635	158	934	45	5	0	22	7.473
PT	5.182	745	998	80	69	0	187	3.104
RO	5.935	1.430	607	1	170	0	29	3.698
SE	18.375	6.476	1.399	11	8	0	0	10.481
SI	1.026	327	1	11	24	0	43	620
SK	1.592	332	1	6	44	0	7	1.203
UK	11.835	541	3.466	51	650	0	1	7.126

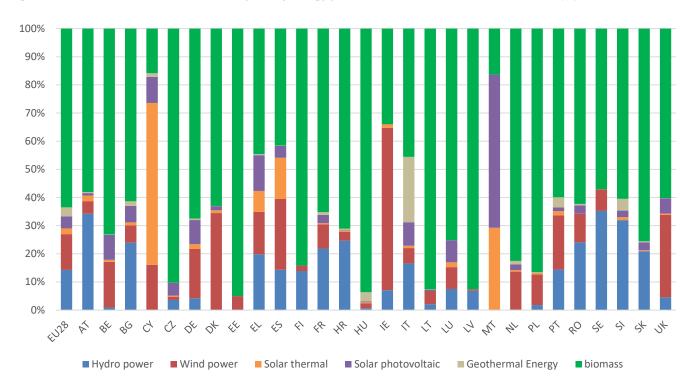


Figure 1.6 Share of renewables out of total primary energy production in EU28 Member States in 2015(%)

Source: Eurostat and AEBIOM calculations

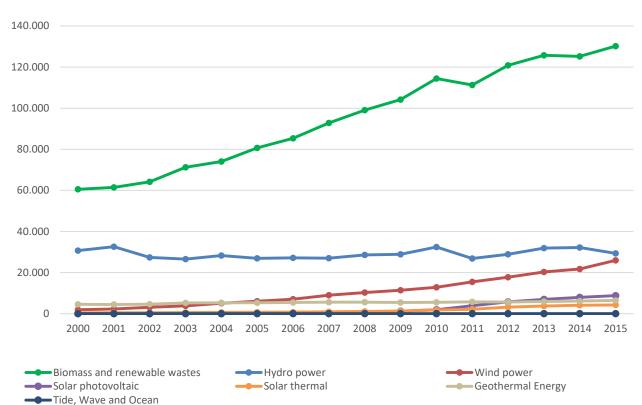


Figure 1.7 Evolution of primary production of renewable energy in EU28 (ktoe)

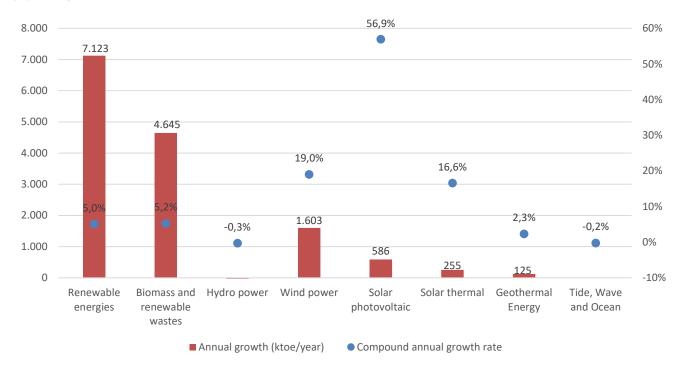


Figure 1.8 Growth in primary energy production (ktoe/year) of renewable energy and compound annual growth rate (%) in the period between 2000 and 2015 in EU28

In 2015, the share of energy from renewable sources in gross final consumption of energy reached 16,7% in Europe, compared with 8,5% in 2004, the first year for which the data is available.

RES share is one of the headline indicators of the Europe 2020 energy & climate package. The target to be reached by 2020 for the EU is a share of 20% energy from renewable sources in gross final consumption of energy. Each EU Member State has its own RES energy target under 2020.

The Europe 2020 strategy also sets up a specific methodology regarding the share of transport fuels from renewable sources, counting multiple times some renewable energy for transport. The result of this technology is reported numbers that are higher than in reality. This methodology is explained in the chapter 6 of this report. The following graphs in this chapter take into account that methodology for the calculation. The target share in renewable energy for transport should be 10% for all Members State by 2020.

Table 1.8 Share of renewable energy in gross final energy consumption in EU28 Member States (%)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2020 Targets
EU28	8,5%	9,0%	9,5%	10,4%	11,0%	12,4%	12,9%	13,2%	14,4%	15,2%	16,1%	16,7%	20,0%
AT	22,6%	23,9%	25,4%	27,2%	28,1%	29,9%	30,4%	30,6%	31,4%	32,3%	32,8%	33,0%	34,0%
BE	1,9%	2,3%	2,6%	3,1%	3,6%	4,7%	5,7%	6,3%	7,2%	7,5%	8,0%	7,9%	13,0%
BG	9,4%	9,4%	9,6%	9,2%	10,5%	12,1%	14,1%	14,3%	16,0%	19,0%	18,0%	18,2%	16,0%
CY	3,1%	3,1%	3,3%	4,0%	5,1%	5,6%	6,0%	6,0%	6,8%	8,1%	8,9%	9,4%	13,0%
CZ	6,8%	7,1%	7,4%	8,0%	8,6%	9,9%	10,5%	11,0%	12,8%	13,8%	15,1%	15,1%	13,0%
DE	5,8%	6,7%	7,7%	9,1%	8,6%	9,9%	10,5%	11,4%	12,1%	12,4%	13,8%	14,6%	18,0%
DK	14,9%	16,0%	16,3%	17,8%	18,6%	20,0%	22,1%	23,5%	25,7%	27,4%	29,3%	30,8%	30,0%
EE	18,4%	17,5%	16,1%	17,1%	18,9%	23,0%	24,6%	25,5%	25,8%	25,6%	26,3%	28,6%	25,0%
EL	6,9%	7,0%	7,2%	8,2%	8,0%	8,5%	9,8%	10,9%	13,5%	15,0%	15,3%	15,4%	18,0%
ES	8,3%	8,4%	9,2%	9,7%	10,8%	13,0%	13,8%	13,2%	14,3%	15,3%	16,1%	16,2%	20,0%
FI	29,2%	28,8%	30,0%	29,6%	31,3%	31,3%	32,4%	32,8%	34,4%	36,7%	38,7%	39,3%	38,0%
FR	9,4%	9,5%	9,3%	10,1%	11,1%	12,1%	12,5%	11,1%	13,4%	14,1%	14,7%	15,2%	23,0%
HR	23,5%	23,8%	22,7%	22,2%	22,0%	23,6%	25,1%	25,4%	26,8%	28,0%	27,9%	29,0%	20,0%
HU	4,4%	4,5%	5,1%	5,9%	6,5%	8,0%	12,8%	14,0%	15,5%	16,2%	14,6%	14,5%	13,0%
IE	2,4%	2,9%	3,1%	3,6%	4,1%	5,1%	5,6%	6,6%	7,2%	7,7%	8,7%	9,2%	16,0%
IT	6,3%	7,5%	8,3%	9,8%	11,5%	12,8%	13,0%	12,9%	15,4%	16,7%	17,1%	17,5%	17,0%
LT	17,2%	16,8%	16,9%	16,5%	17,8%	19,8%	19,6%	19,9%	21,4%	22,7%	23,6%	25,8%	23,0%
LU	0,9%	1,4%	1,5%	2,7%	2,8%	2,9%	2,9%	2,9%	3,1%	3,5%	4,5%	5,0%	11,0%
LV	32,8%	32,3%	31,1%	29,6%	29,8%	34,3%	30,4%	33,5%	35,7%	37,1%	38,7%	37,6%	40,0%
MT	0,1%	0,2%	0,2%	0,2%	0,2%	0,2%	1,0%	1,9%	2,8%	3,7%	4,7%	5,0%	10,0%
NL	2,1%	2,5%	2,8%	3,3%	3,6%	4,3%	3,9%	4,5%	4,7%	4,8%	5,5%	5,8%	14,0%
PL	6,9%	6,9%	6,9%	6,9%	7,7%	8,7%	9,3%	10,3%	10,9%	11,4%	11,5%	11,8%	15,0%
PT	19,2%	19,5%	20,8%	21,9%	23,0%	24,4%	24,2%	24,6%	24,6%	25,7%	27,0%	28,0%	31,0%
RO	16,3%	17,3%	17,1%	18,3%	20,5%	22,7%	23,4%	21,4%	22,8%	23,9%	24,8%	24,8%	24,0%
SE	38,7%	40,6%	42,7%	44,2%	45,3%	48,2%	47,2%	48,7%	51,1%	52,0%	52,5%	53,9%	49,0%
SI	16,1%	16,0%	15,6%	15,6%	15,0%	20,1%	20,4%	20,3%	20,8%	22,4%	21,5%	22,0%	25,0%
SK	6,4%	6,4%	6,6%	7,8%	7,7%	9,4%	9,1%	10,3%	10,4%	10,1%	11,7%	12,9%	14,0%
UK	1,1%	1,3%	1,5%	1,8%	2,7%	3,3%	3,7%	4,2%	4,6%	5,7%	7,1%	8,2%	15,0%

Note: Renewable energy sources cover solar thermal and photovoltaic energy, hydro (including tide, wave and ocean energy), wind, geothermal energy and biomass (including biological waste and liquid biofuels). The contribution of renewable energy from heat pumps is also covered for the Member States for which this information was available. The renewable energy delivered to final consumers (industry, transport, households, services including public services, agriculture, forestry and fisheries) is the numerator of the Europe 2020 target. The denominator, the gross final energy consumption of all energy sources, covers total energy delivered for energy purposes to final consumers as well as the transmission and distribution losses for electricity and heat.

Source: Eurostat

Table 1.9 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	28,8%	18,6%	6,7%
AT	70,3%	32,0%	11,4%
BE	15,4%	7,6%	3,8%
BG	19,1%	28,6%	6,5%
СУ	8,4%	22,5%	2,5%
CZ	14,1%	19,8%	6,5%
DE	30,7%	12,9%	6,8%
DK	51,3%	39,6%	6,7%
EE	15,1%	49,6%	0,4%
EL	22,1%	25,9%	1,4%
ES	36,9%	16,8%	1,7%
FI	32,5%	52,8%	22,0%
FR	18,8%	19,8%	8,5%
HR	45,4%	38,6%	3,5%
HU	7,3%	21,3%	6,2%
IE	25,2%	6,4%	6,5%
IT	33,5%	19,2%	6,4%
LT	15,5%	46,1%	4,6%
LU	6,2%	6,9%	6,5%
LV	52,2%	51,8%	3,9%
MT	4,2%	14,1%	4,7%
NL	11,1%	5,5%	5,3%
PL	13,4%	14,3%	6,4%
PT	52,6%	33,4%	7,4%
RO	43,2%	25,9%	5,5%
SE	65,8%	68,6%	24,0%
SI	32,7%	34,1%	2,2%
SK	22,7%	10,8%	8,5%
UK	22,4%	5,5%	4,4%

^{*} 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.

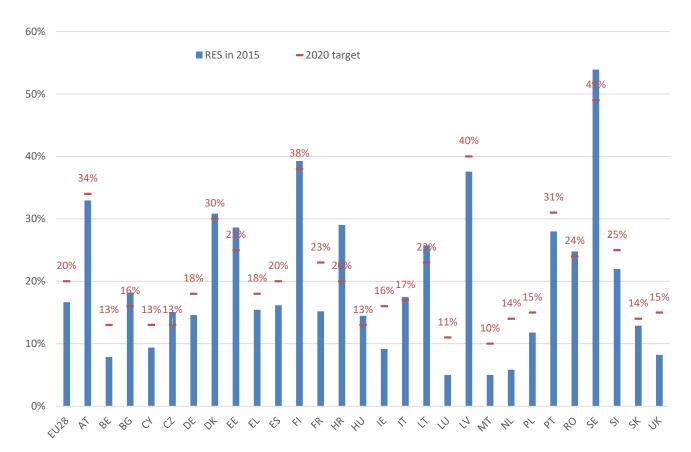


Figure 1.9 Share of renewable energy in gross final energy consumption in EU28 Member States in 2015 and targets for 2020* (%)

* 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

With its binding 2020 renewable energy targets, the European Union has been a front-runner in international climate and energy policy design. The global energy transition is well under way. In 2016, renewable energy accounted for two-thirds of all new generating power capacity installed globally, and, according to the IEA, is estimated to grow at twice the rate of coal and gas combined over the next five years. However, the share of renewables in total final energy consumption is not growing as quickly as it needs to be. The heating and cooling sector as well as the transport sector still lag behind when it comes to integrating high-shares of renewables into their energy mix. Climate commitments can only be reached if the majority of remaining fossil fuel reserves are kept in the ground; and both renewable energy and energy efficiency are scaled-up dramatically. To accelerate the transition to a healthier, more-secure and climate-safe energy future, we therefore need to build a smarter, more flexible system that maximises the use of all renewable energy sources.

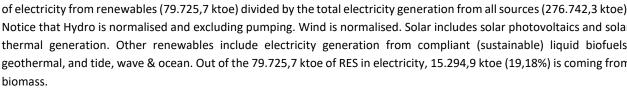
Christine Lins Executive Secretary REN21



RES-T RES-H&C RES-E 28,8% 27,5% 25,4% 23,5% 21,7% 19,7% 19,0% 18,6% 18,1% 17,0% 16,9% 16,4% 16,1% 15,6% 15,4% 14,8% 14,9% 14,7% 14,3% 13,1% 12,8% 11,4% 10,9% 10,2% 6,5% 6,7% 5,9% 5,6% 5,2% 4,6% 3,9% 4,0% 3,1% 2.5% 1,8% 1,4% 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

Figure 1.10 Evolution of the share of renewable energy in gross final energy consumption in the different sectors in EU28 (%)

For the 2020 targets, the share of renewables in electricity in 2015 (28,81%) is calculated as the gross final consumption of electricity from renewables (79.725,7 ktoe) divided by the total electricity generation from all sources (276.742,3 ktoe). Notice that Hydro is normalised and excluding pumping. Wind is normalised. Solar includes solar photovoltaics and solar thermal generation. Other renewables include electricity generation from compliant (sustainable) liquid biofuels, geothermal, and tide, wave & ocean. Out of the 79.725,7 ktoe of RES in electricity, 15.294,9 ktoe (19,18%) is coming from



Wind 8,85% Solar 3,35% Non RES RES Solid biofuels 197.01,6 79.725,7 2,82% 71,19% 28,81% Other biomass 2,71% Hydro 10,86% All other renewables 0,22%

Figure 1.11 Share of renewable energy in gross final consumption of electricity in EU28 in 2015 (ktoe)

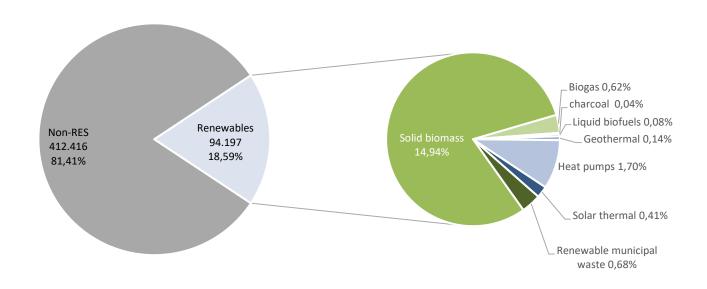
Source: Eurostat and AEBIOM calculation

^{*} 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.

In 2015, renewable energy accounted for 18,59% of total energy use for heating and cooling in the EU28. This is a significant increase from 10,2 % in 2004. Increases in industrial sectors, services and residential use (building sector) contributed to this growth.

Out of the 94.197 ktoe of renewable heat, 82.922 ktoe were generated from biomass sources, accounting for 88% of the renewables in the heat sector.

Figure 1.12 Share of renewable energy in gross final consumption of energy for heating & cooling in EU28 in 2015 (ktoe)



Source: Eurostat and AEBIOM calculation

Figure 1.13 shows the proportion of renewables in the transport sector in EU28. The ratio determining a Member State's share of RES in transport (RES-T) is defined in the RES Directive. As it can be observed, the 6,7% of RES in transport mentioned in table 1.8 doesn't correspond to the real figure obtained by dividing energy from renewables consumed in transport (14.944 ktoe) by the total energy consumed in transport (296.706 ktoe). This is mainly due to the multipliers applied in this calculation:

- As defined in Article 21(2), biofuels produced from wastes, residues, non-food cellulosic material and lignocellulosic material (3.136 ktoe) shall be considered to be twice that made by other biofuels.
- A multiplier of 5 is applied to renewable electricity in road transport (64 ktoe) and 2,5 is applied to renewable electricity in rail transport (1.342 ktoe).

Those multipliers increase the real figure of renewables in transport from 14.944 ktoe to 20.269 ktoe as it can be observed in figure 1.14. Dividing 20.269 ktoe by 302.113 ktoe (total energy in transport also with the multiple counting) we obtain the official figure of RES-T: 6,7%.

Ren. electricity in road transport 0,02%
Ren. electricity in rail transport 0,45%
Ren. electricity in all other transport modes 0,10%

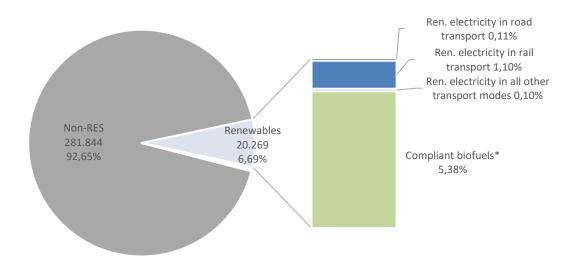
Non-RES
281.762
94,96%

Compliant biofuels*
4,46%

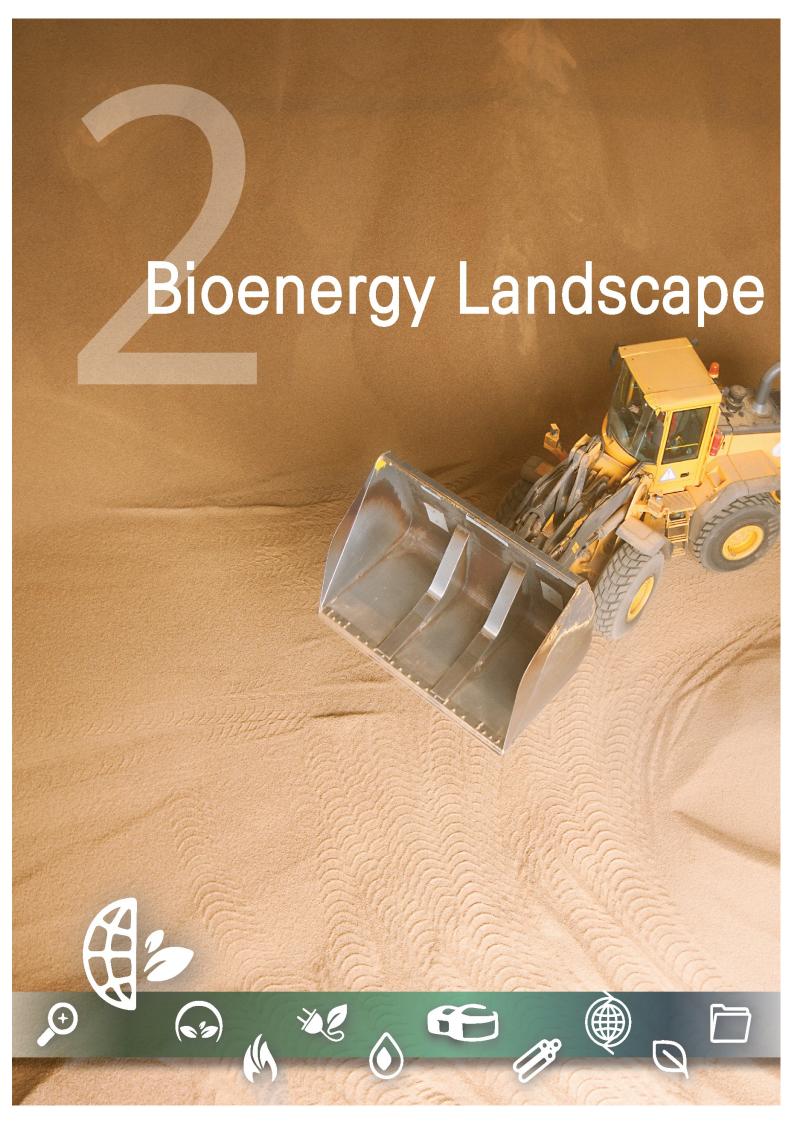
Figure 1.13 Share of renewable energy in transport in EU28 in 2015 (ktoe)

*As define by Directive 2009/28/EC.
Source: Eurostat and AEBIOM calculations

Figure 1.14 Share of renewable energy in transport in EU28 in 2015 with multiple counting* (ktoe)



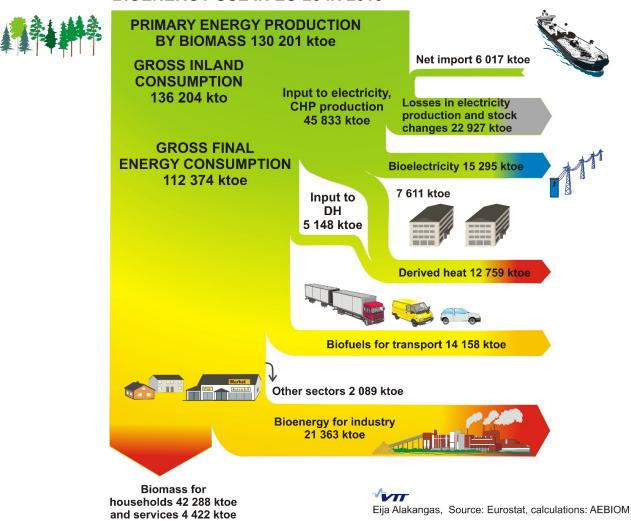
*As define by Directive 2009/28/EC. Source: Eurostat and AEBIOM calculations



2.1 Current bioenergy balance

Figure 2.1 Bioenergy balance in 2015 in EU28 (ktoe)

BIOENERGY USE IN EU-28 IN 2015



Source: Eurostat and AEBIOM calculations. Graph done by Eija Alakangas, VTT

Other 13.033 1% 144.874 Nuclear 19% 221.202 29% Total petroleum products 74.842 10% Other RES Gas 74.842 107.588 10% 14% **Biomass** 130.201 17%

Figure 2.2 Contribution of biomass to the total EU28 primary energy production in EU28 in 2015 (ktoe, %)

Source: Eurostat, AEBIOM calculations

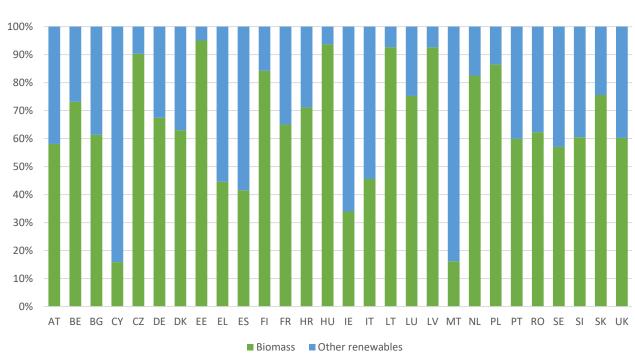


Figure 2.3 Contribution of biomass to the total primary renewable energy production in 2015 in EU28 Member States (%)

Source: Eurostat, AEBIOM calculations

Table 2.1 Primary energy production of biomass in EU28 Member States in 2015 (ktoe)

	Total biomass	Solid biofuels (excluding charcoal)	Biogas	Municipal waste (renewable)	Liquid biofuels
EU28	130.201	91.443	15.612	9.485	13.661
AT	5.401	4.474	300	182	445
BE	2.163	1.171	227	373	392
BG	1.247	1.160	20	8	60
CY	19	7	11	0	1
CZ	3.863	2.954	613	80	216
DE	26.229	12.062	7.854	2.994	3.319
DK	2.222	1.590	152	467	13
EE	1.222	1.209	13	0	0
EL	1.178	952	91	0	134
ES	7.009	5.260	262	252	1.235
FI	8.750	7.901	103	273	473
FR	13.931	9.661	539	1.212	2.519
HR	1.584	1.532	36	0	15
HU	3.034	2.511	80	66	377
IE	333	202	55	53	24
IT	10.740	7.340	1.872	846	682
LT	1.359	1.205	23	16	114
LU	85	55	18	12	0
LV	2.158	2.009	88	0	61
MT	2	0	2	0	1
NL	3.971	1.364	327	841	1.440
PL	7.473	6.268	229	40	936
PT	3.104	2.603	83	97	321
RO	3.698	3.521	18	1	157
SE	10.481	9.129	167	908	276
SI	620	590	30	0	0
SK	1.203	890	149	15	149
UK	7.126	3.824	2.252	749	301

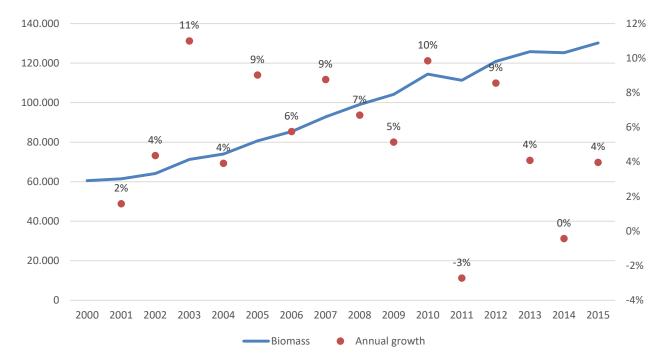
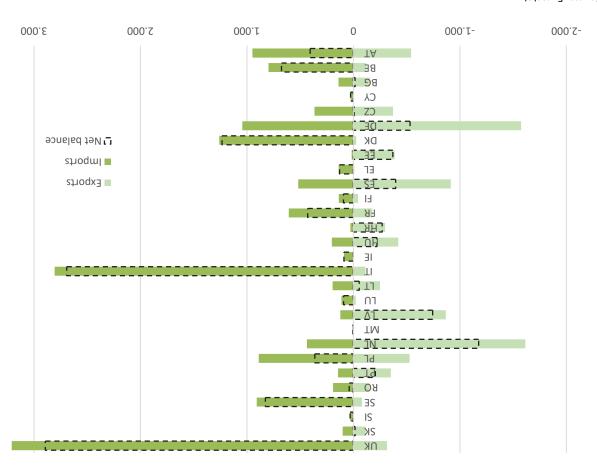


Figure 2.4 Evolution of primary energy production of biomass (ktoe) and annual growth (%) in EU28

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

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Solid biomass (excluding charcoal)	67.303	68.928	72.421	76.508	78.822	86.289	82.119	88.732	90.347	87.229	91.443
Annual growth solid biomass fuels	6,9%	2,4%	5,1%	5,6%	3,0%	9,5%	-4,8%	8,1%	1,8%	-3,5%	4,8%
Biogas	4.000	4.399	5.783	6.604	7.397	8.530	10.438	12.215	13.963	14.986	15.612
Annual growth biogas	11,2%	10,0%	31,5%	14,2%	12,0%	15,3%	22,4%	17,0%	14,3%	7,3%	4,2%
Municipal waste (renewable)	6.025	6.536	7.263	7.225	7.422	7.864	8.156	8.406	8.724	9.033	9.485
Annual growth Municipal waste	13,8%	8,5%	11,1%	-0,5%	2,7%	6,0%	3,7%	3,1%	3,8%	3,6%	5,0%
Biofuel	3.373	5.486	7.362	8.716	10.510	11.725	10.593	11.482	12.743	13.982	13.660
Annual growth biofuel	53,9%	62,6%	34,2%	18,4%	20,6%	11,6%	-9,7%	8,4%	11,0%	9,7%	-2,3%
Total biomass	80.701	85.349	92.829	99.053	104.151	114.408	111.306	120.835	125.776	125.229	130.200
Annual growth total biomass	9,0%	5,8%	8,8%	6,7%	5,1%	9,8%	-2,7%	8,6%	4,1%	-0,4%	4,0%

Figure 2.5 Imports and exports of biomass and renewable wastes in EU28 Member States in 2015 (ktoe)



Source: Eurostat



Bioenergy markets are continuing their growth at a constant pace, as it has been the case over the past 10 years now. These are positive news. However, this general trend hides major differences between the electricity, transport and heat sectors. While the two first are highly dependent on political supports at European and national levels, the heat market remains less supported, but accompanied by standards and emissions regulations. Even with low fossil fuel prices the bioheat business keep its dynamism.

Looking at national situations, bioenergy, in Scandinavian countries is mainly driven by the pulp and paper industry, traditionally using bioenergy, and by a switch to biomass in district heating. Germany, Italy and France are more heterogeneous in their markets and political approaches, showing clear national preferences: a model influenced by biogas development in Germany, while Italy decided to bet on wood stoves, etc. At the opposite, national political incoherency or/and limited ambition, explain partly why large energy consuming countries are not ranking among the first bioenergy nations.

Considering bioenergy future, AEBIOM believes that in the short term bioheat and bioelectricity will continue to grow while transport biofuels will suffer from inconsistences in European legislations. Regarding medium-term perspectives, the situation is less clear. Ongoing debates about the role that bioenergy could play in decarbonising EU economy by 2050 are showing political divergences and a growing risk factor. In such a key momentum, clear and coherent policy signals are needed to encourage further investors and business to contribute to the EU energy transition.

Jean-Marc Jossart Secretary General (MOIBJA) noistioossa Association (AEBIOM)

Table 2.3 Breakdown of imports and exports of biomass in EU28 Member States in 2015 (ktoe)

			Import	:s				Exports		
	Total	Solid biomass (excluding charcoal)	Municipal waste (renewable)	Charcoal	Liquid biofuels	Total	Solid biomass (excluding charcoal)	Municipal waste (renewable)	Charcoal	Liquid biofuels
AT	948	410	0	11	527	542	249	0	1	293
BE	797	771	2	6	18	122	n.a.	0	0	122
BG	140	28	0	1	111	155	132	0	3	20
CY	27	3	7	9	9	0	n.a.	0	0	0
CZ	366	144	0	0	222	372	224	0	0	148
DE	1.043	n.a.	0	0	1.043	1.575	n.a.	0	0	1.575
DK	1.260	942	55	0	264	26	n.a.	0	0	26
EE	16	13	0	0	3	387	387	0	0	0
EL	139	63	0	45	31	8	2	0	0	6
ES	518	0	0	0	518	915	0	0	0	915
FI	137	67	0	0	70	43	42	0	0	2
FR	608	n.a.	0	0	608	178	n.a.	0	0	178
HR	28	15	0	4	9	298	293	0	5	1
HU	202	59	9	0	134	422	91	0	0	332
IE	90	27	0	0	63	0	0	0	0	0
IT	2.805	1.262	0	43	1.501	113	25	0	1	88
LT	196	135	0	5	56	250	146	0	4	100
LU	113	30	0	0	83	22	22	0	0	0
LV	123	98	0	3	22	867	805	0	8	55
MT	5	1	0	0	4	0	0	0	0	0
NL	437	90	167	33	147	1.614	274	35	27	1.278
PL	890	661	0	0	229	528	155	0	0	373
PT	144	48	0	29	68	351	312	0	4	35
RO	191	99	0	0	92	151	106	0	0	45
SE	908	n.a.	0	0	908	82	n.a.	0	0	82
SI	31	n.a.	0	0	31	0	n.a.	0	0	0
SK	101	0	0	0	100	116	11	0	0	105
UK	3.209	2.482	0	0	726	315	209	0	0	106

Table 2.4 Gross inland consumption of bioenergy in EU28 Member States in 2015 (ktoe)

	Total bioenergy	Solid biofuels (excluding charcoal)	Biogas	Municipal waste (renewable)	Liquid biofuels	Charcoal
EU28	136.204	95.285	15.612	9.690	15.482	135
AT	5.749	4.573	300	182	683	10
BE	2.838	1.942	227	375	288	6
BG	1.207	1.035	20	8	147	-2
CY	47	10	11	8	10	9
CZ	3.863	2.874	613	80	296	0
DE	25.697	12.062	7.854	2.994	2.788	0
DK	3.456	2.532	152	521	251	0
EE	842	825	13	0	3	0
EL	1.311	1.013	91	0	162	45
ES	6.754	5.260	262	252	980	0
FI	8.844	7.927	103	273	541	0
FR	14.327	9.661	539	1.212	2.916	0
HR	1.318	1.258	36	0	24	-1
HU	2.808	2.480	80	75	174	0
IE	423	228	55	53	88	0
IT	13.445	8.578	1.872	846	2.108	42
LT	1.311	1.204	23	16	68	1
LU	177	64	18	12	83	0
LV	1.365	1.259	88	0	25	-6
MT	8	1	2	0	5	0
NL	2.800	1.179	327	974	314	6
PL	7.825	6.774	229	40	782	0
PT	2.887	2.339	83	97	344	25
RO	3.736	3.514	18	1	203	0
SE	11.298	9.129	167	908	1.094	0
SI	651	590	30	0	31	0
SK	1.187	879	149	15	144	0
UK	10.032	6.097	2.252	749	933	0

Energy dependency, in the table below, is calculated as net imports divided by gross inland consumption. Negative figures identify net exporting countries.

Table 2.5 Bioenergy dependency in EU28 Member States in 2015 (%)

	Total biomass	Solid biofuels (excluding charcoal)	Liquid biofuels
EU28	4,4%	4,2%	11,1%
AT	7,1%	3,5%	34,3%
BE	23,8%	39,7%	-36,1%
BG	-1,2%	-10,0%	61,9%
CY	57,4%	30,0%	90,0%
CZ	-0,2%	-2,8%	25,0%
DE	-2,1%	0,0%	-19,1%
DK	35,7%	37,2%	94,8%
EE	-44,1%	-45,3%	100,0%
EL	10,0%	6,0%	15,4%
ES	-5,9%	0,0%	-40,5%
FI	1,1%	0,3%	12,6%
FR	3,0%	0,0%	14,7%
HR	-20,5%	-22,1%	33,3%
HU	-7,8%	-1,3%	-113,8%
IE	21,3%	11,8%	71,6%
IT	20,0%	14,4%	67,0%
LT	-4,1%	-0,9%	-64,7%
LU	51,4%	12,5%	100,0%
LV	-54,5%	-56,2%	-132,0%
MT	62,5%	100,0%	80,0%
NL	-42,0%	-15,6%	-360,2%
PL	4,6%	7,5%	-18,4%
PT	-7,2%	-11,3%	9,6%
RO	1,1%	-0,2%	23,2%
SE	7,3%	0,0%	75,5%
SI	4,8%	0,0%	100,0%
SK	-1,3%	-1,3%	-3,5%
UK	28,8%	37,3%	66,5%

Source: Eurostat and AEBIOM calculations

According to the latest Eurostat statistics, bioenergy remains the major source among renewables in Europe, accounting for more than 60% of all renewables.

Table 2.6 Gross final energy consumption, overall RES and bioenergy in EU28 Member States in 2015 (ktoe)

	Total	RES*	%RES/Total Final energy	Bioenergy*	% Bioenergy /Total Final energy	% Bioenergy /RES
EU28	1.083.957	185.418	17,1%	111.807	10,3%	60,3%
AT	27.370	9.373	34,2%	4.876	17,8%	52,0%
BE	35.780	3.061	8,6%	2.078	5,8%	67,9%
BG	9.508	2.053	21,6%	1.184	12,4%	57,7%
CY	1.660	143	8,6%	44	2,7%	30,7%
CZ	24.187	3.950	16,3%	3.313	13,7%	83,9%
DE	212.124	32.511	15,3%	18.955	8,9%	58,3%
DK	13.946	4.486	32,2%	3.178	22,8%	70,8%
EE	2.765	797	28,8%	733	26,5%	92,0%
EL	16.502	2.722	16,5%	1.250	7,6%	45,9%
ES	80.461	14.191	17,6%	5.487	6,8%	38,7%
FI	24.181	9.926	41,0%	8.192	33,9%	82,5%
FR	144.123	21.093	14,6%	12.833	8,9%	60,8%
HR	6.587	1.926	29,2%	1.253	19,0%	65,1%
HU	17.309	2.585	14,9%	2.389	13,8%	92,4%
IE	11.214	1.055	9,4%	358	3,2%	33,9%
IT	116.444	18.944	16,3%	10.679	9,2%	56,4%
LT	4.869	1.322	27,2%	1.100	22,6%	83,2%
LU	3.988	429	10,8%	155	3,9%	36,1%
LV	3.788	1.383	36,5%	1.210	32,0%	87,5%
MT	572	19	3,3%	7	1,2%	35,6%
NL	48.505	2.667	5,5%	1.828	3,8%	68,5%
PL	62.251	7.849	12,6%	6.582	10,6%	83,9%
PT	16.038	4.476	27,9%	2.370	14,8%	52,9%
RO	21.893	5.926	27,1%	3.627	16,6%	61,2%
SE	31.759	18.696	58,9%	10.357	32,6%	55,4%
SI	4.689	1.074	22,9%	620	13,2%	57,8%
SK	10.077	1.326	13,2%	893	8,9%	67,4%
UK	131.370	11.436	8,7%	6.257	4,8%	54,7%

^{*} Note: As difference from Eurostat methodology, AEBIOM includes the gross electricity production and derived heat produced from RES and biomass in their respective final energy consumption.

Source: Eurostat, AEBIOM calculations

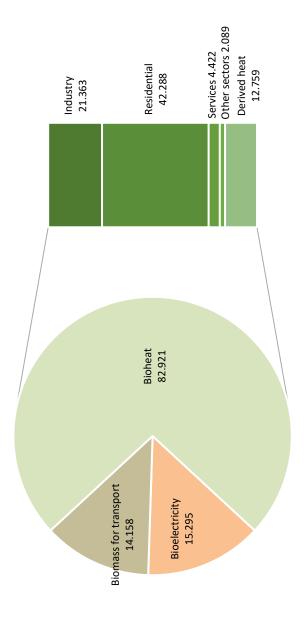
Table 2.7 Bioenergy balance in Europe in EU28 Member States in 2015 (ktoe)

Gross final energy consumption (1+2+3+4+5+6+7)	112.374	4.907	2.075	1.187	44	3.329	19.082	3.238	792	1.251	5.487	8.140	12.971	1.263	2.416	357	10.615	1.192	158	1.229	∞	1.880	6.549	2.371	3.632	10.443	627	901	6.261
Input to heating plants	5.148	588	0	∞	0	38	901	504	102	0	0	702	487	0	59	0	91	431	5	136	0	21	36	0	48	894	10	58	30
Input to Power and CHP plants	45.833	1.518	1.285	46	7	1.115	11.024	1.510	253	75	1.654	2.709	2.428	87	627	115	5.286	184	36	279	1	1.581	2.401	780	143	3.833	71	499	6.287
Gross inland consumption	136.204	5.749	2.838	1.207	47	3.863	25.697	3.456	842	1.311	6.754	8.844	14.327	1.318	2.808	423	13.445	1.311	177	1.365	∞	2.800	7.825	2.887	3.736	11.298	651	1.187	10.032
Export	9.453	542	122	155	0	372	1.575	56	387	8	915	43	178	298	422	0	113	250	22	867	0	1.614	528	351	151	82	0	116	315
Import	15.470	948	797	140	27	366	1.043	1.260	16	139	518	137	809	28	202	06	2.805	196	113	123	2	437	890	144	191	806	31	101	3.209
Primary energy Production	130.201	5.401	2.163	1.247	19	3.863	26.229	2.222	1.222	1.178	7.009	8.750	13.931	1.584	3.034	333	10.740	1.359	85	2.158	2	3.971	7.473	3.104	3.698	10.481	620	1.203	7.126
	EU28	AT	BE	BG	5	CZ	DE	DK	田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田田	EL	ES	ᇤ	FR	H	H	Ш	⊨	占	21	>	Ε	N	Ы	PT	RO	SE	SI	SK	A N

Source: Eurostat, AEBIOM calculations

Derived heat	12.759	887	47	12	1	205	1.532	1.442	218	0	0	1.769	1.049	20	120	0	988	457	15	222	0	312	308	0	73	3.000	35	130	19
Bioelectricty (6)	15.295	379	474	24	4	412	4.327	362	65	20	496	982	209	23	186	41	1.668	38	11	99	⊣	424	854	267	45	926	23	143	2.527
Final use other sectors	2.089	206	51	11	4	124	0	55	4	29	75	159	141	0	10	0	34	11	က	16	0	138	466	7	113	136	0	36	262
Final use transport	14.158	646	261	146	10	297	2.567	232	က	142	928	497	2.949	24	175	88	1.167	89	83	25	Ŋ	297	780	328	203	1.102	29	144	933
Final use services	4.422	9/	48	18	9	29	2.720	39	12	35	97	78	496	2	32	22	75	38	1	83	Н	102	212	35	1	40	2	17	73
Final use residential	42.288	1.581	525	716	∞	1.753	5.317	296	361	830	2.517	1.195	6.464	1.161	1.765	32	6.394	491	20	458	Н	445	2.519	764	2.951	928	463	24	1.608
Final use industry (1)	21.363	1.132	699	260	11	479	2.619	141	104	195	1.344	3.460	1.363	30	128	174	391	88	25	359	0	162	1.410	970	246	4.281	75	407	839

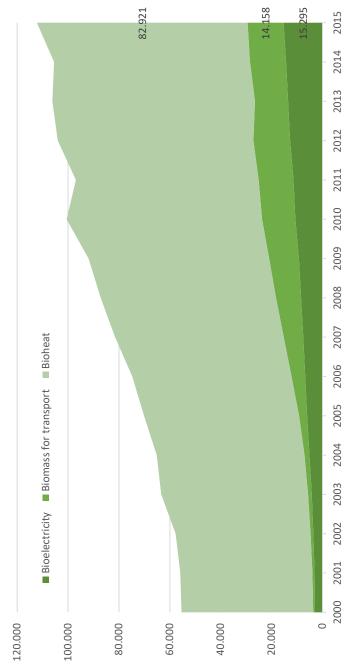
Figure 2.6 Gross final energy consumption of biomass in heat, electricity and transport in EU28 Member States in 2015 (ktoe)



consumption. Besides this amount, the industry is using also biomass to produce electricity (partly for their own use and the rest to Note: The 21.363 ktoe of bioheat consumed in the industry refers only to the biomass directly used to produce heat for their own be put in the grid).

Source: Eurostat, AEBIOM calculations

Figure 2.7 Evolution of gross final energy consumption of bioenergy 2000-2015 in EU28 (ktoe)



Source: Eurostat, AEBIOM calculations

2.2 Overview of the National Renewable Energy Action Plans

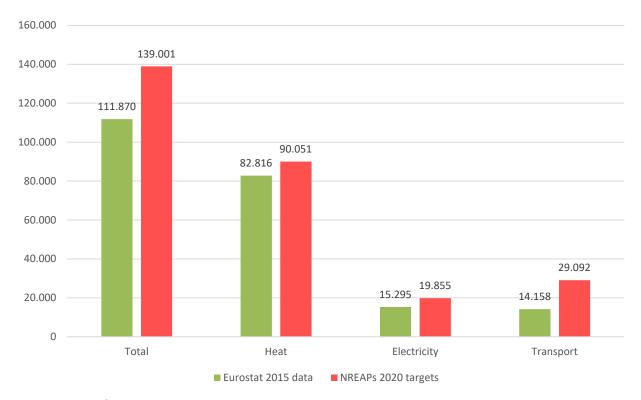
This section presents the Member States progress in deploying bioenergy to achieve the 2020 targets. EU and Member States progress is assessed on the basis of Eurostat data extracted in 2017 for 2015 and compared with the targets submitted by Member States in the NREAPs.

From the information of the following graphs we can conclude that EU and most Member States are currently on the right track to achieve 2020 targets on biomass in heating and cooling. Already 13 Member States have met the 2020 target (Austria, Czech Republic, Germany, Denmark, Estonia, Finland, Croatia, Hungary, Italy, Latvia, Malta, The Netherlands, Slovakia). On the other hand, Ireland, France and Belgium are the countries with the most challenging path towards the 2020 goals.

The trajectory towards the 2020 targets of biomass for electricity is more heterogeneous among Member States. Czech Republic, Germany, Estonia, Italy and United Kingdom are the countries performing the best in this area and already fulfill their targets. However still 11 countries have performed less than 40% of the goals.

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 – with a share of 6,71% renewable energy in transport in 2015.

Figure 2.8 Gross final energy consumption of bioenergy in 2015 (Eurostat) compared with the 2020 objectives (NREAPs) in EU28 (ktoe)



Source: Eurostat and NREAPs targets

State of play biomass for heating and cooling

Table 2.8 Biomass for heating and cooling in EU28 Member States in 2015 to meet the 2020 targets (ktoe)

	2015	2020 TARGETS	% of achievement (2015/2020)	Expected annual growth to meet the 2020 targets
EU28	82.921	90.051*	92%	2%
AT	3.882	3.607	108%	-1%
BE	1.340	2.034	66%	9%
BG	1.017	1.073	95%	1%
CY	30	30	99%	0%
CZ	2.620	2361	111%	-2%
DE	12.188	11.355	107%	-1%
DK	2.644	2.643	100%	0%
EE	699	607	115%	-3%
EL	1.089	1.222	89%	2%
ES	4.033	4.950	81%	4%
FI	6.661	6.610	101%	0%
FR	9.513	16.455	58%	12%
HR	1.216	397	306%	-20%
HU	2.055	1.277	161%	-9%
IE	228	486	47%	16%
IT	7.780	5.670	137%	-6%
LT	1.086	1.023	106%	-1%
LU	64	76	84%	3%
LV	1.138	1.392	82%	4%
MT	2	2	116%	0%
NL	1.159	938	124%	-4%
PL	4.915	5.089	97%	1%
PT	1.776	2.322	76%	6%
RO	3.384	3.876	87%	3%
SE	8.415	9.426	89%	2%
SI	575	526	109%	-2%
SK	614	690	89%	2%
UK	2.801	3.914	72%	7%

^{*}EU figures are calculated by AEBIOM as a sum of all Member States figures. Source: Eurostat for 2013 data and NREAPs targets for 2020 data.

State of play bioelectricity

Table 2.9 Total contribution (gross electricity generation) of bioelectricity in EU28 Member States in 2015 to meet the 2020 targets (GWh)

	2015	2020 TARGETS	% of achievement (2015/2020)	Expected annual growth to meet the 2020 targets
EU28	177.881	230.917*	77%	5%
AT	4.408	5.147	86%	3%
BE	5.513	11.039	50%	15%
BG	279	865	32%	25%
CY	47	143	33%	25%
CZ	4.792	4.483	107%	-1%
DE	50.323	49.457	102%	0%
DK	4.210	8.846	48%	16%
EE	756	346	218%	-14%
EL	233	1.259	18%	40%
ES	5.768	10.017	58%	12%
FI	11.421	12.910	88%	2%
FR	5.920	17.171	34%	24%
HR	267	698	38%	21%
HU	2.163	3.324	65%	9%
IE	477	1.006	47%	16%
IT	19.399	18.780	103%	-1%
LT	442	1.223	36%	23%
LU	128	334	38%	21%
LV	768	1.226	63%	10%
MT	12	135	9%	62%
NL	4.931	16.639	30%	28%
РО	9.932	14.218	70%	7%
PT	3.105	3.516	88%	3%
RO	523	2.900	18%	41%
SE	10.769	16.689	65%	9%
SI	267	676	40%	20%
SK	1.663	1.710	97%	1%
UK	29.389	26.160	112%	-2%

^{*}EU figures are calculated by AEBIOM as a sum of all Member States figures. Source: Eurostat and NREAPs targets

State of play biofuels for transport

Table 2.10 Total contribution of biofuels for transport in EU28 Member States in 2015 to meet the 2020 targets* (ktoe)

	Bioet	hanol	Bio	diesel		Total biofuels	S
	2015	2020 TARGETS	2015	2020 TARGETS	2015	2020 TARGETS	% of achievement (2015/2020)
EU28	2.680	7.283**	11.345	21.575**	14.026	28.859**	49%
AT	60	80	585	410	645	490	132%
BE	41	91	221	698	261	789	33%
BG	32	42	114	154	146	196	75%
CY	0	15	10	23	10	38	26%
CZ	63	128	233	495	297	623	48%
DE	744	857	1.792	4.443	2.536	5.300	48%
DK	0	94	232	167	232	261	89%
EE	3	38	0	51	3	89	4%
EL	0		142		142		
ES	189	400	769	3.100	958	3.500	27%
FI	65	130	432	430	497	560	89%
FR	421	650	2.528	2.850	2.949	3.500	84%
HR	0	414	24	203	24	617	4%
HU	43	304	133	202	175	506	35%
IE	24	139	64	342	88	481	18%
IT	25	600	1.142	1.880	1.167	2.480	47%
LT	10	36	58	131	68	167	41%
LU	7	23	76	193	83	216	38%
LV	8	18	17	28	25	46	53%
MT	0	0	5	0	5	0	
NL	142	282	156	552	297	834	36%
PL	154	451	627	1.451	780	1.902	41%
PT	22	27	302	450	324	477	68%
RO	62	163	141	326	203	489	41%
SE	133	465	872	251	1.005	716	140%
SI	7	19	23	174	29	192	15%
SK	23	75	121	110	144	185	78%
UK	404	1.743	529	2.462	933	4.205	22%

^{*}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. For more info see figures 1.13 and 1.14

Source: Eurostat and NREAPs targets

^{**}EU figures are calculated by AEBIOM as a sum of all Member States figures.

2.3 Socio-economic indicators

Table 2.11 Employment (direct and indirect jobs) in the different bioenergy markets in EU28 Member States in 2015

	TOTAL	Solid biomass Biogas	Biofuels	Biogas	Renewable urban waste*
EU28	489.000	314.700	95.900	63.950	14.450
AT	>17.300	15.450	1.200	650	n.a.
BE	12.150	3.500	7.500	550	600
BG	4.150	3.500	500	100	<50
CY	>150	<50	<50	50	n.a.
CZ	11.450	8.900	1.400	900	250
DE	>113.200	45.400	22.800	45.000	n.a.
DK	6.750	4.800	1.100	250	600
EE	>3.700	3.600	<50	50	n.a.
EL	>3.750	2.800	750	200	n.a.
ES	24.250	15.800	7.500	500	450
FI	25.950	23.700	1.800	250	200
FR	77.000	50.000	22.000	4.400	600
HR	>4.900	4.600	150	150	n.a.
HU	5.200	4.250	650	150	150
IE	1.400	600	400	200	200
IT	34.600	22.000	6.000	5.500	1.100
LT	4.100	3.600	300	150	<50
LU	1.650	150	1.400	50	<50
LV	6.300	6.000	100	150	<50
MT	>50	0	<50	0	n.a.
NL	8.750	4.100	2.800	500	1.350
PL	25.650	18.800	6.000	800	<50
PT	9.850	7.800	1.600	150	300
RO	>11.800	11.100	650	50	n.a.
SE	33.000	27.400	4.500	100	1.000
SI	2.150	1.800	200	100	<50
SK	3.500	2.700	550	200	<50
UK	36.300	22.300	3.900	2.800	7.300

Note: Employment data covers both direct and indirect jobs. Direct jobs are those directly derived from RES manufacturing, equipment and component supply, or onsite installation and O&M. 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). Socio economic indicators for the bioenergy sectors (biofuels, biomass and biogas) include the upstream part, namely fuel supply in the agricultural, farming and forestry sectors. For solid biomass, the activity in terms of self-production / consumption of wood by individual households and the «informal» market is not included in our work.In EurObserv'ER estimations, job figures are rounded to 50 jobs.

*Only direct jobs

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

Table 2.12 Turnover in the different bioenergy markets in EU28 Member States in 2015 (million €)

	TOTAL	Solid biomass	Biofuels	Biogas
EU 28	56.010	36.000	13.100	6.910
AT	2.630	2.045	400	185
BE	655	340	250	65
BG	395	340	50	<5
CY	20	<5	10	<5
CZ	1.340	860	330	150
DE	11.800	6.975	2.500	2.325
DK	700	460	200	40
EE	360	350	<5	<5
EL	440	275	140	25
ES	2.515	1.530	920	65
FI	2.525	2.300	200	25
FR	8.770	5.130	3.030	610
HR	480	440	30	10
HU	630	410	200	20
IE	195	60	120	15
IT	5.750	2.150	1.100	2.500
LT	420	350	65	<5
LU	100	15	80	<5
LV	625	580	25	20
MT	5	0	<5	0
NL	870	400	300	170
PL	2.595	1.825	710	60
PT	1.110	760	330	20
RO	1.285	1.080	200	<5
SE	3.695	2.650	1.000	45
SI	210	170	30	10
SK	430	260	130	40
UK	5.460	4.240	740	480

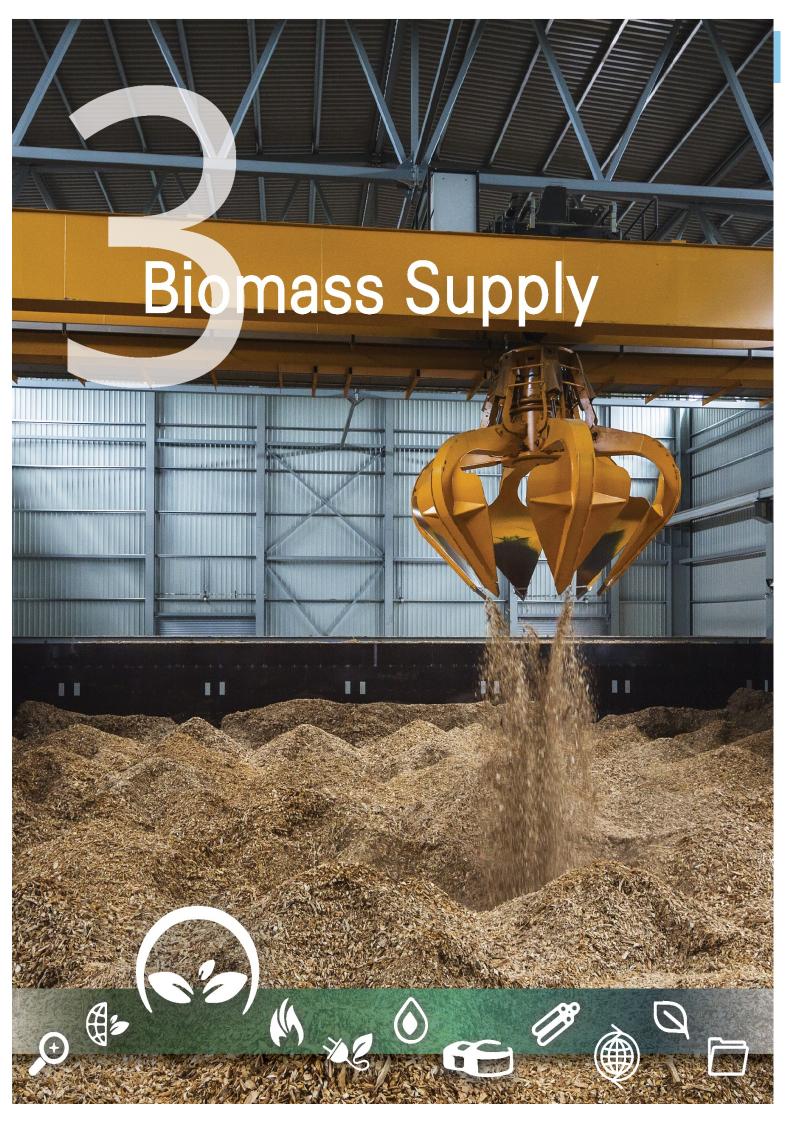
Note: Turnover figures, expressed in current million euros (M€). The focus on the main economic investment activity of the supply chain (manufacturing, distribution and installation of equipment, plant operation and maintenance). Turnover arising from electricity or heat sale, financial and training activities, or publicly funded research, etc. are excluded.

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

"In the framework of the EurObserv'ER consortium, RENAC and Observ'ER have estimated employment figures for the biomass sectors in the EU to be in the area of 489 000 direct and indirect jobs, which accounts for 43% of employment in the RES sectors. Employment related to bioenergy is far above employment generated in the wind or the PV sector (respectively 332 000 and 110 750 jobs). As far as turnover is concerned, the bioenergy sectors (excluding waste) generated 5,46 billion euros in the same year, which means they contributed to almost 37% of the revenues created in the RES sectors. Major players are the large European countries (DE, FR, UK, IT) but also the Nordic countries (SE, FI) which have a large forestry industry. Bioenergy contributions to European employment and turnover are bound to increase in the near future thanks to the European Commission's proposal for a new directive on renewable energy (The so called "winter package"). Jobs will develop particularly in the solid biomass sector, since the biofuels sector is in a position of wait and see as far as investments in the 1st generation of biofuels are concerned. The future of employment in the biogas sector is largely political, as it depends on the will to support biomethane production to replace part of the natural gas consumption – which could go as high as 10% penetration."



Diane Lescot
Observ'ER, leader of the EurObserv'ER consortium



3.1 Overview

Figure 3.1 Land Use by Type in EU28 2015

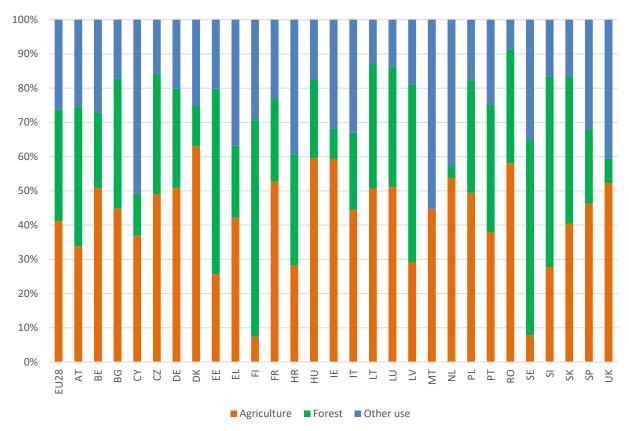
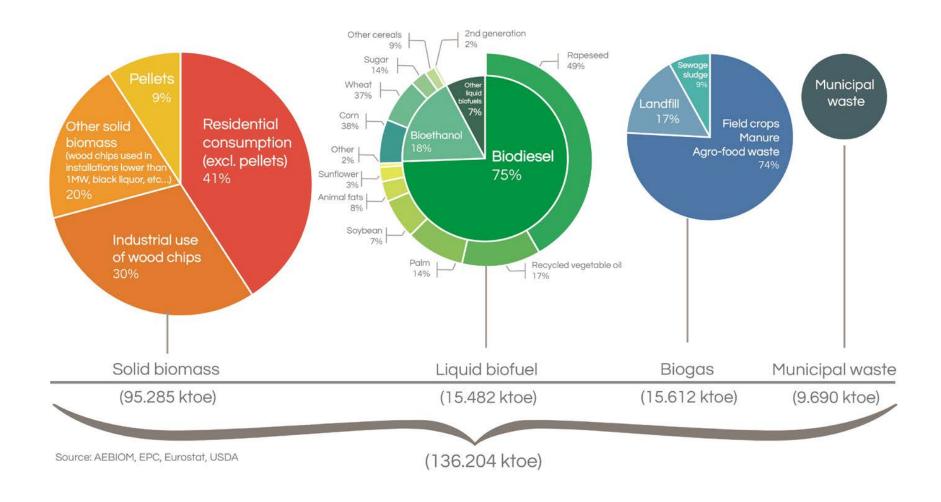


Figure 3.2 Gross inland consumption of biomass by type, use and source in the EU28 (ktoe and %)



3.2 Biomass from agricultural land and by-products

The European Union (EU28) utilized 106,9 million hectares of arable land in 2015. The total Utilised Agricultural Area (UAA) is higher (177,1 million hectares) as this includes permanent grasslands and orchards. The split between various crops and land types can be seen in the next figure in more detail. The two largest groups from utilized agricultural land are permanent grassland (33%) and wheat (15,1%). The amount of abandoned land, which could be used for bioenergy production is not shown in the figure, as it is not measured as a specific class. Abandoned land is classified currently under permanent grasslands or fallow.

Orchards and others 11,7 26,8 Other cereal Barley 9,1 Permanent grassland 12,2 58,5 Rice .0,4 Rapeseed 6,5 Other oilseeds Sugar beet Set-aside and fallow 1,4 land potatoes 6,7 Other arable crops Protein crops 1,6 4,9 1,3

Figure 3.3 Composition of EU28 agricultural land use 2015 (million ha)

Source: European commission DG AGRI (Medium-term prospects for EU agricultural markets and income 2015-2024)

Table 3.1 Agricultural land use per EU28 Member States in 2015 (1000 ha)

	Utilised agricultural area	Arable land	Permanent grassland	Permanent crops	Fallow land
EU28	178.779	106.932	59.349	11.857	7.062
AT	2.720	1.346	1.307	65	48
BE	1.331	836	476	19	9
BG	5.011	3.494	1.369	133	235
CY	126	98	2	26	17
CZ	3.494	2.496	958	39	35
DE	16.731	11.846	4.677	205	310
DK	2.633	2.349	255	29	27
EE	994	666	315	3	55
EL	5.092	2.893	930	1.269	265
ES	23.897	12.657	6.399	4.728	3.289
FI	2.273	2.241	28	3	271
FR	29.115	18.659	9.528	1.010	473
HR	1.538	842	618	75	34
HU	5.346	4.332	761	179	169
IE	4.429	452	3.975	2	2
IT	12.661	6.602	3.579	2.447	272
LT	3.006	2.170	798	30	91
LU	131	63	67	2	0
LV	1.885	1.230	648	7	60
MT	12	9	0	1	1
NL	1.846	1.033	766	38	7
PL	14.398	10.887	3.093	391	134
PT	3.700	1.117	1.817	751	333
RO	13.835	8.757	4.655	317	501
SE	3.028	2.575	450	3	167
SI	477	171	279	27	1
SK	1.922	1.350	521	19	42
UK	17.147	5.761	11.079	38	214

Note 1: For arable area, one plot can be counted twice if it is sown twice in the year.

Note 2: Due to the difference in source, slight changes may exists in the numbers with figure 3.3.

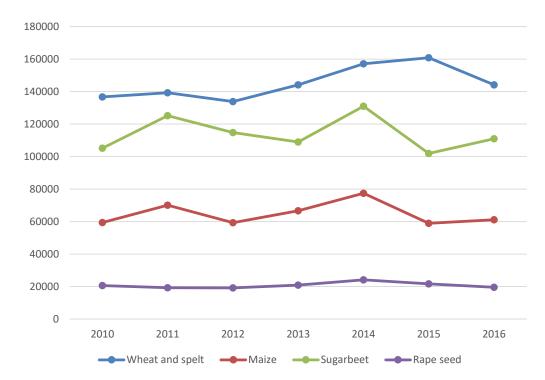


Figure 3.4 Crop production development in EU28 (thousand tonnes)

The following section describes the consumption of crops for energy purposes in the EU28. The production of bioenergy from crops focus on biofuel, 1st generation biofuel representing the main share of it.

Straw can also be used for bioenergy through combustion. However Europe wide statistics on straw consumption for energy do not exist. In the EU, Denmark is the largest consumer of straw for energy. Other countries which also consume straw for energy are Hungary, UK and Spain, but volumes are smaller.

The waste produced from the agricultural sector can be used to produce energy but is not covered in this chapter due to the lack of data.

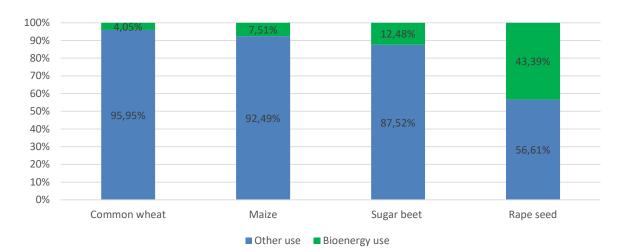


Figure 3.5 Share of the bioenergy consumption of the main crops used for energy in EU28 in 2015

Note: Vegetable oil represent: Rapeseed- soybean-, sunflower seed- and groundnut-based oils plus cottonseed oil, palm oil, palm kernel oil and coconut oil.

Source: DC agri EU AGRICULTURAL OUTLOOK Prospect for the EU agricultural markets and income 2016-2026

^{*}Number for the 2015 Italy's wheat and spelt production and the 2016 Slovakia's wheat and spelt production estimated Source: Eurostat



Figure 3.6 Evolution of feedstock for EU28 bioethanol production (in 1000 tonnes)

Source: ePURE, European renewable ethanol, aggregate and audited data of ePURE members

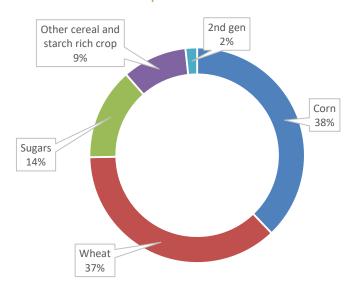


Figure 3.7 Share of feedstock for EU28 bioethanol production in 2015

Source: ePURE, European renewable ethanol, aggregate and audited data of ePURE members

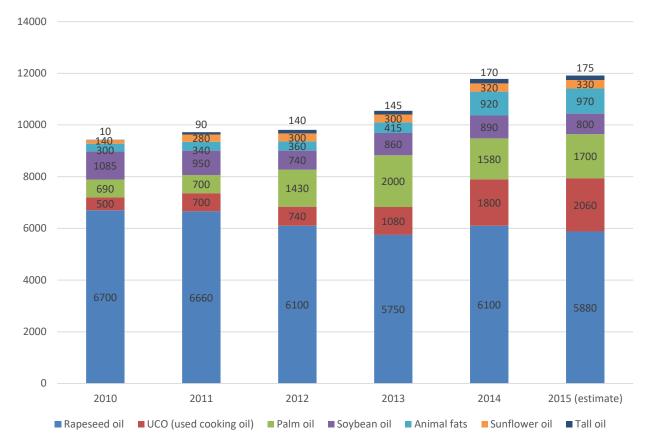


Figure 3.8 Evolution of the feedstock for EU28 biodiesel production (in 1000 tonnes)

Source: USDA foreign agricultural service, EU Biofuels Annual 2016

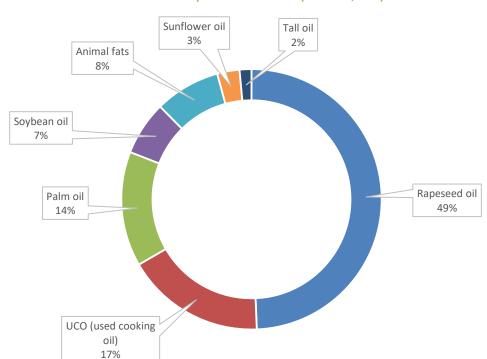


Figure 3.9 Share of feedstock for EU28 biodiesel production in 2015 (estimate, in %)

Source: USDA foreign agricultural service, EU Biofuels Annual 2016

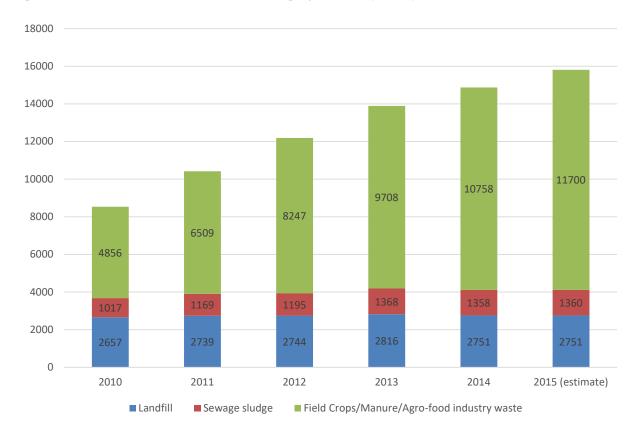


Figure 3.10 Evolution of the feedstock for EU28 biogas production (in ktoe)

Source: USDA foreign agricultural service, EU Biofuels Annual 2016

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 AEBIOM's enquiry. For this, the stakeholders cited in the sources were contacted to get the table below.

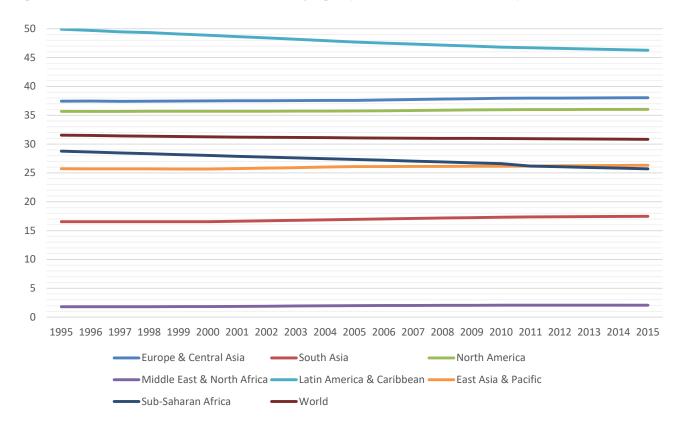
Table 3.2 Energy crops in some of the EU28 Member states (in ha)

	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
BG						
CY						
CZ						
DE		N.A.	5.000	5.000		2017
DK	N.A.	5.500	N.A.	5.500		2015
EE						
EL						
ES						
FI						
FR	3.000	N.A.	N.A.	220		2015
HR		0	0	0	Experimental field only	2017
HU						
IE	700	1.100	0	1.100	1.800	2017
IT						
LT						
LU						
LV						
MT						
NL		N.A.	N.A.	13	245	2016
PL	733	7.728	3.175	10.903	22.539	2013
PT						
RO						
SE		11.552	3.000	14.552	14.552	2016
SI						
SK						
UK	9.000	N.A.	N.A.	N.A.	9.000	2017 (estimate)

Source: Data collected by AEBIOM; 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

Figure 3.11 Evolution of the forest area in the world by region (World bank classification, in %)



Source: World Bank

In 2015 (latest available statistics of forest resources at a European level), the EU28 had approximately 181 million hectares of forests and other wooded land, corresponding to 42,6 % of its land area (which is 424, 6 million hectares). EU's forests and other wooded land cover approximately the same proportion of land area as that used for agriculture.

The area covered by forests and other wooded land in the EU28 is increasing. Over the past 25 years (1990 to 2015) the area of forest cover and other wooded land increased in total by 5,16 %, equivalent to an average increase of 0,2 % per annum. The rates of change in individual EU28 Member States varied substantially. Among the 28 countries, Denmark was the only country whose forests area decreased slightly (3,17%). While in some others observed almost no change was observed (Luxembourg, Sweden, Greece, Finland, Germany, Slovakia, and Czech Republic). Increases ranging from of 10 % to 25 % were observed in the United Kingdom, Lithuania, Hungary, Bulgaria, Croatia and Italy, while Ireland recorded a 55 % increase during these 20 years.

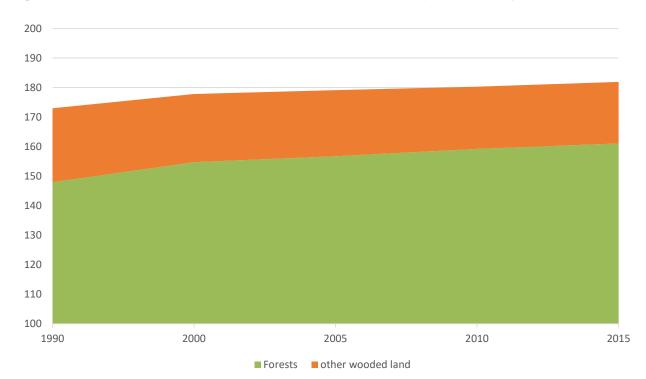


Figure 3.12 Evolution of total area of forest and other wooded land in EU28 (million hectares)

Across EU28 Member States, in 2015, there were 7 countries which had more than half of their land area covered by forests and other wooded land (Portugal, Spain, Latvia, Estonia, Slovenia, Sweden and Finland). About three quarters of the land area was covered by forests and other wooded land in Finland and Sweden.

Table 3.3 Forest area in the EU28 Member States, 2015 (thousand 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		

Socioeconomically, EU28 forests vary from small family holdings to state forests or to large estates owned by companies, many as part of industrial wood supply chains. Around 60% of the EU28's forests were privately owned in 2010. This percentage is the highest (98,4%) in Portugal and the lowest in Bulgaria (13,2%).

Table 3.4 Forest ownership (1000 ha) in 2010 for EU28 Member States

	In public ownership	In private ownership	% of private ownership	
EU28	63044	94995	60%	
AT	878	2527	74%	
BE	317	364	53%	
BG	3286	451	12%	
CY	119	54	31%	
CZ	2037	621	23%	
DE	5932	5477	48%	
DK	139	448	76%	
EE	923	1038	53%	
EL	2907	845	23%	
ES	5333	12855	71%	
FI	6744	15474	70%	
FR	4064	12360	75%	
HR	1376	544	28%	
HU	1178	853	42%	
IE	386	339	47%	
IT	3032	5996	66%	
LT	1333	837	39%	
LU	41	46	53%	
LV	1755	1594	48%	
MT	0	0	N.A.	
NL	181	192	51%	
PL	7643	1686	18%	
PT	98	3141	97%	
RO	4363	2152	33%	
SE	6822	21192	76%	
SI	315	932	75%	
SK	974	786	45%	
UK	868	2191	72%	

Source: FOREST EUROPE/UNECE/FAO

Table 3.5 Certified areas in the EU28 Member States in June 2017 (1000 ha)

	PEFC	FSC
EU28	66.699	35.028
AT	3.051	1
BE	300	23
BG	0	1.290
CZ	1.795	53
DE	7.392	1.149
DK	265	209
EE	1.175	1.414
ES	2.065	251
FI	17.661	1.366
FR	8.203	40
HR	0	2.039
HU	0	304
IE	376	447
IT	827	65
LT	0	1.095
LU	34	2
LV	1.692	1.016
NL	0	170
PL	7.252	6.926
PT	258	378
RO	0	2.630
SE	11.658	12.143
SI	50	260
SK	1.237	147
UK	1.410	1.610

Source: PEFC and FSC

"One of the key findings from the "biomass supply" chapter is that sustainably managed forests are able to ensure significant wood availability as part of the solution to decarbonize European societies. Wood substitutes for non-renewable materials and energy, wood products store carbon and growing forests remove CO2 from the atmosphere. The triple climate benefit coming from forestry is of vital importance to reach the Paris Agreement goals for mitigating climate change.

Investments by European countries have already resulted in a very positive trend in the development of forest area and resources. Over the past 25 years, the growing stock of European forests has increased by 7,3 billion m³, whereas the stock available for wood supply has grown by more than 5 billion m³. Furthermore, only about 63 % of the annual increment is used, allowing for additional availability for the future. These figures are promising for the shift towards a European bioeconomy.

Fostering innovation and promoting wood use are crucial in order to ensure the vitality of the forest-based sector. Low quality assortments continue to represent 21 % of the primary production from European forests and the bioenergy sector is a natural customer for this significant resource. The promotion of bioenergy can play a key role in providing incentives and financial means for forest owners and managers to take additional measures to guarantee the high-quality management of their forests.

A dynamic forestry sector throughout Europe is essential to ensure the provision of the wide array of ecosystem services coming from forests. The use of forest biomass for bioenergy supports forest managers in balancing environmental integrity, societal values and the economic viability of sustainable forest management."

Piotr Borkowski, Executive Director of the European State Forest Association EUSTAFOR



The total stock of forests and other wooded land in the EU28 comes to some 26,5 billion m³ over bark solid in 2015. Germany had the highest share (13,8 %), followed by Sweden (11,26 %) and France (10,77%). Germany also had the largest growing stock in forests available for wood supply in 2015, some 3,5 billion m³, while Finland, Poland, France and Sweden each reported between 2,0 and 2,3 billion m³.

The FAO defines the growing stock as being "the living tree component of the standing volume".

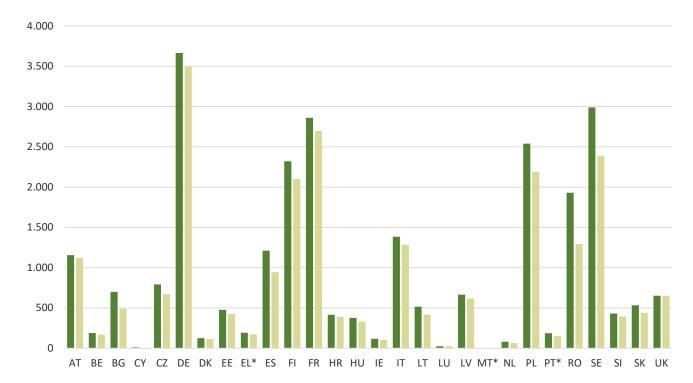


Figure 3.13 Growing stock of forest stock in EU28 Member States, 2015 (millions of m3 over bark)

■ Stock of forests available for wood supply

■ Stock of forests

^{*}For EL growing stock of forests available for wood supply from 2010. *For MT and PT Growing stock of forests taken from 2010. Source: Eurostat

26,5 24,9 22,0 19,2 23,1 22,1 21,0 19,8 17,6 Stock of forests -Stock of forests available for wood supply 1990 2000 2005 2010 2015

Figure 3.14 Evolution of growing stock of forest in EU28 (billions of m³)

Source: Eurostat

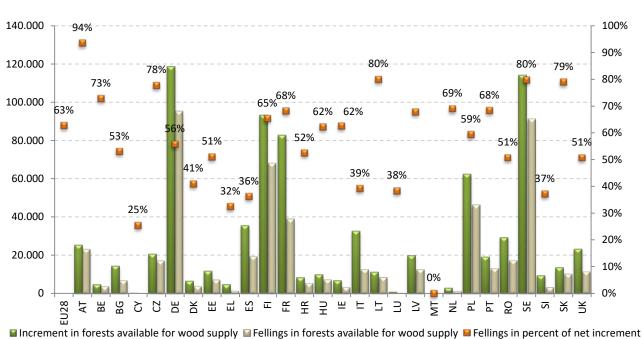


Figure 3.15 Increment and fellings in forest available for wood supply (thousands of m³) and percentage of fellings compared with net increment per EU28 Member States in 2010

Among EU Member States, Sweden produced the most roundwood (74 million m³) in 2016, followed by Finland, Germany and France. 21.6% of EU28's roundwood production in 2016 was used as wood for fuel, while the remainder was industrial roundwood used either for sawnwood and veneers, or for pulp and paper production.

In most of the countries, the majority of roundwood removals was for industrial purposes. In Sweden, Ireland, Slovenia, Portugal, more than 90 % of total roundwood production was used as industrial roundwood in 2016. While Cyprus, The Netherland, 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 3.6 Wood removals from forests in EU28 Member States by assortment in 2016 (thousand m³)

		fuel	Sawlogs and veneer logs	Pulpwood	Other industrial roundwood
EU28 2	152.375	97.677	196.005	149.179	9.515
AT	16.763	4.590	9.006	3.167	0
BE	5.412	893	2.965	1.381	173
BG	6.410	2.928	1.502	1.919	61
CY	16	13	3	0	0
CZ	16.472	2.390	9.074	4.918	90
DE	52.194	9.413	28.183	11.992	2.605
DK	3.456	2.218	842	333	62
EE	9.735	3.161	4.076	2.445	52
EL	1.432	1.065	304	0	63
ES	16.880	3.500	3.943	9.167	270
FI	62.291	7.964	23.410	30.917	0
FR	50.971	25.859	16.468	8.128	516
HR	5.165	1.768	2.402	988	6
HU	5.798	2.679	1.105	1.144	871
IE	2.908	203	1.559	982	164
IT	5.153	3.064	1.120	682	287
LT	6.747	2.085	3.494	1.168	0
LU	381	70	113	198	0
LV	12.651	1.300	7.969	2.640	742
MT	0	0	0	0	0
NL	2.271	1.397	392	470	13
PL	42.335	4.975	16.858	19.455	1.047
PT	11.613	600	2.054	8.635	324
RO	15.927	4.882	8.993	1.045	1.008
SE	74.200	7.000	35.700	31.000	500
SI	9.267	515	5.003	3.717	32
SK	5.381	1.272	2.989	990	131
UK	10.545	1.872	6.477	1.698	498

Source: FAOSTAT

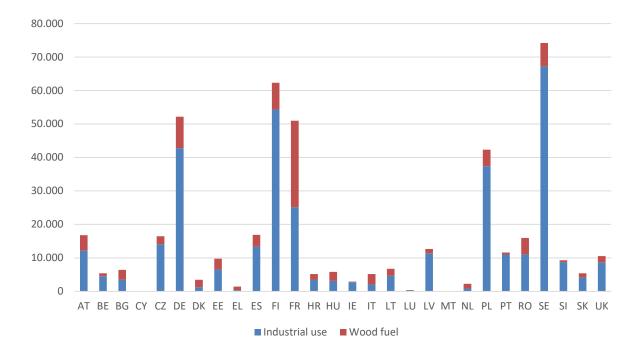


Figure 3.16 Roundwood removals in EU28 Member States according to end use in 2016 (1000m³)

Source: FAOSTAT





It should be remembered that these wood fuel data count the amount of wood removals that are burnt directly (i.e. residential use of firewood and industrial burning of chips). Most energy from wood comes from the use of forest-based industry co-products such as chips or black liquor from pulping. The Joint Wood Energy Enquiry (JWEE 2013 available at http://www.unece.org/forests/jwee) shows that these co-products represent the majority of wood for energy uses (62%). Recovered wood waste's share is about 5% (mainly waste from construction, but also packaging and old furniture). The remaining part corresponds to woody biomass from forest and other wooded areas. For wood pellets the source is also mostly industry co-products (74%).

Alex McCusker and Florian Steierer, UNECE/FAO Forestry and Timber Section

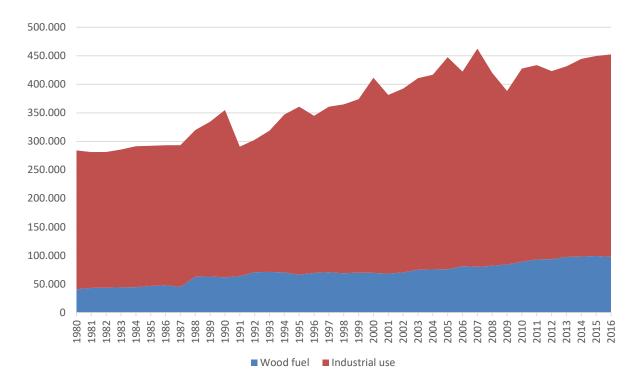


Figure 3.17 Evolution of the roundwood production by type of end use in the EU28 (in 1000m³)

Source: FAOSTAT

EU28 is a net importer of wood fuels. However, the net import account to less than 2% of the total solid biomass production in the EU.

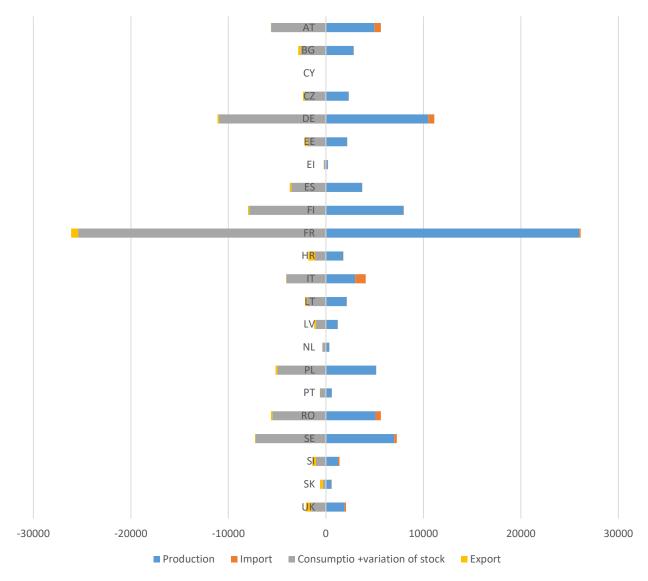
Table 3.7 Roundwood trade in EU28 Member States in 2015 (thousand m³)

	Fuelwood	(including v	vood for charc	oal)	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	2.110	/	229	/	17.532	/	3.518	/
AT	112	664	0	13	282	7.849	5	830
BE	36	198	3	27	65	4.488	582	1.344
BG	0	2	57	301	2	13	173	224
CY	2	2	0	0	0	0	0	0
CZ	4	19	6	161	224	2.329	37	4.530
DE	295	624	1	166	1.223	8.716	749	3.741
DK	10	138	0	202	26	396	156	651
EE	2	6	49	287	35	287	111	2.431
EL	33	189	0	6	9	436	9	41
ES	0	3	4	159	23	751	18	1.896
FI	18	23	3	125	4.857	5.710	82	717
FR	5	163	19	711	256	1.347	678	4.303
HR	30	33	0	689	6	52	8	331
HU	107	134	0	243	84	297	27	723
IE	0	8	0	1	1	285	0	305
IT	569	1.078	2	30	332	2.677	15	213
LT	10	33	5	215	226	372	63	1.406
LU	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
LV	0	4	25	176	689	1.560	380	3.002
MT	0	1	0	0	0	1	0	0
NL	5	16	3	30	39	326	63	550
PL	16	17	3	199	1.979	2.535	33	2.464
PT	0	2	0	6	2.009	2.009	358	358
RO	550	552	42	143	1.773	1.792	146	169
SE	133	272	9	63	3.249	6.941	328	570
SI	89	152	0	380	26	297	33	2.303
SK	42	37	0	285	174	507	23	2.358
UK	78	146	0	573	7	473	24	271

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

This graphic represent the total volume of production, trade (intra and extra EU28) and consumption + the stock variation of the wood fuel in the EU28 member states. The figure shows that trade in wood fuel do not account as a major parameter in the EU28 member states, most of the production being usually consumed directly in the country of production

Figure 3.18 EU-28 member state* wood fuel balance in 2015 - production, import, export, consumption + stock variation (thousand tonnes)

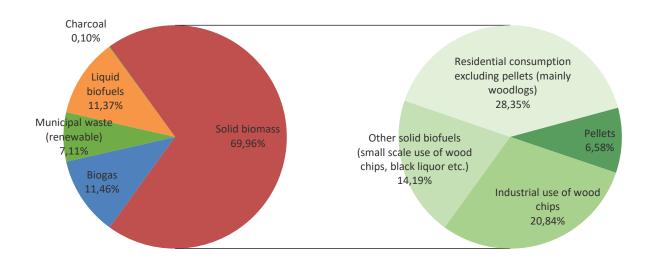


Note: 1) BE, DK, EL, HU, LU, and MT not shown in the data.

2) Consumption + stock variation estimated

In its various forms, from logs to black liquor to pellets, wood accounts for about half of Europe's renewable-energy consumption. In some countries, such as Poland and Finland, wood meets more than 80% of renewable-energy demand.

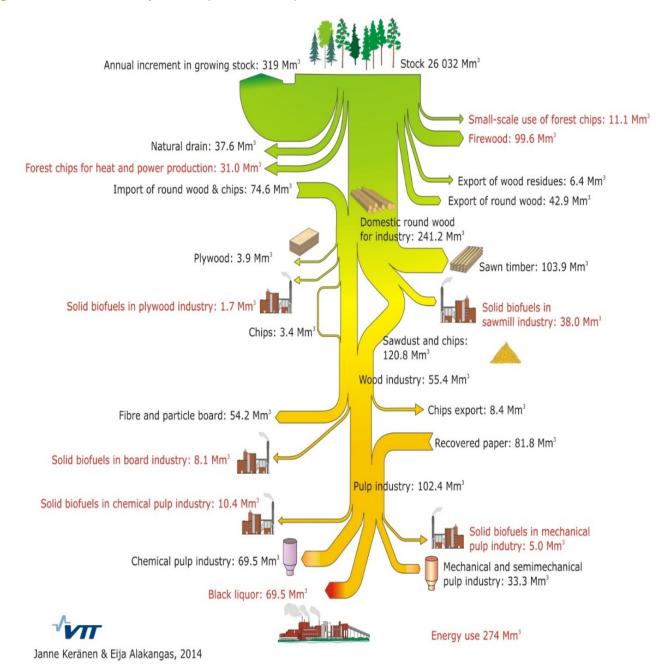
Figure 3.19 Gross inland energy consumption of Biomass and renewable wastes for bioenergy in 2015



Sources: Graph on the left: Eurostat; Graph on the right: AEBIOM, EPC survey, BASIS Bioenergy project

The image below depicts the wood flows in Europe in 2013. The total amount of wood used for energy was 274 million m³ while the energy wood removals was only 99,6 million m³. This is possible because of cascading use of wood, in which for instance sawn wood, veneer and pulp are first made out of round wood, and the residues of these production processes are used for energy. These residues can be bark, shavings, saw dust, black liquor etc..

Figure 3.20 Wood use in Europe in 2013 (million solid m³)



Source: Janne Keränen and Eija Alakangas, VTT 2014

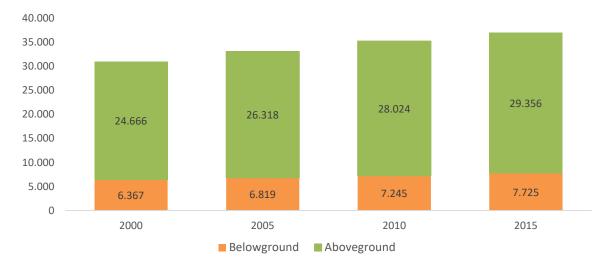


Figure 3.21 The evolution of carbon stock in forest in EU28 (million tonnes of CO2)

Source: FAO/UNECE/Forest Europe

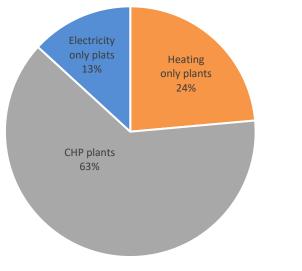
Table 3.8 Evolution of carbon in living biomass in forests and other wooded land in EU28 Member States (million tonnes of CO₂)

				For	est			
		Above	ground			Below	ground	
	2000	2005	2010	2015	2000	2005	2010	2015
EU28	24.666	26.318	28.024	29.356	6.367	6.819	7.245	7.725
AT	1.072	1.105	1.123	1.145	279	283	286	290
BE	180	198	209	220	37	40	44	44
BG	462	521	569	613	128	147	158	169
CY	7	7	11	11	4	4	4	4
CZ	1.002	1.053	1.079	1.134	184	195	198	209
DE	3.307	3.442	3.556	3.769	521	539	558	595
DK	117	114	117	125	18	22	22	26
EE	492	488	481	481	128	128	125	125
EL	209	217	228	0	59	62	62	62
ES	1.251	1.428	1.556	1.681	415	473	514	554
FI	2.004	2.088	2.191	2.191	620	646	675	675
FR	2.995	3.329	3.553	3.876	855	947	1.024	1.130
HR	624	668	705	719	191	202	217	220
HU	316	323	345	360	77	81	84	88
IE	99	114	147	147	22	26	33	na
IT	1.461	1.604	1.747	1.886	360	396	429	466
LI	437	451	473	499	99	103	110	114
LU	29	29	29	29	4	4	4	4
LV	642	664	734	793	206	213	235	253
MT	0	0	0	0	0	0	0	0
NL	73	77	88	99	15	15	18	18
PL	1.670	1.835	2.345	2.514	334	367	470	503
PT	264	264	268	na	110	110	110	na
RO	1.787	1.795	1.828	2.283	411	411	418	679
SE	2.800	3.002	3.035	3.068	932	1.002	1.013	1.024
SK	319	363	396	422	73	84	92	95
SL	573	609	639	664	125	132	139	143
UK	473	528	584	639	169	191	209	231

Source: FAO/UNECE/Forest Europe

The following graphs provide information on the industrial use of woodchips in Europe. They present the results of **BASIS project**¹, coordinated **by AEBIOM and co-funded by the Intelligent Energy Europe Programme of the European Union**. During three years, a consortium formed by 9 partners and lead by AEBIOM, worked on collecting data of bioenergy plants larger than 1MW consuming wood chips. 4059 plants were identified. The data on wood chips use is accompanied by information on feedstock potential and sustainability aspects in order to provide a complete overview of the sustainable supply and competition to the final user. All information collected is shown in a user friendly GIS.

Figure 3.22 Wood chips consumption in EU28 by plant type and by plant size class in (%)



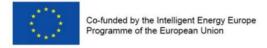
Wood chip consumption by energy use (EU28)

Source: BASIS project

(EU28)

BASIS (Biomass Availability and Sustainability Information System) is a project co-founded by the Intelligent

Energy Europe Programme of the European Union. All information available here: www.basisbioenergy.eu



¹⁻⁵MW
7%
5-10MW
8%
10-20MW
10%

Wood chip consumption by plant size class

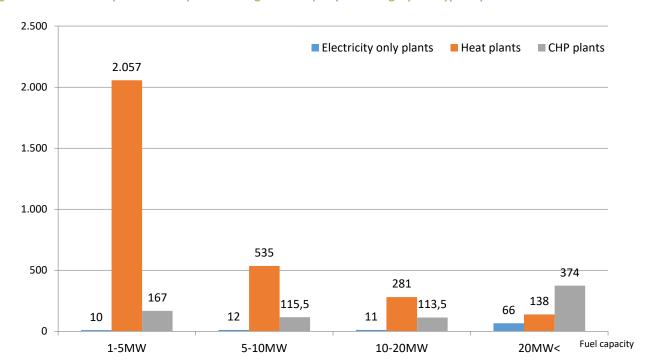


Figure 3.23 Number of plants in Europe consuming wood chips by size category and type of plant in EU28

Source: BASIS project

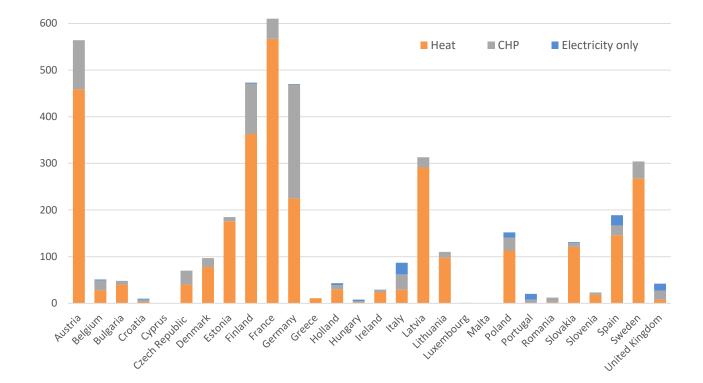


Figure 3.24 Number of plants consuming wood chips by type of plant in EU Member States

Source: BASIS project

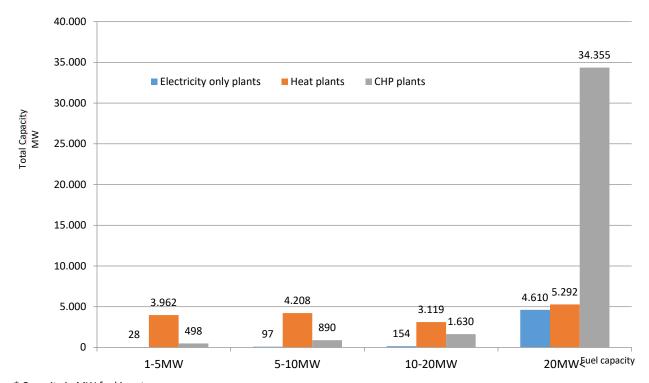


Figure 3.25 Capacity* of plants in EU28 consuming wood chips by size category and type of plant

* Capacity in MW fuel input. Source: BASIS project

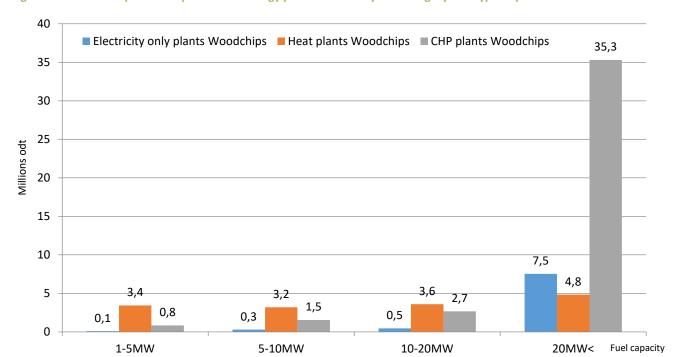


Figure 3.26 Wood chips consumption of bioenergy plants in EU28 by size category and type of plant

Source: BASIS project

3.4 **Biomass from waste**

Table 3.9 Waste generated in EU28 Member States, 2014 (thousand tonnes)

	Total Waste	Paper and cardboard wastes	Wood wastes	Animal and vegetal wastes	Household and similar wastes	Common sludges
EU28	2.502.890	46.050	50.290	90.230	156.540	18.490
AT	55.868	1.441	1.170	1.888	2.774	432
BE	65.573	4.310	3.373	5.635	4.091	579
BG	179.677	416	266	N.A.	2.775	79
CY	2.051	125	12	112	148	7
CZ	23.395	789	197	583	2.941	349
DE	387.504	8.100	11.933	15.011	21.107	1.615
DK	20.081	836	435	1.087	2.476	188
EE	21.804	91	551	150	307	27
EL	69.759	480	92	575	4.086	138
ES	110.518	3.087	1.072	8.059	18.169	1.438
FI	95.970	631	4.231	1.079	1.433	398
FR	324.463	7.204	6.154	11.304	21.332	1.394
HR	3.725	221	91	N.A.	1.342	17
HU	16.651	762	143	699	3.294	164
IE	15.167	521	318	N.A.	1.850	617
IT	159.107	5.171	4.421	6.922	16.798	5.455
LT	6.200	172	126	551	933	49
LU	7.073	94	80	95	212	11
LV	2.621	108	79	105	552	23
MT	1.665	17	15	N.A.	207	10
NL	133.250	2.243	2.561	14.719	6.844	638
PL	179.018	1.395	3.864	4.680	6.935	626
PT	14.587	1.046	304	183	4.476	687
RO	175.591	506	2.304	N.A.	5.082	213
SE	167.027	1.130	1.466	2.205	2.165	423
SI	4.686	140	275	290	360	180
SK	8.863	243	254	N.A.	1.396	294
UK	251.037	4.773	4.507	10.366	22.455	2.440

Table 3.10 Treatment of non-hazardous wood waste in EU28 member states (1000 tonnes)

	Total waste treatment	Landfill / disposal (D1- D7, D12)	Deposit onto or into land	Incineration / disposal (D10)	Incineration / energy recovery (R1)	Recovery other than energy recovery - backfilling	Recovery other than energy recovery - except backfilling
EU28	42.033	460	460	382	20.673	105	17.343
BE	823	0	0	48	379	0	396
BG	266	0	0	0	84	n.a.	181
CZ	305	5	5	0	19	1	281
DK	294	1	1	0	27	0	266
DE	9.557	0	0	n.a.	6.896	0	n.a.
EE	388	0	0	0	206	0	182
IE	185	0	0	0	56	24	105
EL	60	41	41	0	5	0	13
ES	1.070	43	43	0	108	0	919
FR	6.122	282	282	92	1.646	0	4.102
HR	27	1	1	0	24	0	1
IT	3.652	1	1	3	691	0	2.958
CY	13	9	9	0	0	0	4
LV	25	4	4	0	10	0	10
LT	94	1	1	0	32	0	61
LU	1	0	0	0	n.a.	0	n.a.
HU	128	0	0	0	10	0	117
MT	0	0	0	0	0	0	0
NL	2.095	1	1	1	1.223	0	870
AT	1.248	0	0	n.a.	n.a.	0	839
PL	4.717	0	0	0	2.389	0	2.328
PT	163	1	1	0	22	n.a.	140
RO	3.218	0	0	0	1.569	0	1.649
SI	160	0	0	0	148	0	12
SK	170	3	3	2	57	0	109
FI	3.099	36	36	59	2.889	0	115
SE	1.590	4	4	0	1.556	0	30
UK	2.564	25	25	177	628	80	1.655

Table 3.11 Municipal waste by waste operation in EU28 member states, 2015 (thousand tonnes)

	Waste generated	Total waste treatment	Landfill disposal	Total incineration	Incineration disposal	Incineration energy recovery	Material recycling	Composting and digestion
EU28	242.258	235.396	61.988	64.379	9.512	54.868	69.355	39.674
AT	4.836	4.728	144	1.833	0	1.833	1.241	1.511
BE	4.708	4.602	43	2.043	848	1.195	1.615	901
BG	3.011	2.960	1.994	82	0	82	573	311
CY	541	500	403	0	0	0	72	25
CZ	3.337	3.337	1.755	590	4	586	851	141
DE	51.046	49.797	106	15.973	4.709	11.264	24.414	9.304
DK	4.485	4.485	51	2.359	0	2.359	1.223	852
EE	473	411	35	243	0	243	117	17
EL	5.249	5.249	4.426	18	N.A.	18	670	135
ES	20.151	20.151	11.101	2.342	0	2.342	3.393	3.316
FI	2.738	2.738	315	1.312	0	1.312	770	341
FR	33.399	33.400	8.603	11.600	364	11.236	7.433	5.764
HR	1.654	1.617	1.319	0	0	0	270	28
HU	3.712	3.710	1.991	525	0	525	963	231
IE	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
IT	29.524	26.253	7.819	5.582	3.071	2.511	7.649	5.203
LT	1.300	1.283	702	150	0	150	298	132
LU	356	356	63	121	0	121	101	70
LV	798	723	494	0	N.A.	0	182	47
MT	269	260	241	1	0	1	18	0
NL	8.855	8.856	125	4.152	97	4.055	2.179	2.400
PL	10.863	10.864	4.808	1.439	121	1.318	2.867	1.750
PT	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
RO	4.895	4.281	3.522	116	0	116	277	365
SE	4.377	4.377	35	2.241	0	2.241	1.417	684
SK	1.784	1.683	1.226	191	0	191	136	130
SL	926	869	210	158	0	158	430	71
UK	31.567	30.757	7.124	9.907	297	9.610	8.602	5.124

Note: Part of the "composting and digestion" include energy recovery

Composting and digestion 17%

Landfill disposal 26%

Material recycling 30%

Incineration energy recovery 23%

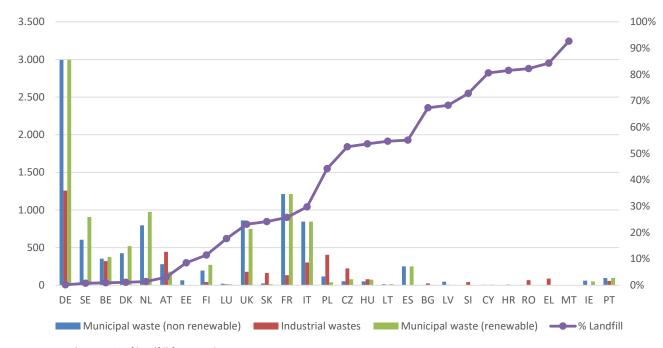
Figure 3.27 Municipal waste treatment in EU28 by treatment in 2015 (in %)

Note: Part of the "composting and digestion" include energy recovery

Source: Eurostat

The figure below shows the relation between the energy production from municipal waste in the EU28 member state and the percentage of municipal waste thrown into landfill. Countries with a low percentage of landfill treatment tend to produce more energy from their municipal waste. A high percentage of waste thrown into landfill indicate a potential resource in energy and recycling.

Figure 3.28 Gross inland consumption of energy from waste by type (left axis, in ktoe) and % of waste thrown into landfill (right axis, in %) in the EU28 member state



Note: no numbers on % of landfill for IE and PT

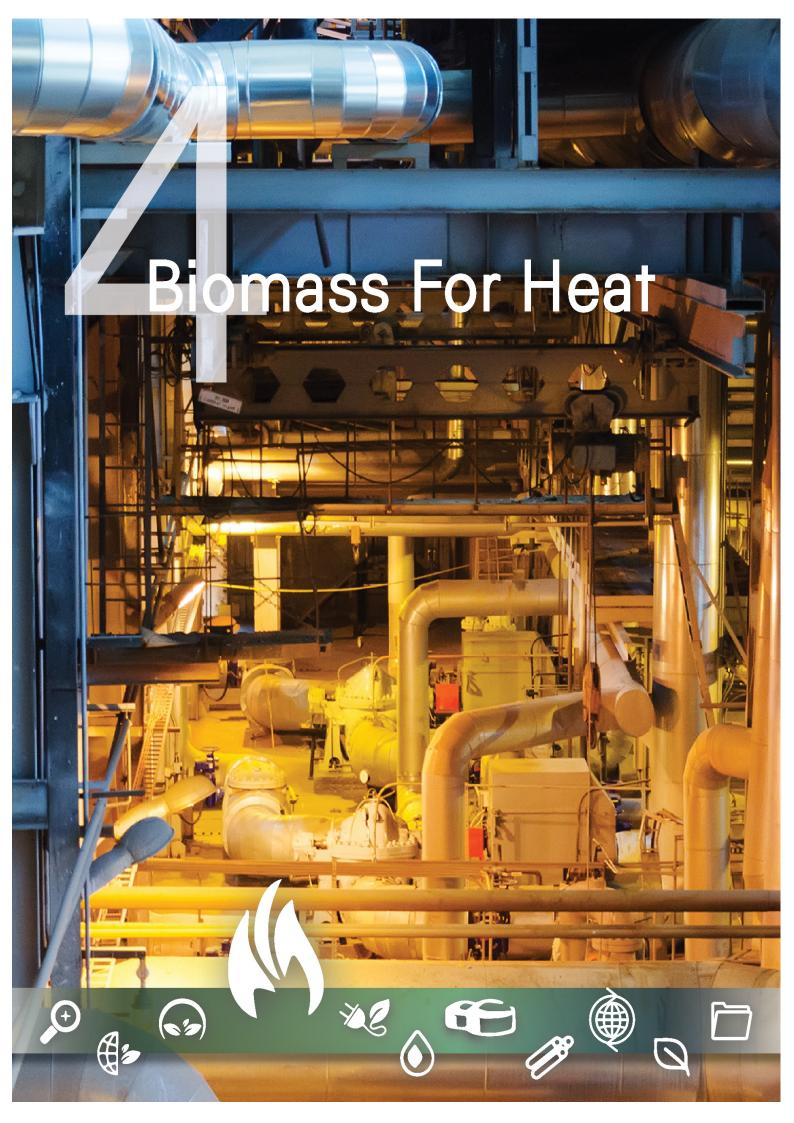
Figure 3.29 Waste to energy in 2014

- Waste-to-Energy plants operating in Europe (not including hazardous waste incineration plants)
- Waste thermally treated in Waste-to-Energy plants in million tonnes



^{*} Includes plant in Andorra

Source: CEWEP (Data supplied by CEWEP members unless specified otherwise)



4.1 Heat and RES heat demand in Europe

The following tables give an overview of the fuels used in Europe for the production of heat. At the same time, this is a good indicator to estimate the potential of biomass to replace fossil fuels.

In the following tables and according to Eurostat, <u>autoproducer</u> represents enterprises, either privately or publicly owned, which generate electricity and/or heat wholly or partly for their own use as an activity which supports their primary activity.

While <u>main activity</u> represents enterprises, both privately or publicly owned, which generate electricity and/or heat for sale to third parties as their principal activity.

Table 4.1 Fuels used for the production of heat in district heating plants in EU28 in 2014 (ktoe)

	Main	activity DH plants		Autoproducer DH plants			
Fuels	Fuel input	Contribution to total input		Fuel input	Contribution to total input	Output	
Solid fossil fuels	3.207	20,47%		277	7,38%		
Oil	606	3,87%		310	8,26%		
Gas	6.113	39,01%		2.546	67,84%		
Other RES	334	2,13%		43	1,15%		
Wastes (non.ren.)	647	4,13%	4,13% 13.503		5,09%	2.889	
Solid biomas	3.993	25,48%		210	5,60%		
Biogas	145	0,93%		9	0,24%		
Municipal waste renewable	569	3,63%		167	4,45%		
Biofuels	55	0,35%		1	0,03%		
TOTAL	15.670	100%	13.503	3.753	100%	2.889	

Source: Eurostat

Table 4.2 Fuels used for the production of heat and electricity in CHP plants in EU28 in 2014 (ktoe)

	Main	activity CHP plant	s	Autoproducer CHP plants				
Fuels	Fuel input	Contribution to total input	Output	Fuel input	Contribution to total input	Output		
Solid fossil fuels	57.208	48,74%		2.482	7,17%			
Oil	4.029	3,43%		1.939	5,60%			
Gas	33.859	28,85%		19.971	57,67%			
Other RES	0	0,00%	33.875	0	0,00%	6.247 ktoe Heat 16.568 ktoe		
Wastes (non.ren.)	3.190	2,72%	ktoe Heat	2.032	5,87%			
Solid biomas	10.403	8,86%	38.964 ktoe	4.677	13,51%			
Biogas	5.250	4,47%	Electricity	1.459	4,21%	Electricity		
Municipal waste renewable	3.064	2,61%		2.041	5,89%			
Biofuels	368	0,31%		25	0,07%			
TOTAL	117.370	100%		34.628	100%			

The residential, services, industry and other sectors also consume fuels for heat production. Among all the industry types, in the table below it is shown the paper, pulp & print industry and the wood working industry which are the ones consuming more biomass. It should be noted that beside these numbers, surplus of heat delivered into the grid by the same installation are compiled in table 4.2 under the rubric "autoproducer".

Table 4.3 Fuels used in the residential and service sectors and pulp & paper industry for heat production in EU28 in 2015 (ktoe)

Fuels	Residential	Services	Industry	Out of which: Paper, pulp & print industry	Out of which: Wood and wood product industry
Solid fossil fuels	9.258	1.070	34.897	1.061	41
Oil	34.738	15.257	27.848	718	202
Gas	97.436	44.558	86.634	7.003	494
Other RES	1932	551	17	2	0
Wastes (non.ren.)	6	243	3.175	68.9	37
Charcoal	150	36	8	0	0
Solid biomass	42.077	2.253	20.372	11.845	4.662
Biogas	53	1.756	342	99	1
Municipal					
waste	6	208	553	87	0
renewable					
Biofuels	1	167	89	4	0
TOTAL	185.657	66.099	274.737	20.818	7.926

Source: Eurostat

Figure 4.1 Evolution of share of RES in heating and cooling (ktoe,%)

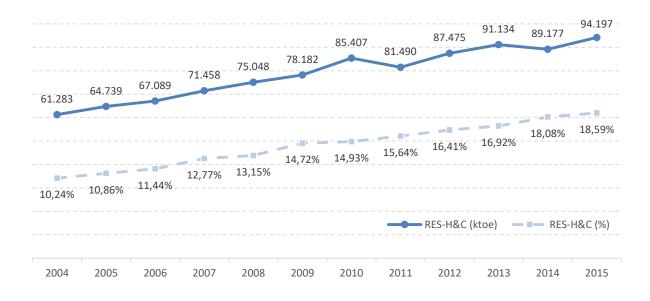


Table 4.4 Total heat consumption* and contribution of renewable heat in EU28 Member States in 2015 (ktoe)

	Total heat consumption	RES heat	% of RES heat in the total heat
EU28	506.614	94.197	18,6%
AT	13.309	4.263	32,0%
BE	18.371	1.404	7,6%
BG	4.005	1.147	28,6%
CY	441	99	22,5%
CZ	13.764	2.729	19,8%
DE	107.503	13.817	12,9%
DK	7.193	2.851	39,6%
EE	1.520	754	49,6%
EL	5.733	1.485	25,9%
ES	27.782	4.663	16,8%
FI	13.399	7.069	52,8%
FR	59.334	11.728	19,8%
HR	3.248	1.253	38,6%
HU	10.185	2.166	21,3%
IE	4.478	287	6,4%
IT	55.753	10.687	19,2%
LT	2.357	1.086	46,1%
LU	1.053	73	6,9%
LV	2.198	1.138	51,8%
MT	85	12	14,1%
NL	25.727	1.419	5,5%
PL	35.087	5.007	14,3%
PT	5.512	1.839	33,4%
RO	13.172	3.410	25,9%
SE	13.956	9.581	68,6%
SI	1.841	627	34,1%
SK	5.786	624	10,8%
UK	53.821	2.979	5,5%

^{*} Total heat includes all elements of "gross final consumption of energy" for other purposes than electricity and transport. Source: Eurostat

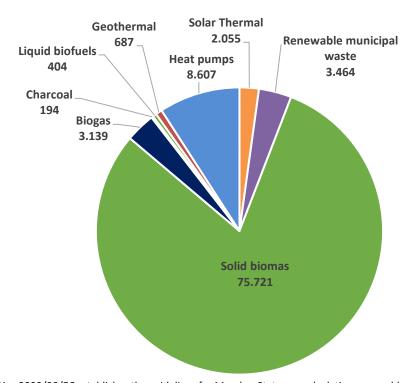


Figure 4.2 Contribution of the different renewables in heating and cooling in 2015 in EU28 (ktoe)

Note: Article 5 of Directive 2009/28/EC establishes the guidelines for Member States on calculating renewable energy from heat pumps from different heat pump technologies. Only renewable energy from heat pumps with an SPF greater than 2.5 should be considered towards the target

Source: Eurostat

4.2 Biomass for heat and derived heat

Figure 4.3 Share of biomass for heat and derived heat in the total heating and cooling consumption in 2015 in the EU28 Member States (%)



At EU level, half of the heat produced from biomass is consumed by households (42.288 ktoe). This is only counting the biomass directly consumed in the houses for the production of heat, excluding the district heating. The residential sector is followed by 21.363 ktoe of biomass for heat in industry and 12.759 ktoe of derived heat.

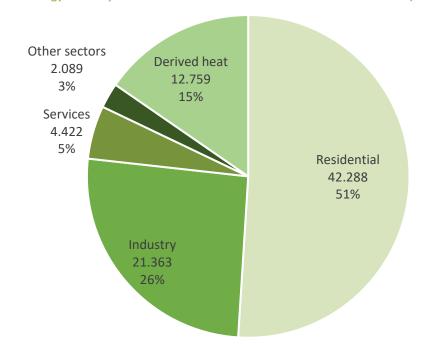


Figure 4.4 Final energy consumption of bioheat in EU28 in 2015 in the different sectors (ktoe, %)

Source: Eurostat and AEBIOM calculations

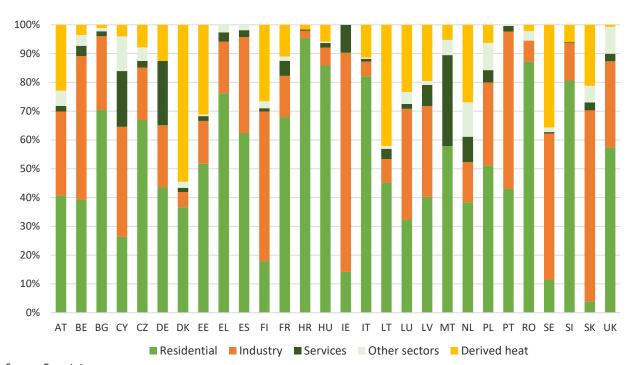


Figure 4.5 Importance of the different sectors in the bioheat consumption in EU28 Member States in 2015 (%)

Six countries (DE, FR, IT, PL, FI, SE) account for 60% of all the biomass for energy in the heat sector.

Table 4.5 Final energy consumption of bioheat in EU28 Member States in 2015 in the different heat sectors (ktoe)

	Total	Residential	Services	Other sectors	Industry	Derived Heat
EU27	82.921	42.288	4.422	2.089	21.363	12.759
AT	3.882	1.581	76	206	1.132	887
BE	1.340	525	48	51	669	47
BG	1.017	716	18	11	260	12
CY	30	8	6	4	11	1
CZ	2.620	1.753	59	124	479	205
DE	12.188	5.317	2.720	0	2.619	1.532
DK	2.644	967	39	55	141	1.442
EE	699	361	12	4	104	218
EL	1.089	830	35	29	195	0
ES	4.033	2.517	97	75	1.344	0
FI	6.661	1.195	78	159	3.460	1.769
FR	9.513	6.464	496	141	1.363	1.049
HR	1.216	1.161	5	0	30	20
HU	2.055	1.765	32	10	128	120
IE	228	32	22	0	174	0
IT	7.780	6.394	75	34	391	886
LT	1.086	491	38	11	89	457
LU	64	20	1	3	25	15
LV	1.138	458	83	16	359	222
MT	2	1	1	0	0	0
NL	1.159	445	102	138	162	312
PL	4.915	2.519	212	466	1.410	308
PT	1.776	764	35	7	970	0
RO	3.384	2.951	1	113	246	73
SE	8.415	958	40	136	4.281	3.000
SI	574	463	2	0	75	35
SK	614	24	17	36	407	130
UK	2.801	1.608	73	262	839	19

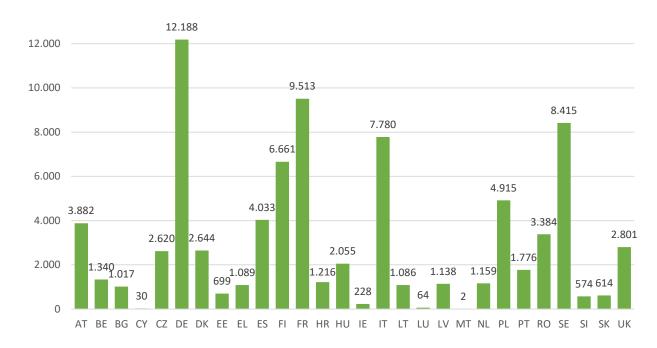


Figure 4.6 Final energy consumption of bioheat in EU28 Member States in 2015 (ktoe)

Source: Eurostat and AEBIOM calculations

4.3 Evolution and prospects of bioheat

The biggest increment of bioheat in Europe, in absolute numbers, was experienced in the residential sector followed by the district heating. Nevertheless, in percentage the biggest increment occurred in the service sector that triple their consumption of bioheat.

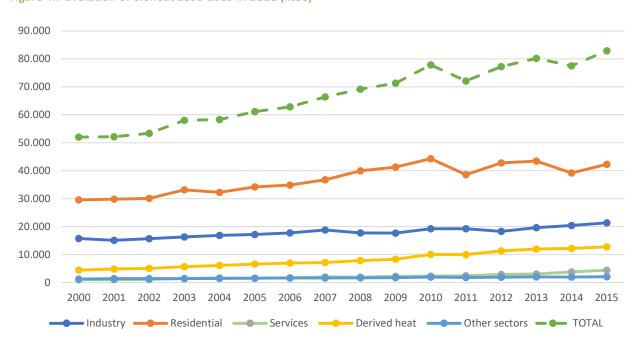


Figure 4.7 Evolution of bioheat 2000-2015 in EU28 (ktoe)

Only Portugal decreased its bioheat consumption between 2000 and 2015. During this period, the countries that experienced the biggest increment were Germany, Italy and United Kingdom.

Table 4.6 Evolution of biomass for heat and derived heat 2000-2015 in EU28 Member States (ktoe)

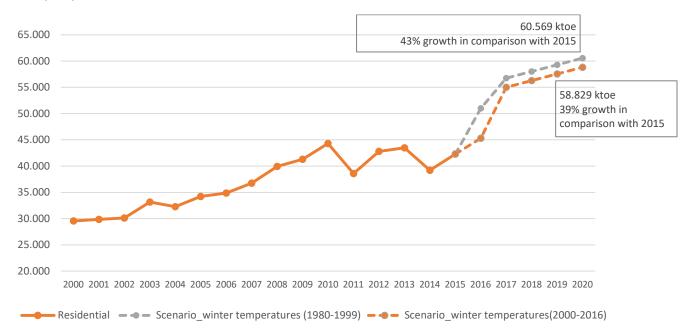
		Industry	,	R	esidenti	al	Ot	her secto	ors	De	erived he	eat
	2000	2010	2015	2000	2010	2015	2000	2010	2015	2000	2010	2015
EU28	15.772	19.297	21.363	29.277	43.053	42.288	2.243	4.233	6.511	4.469	10.061	12.759
AT	705	1.248	1.132	1.435	1.540	1.581	185	260	281	177	885	887
BE	255	588	669	152	518	525	1	42	98	9	44	47
BG	34	166	260	489	711	716	24	14	29	0	2	12
CY	1	8	11	:	6	8	0	7	9	0	0	1
CZ	128	407	479	727	1.158	1.753	7	92	183	122	90	205
DE	453	2.161	2.619	4.028	6.079	5.317	0	998	2.720	254	987	1.532
DK	109	183	141	424	952	967	100	94	94	535	1.260	1.442
EE	79	104	104	332	423	361	14	23	16	64	142	218
EL	233	245	195	702	606	830	11	16	63	0	0	0
ES	1.302	1.144	1.344	1.995	2.464	2.517	64	124	172	0	0	0
FI	3.386	2.987	3.460	936	1.494	1.195	158	273	237	834	1.585	1.769
FR	1.563	1.462	1.363	6.681	7.230	6.464	256	393	637	287	580	1.049
HR	53	51	30	948	1.187	1.161	0	3	5	0	2	20
HU	60	85	128	553	659	1.765	81	49	42	13	72	120
IE	100	153	174	17	27	32	0	16	22	0	0	0
IT	228	208	391	1.280	7.163	6.394	8	23	110	0	258	886
LT	32	76	89	527	574	491	47	43	49	29	186	457
LU	0	28	25	15	18	20	1	5	4	0	3	15
LV	59	226	359	674	598	458	91	94	99	88	102	222
MT	0	0	0	0	1	1	0	0	1	0	0	0
NL	61	103	162	345	409	445	81	184	241	81	175	312
PL	625	921	1.410	2.269	2.693	2.519	629	740	678	44	255	308
PT	1.264	1.451	970	1.150	712	764	0	5	42	0	0	0
RO	261	252	246	2.454	3.526	2.951	20	131	114	14	36	73
SE	4.334	4.231	4.281	616	684	958	339	362	177	1.912	3.261	3.000
SI	75	68	75	358	515	463	2	2	2	6	23	35
SK	91	376	407	0	43	24	0	18	53	0	100	130
UK	281	364	839	172	1.065	1.608	120	221	336	0	15	19

Source: Eurostat

Figures 4.8 to 4.10 present the projections calculated by AEBIOM for bioheat until 2020 in the different sectors. The biomass consumption for heat in the residential sector is predicted using a multiple linear analysis. The selected variables to predict the biomass for heat consumption in the residential sector were heating degree days (HDD); two scenarios were assumed: the first one considering the average HDD of the last winters since 2000 and the second one with the

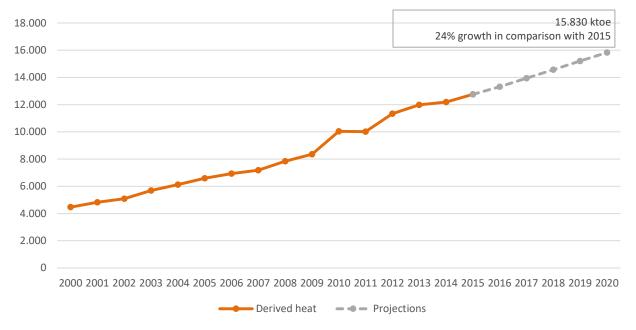
average HDD of 1980-1990. For derived heat, the variables considered in the analysis were the gas and oil price. And for the biomass used in industry the GDP and the economic development of the pulp and paper industry. It should be noticed that policy and taxes are also two main drivers for the bioheat sector evolution, therefore the information provided in the following graphs should be combined with a follow-up on European and national policies on renewables and specifically on biomass.

Figure 4.8 Evolution of biomass for heat in the residential sector between 2000-2015 and projections until 2020 in EU28 (ktoe)



Source: Eurostat (data 2000-2015) and projections based on AEBIOM methodology

Figure 4.9 Evolution of derived heat between 2000-2015 and projections until 2020 in EU28 (ktoe)



Source: Eurostat (data 2000-2015) and projections based on AEBIOM methodology



Figure 4.10 Evolution of biomass used for heat in industry between 2000-2015 and projections until 2020 in EU28 (ktoe)

Source: Eurostat (data 2000-2015) and projections based on AEBIOM methodology

"Bioheat is the real unsung bioenergy hero. By its very nature, the biomass used, the technology solutions deployed, the financing and business models applied and the heat use applications vary tremendously. Across Europe, bioheat installations range from industrial units of a few hundred MW down to household appliances of a few kW – from designer wood and pellet stoves providing supplementary heat and solace in living rooms, industrial boilers providing process energy to large municipal and independent combined heat and power (CHP) plants distributing heat and cooling via district energy networks.

For the most part, growth in bioheat has come about without the need for long-term direct subsidies. Instead, stable long-term technology agnostic "Polluter Pays Principle" (PPP) style of steering instruments such as a carbon dioxide (CO2) tax provide financial incentive and environmental motivation. Subsidised or not, each and every installation has either replaced an existing fossil fuelled alternative or prevented the installation or building of a new one while at the same time, creating new jobs and supporting existing ones right across the bioenergy value chain for every ktoe displaced.

Bioheat delivers on all of these social, economic, environmental and climate benefits yet the total annual volume of available biomass for energy use in Europe continues to accumulate. This is perhaps the best news of all given that over 80 percent of Europe's heat demand is still met using fossil fuels. Together with other measures, such energy efficiency and waste heat utilisation biomass is warming up to the challenge."

Alan Sherrard Editor in Chief Bioenergy International

Table 4.7 Main factor of development of bioheat in EU28 Member States

Other sectors	 Low oil and gas prices. 	 Interest has grown a lot in the last years but the consumption of biomass for heat in other sectors is still low. The low prices of fossil fuels doesn't stimulate the growth of the sector. 		biomass. (industry, residential, etc. id can be combined with	So-called Bioenergy communities are on the rise. A mixture of heating grid and "neighborhood - heat" projects often take advantage of locally sourced
Derived heat	 District heating cannot compete with the low gas/oil prices in new projects. There are high restrictions for new plants and only projects in best locations would be allowed. But those locations have already existing project. 	 Support to district heating is less ⇒ attractive in 2016 and it is too costly now to install it. Between 2014-2016 blonly two new district heating were installed in new residential areas. There is not a cultural habit to have district heating. 	.A.Z.	 In 2014 there has been introduced support scheme for bioheat production. Based on bonuses, price of bonuses is 52 CZK/GJ, approx. 2 EUR/GJ. It covers the price difference between the price of coal and biomass. Support is granted for installation from 200 kWth and above. Heat can be used in any useful way except for electricity generation (industry, residential, etc. There are also investment subsidies for boiler installation and creation or reconstruction of heat distribution system. Investment aid can be combined with operational one. 	assessing possibilities for decarbonizing their heating grids with a mix of renewable sources.
Industry	 Low oil and gas prices. Not enough support from the Government. 	• Investment support of about 35%-40% (depending on replacement of gas or oil). However slow management from the administration.		 In 2014 there has been introduced support scheme for bioheat production. Based on bonuses, price of bonuses is 52 CZK/GJ, approx. 2 EUR/GJ. It covers Support is granted for installation from 200 kWth and above. Heat can be used There are also investment subsidies for boiler installation and creation or reconoperational one. 	Decarbonization of processing energy, especially high temperature applications are currently only possible with bioenergy. The Industry is slowly
Residential	→ Low oil prices and mild winters in the past years don't allow to accelerate the installations of biomass devices in households. The interdiction of oil boilers in new buildings from 2019 on in Lower Austria has set a sign which could improve the situation.	 Big increase in new installation is not likely to happen, because of low prices of heating fuel and no big incentive is expected. At the beginning of 2016, it has been a reduction of the grant for biomass boilers (previous investment support was from 2.000-4.000€, while now is 800-2.400€) 		 In 2014 there has been introduced support scheme fo Based on bonuses, price of bonuses is 52 CZK/GJ, appr Support is granted for installation from 200 kWth and a There are also investment subsidies for boiler installatic operational one. 	→ Market incentive Program is under revision to boost the use of renewable heat and use of biomass.
	Α	BE	BG	5 B	DE

Other sectors	biomass. Capacities ranging from 200 kW to 10 MW and more	 Currently conversion to renewable energy in industry is supported under a special program ("RE for process") However, there is some doubt about the future of this program 			 Growing offer of biomass with better distribution network The crisis slowed down the consumption of energy in the service sector. It seems the economy is recovering but slowly.
Derived Heat		 A number of municipalities have goals of carbon neutrality and require district heating providers to supply carbon-free heat. Biomass is exempted from energy tax and CO₂-tax, making it an attractive business case relative to fossil fuels in heat and CHP plants. A massive conversion of previously mainly coal-fired central power plants to now biomass-fuelled plants is approaching completion and the biggest heat and power producer Ørsted (formerly DONG) will cease using coal altogether in 2023. Some smaller district heating plant want to convert from natural gas to biomass or to install small biomass summer boilers just for hot water. 	N.A.	N.A.	In the past the energy policies in Spain have promoted the individual heating systems and the district heating market has been almost nonexistent. Nevertheless, in the last years it has been an increasing interest from the regional and national administration to promote DH. The values in 2015 are:
Industry	developing bioenergy solutions for such applications	A program offering special investment support to conversions to renewable energy in industry was stopped partly due to limited interest.	2	2	 Growing offer of biomass with better distribution networks The crisis slowed down the consumption of energy in the industry. It seems that the economy is recovering but slowly The big users of biomass for industrial use in Europe (big electric generation plants) are using less solid biofuels like olive cake so its price is decreasing and
Residential	The sale of Biomass-boilers is stable but considers its main competitor in low oil prices.	• Biomass is exempted from energy tax and CO2 tax, making it an attractive business case relative to fossil fuels in domestic heat. However, there are some doubts as to how long the tax exemption will continue, which might affect the positive outlook.			 New schemes in the central government and some regions to boost the biomass heat installations. High offer of biomass at low prices and increasing knowledge and acceptance of biomass by the general public. Low oil prices and the last warm winter created a delay toward the shift to biomass boilers
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Other sectors		 → No major incentives to be seen and low fossil fuel prices 	gie (PPE) : multiyear budget for ergy production. vironment and the Control of Energy), rict heating) in other sectors, including ie.
Derived Heat	 7 district heating networks bigger than 5MW with a total capacity of 63.131 kW. 181 district heating networks smaller than 5MW with a total capacity of 137.269 kW. Projections estimate the total capacity to grow to 887.520 kW with 688 networks in 2020 	 New major bioheat plants announced for peak demand Several big and mid-size cities are introducing new bio-heating plants to replace old fossil ones on DH-network: Lahti (350 MW), Naantali (450 MW), Seinäjoki (90 MW), Helsinki (100 MW), Turku (40 MW), Tampere (100 MW). 	Programmation pluriannuelle de l'énergie (PPE) : multiyear budget for investment & multiyear program for energy production. According to ADEME (Agency of the Environment and the Control of Energy), the production of energy (including district heating) in other sectors, including services, in 2020 will be around 1,5 Mtoe.
Industry	it is becoming more competitive than fossil fuels in the Spanish market.	o New major pulp plants will produce their energy demand from side streams. Additionally, they will deliver excess side streams to district heat networks and electricity grid	A system of investment aid managed by the French environmental agency (ADEME) called Fonds Chaleur with a budget of around 210 million £/year to help any heat project (wood energy, biogas, geothermal, solar, district heating, energy recovery of waste meaning incineration). Those projects have difficulties to emerge due to the very low price of fossil energies and past mild winters. And the budget of the Fonds Chaleur is seen as insufficient. The target fixed in the Programmation pluriannuelle de l'énergie (PPE) is for solid biomass
Residential	 During 2017 heating oil was increasing slightly and installations of boilers and stoves was increasing Pellet demand in last winter was quite high 	 → No major changes on incentives ◆ Low LFO market prices and no major changes to their taxation 	 Mild winters for the past years Falling oil prices Harmful messages on air quality in Europe and in France National problems: Thermic Regulation (RT1012) excluded wood heating from the bonus when it is used as complementary heating system in a house. In order to get a tax credit the project must be undertaken in its entirety by a registered builder with the qualification label RGE.
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Other sectors		◆ Consideration is given to the possibility of using heat for the production of bio-oils and other bio-derivate, especially as EU legislations foresees a higher share of biodiesel and bio-waste, and more and more owners of CHP plants consider the possibility of organizing production of bio derivates as part of their technological process, and because of a surplus of the produces heat.		y sources by 2020. The renewable heat ization in the timber processing sector. and now faces potential EU fines. The reland falls short of its overall combined A • A Renewable Heat Incentive is to be introduced in 2017 • Government has RH targets to meet at National level, with substantial fines if not achieved
Derived Heat		 Some specific legal measures suggest the construction of a CHP plant in areas where there is a possibility that their derived heat will be used for other purposes outside the industry, but the same is not supported by the Government with concrete subsidy measures. There are pioneering examples of district heating design, and there is no implementation of measures to promote this form of energy utilization. 	N.A.	The Irish government white paper on energy policy set a target of 12 percent of thermal energy to come from renewable energy sources (RES-H) trajectory, Ireland's 2020 target will not be achieved, and Ireland now faces potential EU fines. The Sustainable Energy Authority of Ireland has estimated the cost to Ireland may be up to £150 million for each percentage point Ireland falls short of its overall combined RES target of 16 percent. Therefore new investment in the bioenergy sector are predicted. → • Do not forese any further → • A Renewable Heat Incentive is to be introduced in 2017 • Covernment has RH targets to meet at National level, with inteland and many installers have relocated to South → • In January 2016, they stopped meet to National level, with installers have relocated to South ← RH in North Ireland and many installers have relocated to South ← Ireland falls short of its overall combined area will not be achieved, and Ireland not fine to the time of the fat incentive is to be introduced in 2017 • A Renewable Heat Incentive is to be introduced in 2017 • A Renewable Heat Incentive is to be introduced in 2017 • A Renewable Heat Incentive is to be introduced in 2017 • A Renewable Heat Incentive is to be introduced in 2017 • A Renewable Heat Incentive is to be introduced in 2017 • A Renewable Heat Incentive is to be introduced in 2017 • A Renewable Heat Incentive is to be introduced in 2017 • In January 2016, they stopped meet at National level, with installers have relocated to South • In January 2016, they stopped meet at National level, with installers have relocated to South in anticipation of new RHI • In January 2016, they stopped meet at National level, with any substantial fines if not achieved in 2017
Industry	: 12 000 ktoe in 2018 and between 13 000 and 14 000 Ktoe in 2023. The target for heating district is 1,35Mtoe in 2018 and between 1,9 and 2,3 Mtoe in 2023.	 The industry, especially the wood industry, uses heat in the process of drying wood and other forms. The heat users in the industry with surplus of raw materials often initiate the construction of a CHP plant. 		wever, having grown slowly to 6.5 percent in 2014, wever, having grown slowly to 6.5 percent in 2014, ble energy sources (RES-H) trajectory, Ireland's 2020 has estimated the cost to Ireland may be up to £150 w investment in the bioenergy sector are predicted. 7 • A Renewable Heat Incentive is 7 • A to be introduced in 2017 • Government has RH targets to sid meet at National level, with substantial fines if not achieved • In January 2016, they stopped the RHI in North Ireland and many installers have relocated to South Ireland in anticipation of new RHI. • In Currently there is a massive
Residential		 There are no incentives for the ⇒ use of heat district heating systems. 		The Irish government white paper on energy policy set a tasector remains largely undeveloped, however, having grow Based on its current heat from renewable energy sources (I Sustainable Energy Authority of Ireland has estimated the can RES target of 16 percent. Therefore new investment in the financial incentives • Lack of awareness of citizens • Low cost of fossil fuels • Low cost of fossil fuels • Low cost of fossil fuels • In January 2 the RHI in No installers have Ireland in ant Ireland in ant Currently the
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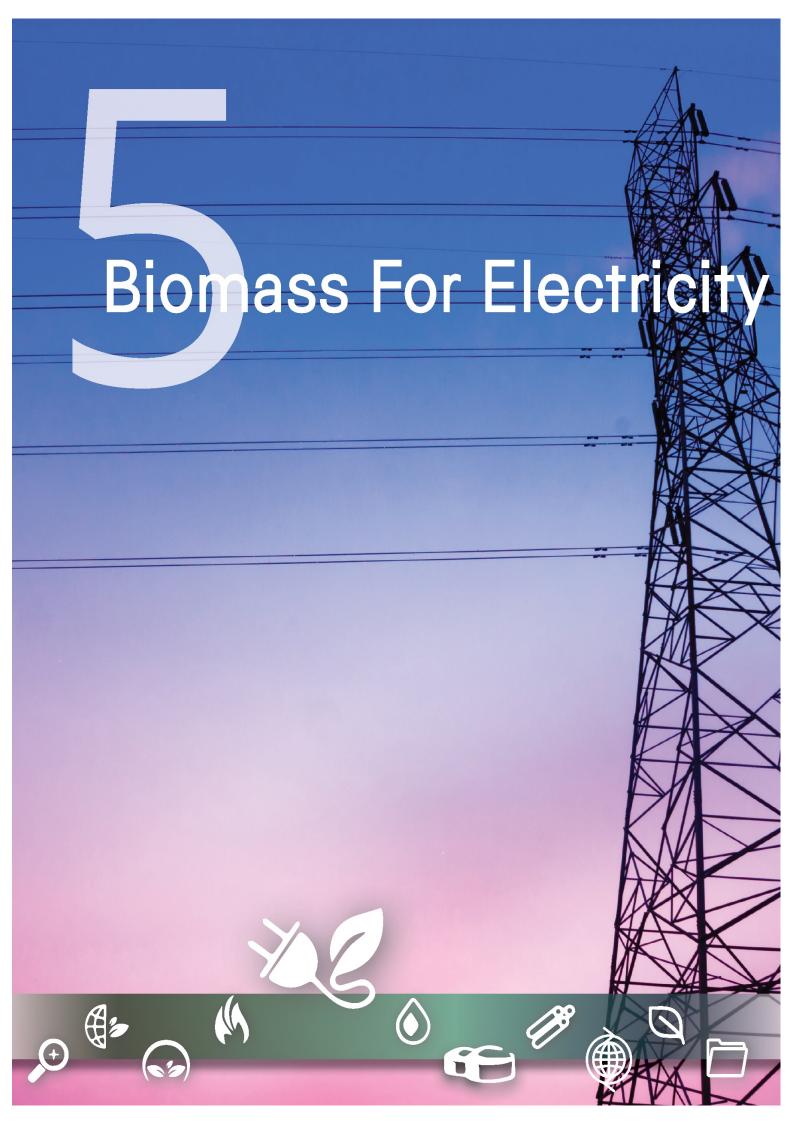
Other sectors		There are no significant measures for increasing the use of biomass in this sector
Derived Heat	 With fossil fuel prices now at an all- time low, incentives are needed to support new projects 	 ◆ There are no significant measures for increasing the use of biomass in this sector
Industry		• Feed-in-tariff called Certificati Bianchi or Titoli di Efficienza Energetica are certificates for the energy savings and the reduction of energy consumption. Investment support for Energy efficiency measures for biomass plants.
Residential		 Feed-in-tariff called Conto Termico. Investment support scheme to help the technological turnover within heating systems. This support scheme helps the replacement of existing outdated heating and cooling systems fed with biomass and heating oil with high performing renewable energy devices (both boilers and stoves). The Conto Termico is based on a supply-chain approach to guarantee efficiency and low emissions. Just high-quality heating systems shall be installed. The minimum requirements for heating systems are shown in Table 1. Air pollution will be one of the main market driver for the future development of the biomass heating systems in Italy Huge potential for replacing outdated biomass heating systems, mainly wood stoves. Investment in R&D for reducing the air pollution from biomass combustion will be one of the key driver for the residential market Wood fuels are still cheaper than oil and market penetration among families
		E

Other sectors	• Foreseen a slight biomass using growth in agriculture (cheaper to use because farmers have an infrastructure for that)		→ No major changes expected.		 SDE scheme focus very much in this market. Service sector is a big user of natural gas and pay a large
Derived Heat	 Foreseen two more big CHP plants in Vilnius and Kaunas. The cogeneration power plant planned in Vilnius will comprise 18 MW electric power and, respectively, about 53 MW thermal power wastefired and about 70 MW electric power and, respectively, about 174 MW thermal power biofuel-fired high-efficiency cogeneration facilities. For Kaunas plant the goal is to define the potential range of capacities (23 MW +/- 25 % of electricity generating capacity and about 70 MW +/- 25 % of heating generating capacity accordingly). Some more biomass boilers will be built in smaller cities The use of biomass for energy production in the DH sector accounted for 65% in 2014 and will grow to 70-80% in 2020 	N.A.	A Slight growth due to feed-in tariffs for bioelectriciy and an increase number of CHP plants.	N.A.	 • Holland has indigenous natural gas, nevertheless the government announced the reserves to last for 17 years. Besides natural gas exploration
Industry	because of cost efficiency as because of cost efficiency as biomass is much cheaper than gas. Wood chips prices are about 4 times cheaper than natural gas.		Historically industry in Latvia have been using mainly gas. As biomass is cheaper than gas, industry are switching progressively to biomass. 90% of the bioheat in industry uses wood chips.		 In the country targets of renewables up to 2025, biomass will contribute to almost half. Government is in discussion with
Residential	 Foreseen State support for changing old furnaces to new more efficient technologies. Nevertheless, it is not necessary that all the residents who will have to change their old furnaces to some newer technology will change to efficient biomass boilers – they may change them to some other technologies as well. Boilers' efficiency when changing to new ones will increase from 40% to 80-85% and it will reduce biomass usage in the country. At the moment there are about 400.000 private households in Lithuania using about 500-550 ktoe of biomass. 		Consumers are switching to cheaper fuels that offer a comfort level. While gas prices in Latvia are about the same as in Central Europe, pellets are far cheaper. Also more promotion for pellets consumption is expected.		• New investment subsidy in 2016 for small boilers and households (until 500kW). It is the first time that there is a support to the
	<u>*</u>	3	2	Ā	*

Other sectors	amount on energy tax, which makes biomass an attractive alternative. Natural gas is cheaper for greenhouses but government is asking them to reduce the consumption and increase the consumption of RES. • Farming industry is increasing the use of pellets.	Investment support in the service sectors. For example, some hospitals are switching to biomass.
Derived Heat	is the responsible for earthquakes in the country. The combination of these factors is making the government to act for reducing natural gas use and promote renewables. District heating could be an alternative to reduce natural gas consumption in cities.	From 2000-2004 there were ecofunds to support municipalities to change coal based boilers to straw or biomass. The growth of CHP industry was high during this years. When ecofunds were not available, the growth stopped. Currently the government dedicates structural funds to support renewable heat however biomass is not the only choice (solar collectors, heat pumps), therefore the growth from the coming years is expected to be lower than in the previous decade.
Industry	industry to see how to reach this target and more use of biomass for heat in industry is expected in the coming years.	In the past years the consumption of biomass for heat in industry grew a lot in Poland because many industries (wood-based, food industry) switched from coal to biomass based heat in order to use their own resources. The use of heat in industry is expected to grow but the room for growth is more limited.
Residential	biomass for heat market which gives a positive insight to the market. • Holland has indigenous natural gas, nevertheless the government announced the reserves to last for 17 years. Besides natural gas exploration is the responsible for earthquakes in the country. The combination of these factors is making the government to act for reducing natural gas use and promote renewables. Housing will play an important role.	 The regulation on limitation of emissions stimulates municipalities to switch from coal to biomass, nevertheless the implementation of the plans is being slower than expected. Strong lobbying of coal industry. For example, they proclaim that have new "blue" coal fuel with lower emissions. Government support to coal industry In the Renewable Energy Act released in February 2016, cofiring is supported; even if this support was removed in previous versions. Besides government announced that coal mines won't be close. Cheap prices of coal and worries of the citizens for the security of supply, don't incentive the investment in biomass devices at this moment.
		* <u></u>

	F	8	ᅜ
Residential	The major factor influencing negatively major forest areas are extremely fragm of biomass. Moreover, in the last few development, this situation led to an extra addition, the lack of clear Portuguese. This conjunction of factors leads to Portas conjunction of factors leads to Portas schemes for biomass in the residential heating sector, only indirect ones through building energy certification following as result of the application of the Energy Performance of Buildings Directive (2010/31/EU).		→ No major changes expected. Of the 2 million single homes in Sweden, in 2016 only 304 000 had their own boilers (the rest are supplied with electric heating, heat pumps or district heating), and the number of boilers decreased with 136 000 since 2008 (-31%). 86.9% of the boilers use some kind of solid fuel (up from 73.2% in 2008). 83 000 of these boilers use wood pellets (down 3 200 from 2015), the rest mainly firewood. In addition, there are 1.8 million wood stoves and 30 000 pellet stoves in use. No subsidies are given, but the market is driven by carbon taxation.
Industry	The major factor influencing negatively the development of bioelectricity and bioheat s major forest areas are extremely fragmented by small private owners, which makes it of biomass. Moreover, in the last few decades Portugal have experienced a growing g development, this situation led to an exodus of populations from the rural interior, which makes it of biomass. Moreover, in the last few decades Portugal have experienced a growing g development, this situation led to an exodus of populations from the rural interior, which makes it of biomass. In the last few decades Portugals acromated a growing g development, this situation led to an exodus of populations and strongle large forest legislation and a strong land-use plannin. This conjunction of factors leads to Portuguese large forest territory losses in dry years. In addition, the lack of clear Portuguese forest legislation and a strong land-use plannin. This schemes for biomass in the lact forest industry, and construction. In A.A. In addition, the lack of clear Portuguese forest legislation and a strong land-use plannin. This plant in differency where a large forest industry, and construction. In A.A. In addition, the lack of clear Portuguese forest legislation and a strong large formal undustrict. which makes it of popularial in additions are an extended and any plan. In A.A. In addition, the lact in the lact industry, and construction. In A.A. In addition, which lactors industry, and construction. In A.A. In addition, which lactors in the forest industry, and construction. In A.A. In addition, which lactor industrial use of bossil has been converted to biomass. In addition, where a limost all use of fossil has been converted to biomass. In addition, which lactric heating, here almost all use of fossil has been converted to biomass. In addition, which lactric heating, here almost all use of fossil has biomass outside ETS and the forest industry, and construction.		
Derived Heat	The major factor influencing negatively the development of bioelectricity and bioheat sectors is forest fragmentation combined with internal migrations. In Portugal, the major forest areas are extremely fragmented by small private owners, which makes it operationally impractical and economically nonviable to exploit the real potential of biomass. Moreover, in the last few decades Portugal have experienced a growing gulf between peripheral rural regions and coastal rural regions due to economic development, this situation led to an exodus of populations from the rural interior, which ultimately caused the negligence of large forest areas. This conjunction of factors leads to Portuguese forest territory losses in dry years. There are not direct support Schemes for biomass in the bioheat in industry sector. Lesidential heating sector, only support schemes through the energy certification of the programme is integrated into programme is integrated into plan. Energy Performance of Buildings Directive (2010/31/EU).	N.A.	→ District heating already covers almost all floor space in apartments and offices, and 75% of the fuel in DH is biomass and biogenic waste. Some expansion to single homes and industry is possible, but efficiency measures in existing buildings counterbalance the expansion of the grids.
Other sectors	with internal migrations. In Portugal, the ly nonviable to exploit the real potential d coastal rural regions due to economic rge forest areas. Ispects difficult to overcome. Possible development due to the Portuguese's Adaptation Climate Change Strategy.		The sector is mainly driven by carbon taxation. But also by possibilities to get direct support for climate projects (Klimatklivet). The money available under this scheme was increased in the newly proposed state budget. Tax deductions have been removed for greenhouses, and these are converting to biomass. Fossil free farming is developed, but the tax incentives are weaker than in other sectors.

New support schemes will be announced in December 2016 (to be implemented in April 2017), nevertheless the current government proposal is not to update support to heat in residential market which at the moment is too low to stimulate citizens to switch to biomass.
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5.1 Electricity and RES electricity in Europe

The table below shows the fuels used in Europe for the electricity generation in power plants. Table 4.2 (chapter 4) gives the figures for electricity generation in CHP plants.

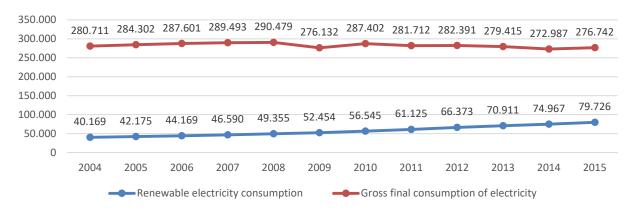
In the following tables and according to Eurostat, <u>autoproducer</u> represents enterprises, either privately or publicly owned, which generate electricity and/or heat wholly or partly for their own use as an activity which supports their primary activity. While <u>main activity</u> represents enterprises, both privately or publicly owned, which generate electricity and/or heat for sale to third parties as their principal activity

Table 5.1 Fuels used for the production of electricity in electricity plants* in EU28 in 2015 (ktoe)

	Main activity	electricity plants		Autoproducer electricity plants				
Fuels	Fuel input	Contribution to Fuel input	Output	Fuel input	Contribution to Fuel input	Output		
Solid fossil fuels	126.215	30,31%		695	5,40%			
Oil	7.157	1,72%		189	1,50%			
Gas	38.400	9,22%		5.194	40,70%			
Other RES	7.815	1,88%		0	0,00%			
Wastes (non.ren.)	2.180	0,52%	151.573	1.526	12,00%	4.281		
Solid biomass	7.717	1,85%	131.373	1.630	12,80%	4.201		
Biogas	3.188	0,77%		2.305	18,10%			
Municipal waste renewable	1.857	0,45%		1.188	9,30%			
Biofuels	622	0,15%		38	0,30%			
Nuclear heat	221.202	53,13%		0	0,00%			
TOTAL	416.353	100%	151.573	12.766	100%	4.281		

^{*} Power plant producers are classified either as "Main activity producers" (plants operated by private or public owners which are producing the electricity or heat for sale to third parties as their main business) or as "Autoproducers" (plants operated by private or public owners which are not producing the electricity or heat as their main business, but wholly or partly for their own consumption). Source: Eurostat

Figure 5.1 Evolution of total gross final consumption of electricity* and gross final consumption of electricity from renewable sources in EU28 (ktoe)



^{*} Calculated according to the methodology established on Directive 2009/28/EC and also Regulation (EC) No 1099/2008. Hydro is normalised and excluding pumping. Wind is normalised. Solar includes solar photovoltaics 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

70,3% 70% 65,8% ■ Share of RES for electricity Growth 2004-2015 60% 52,6% 52.2% 51,3% 50% 45,4% 43,2% 40% 36,9% 33,5% 32,7% 32,5% 30,7% 28,8% 30% 25,2% 22.1% 19,1% 18,8% 20% 15.5% 13,4% 11,1% 14,1% 10% 0% 426650446464666446060000 8 8 80 St

Figure 5.2 Share of RES in total gross final consumption of electricity* in EU28 Member States in 2015 (%) and growth of this share between 2004 and 2015 (in percentage points)

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

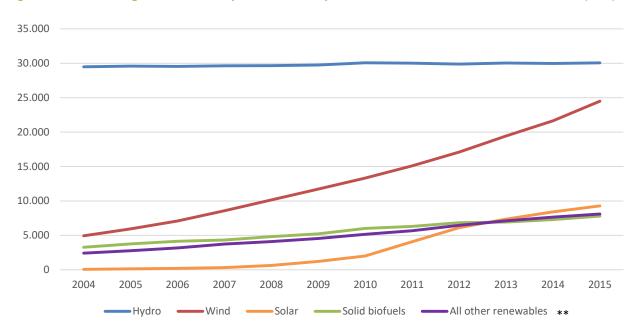


Figure 5.3 Evolution of gross final consumption of electricity from renewable sources* in EU28 - 2004-2015 (ktoe)

^{*} 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

100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0% £1728 8k 4 4 经数据的 经存货 经 < 小学学的 2 20 SK 5 5 ■ electricity from CHP out of total electricity generation ■ bioelectricity from CHP out of total bioelectricity

Figure 5.4 Share of gross electricity generation from CHP and share of bioelectricity produced from CHP in 2015 in EU28 Member States (%)

Source: Eurostat

Figure 5.5 Share of renewable electricity generation in the EU28 in 2015 (%)

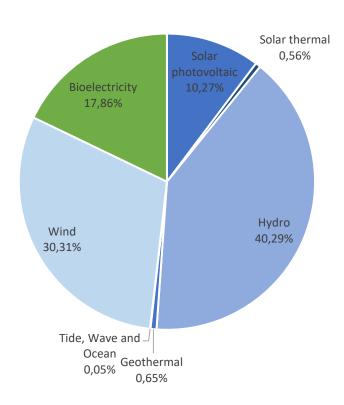
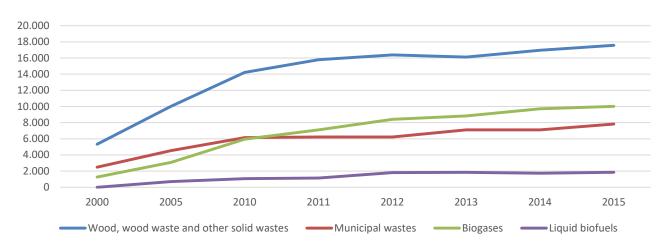


Table 5.2 Gross electricity generation from renewables in EU28 Member States in 2015 (ktoe)

	Renewables	Hydro	Wind	Bioelectricity	Solar photovoltaic	Solar thermal	Geothermal	Tide, wave and ocean
EU28	85.634,7	34.500,5	25.956,1	15.295,3	8.798,9	480,9	560,9	42,1
AT	4.670,3	3.794,3	416,2	379,2	80,6	0,0	0,0	0,0
BE	1.432,9	216,5	479,3	473,5	263,6	0,0	0,0	0,0
BG	837,5	570,3	124,8	23,5	118,9	0,0	0,0	0,0
CY	34,3	0,0	19,0	4,4	10,9	0,0	0,0	0,0
CZ	1.029,6	373,8	49,3	411,8	194,7	0,0	0,0	0,0
DE	17.128,9	2.649,9	6.810,5	4.327,1	3.329,9	0,0	11,5	0,0
DK	1.630,4	1,5	1.215,2	361,7	52,0	0,0	0,0	0,0
EE	129,2	2,3	61,5	65,4	0,0	0,0	0,0	0,0
EL	1.285,7	533,3	397,3	19,8	335,3	0,0	0,0	0,0
ES	8.903,4	2.974,7	4.241,2	495,8	710,8	480,9	0,0	0,0
FI	2.624,7	1.441,9	200,1	981,9	0,8	0,0	0,0	0,0
FR	8.536,4	5.534,0	1.827,1	509,2	624,2	0,0	0,0	41,9
HR	674,1	577,9	68,4	22,9	4,9	0,0	0,0	0,0
HU	276,0	20,1	59,6	185,8	10,5	0,0	0,0	0,0
IE	725,2	119,0	565,2	40,9	0,1	0,0	0,0	0,0
IT	9.610,7	4.161,8	1.276,4	1.668,0	1.972,7	0,0	531,8	0,0
LT	260,2	146,0	69,6	38,3	6,3	0,0	0,0	0,0
LU	283,0	254,5	8,8	10,8	8,9	0,0	0,0	0,0
LV	238,7	160,0	12,6	66,1	0,0	0,0	0,0	0,0
MT	8,6	0,0	0,0	0,6	8,0	0,0	0,0	0,0
NL	1.177,3	8,0	649,1	423,8	96,4	0,0	0,0	0,0
PL	2.054,0	261,2	933,6	854,3	4,9	0,0	0,0	0,0
PT	2.291,5	940,5	998,1	267,0	68,4	0,0	17,5	0,0
RO	2.317,4	1.494,5	607,4	45,1	170,4	0,0	0,0	0,0
SE	8.830,1	6.497,4	1.398,8	925,6	8,3	0,0	0,0	0,0
SI	423,0	376,0	0,5	22,9	23,6	0,0	0,0	0,0
SK	566,0	379,0	0,5	143,0	43,5	0,0	0,0	0,0
UK	7.655,0	1.011,7	3.466,0	2.527,0	650,1	0,0	0,0	0,2

5.2 Bioelectricity in Europe

Figure 5.6 Evolution (2000-2015) of electrical capacity from biomass in EU28 (MW)



Source: Eurostat

Table 5.3 Electrical capacity from biomass in EU28 Member States in 2015 (MW)

	Municipal wastes	Wood, wood waste and other solid wastes	Biogas	Liquid biofuels
EU28	7.827	17.571	10.014	1.846
AT	570	993	194	1
BE	248	588	183	39
BG	0	34	20	0
CY	0	0	10	0
CZ	45	380	368	0
DE	1.924	2.075	4.803	233
DK	331	973	102	1
EE	210	165	11	0
EL	0	2	49	0
ES	234	677	224	0
FI	0	1.794	0	0
FR	782	483	320	0
HR	0	25	28	0
HU	49	422	69	0
IE	22	5	53	0
IT	830	616	1.336	996
LT	10	45	21	0
LU	17	4	12	0
LV	0	66	60	0
MT	0	0	3	0
NL	649	299	239	0
PL	15	740	216	0
PT	79	471	66	0
RO	0	104	14	0
SE	876	3.700	2	576
SI	0	30	32	0
SK	11	145	91	0
UK	925	2.735	1.488	0

Table 5.4 Gross electricity generation from bioenergy in EU28 Member States in 2015 (ktoe)

	Total	Renewable municipal waste	Solid biomass excl. Charcoal	Biogas	Biofuel
EU28	15.295,30	1.781,80	7.801,30	5.238,30	473,90
Share (%)	100%	11,65%	51,00%	34,25%	3,10%
AT	379,2	24,8	300,7	53,7	0
BE	473,5	74,6	305,6	82,1	11,2
BG	23,5	0	13,1	10,4	0
CY	4,4	0	0	4,4	0
CZ	411,8	7,5	179,8	224,5	0
DE	4.327,10	496	948,8	2.843,80	38,50
DK	361,7	79	241	41,7	0
EE	65,4	0	61,1	4,3	0
EL	19,8	0	0,1	19,7	0
ES	495,8	66,1	345,2	84,5	0
FI	981,9	40,5	910,4	30,8	0,2
FR	509,2	171,9	184	153,3	0
HR	22,9	0	7,7	15,2	0
HU	185,8	17,9	142,7	25,2	0
IE	40,9	6,6	16,9	17,4	0
IT	1.668,00	201,6	339,4	706,1	420,9
LT	38,3	3,6	27,3	7,4	0
LU	10,8	3,4	2,1	5,3	0
LV	66,1	0	32,5	33,6	0
MT	0,6	0	0	0,6	0
NL	423,8	171,7	163,1	89	0
PL	854,3	0	776,1	77,9	0,3
PT	267	25,1	216,6	25,3	0
RO	45,1	0	39,8	5,3	0
SE	925,6	150,4	771,9	0,9	2,4
SI	22,9	0	11,2	11,4	0,3
SK	143	1,9	94,5	46,6	0
UK	2.527,00	239,2	1.669,70	618,1	0

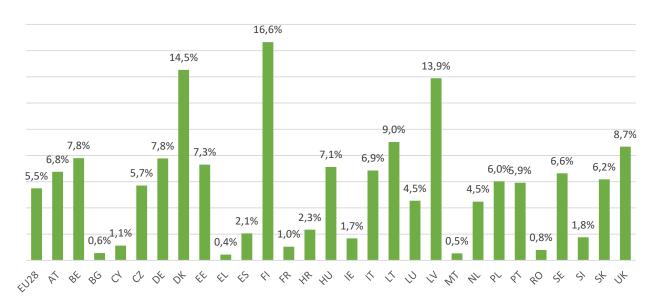
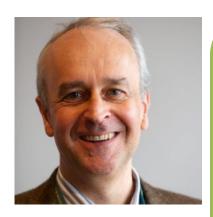


Figure 5.7 Share of bioelectricity generation out of total gross electricity generation in EU28 Member States in 2015 (%)



BioPower in Europe doubled between 2000 and 2005 and tripled between 2000 and 2015: this came about mainly due to the conversion of several **coal** boilers to wood pellets. This trend is led mainly by Belgium, the Netherlands, the UK and Denmark. However, since this time the growth has been much more modest due to a significant reduction in the support given to cofiring, where this support existed.

The main growth of renewable electricity has come from wind power and, especially at the beginning, from solar power, whose growth has been much smaller in recent years due to reduced support.

Biopower generates slightly less than 20% of the total renewable electricity output in Europe, comparable to the situation in Belgium. Today the debate on EU sustainability criteria for biomass places the sector under scrutiny: depending on the final outcome it may be severely restricted.

Nevertheless, biopower will be needed in the future to sustain further ambitious targets for the decarbonisation of the power sector in Europe in the coming decades. Biopower also has a role to play as a major source of low-carbon dispatchable power needed as a backup to erratic generation of wind and solar power.

In the short term, the growth of biopower is expected to remain relatively stable in countries such as Belgium and the UK, to remain low in the Netherlands and to grow most strongly in Denmark, as well as in Northern and Eastern Europe as this is the area where most of the solid biomass resources are available in large quantities. The recent development by SBP of third-party certification of solid biomass resources has gained sufficient recognition to offer guarantees that the biomass used for large scale biopower is sustainable.

Yves RYCKMANS, PhD Engineer Chief Technology Officer Biomass and Solid Fuels at Engie-Laborelec

Table 5.5 Bioelectricity generated from CHP and electricity only plants in EU28 Member States in 2015 (ktoe)

	CHP plants	Electricity plants	% of bioelectricity produced in CHP plants
EU28	8.829,5	6.465,8	58%
AT	202,9	176,3	54%
BE	234,3	239,2	49%
BG	20,2	3,3	86%
CY	4,4	0,0	100%
CZ	403,2	8,6	98%
DE	2.843,2	1.483,9	66%
DK	361,6	0,1	100%
EE	59,4	6,0	91%
EL	16,8	3,0	85%
ES	105,3	390,5	21%
FI	856,7	125,2	87%
FR	341,3	167,9	67%
HR	20,8	2,1	91%
HU	81,4	104,4	44%
IE	3,7	37,2	9%
IT	822,9	845,1	49%
LT	38,3	0,0	100%
LU	7,4	3,4	69%
LV	66,1	0,0	100%
MT	0,6	0,0	100%
NL	271,9	151,9	64%
PL	686,0	168,3	80%
PT	149,5	117,5	56%
RO	33,3	11,8	74%
SE	925,6	0,0	100%
SI	22,6	0,3	99%
SK	132,6	10,4	93%
UK	117,6	2.409,4	5%

5.3 Evolutions and prospects of bioelectricity

Table 5.6 Evolution of bioelectricity 2000-2014 in EU28 Member States (ktoe)

	Tot	al bioelectri	city	Bioele	ectricity fro plants	om CHP	Bioelect	tricity from e	
	2000	2010	2015	2000	2010	2015	2000	2010	2015
EU28	2.929	10.642	15.295	1.750	6.546	8.830	1.179	4.096	6.466
AT	132	384	379	95	216	203	37	168	176
BE	49	373	474	16	142	234	33	231	239
BG	0	3	24	0	3	20	0	0	3
CY	0	3	4	0	3	4	0	0	0
CZ	45	186	412	31	130	403	14	56	9
DE	372	2.950	4.327	0	1.937	2.843	372	1.013	1.484
DK	112	395	362	112	395	362	0	0	0
EE	1	64	65	1	44	59	0	20	6
EL	0	16	20	0	3	17	0	14	3
ES	128	345	496	58	113	105	70	232	391
FI	743	944	982	687	798	857	56	146	125
FR	213	382	509	125	185	341	88	197	168
HR	0	3	23	0	3	21	0	0	2
HU	6	198	186	6	28	81	0	170	104
IE	8	27	41	0	4	4	8	24	37
IT	120	812	1.668	56	280	823	64	532	845
LT	0	13	38	0	13	38	0	0	0
LU	2	7	11	0	5	7	2	2	3
LV	0	6	66	0	5	66	0	1	0
MT	0	0	1	0	0	1	0	0	0
NL	171	605	424	65	350	272	107	255	152
PL	19	542	854	16	542	686	3	0	168
PT	112	225	267	89	135	150	23	90	118
RO	0	10	45	0	6	33	0	4	12
SE	352	1.048	926	352	1.048	926	0	0	0
SI	6	19	23	6	18	23	0	1	0
SK	0	57	143	0	57	133	0	0	10
UK	338	1.028	2.527	35	86	118	304	942	2.409

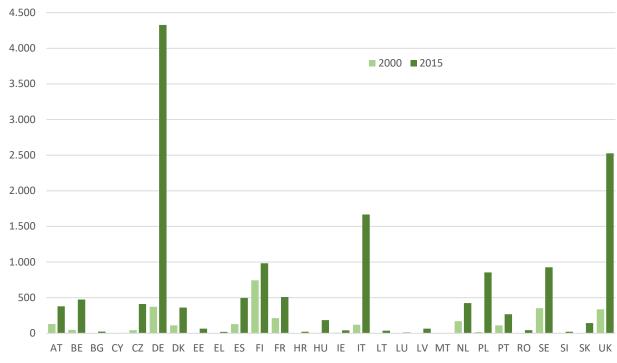


Figure 5.8 Total bioelectricity in 2000 and 2015 in EU28 Member States (ktoe)

Figure 5.9 shows the projections calculated by AEBIOM for bioelectricity until 2020. The bioelectricity generation is predicted using a multiple linear analysis where the historical bioelectricity consumption (Eurostat data, between 2000 and 2015), was correlated with the GDP per capita and the evolution of the use of other RES in electricity.

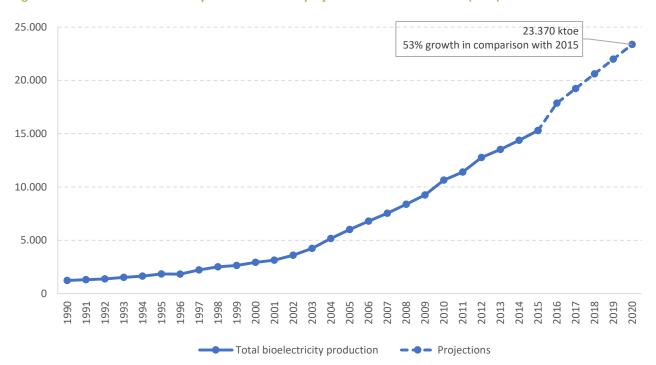


Figure 5.9 Evolution of bioelectricity in 1990-2015 and projections until 2020 in EU28 (ktoe)

Source: Eurostat (data 1990-2015) and projections based on AEBIOM methodology

100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0% 1992 1993 1995 1996 1997 1999 2002 2007 2008 2009 2010 2012 2013 2001 ■ Contribution bioenergy to renewable electricity generation ■ Other renewable electricity

Figure 5.10 Contribution of bioelectricity to the renewable electricity generation in EU28 between 1990-2015 and projections until 2020 in EU28 (ktoe)

Source: Eurostat (data 2000-2015) and projections based on AEBIOM methodology

 Bioelectricity produced in CHP plants No major growth is expected due to lack of support. The support given to plants was guaranteed for 13 years, which will be reached by 100 to 2020 in most of the cases. If no new supports are implemented it is expected that Austria will lose about 80 % of biomass and biogas CHP plants. • Main industries have already installed CHP, some are reaching their end-of-life and will not be replaced if incentives are not attractive. However some industries could consider new CHP projects. • New gasifiers (30-50 KWe) is an emerging market in the service or industry sector. • There was another project expected in 2016 from Belgian Eco Energy (BE) in Gent of 215 MW electricity and 110MW heat. The project stopped due to the implementation of a tax on Green Electricity and the rejection of green certificates. • Renewable Energy Law 165/2012 is not supporting new installations of electricity generation. There is a support for CHP, but the support is guaranteed only for a period of one year. It is now giving sufficient certainties for investors. • In the 2015 support of biomass cofiring with with coal has been limited to installation with more than 70 % efficiency. This caused significant reduction in the cofiring sector and created approximatively 300 000 t/y of biomass to heat project are now in the installation. • The revised Renewable Energy Lav 2017 (EEG- Eneuerbare-Energien-Gesetz), entered into force in January 2017, introducing an auction based system for all bioenergy technologies (solid and gaseous biomass). All technologies compete in a tender process for 150 MW/year, closing date It *6 f September. Both, new and existing plants (after initial 20 year period) are eligible for the auction system • The first bidding round in September 2017 only saw 33 bids, 9 tenders 	Bioelectricity produced in electricity only plants	 No major growth is expected due to lack of support. 	• The power plant Les Awirs, owned by Engie, which generates 600GWh annually will stop in 2020.	N.A.	N.A.	It is not supported any longer.	The revised Renewable Energy Law 2017 provides an auction system only granting a feed in tariff for electricity. Heat, as well as balancing energy should be part of the equation in order to enable low bids for electricity. Electricity only-plants are assumed to be uncompetitive without heat sales.
		growth is expected due to lack of support. The support ints was guaranteed for 13 years, which will be reached by to in most of the cases. If no new supports are implemented at that Austria will lose about 80 % of biomass and biogas	 • Main industries have already installed CHP, some are reaching their end-of-life and will not be replaced if incentives are not attractive. However some industries could consider new CHP projects. • New gasifiers (30-50 KWe) is an emerging market in the service or industry sector. • There was another project expected in 2016 from Belgian Eco Energy (BBE) in Gent of 215 MW electricity and 110MW heat. The project stopped due to the implementation of a tax on Green Electricity and the rejection of green certificates. 	"Z	"Z		 The revised Renewable Energy Law 2017 (EEG- Erneuerbare-Energien-Gesetz), entered into force in January 2017, introducing an auction based system for all bioenergy technologies (solid and gaseous biomass). All technologies compete in a tender process for 150 MW/year, closing date 1st of September. Both, new and existing plants (after initial 20 year period) are eligible for the auction system The first bidding round in September 2017 only saw 33 bids, 9 tenders not accepted due to missing declarations or formal requirements Average auction value: 14,30 ct/kWh new plants: 14,81 ct/kWh

	Bioelectricity produced in CHP plants	Bioelectricity produced in electricity only plants
	 existing plants: 14,16 ct/kWh Only 27 MW have been auctioned, the non-assigned volume will be auctioned next year. 	
ă O	 The development is expected to be positive towards 2020, but levelling off thereafter To incentivize the conversion from fossil fuel (mainly coal) based power, biomass is exempted from energy tax and CO₂-tax, making it an attractive business case. This has caused a massive conversion of previously mainly coal-fired central CHP plants to now biomass-fueled plants Increased wind power capacity reduces the need for thermal power generating capacity Low power market prices make it less attractive to add new power capacity, regardless of whether it is biomass-based or fossil The motivation for new or conversions of CHP plants is heat generation, not power 	
出		N.A.
ᆸ		N.A.
SI .	 No feed-in tariffs or another support scheme since 2012 New tax for electricity generation (7%) No expectative that the government will change its policy 	 No feed-in tariffs or another support scheme since 2012. There will be few new projects that are still under construction and will benefit for the previous feed-in tariffs. New tax to electricity generation (7%) No expectative that the government will change its policy There was a reverse auction for 200MW. The projects who won the auction did a price reduction of 100% of the feed-in-tariff value. Therefore, there are some concerns about the economic viability of those projects and they are not expected soon.
* <u></u>	 Major uncertainty remains over the electricity markets due to overcapacity on the Nordic markets which decreases profitability of bioelectricity from CHP and condensing power. Low electricity prices and surplus of electricity on the market. 	 Major uncertainty remains over the electricity markets due to overcapacity on the Nordic markets which decreases profitability of bio-electricity from CHP and condensing power. Low electricity prices and surplus of electricity on the market.
Æ	Since 2016, France have a system of call for tenders for installations above 300 kW. It is a three year call for tenders (2016, 2017 and 2018). The power demand is 50MW each year for wood energy (including 10MW for installations under 3 MW). The price proposed has to be between 50€/MWh and 200€/MWh. For the first year, 12 projects were selected for a total of 64,61 MW. Since 2016, a multiyear program for energy production called <i>Programmation pluriannuelle de l'énergie</i> (PPE) has been implemented. It gives target production: for electricity from wood energy, it is 540 MW by the end of 2018 and between 237 MW and 300 MW by the end of 2023. The work has begun to make a new one by the end of 2018 with targets for 2028.	2016, France have a system of call for tenders for installations above 300 kW. It is a three year call for tenders (2016, 2017 and 2018). The power and is 50MW each year for wood energy (including 10MW for installations under 3 MW). The price proposed has to be between 50¢/MWh and /MWh. For the first year, 12 projects were selected for a total of 64,61 MW. Since 2016, a multiyear program for energy production called <i>Programmation pluriannuelle de l'énergie</i> (PPE) has been implemented. It gives target of production: for electricity from wood energy, it is 540 MW by the end of 2018 and between 237 MW and 300 MW by the end of 2023. The work has begun to make a new one by the end of 2018 with targets for 2028.
Ŧ	 The OIE Act foresees a large support for the use of RES, i.e. the production of electricity from CHP plants. Initially, all RES had the same 	- The RES Law and related regulations provide that every biomass electricity producer must use the obtained heat. It is also defined

Bioelectricity produced in electricity only plants	through the use of at least 50 percent of the heat produced, which must be used in the technological process of CHP plants or other forms of energy consumption, such as pelletizing, woodworking, greenhouse heating and other heat consumers. le le t t	N.A.	• Support measures for bioelectricity • Two new E only plants: 8MW and 15MW • Two new E only plants: 8MW and 15MW	• No specific measures for supporting bioelectricity are foreseen. Since the electricity generation is largely based on public support schemes, it is possible to predict that in the coming years the production will be stable or declining	I	N.A.	✓ No electricity from electricity only plants f	N.A.
Bioelectricity produced in CHP plants	position but wind power plants were in a better position as they secured a quota of 725 MW, while CHP cogeneration on biomass achieved a 125MW quota. - 14 CHP plants were built with 25MW, while the remaining installations were in the process of obtaining a permit or a construction. - In 2016, the Government announced the taxation of the RES, so the sectoral association CROBIOM has initiated consultations with the Ministry of Environment and Energy in order to point out to the possible damages to the further development of the sector. However, the government dropped from the above-mentioned measure on 6th June 2017. - The entire OIE system is not precisely designed and there are problems with the payment of the feed-in tariff incentive, which the Government on 9th of June 2017 has temporarily adjusted by increasing the fee for the RES paid by all electricity consumers, including the economy and households.		 Ireland has traditionally generated substantial amounts of electricity from peat. This is to be discontinued and the plants are being converted to consume biomass Support measures for bioelectricity Several significant bioelectricity plants are under construction: Veolia 42.5 MW CHP plant in Killala. Government has National targets to meet that will incur fines, if not met 	 No specific measures for supporting bioelectricity are foreseen. The Decree on the High Efficiency Cogeneration is still pending. 	Foreseen two more big CHP plants in Vilnius and Kaunas. It is expected that by 2020 CHP from waste and biomass will produce about 12% of total power demand in Lithuania.		The growth will most probably continue until the end of 2017 and afterwards stop. The current feed-in tariff is only valid for projects that will start production by the end of 2017. There are new projects (1-2MW) that are on building stage and will start production by the end of 2017. New support schemes are announced by 2019.	
		呈	<u>*</u>	Ė	5	3	2	Ε

Bioelectricity produced in CHP plants

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It was a decrease of bioelectricity production between 2009 and 2014 due the stop on subsidies for co-firing that now are on place again.

The parties of the Dutch Energy Agreement for Sustainable Growth (2013) have agreed that maximum 25 PJ (600ktoe) renewable energy will be produced by co-firing of biomass in coal-fired power stations in order to attain the renewable energy goals in 2020. K

In 2015 and 2016 it has been a total of 374 ktoe in SDE awarded projects (the majority CHP). Nevertheless it should be notice that awarded projects is

not a 100% guarantee for realization. Bioelectricity from CHP grew considerably in the past years due to green certificates. Nevertheless, utilities complaint that now the low prices of green certificates doesn't make it attractive anymore. K

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• Still the government supports cofiring, therefore the market is expected to grow but not as much as in the past.

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The major factor influencing negatively the development of bioelectricity and bioheat sectors is forest fragmentation combined with internal migrations. In Portugal, the major forest areas are extremely fragmented by small private owners, which makes it operationally impractical and economically nonviable exploiting the real potential of biomass. Moreover, in the last few decades Portugal have experienced a growing gulf between peripheral rural regions and coastal rural regions due to economic development, this situation led to an exodus of populations from the rural interior, which ultimately caused the neglected of large forest areas.

In addition, the lack of clear Portuguese forest legislation and a strong land-use planning makes the above mentioned negative aspects difficult to overcome. This conjunction of factors leads to Portuguese large forest territory losses in dry years.

7 In 2017, the decree-law 64/2017 was published. It defines new rules for building and operation of power plants that produce electricity from forest biomass:

- An overall capacity of 60 MW was provided.
- Biomass power plants will be able to sell electricity at a favorable price, however the value of the remuneration is still
- This regulation intends to protect the forest and reduce the risk of fire, to boost the market for forest biomass and the local economy, to promote good practices of sustainable forestry.

Prior to the decree-law 64/2017 there was no support mechanism to schemes for any type of renewable power plants were withdrawn with the decree-law n. ⁹ 215-B/2012. Under this regulation new power plants promote electricity through bioenergy large power plants. The support had to be integrated in the wholesale market prices or enter into a power purchase agreement. Small scale units have a support scheme available (decree-law n. º153/2014) that promotes self-consumption units (under 1 MW) and small production units (under 250 kW).

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on energy efficiency and cogeneration, transposing to Portuguese law CHP plants licensed before the prior stated decree-law are regulated under the Decree-Law 68-A/2015. This decree establishes a framework 7 The decree-law 64/2017 applies also to CHP plants with some rules.

remuneration of the electricity produced in cogeneration power plants. The decree establishes a maximum value of 7.5 €/MWh for the

Directive 2012/27/EU on energy efficiency.

Bioelectricity produced in electricity only plants	No electricity production in electricity only plants.	N.A. N.A.	 DECC has introduced a cap of 400MW on the total new build dedicated biomass capacity in England and Wales that can expect grandfathered support under the Renewables Obligation (RO). Grandfathering is applicable at the time of full accreditation of the generating station and will be maintained for the accredited capacity of the station for the entire duration of its RO support. Projects applying to the 400MW cap must be aiming to commission under the RO by 31 March 2017. Drax unit 1, 645 MW Biomass conversion project in Selby, North Yorkshire, Drax Group (not yet received EU State Aid clearance) Lynemouth, 420MW biomass conversion project in Ashington Northumberland, RWE group.
Bioelectricity produced in CHP plants	All Swedish bioelectricity production takes place in CHP, in district heating and in industry, mainly forest industry. The green certificate scheme for renewable electricity has been expanded to 2030, with TWh production capacity added 2020 – 2030. This will enable new investments, but most will be new wind-power, as over-capacity and low electricity prices will hold investments back in bioelectricity sector, unless some new support is introduced for guarantee of capacity. 12 TWh biopower produced yearly (7% of total power production), half in district heating, half in industry.	N.A. N.A.	A • Teeside, 299MW biomass CHP project in Middlesbrough, MGT Power
	38	s x	*

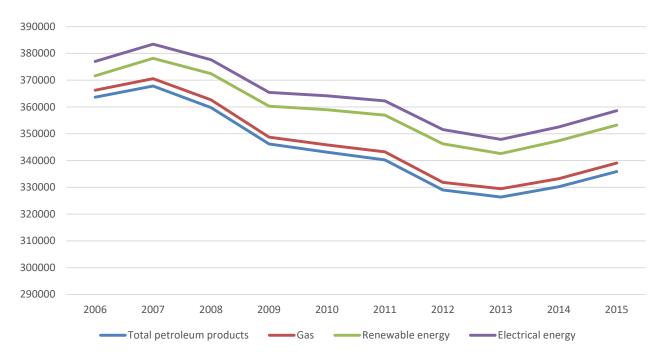
*Information from 2016 Source: AEBIOM

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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 358.629 ktoe in 2015, out of which 93,6% was from oil.

Table 6.1 Final energy consumption in transport in EU28 in 2015 (ktoe)

	Total products	Solid fuels	Total petroleum products	Gas	Electrical energy	Biofuels	Biogas	Biogasoline	Biodiesels	Other liquid biofuels
Total	358.629	10	335.867	3.226	5.368	14.158	128	2.680	11.345	5
Rail	6.221	10	2.049	0	4.135	27	0	0	27	0
Road	293.988	N.A.	277.706	1.751	410	14.122	128	2.678	11.312	5
International aviation	45.756	N.A.	45.756	N.A.	N.A.	0	N.A.	0	0	N.A.
Domestic aviation	5.540	N.A.	5.540	N.A.	N.A.	0	N.A.	0	0	N.A.
Domestic Navigation	4.540	0	4.536	0	N.A.	5	0	2	3	0
Consumption in Pipeline transport	1.507	N.A.	1	1.411	95	0	N.A.	0	0	N.A.
Non- specified (Transport)	1.077	0	280	64	729	5	0	0	4	0

According to Eurostat, in 2015 the contribution of renewables to the transport sector accounted to 14.158 ktoe. It should be noticed that in this figure, only biogas and liquid biofuels are included but not the renewable electricity used in transport.

Table 6.2 Final energy consumption of the different fuels in transport in 2015 in EU28 Member States (ktoe)

	All products	Total petroleum products	Gas	Electricity	Biofuels
EU28	358.629	335.867	3.226	5.368	14.158
AT	9.000	7.819	268	267	646
BE	10.444	9.996	48	139	261
BG	3.402	2.987	239	30	146
CY	867	858	0	0	10
CZ	6.489	5.987	66	138	297
DE	63.168	59.205	427	970	2.567
DK	4.949	4.681	2	34	232
EE	785	775	3	4	3
EL	6.577	6.387	15	33	142
ES	33.595	31.803	312	522	958
FI	4.791	4.227	7	60	497
FR	50.077	46.104	149	875	2.949
HR	2.107	2.059	3	21	24
HU	4.354	4.047	32	100	175
IE	4.624	4.532	0	4	88
IT	39.541	36.353	1.087	933	1.167
LT	1.832	1.728	30	6	68
LU	2.420	2.326	0	11	83
LV	1.147	1.113	0	9	25
MT	311	307	0	0	5
NL	14.273	13.788	36	151	297
PL	17.241	15.835	359	267	780
PT	6.613	6.245	13	27	328
RO	5.577	5.280	1	93	203
SE	8.668	7.308	34	223	1.102
SI	1.799	1.754	2	13	29
SK	2.212	1.924	92	52	144
UK	51.766	50.439	0	385	933



6.2Renewable in transport

Towards the 2020 targets

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

- Compliant biofuels (liquid and gaseous) in all modes of transport and, where applicable, the respective **multiplier (2×)** as defined in Article 21(2) for biofuels produced from wastes, residues, non-food cellulosic material and ligno-cellulosic material.
- Renewable electricity, by applying the national or European RES-E share to the total electricity consumption in transport (proportionality of renewable electricity in the grid principle) with the respective multiplier (2.5×) for in rail transport and 5X for in road, 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 with reported consumption in the transport sectors.

The denominator 'energy consumed in transport' is, for the purpose of the calculation %RES-T, defined as the sum of the following elements: Petrol in all modes of transport, diesel in all modes of transport (non-bio gas/diesel oil), all biofuels (compliant and non-compliant) in road and rail transport (no multiplier) and electricity in all modes of transport (no multiplier).

The multiplication factors create **virtual renewable energy**, counted for the target but non-existing in reality. This virtual energy doesn't help the EU to reduce the GHG emission in transport sector or to replace fossil fuels.

The following three figures (6.2, 6.3, 6.4) and table 6.3 present the contribution of renewables in transport, according to the above explained methodology. Note that the data from this chapter come from Eurostat but from a different data base than the other biofuel chapters. The number are therefore slightly different.

The drastic drop in 2011 that can be observed in the production of compliant biofuels is due to the adaptation of the industry in implementing the sustainability legislation. For data for year 2011 and onwards, countries shall report as compliant biofuels only those biofuels and bioliquids for which compliance with Articles 17 (Sustainability criteria for biofuels and bioliquids) and 18 (Verification of compliance with the sustainability criteria for biofuels and bioliquids) can be fully demonstrated.

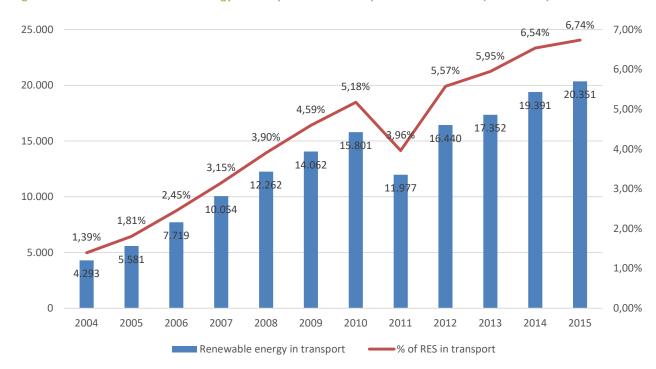


Figure 6.2 Evolution of renewable energy consumption in the transport sector* in EU28 (ktoe and %)

* Multipliers applied Source: Eurostat

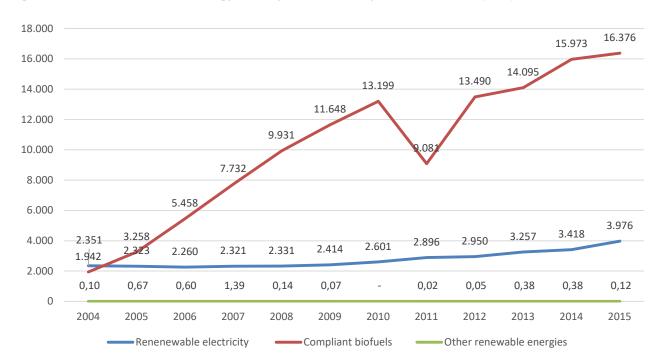
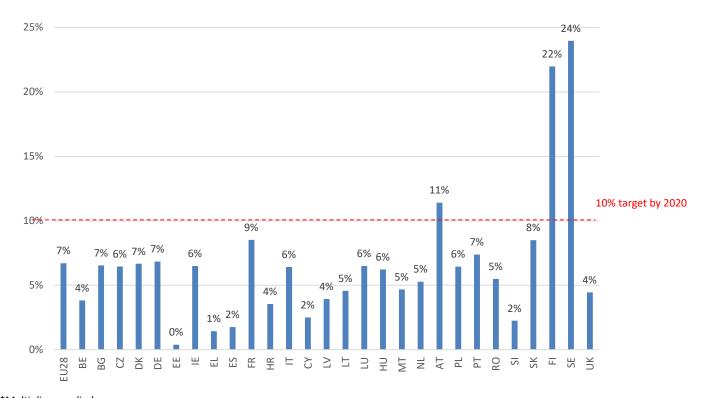


Figure 6.3 Evolution of renewable energy consumption in the transport sector* in EU28 (ktoe)

Note: Due to inconsistencies in Eurostat database, the sum of the different type of RES in transport can be different with figure 6.2 Source: Eurostat, AEBIOM calculation

^{*} Multipliers applied

Figure 6.4 Status towards fulfilling the 2020 targets for renewables energy in the transport sector* in EU28 Member States in 2015 (%)



*Multipliers applied Source: Eurostat The 20.269 ktoe of renewables in transport are in reality 14.953 ktoe without multiple counting rules. Table 6.3 shows the raw data of renewables in transport (ktoe and contribution to the total energy used in transport) without applying multipliers in comparison with the official figures calculated with the methodology defined by the European Commission.

Table 6.3 Share of renewables in the transport sector in EU28 Member States in 2015 with and without application of multipliers

	RES in transport accord	ding to EC methodology	RES in transpo	rt without multipliers	
	RES in transport (ktoe)	Contribution RES-T (%)	RES in transport (ktoe)	Contribution RES-T (%)	Difference (%)
EU28	20.269	6,71%	14.953	5,03%	1,68%
AT	945	11,40%	808	9,90%	1,50%
BE	343	3,82%	290	3,25%	0,58%
BG	166	6,54%	152	6,02%	0,52%
CY	15	2,50%	9	1,55%	0,95%
CZ	387	6,45%	332	5,57%	0,88%
DE	3.740	6,83%	2.830	5,24%	1,59%
DK	269	6,67%	247	6,14%	0,52%
EE	3	0,39%	1	0,14%	0,25%
EL	71	1,43%	49	0,99%	0,44%
ES	478	1,75%	192	0,71%	1,04%
FI	1.001	21,98%	515	12,63%	9,35%
FR	3.697	8,52%	3.218	7,48%	1,04%
HR	69	3,54%	33	1,73%	1,81%
HU	262	6,22%	199	4,79%	1,43%
IE	252	6,48%	129	3,43%	3,05%
IT	2.121	6,42%	1.456	4,48%	1,93%
LT	72	4,56%	69	4,35%	0,21%
LU	131	6,49%	84	4,23%	2,26%
LV	38	3,92%	27	2,79%	1,13%
MT	9	4,67%	5	2,46%	2,21%
NL	546	5,27%	334	3,29%	1,98%
PL	941	6,44%	848	5,83%	0,61%
PT	396	7,38%	341	6,42%	0,97%
RO	292	5,49%	237	4,49%	1,00%
SE	2.029	23,96%	1.315	16,89%	7,07%
SI	40	2,24%	33	1,90%	0,35%
SK	176	8,50%	157	7,63%	0,87%
UK	1.780	4,45%	1.042	2,65%	1,80%

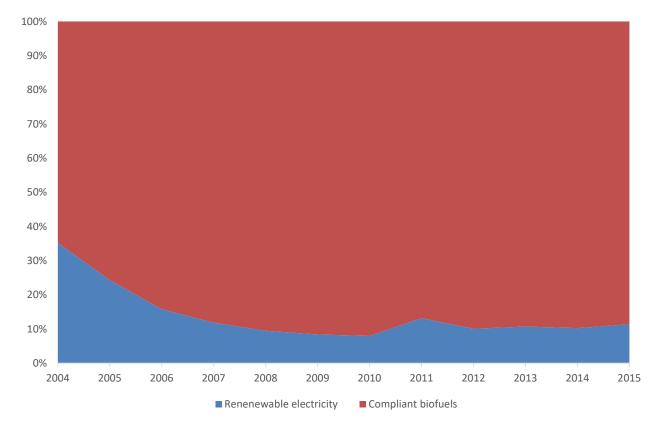


Figure 6.5 Share of renewables in the transport sector by type in EU28 without multipliers (%)

"Even opponents of biofuels recognise that Europe is falling behind when it comes to decarbonising its transport sector. What they fail to acknowledge is the reality that without using all the tools in its box, Europe will not be able to reverse that trend. Europe needs a new commitment to sustainable biofuels, not a policy—as proposed by the European Commission— that only serves to help the fossil fuel industry.

The Commission admits that transport is the only sector in which EU countries are consistently falling short of their targets for renewable energy. The lack of progress is already dramatic when looking at how many Member States are well below 10% (figure 6.4). The results are even worse when you remove multiplier factors and look at the real numbers: even stars like Sweden are only at 17% renewable energy in the transport sector.

So why would the EU want to turn back on its ambitions and leave room for 90% or more fossil fuel in its 2030 transport energy mix? Fortunately, many lawmakers see the Commission's RED II proposal as flawed and are trying to change it—either by setting higher ambitions for renewables or by opposing an effort to phase out truly sustainable crop-based biofuels such as European ethanol.

As Europeans' concerns about climate change and air quality grow more urgent—and as the EU seeks to re-assert its role as a leader in the fight against climate change— it's clear that all sustainable biofuels (first- and second-generation) have to play a role. It is important to remind lawmakers that crop-based biofuels don't just contribute to reducing emissions of greenhouse gases and harmful pollutants, they also have other societal benefits, such as offsetting the need to import animal feed and providing income for farmers and jobs in rural communities."

Emmanuel Desplechin Secretary General, ePURE



6.3 Liquid biofuels for transport

Table 6.4 Biofuels production capacities in EU28 Member States in 2015 (thousand tonnes)

EU28 22.304 5.856 BE 450 408 BG 160 26 CZ 420 160 DK 0 0 DE 4.212 769 EE 0 0 IE 30 0 EL 994 0 ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE		Biodiesels	Biogasoline
BG 160 26 CZ 420 160 DK 0 0 DE 4.212 769 EE 0 0 IE 30 0 EL 994 0 ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	EU28	22.304	5.856
CZ 420 160 DK 0 0 DE 4.212 769 EE 0 0 0 IE 30 0 EL 994 0 ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	BE	450	408
DK 0 0 DE 4.212 769 EE 0 0 0 IE 30 0 EL 994 0 ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	BG	160	26
DE 4.212 769 EE 0 0 IE 30 0 EL 994 0 ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	CZ	420	160
EE 0 0 IE 30 0 EL 994 0 ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	DK	0	0
IE 30 0 EL 994 0 ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	DE	4.212	769
EL 994 0 ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	EE	0	0
ES 4.237 464 FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	IE	30	0
FR 2.760 1.092 HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	EL	994	0
HR 64 0 IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	ES	4.237	464
IT 2.212 332 CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	FR	2.760	1.092
CY 14 0 LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	HR	64	0
LV 173 19 LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	IT	2.212	332
LT 140 20 LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 0 SK 177 112 FI 480 30 SE 310 201	CY	14	0
LU 0 0 0 HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	LV	173	19
HU 150 494 MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	LT	140	20
MT 1 0 NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	LU	0	0
NL 2.176 0 AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	HU	150	494
AT 646 210 PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	MT	1	0
PL 1.286 725 PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	NL	2.176	0
PT 721 0 RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	AT	646	210
RO 200 80 SI 0 0 SK 177 112 FI 480 30 SE 310 201	PL	1.286	725
SI 0 0 SK 177 112 FI 480 30 SE 310 201	PT	721	0
SK 177 112 FI 480 30 SE 310 201	RO	200	80
FI 480 30 SE 310 201	SI	0	0
SE 310 201	SK	177	112
	FI	480	30
UK 291 715	SE	310	201
	UK	291	715

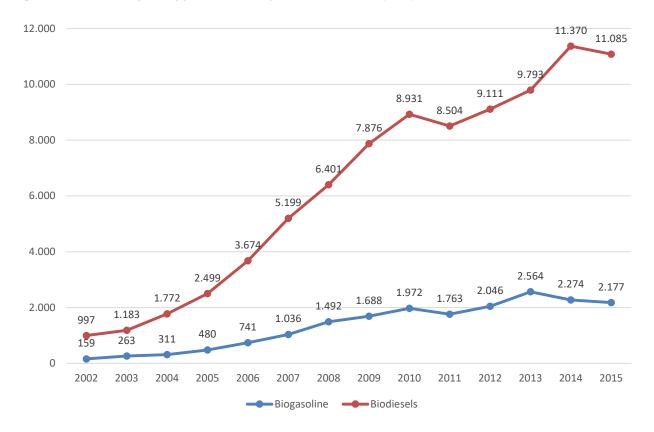
Table 6.5 Primary production and net imports of liquid biofuels in EU28 Member States in 2015 (ktoe)

	Tot	tal liquid bio	ofuel	Biodies	el	Biogasoli	ne
	Primary	Net	Biofuel import	Primary	Net	Primary	Net
	production	import	dependency*	production	import	production	import
EU28	13.660	930	6%	11.085	391	2.177	539
AT	445	236	35%	304	317	140	-80
BE	392	-119	-41%	223	0	163	-119
BG	60	91	62%	43	74	16	17
CY	1	9	92%	1	9	0	0
CZ	216	75	25%	148	85	68	-11
DE	3.319	-508	-18%	2.765	-834	436	326
DK	13	236	94%	0	236	0	0
EE	0	3	105%	0	0	0	3
EL	134	24	15%	134	24	0	0
ES	1.235	-402	-41%	983	-310	252	-92
FI	472	69	13%	432	0	0	69
FR	2.519	436	15%	2.139	391	380	45
HR	15	8	33%	15	8	0	0
HU	377	-213	-123%	131	-4	246	-208
IE	24	64	73%	24	38	0	25
IT	682	638	30%	510	625	8	13
LT	114	-46	-68%	104	-45	10	-1
LU	0	81	98%	0	74	0	7
LV	61	-32	-129%	59	-38	2	6
MT	1	4	93%	1	4	0	0
NL	1.440	-1.135	-362%	1.440	-1.281	0	146
PL	936	-143	-18%	822	-186	112	43
PT	321	35	10%	318	10	0	25
RO	157	50	24%	132	8	25	42
SE	276	825	75%	130	755	95	70
SI	0	N.A.	N.A.	0	N.A.	0	6
SK	149	-17	-12%	96	26	54	-43
UK	301	632	68%	132	380	169	252

^{*} 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 while positive values over 100 % indicate the accumulation of stocks during the reference year. Source: Eurostat

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Figure 6.6 Evolution of primary production of liquid biofuels in EU28 (ktoe)



14.000 11.474 11.397 11.345 12.000 10.732 10.262 10.328 10.000 9.258 7.693 8.000 5.807 6.000 3.898 4.000 2.805 2.864 2.822 2.675 2.657 2.680 2.470 2.239 1.800 1.603 2.000 1.169 1.163 876 573 304 241 0 2005 2008 2003 2004 2006 2007 2009 2010 2011 2012 2013 2014 2015 Biogasoline Biodiesels

Figure 6.7 Evolution of final energy use of liquid biofuels in transport in EU28 (ktoe)

Table 6.6 Share of the total use of biofuel in the transport sector by type of biofuel in 2015

Type of biofuel	Type of consumption	Energy in (ktoe)	Share used in the transport sector (%)
Biogasoline	Gross inland consumption	2.728,6	
	Gross inland consumption in Transport	2.680,2	98,2%
Biodiesel	Gross inland consumption	11.562,6	
	Gross inland consumption in Transport	11.345,3	98,1%
Other liquid biofuel	Gross inland consumption	1.191,3	
	Gross inland consumption in Transport	4,5	0,3%
Total	Gross inland consumption	15.482,5	
	Gross inland consumption in Transport	14.030,0	90,6%

Table 6.7 Final energy use of liquid biofuels in transport in EU28 Member States in 2015 (ktoe)

	Biogasoline	Biodiesels
EU28	2.680	11.345
AT	60	585
BE	41	221
BG	32	114
CY	0	10
CZ	63	233
DE	744	1.792
DK	0	232
EE	3	0
EI	24	64
EL	0	142
ES	189	769
FI	65	432
FR	421	2.528
HR	0	24
HU	43	133
IT	25	1.142
LT	10	58
LU	7	76
LV	8	17
MT	0	5
NL	142	156
PL	154	627
PT	22	302
RO	62	141
SE	133	872
SI	7	23
SK	23	121
UK	404	529

6.4 Advance liquid biofuels

IEA Bioenergy Task 39 maintains a database on advanced liquid biofuels demonstration facilities. It contains a global overview on production facilities for liquid biofuels which apply technologies that are not yet commercialized.

The database was set up based on information provided by experts within the IEA Bioenergy Task 39 group. This group currently spans 14 countries around the globe, including major biofuel producers such as US, Brazil, and a couple of European countries. Direct contacts with all companies included in the database have been established, and the companies themselves have provided data, flow sheets, pictures and brief technology descriptions. All information is critically reviewed for credibility by IEA Bioenergy Task 39 experts, and other groups such as the ETIP Bioenergy WG 2 experts and experts from NREL have joined this effort.

As the projects and technologies evolve, updates to the database entries become necessary. Updated data is derived from the companies by direct contact, from company websites, presentations and press releases, and from liquid biofuel experts from the above mentioned networks and institutions. The sector is evolving quickly, and it is challenging to follow up with all companies that develop advanced liquid biofuel technologies. Yet, we believe that most production facilities at demonstration and industrial scale are being covered in the database. In the following tables, these facilities are listed, sorted by technology and by status (operational, under construction, planned).

The tables below reflect the status of the database as of 4th October 2017. Although updates are made continuously when new information becomes available, for some of the facilities the information in the database can be up to 2 years old. A major updating effort by all involved experts is just ongoing, so by the time of publishing more accurate information may already be available in the online database.

For more information please contact Dina.Bacovsky@bioenergy2020.eu or visit http://demoplants.bioenergy2020.eu

"While biodiesel (FAME) and ethanol from sugar and starch feedstocks have already long been commercially available, and HVO has just recently been commercialized, advanced biofuels produced from lignocellulosic material have not yet arrived at this level of maturity.

Of all pathways for the production of advanced biofuels from lignocellulosic material, the production of ethanol through hydrolysis and subsequent fermentation has reached the highest level of maturity and is now on the edge of commercialization. Several facilities at industrial scale have been installed and started up during the past few years, and the two largest ones, those of DuPont and POET-DSM, are just entering into production. This has been a painful process with many challenges, but now both companies are confident to ramp up production over the coming year. Another positive news is that Raizen, operating an industrial scale facility on sugarcane bagasse and molasses and currently ramping up production towards nameplate capacity, has announced plans to build further facilities once the first one has reached full capacity.

These developments mark a major milestone in the development of lignocellulosic ethanol, as they indicate the transition from the phase of technology demonstration to the phase of technological learning, which is necessary to come down the cost curve and allow for rapid multiplication of optimized facilities."

Experts view on advanced biofuels Dina Bacovsky, BIOENERGY 2020+



AEBIOM | European Bioenergy Outlook 2016 135

Table 6.8 Operational facilities applying fermentation technology

Company	Project name	City	Country	Year of start-up	Feedstock type	Feedstock	Product	Capacity [t/year]
DuPont	Commercial facility lowa	Nevada	United States	2016	agricultural residues	corn stover	cellulosic ethanol	82.672
POET-DSM Advanced Biofuels	Project Liberty	Emmetsburg	United States	2014	agricultural residues		cellulosic ethanol	75.000
GranBio	Bioflex 1	Sao Miguel	Brazil	2014	lignocellulosic crops	Sugarcane bagasse and straw	cellulosic ethanol	65.000
Longlive Bio- technology Co. Ltd.	Longlive	Yucheng	China	2012	lignocellulosic crops	corn cob	cellulosic ethanol	60.000
Beta Renewables	IBP - Italian Bio Fuel	Crescentino (VC)	Italy	2013	lignocellulosic crops	wheat straw, rice straw, arundo donax, poplar	cellulosic ethanol	40.000
Raizen Energia	Brazil	Costa Pinto, Piracicava	Brazil	2015	lignocellulosic crops	bagasse	cellulosic ethanol	31.600
Henan Tianguan Group	Henan 2	Nanyang	China	2011	lignocellulosic crops		cellulosic ethanol	30.000
Borregaard Industries AS	ChemCell Ethanol	Sarpsborg	Norway	1938	lignocellulosic crops	sulfite spent liquor (SSL, 33% dry content) from spruce wood pulping	cellulosic ethanol	15.800
Henan Tianguan Group	Henan 1	Zhenping	China	2009	lignocellulosic crops	Wheat/corn stover	cellulosic ethanol	10.000
Quad-County Corn Processors	Quad Country Biorefionery	Galva, IA	United States	2014	lignocellulosic crops	corn kernel fibre	cellulosic ethanol	9:000
Anhui BBCA Biochemical	BBCA	Bengbu	China	5009	lignocellulosic crops	Corncob/corn stover	cellulosic ethanol	2.000
Chempolis Ltd.	Chempolis Biorefining Plant	Oulu	Finland	2008	lignocellulosic crops	non-wood and non-food lignocellulosic	cellulosic ethanol	5.000

						biomass such as		
						straw, reed, empty fruit bunch, bagasse, corn stalks, as well as wood residues		
North European Oil Trade Oy	Ethanolix GOT	Gothenburg	Sweden	2016	organic residues and waste streams	Waste	cellulosic ethanol	4.000
Jilin Fuel Alcohol	Jilin 2	Jilin	China	2006	lignocellulosic crops	Straw	cellulosic ethanol	3.000
Shandong Zesheng Biotech Co.	Zesheng	Dongping	China	2006	lignocellulosic crops	Straw	cellulosic ethanol	3.000
Cane Technology Center (CTC)	CTC	Piracicaba, SP	Brazil	2012	lignocellulosic crops	bagasse	cellulosic ethanol	2.400
logen Corporation	demo	Ottawa	Canada	2004	lignocellulosic crops	wheat, barley and oat straw, corn stover, sugar cane bagasse and other agricultural residues	cellulosic ethanol	1.600
Clariant	sunliquid	Straubing (Muenchen)	Germany	2012	lignocellulosic crops	wheat straw	cellulosic ethanol	1.000
DuPont	Demonstration plant	Vonore	United States	2010	agricultural residues	corn stover, cobs and fibre, switchgrass	cellulosic ethanol	750
ZeaChem	Demonstration	Boardman	United States	2011	lignocellulosic crops	ppoplar trees, wheat straw	cellulosic ethanol	750
Woodland Biofuels	demo	Sarnia, Ontario	Canada	2013	organic residues and waste streams	wood waste	cellulosic ethanol	601
COFCO Zhaodong Co.	COFCO Demo	Zhaodong	China	2006	agricultural residues	Corn stover	cellulosic ethanol	200

Table 6.9 Facilities that are under construction, applying fermentation technology

Company	Project name	City	Country	Year of start-up	Year of start-up Feedstock type Feedstock	Feedstock	Product	Capacity [t/year]
Beta Renewables	Energochemica	Strazske	Slovakia	2017	agricultural residues		cellulosic	55.000
Fiberight LLC	Commercial Plant	Hampden	United States	2018	organic residues and waste streams		cellulosic ethanol	18.000

North European Cellulonix Oil Trade Oy (formerly with St1)	Cellulonix	Kajaani	Finland	2017	lignocellulosic crops	sawdust	cellulosic ethanol	7.900
ArcelorMittal	Ghent Steelanol Ghent	Ghent	Belgium	2018	waste gases	steel flue gas	cellulosic ethanol	09
Beijing Shougang LanzaTech New Energy Technology Co.,	Shougang Commercial	Caofeidian	China	2017	waste gases	steel flue gas	cellulosic ethanol	09

Table 6.10 Facilities that are planned, applying fermentation technology

Company	Project name	City	Country	Year of start-up	Feedstock type	Feedstock	Product	Capacity [t/year]
Beta Renewables	Fujiang Bioproject	Fujiang	China	2018	agricultural residues	wheat straw, corn stover	cellulosic ethanol	90.000
ZeaChem Inc.	Commercial scale biorefinery	Boardman	United States		lignocellulosic crops	poplar trees, wheat straw	cellulosic ethanol	75.000
Lignol	Demo	Vancouver, BC	Canada	2015	lignocellulosic crops	hardwood	butanol	60.125
Beta Renewables	Alpha	Clinton, North Carolina	United States	2018	lignocellulosic crops	energy grasses	cellulosic ethanol	000009
COFCO Zhaodong Co.	COFCO Commercial	Zhaodong	China	2018	lignocellulosic crops		cellulosic ethanol	20.000
Celtic Renewables	Celtic Renewables	Grangemouth	United Kingdom	2018	organic residues and waste streams	draff	butanol	800
LanzaTech	LanzaTech Jet Fuel Demonstration Unit	Soperton	United States	2019	waste gases	steel flue gas	cellulosic ethanol	r.s.
Aemetis	Aemetis Commercial	Keyes	United States		biomass syngas	biomass syngas	cellulosic ethanol	n.s.

Table 6.11 Operational facilities applying a thermochemical technology

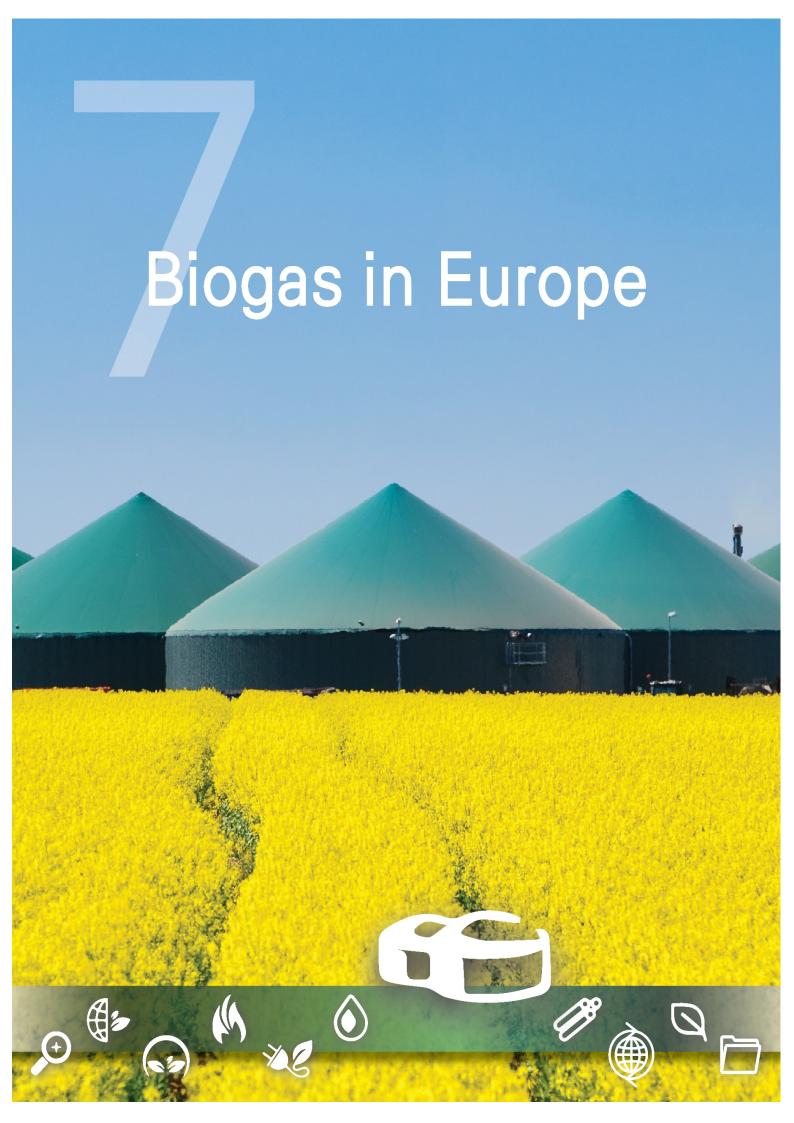
Company	Project name	City	Country	Year of start- up	Technology	Feedstock type	Feedstock	Product	Capacity [t/year]
Fortum	Joensuu demo	Joensuu	Finland	2013	Fast Pyrolysis	lignocellulosic crops	wood residues	bio-oil	50.000
Enerkem Alberta Biofuels LP	Edmonton Waste-to- Biofuels Project	Edmonton	Canada	2014	Fuel Synthesis	organic residues and waste streams	Post-sorted municipal solid waste (MSW)	cellulosic ethanol	30.000
Tembec Chemical Group	Synthesis Tembec Chemical Quebec	Temiscaming	Canada	n.s.	Fuel Synthesis	lignocellulosic crops	spent sulphite liquor feedstock	cellulosic ethanol	13.000
Goteborg Energi AB	GoBiGas Phase 1	Gothenborg	Sweden	2014	Fuel Synthesis	lignocellulosic crops	Forest residues, wood pellets, branches and tree tops	SNG	11.200
Enerkem	Westbury commercial demonstratio n facility	Westbury	Canada	2009	Fuel Synthesis	forest residues	Treated wood (i.e. decommissioned electricity poles, and railway ties), wood waste and MSW	cellulosic ethanol	4.000
Karlsruhe Institute of Technology (KIT)	bioliq	Karlsruhe	Germany	2014	Fuel Synthesis	lignocellulosic crops	straw	DME	809
West Biofuels	LLC Thermal Reformer Synthesis West BiofuelsWood land, CA	Woodland, CA	United States	2007	Fuel Synthesis	forest residues	clean wood, waste wood	FT liquids	s;
Licella	Commercial demonstratio n plant	Somersby	Australia	2008	Hydrothermal Liquefaction	lignocellulosic crops	Radiata Pine, Banna Grass, Algae	bio-oil	350

Table 6.12 Facilities that are under construction, applying a thermochemical technology

Company	Project name	City	Country	Year of start-	Technology	Feedstock	Feedstock	Product	Capacity
Total	BioTfueL demo	Dunkirk	France	2017	Fuel Synthesis	lignocellulosic crops	straw, forest waste, dedicated	FT liquids	200.000
Ensyn	Cote Nord Project	Quebec	Canada	2017	Fast Pyrolysis	forest residues	forest residues	gasoline-type fuels	36.000
Vanerco (Enerkem & Greenfield Ethanol)	Varennes Cellulosic Ethanol	Varennes, PQ	Canada		Fuel Synthesis	organic residues and waste streams	sorted industrial, commercial and institutional waste	cellulosic ethanol	30.000
Go Green Fuels Ltd	Thermal Compressed Biomethane Plant	Swindon	United Kingdom	2018	Fuel Synthesis	organic residues and waste streams	Refuse derived fuel and waste wood	SNG	1.500

Table 6.13 Facilities that are planned, applying a thermochemical technology

	Project name City		Country	Year of start- up	Technology	Feedstock type	Feedstock	Product	Capacity
Vaermla etanol Hagfors	Vaermlandsm etanol Hagfors	Hagfors	Sweden	n.s.	Fuel Synthesis	lignocellulosic crops	woody biomass	methanol	130.000 m3/year
Synthesis Alkmaar	Synthesis HVC Alkmaar	Alkmaar	Netherlands	n.s.	Fuel Synthesis	lignocellulosic crops		SNG	300 MW
Comn	Commercial	Lakeview	United States	n.s.	Fuel Synthesis	forest residues		diesel-type hydrocarbons	n.s.



7.1 Biogas sector in Europe

Table 7.1 Primary energy production from biogas in the EU28 in 2015 (ktoe)

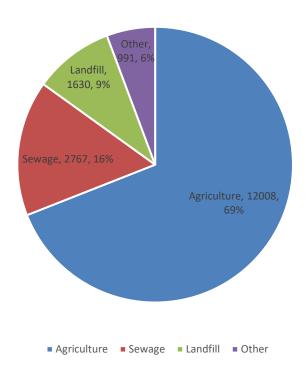
	Biogas	Landfill Gas	Sewage Sludge Gas	Other biogases from anaerobic fermentation
EU28	15.611,8	2.682,1	1.371,7	11.558,0
AT	300,1	4,4	11,2	284,4
BE	226,7	25,7	24,1	176,9
BG	19,6	5,1	1,9	12,6
CY	11,2	0,0	0,5	10,8
CZ	613,4	27,1	40,0	546,2
DE	7.854,2	94,0	452,2	7.308,0
DK	151,6	4,2	21,8	125,6
EE	13,1	11,6	1,5	0,0
EL	91,4	69,9	15,9	5,6
ES	261,6	140,6	70,4	50,5
FI	103,2	27,9	15,5	59,9
FR	538,6	209,2	54,4	275,0
HR	36,0	5,1	3,4	27,5
HU	79,7	16,1	16,9	46,7
IE	54,6	41,0	8,0	5,6
IT	1.871,5	369,0	53,5	1.448,9
LT	23,4	8,2	7,0	8,2
LU	17,7	0,0	1,6	16,1
LV	87,8	8,4	2,0	77,4
MT	1,6	0,0	0,0	1,6
NL	327,1	19,5	55,3	252,3
PL	228,8	50,8	96,6	81,5
PT	82,6	71,2	2,6	8,8
RO	18,3	0,0	0,0	18,3
SE	167,4	6,3	74,7	86,4
SI	29,7	5,0	2,4	22,2
SK	148,6	11,0	10,6	127,1
UK	2.252,4	1.450,8	327,8	473,8



Figure 7.1 Evolution of the number of biogas plants and installed capacity (MWe) in EU28

Source: European Biogas Association, EBA





*EU28 + Norway, Serbia and Switzerland Source: European Biogas Association, EBA

Table 7.2 Number of biogas plants in EU28 (Without Malta) in 2015

	2015					
	2014	Agriculture	Sewage	Landfill	Other	Total
EU28 (without Malta)	16.834	12.008	2.767	1.630	991	17.439
AT	436	201	100	15	128	444
BE	184	123	19	23	39	204
BG	11	8*	2*	1*	n/a*	11*
СН	633	104	481	4	49	638
CY	14	11	2	0	0	13
CZ	554	383	98	56	17	554
DE	10.786	8.856	1.240	400*	350	10.846
DK	155	65	53	28	6	152
EE	18	5	7	6	0	18
EL	18	0	11	3	14	28
ES	n/a	46	28	49	16	139
FI	83	11	16	40	17	84
FR	736	252	87	351	90	780
HR	16	21	1	1	0	23
HU	70*	40	10	20	1	71
IC	n/a	1	0	2	1	4
IE	28	3	7	11	8	29
IT	1.491	1.255	74	180	46	1.555
LT	21	n/a	n/a	n/a	n/a	36
LU	30	26*	4*	6*	n/a*	30*
LV	58	48	1	7	3	59
NL	252	97	80	41	50	268
NO	n/a	6	23	85	9	123
PL	277	60	96	101	20	277
PT	55	2	17	41*	4	64
RO	11	2*	1	3	5	11
RS	7	4	2	1	0	7
SE	279	40	140	60	42	282
SI	26	24	0	0	2	26
SK	139	110	17	11	2	140
UK	446	208	152	75*	88	523

*(data from previous year)

Source: European Biogas Association, EBA

Table 7.3 Biogas production and electricity and heat produced from biogas in EU28 in 2015

	Biogas production (TJ)	Installed electric capacity (MW)	Heat used (TJ)	Electricity generated (GWh)
Total	494.263	8.646	145.049	60.274
AT	5.702	82	1.116	560
BE	7.880*	196	4.310	948
BG	4*	14*	n/a*	1*
CY	500*	10	n/a	37
CZ	23.911*	359	2.336	2.614
DE	221.400*	3.723	65.048	31.890
DK	5.533	77	n/a	401*
EE	302*	11	180	43
EL	829	49	688	230
ES	2.632	175	11	n/a
FI	3.359*	20	1.739	159
FR	18.284*	365	7.884	2.738
HR	695*	31	579*	78*
HU	4.410*	61*	873	194
IE	2.020*	34	108*	183
IT	95.602*	1.171	50.587	9.368
LT	648*	59	27*	n/a
LU	536*	n/a	n/a	334*
LV	3.279	64	1.457	375
MT	n/a	n/a	n/a	33*
NL	13.833	213	6.705	1.148
PL	3.758	209	n/a	690
PT	2.732	n/a	9	248
RO	1.256	9	n/a	26
SE	6.872	95	1.392	62
SI	1.451	27	n/a	141
SK	2.786*	103	n/a	493
UK	64.048	1.491	n/a	7.280

*data from previous year

Source: European Biogas Association, EBA

6 countries have currently achieved their Biogas target for 2020 under the NREAPs: Austria, Germany, Italy, Portugal Sweden and the United Kingdom.

Table 7.4 Biogas production in 2014 and NREAPs targets for 2020 in EU28 MS (ktoe)

	Biogas	NREAPs targets
EU28	15.612	20.820
AT	300	162
BE	227	418
BG	19,6	111
CY	11,2	35
CZ	613	902
DE	7.854	7.748
DK	152	807
EE	13,1	0
EL	91	220
ES	262	761
FI	103	137
FR	539	1.562
HR	36	0
HU	79,7	222
IE	54,6	117
IT	1.872	1.796
LT	23,4	160
LU	17,7	51
LV	88	201
MT	1,6	0
NL	327	1.485
PL	229	1.520
PT	82,6	50
RO	18,3	233
SE	167	26
SI	29,7	90
SK	149	282
UK	2.252	1.724

Source: Eurostat

Table 7.5 Number of biomethane plants in Europe in 2016

	Number of biomethane plants	Total annual production (Mio Nm³)	Plants feeding into grid	Biomethane used in transport (% of biomethane production)	Number of renewable gas filling stations (Compressed + Liquefied)	Filling stations (CNG) **
AT	13	8,4	13	n/a	3 + n/a	177
DK	12	n/a	12	n/a	14 + n/a	11
FI	10	10,3	4	23%	26 + 1	25
FR	20	8,7	17	n/a	22 + 1	44
DE	185	897,7	165*	7%	308 + n/a*	921
HU	2	0,4	1*	n/a	1 + n/a*	9
IT	6	n/a	n/a	n/a	1 + n/a	1046
LU	3*	2,8	n/a*	n/a*	n/a	6
NL	21*	72,1	n/a*	n/a*	61 + n/a	130
ES	1	n/a	0	n/a	n/a	38
SE	61	128,7	13	93%	167 + n/a	154
UK	80	73,9	80	n/a	0 + 3	16

^{*}data from previous year

Source: European Biogas Association, EBA

^{**}CNG Europe, 2016

The biogas sector in Europe flourished in 2015: the number of biogas installations went from 16.834 to 17.439 (+3.6%), the installed electric capacity increased from 8.288 MWel to 8.728 MWel (+5.3%), while the number of biomethane installations went up by 25% (456 plants in 2015). Biomethane production especially (based on biogas upgrading) is on the rise thanks to its versatility (ease to use with properties similar to fossil methane, injection in existing gas grid).

Biogas and biomethane represent a versatile renewable energy, the further expansion of the sector could contribute significantly to decarbonize the most polluting European industries:

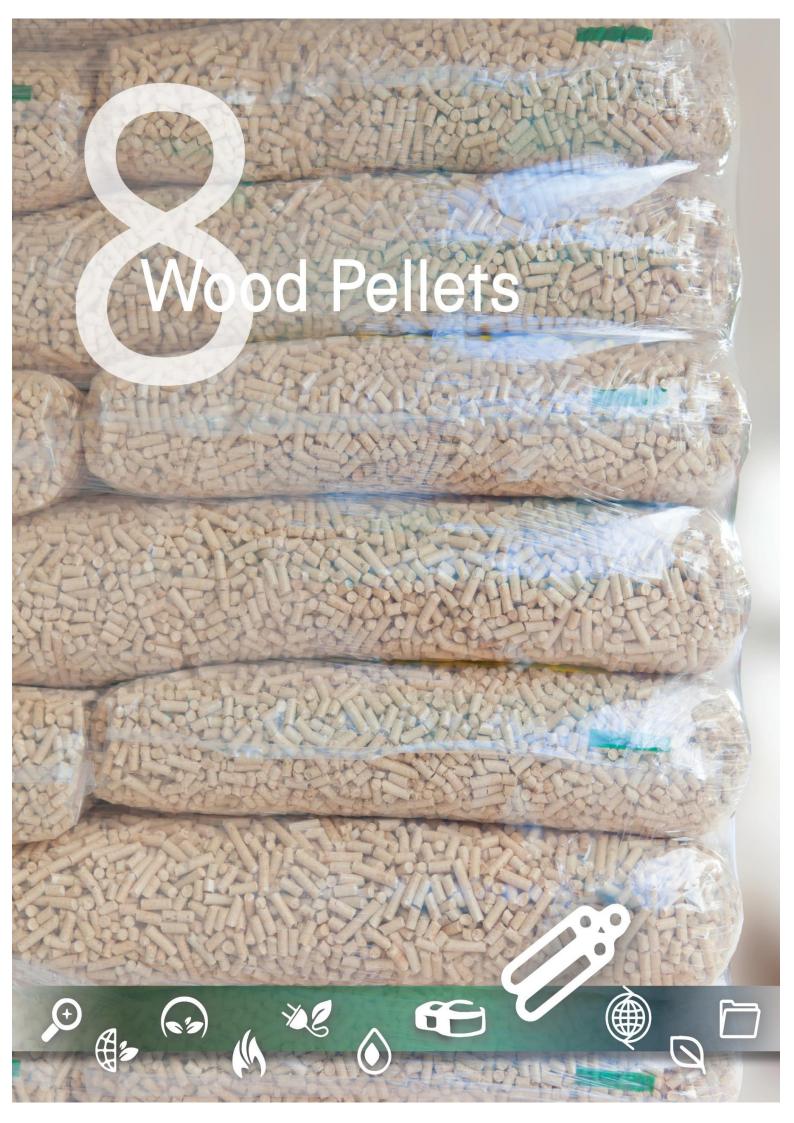
- In the electricity sector (27% of EU gross GHG emissions), biogas production can stabilize the variations of solar and wind electricity generation due to weather dependencies by on-demand production and long-time storage capability;
- In transport (20% of EU gross GHG emissions), biomethane can be used as fuel in light-duty vehicles (such as passenger CNG cars), heavy-duty vehicles (such as truck and bus fleets) and marine transport;
- In agriculture (12% of gross EU GHG emissions), the anaerobic digestion of agricultural by-products avoids the rotting of biocomponents on the fields and the release of high warming potential methane;
- In waste management, anaerobic digestion can treat organic waste and avoid the rotting of organic materials in landfills.

Anaerobic Digestion (AD) is a well-developed and optimized technology for biogas production. Other technologies are also on the rise such as biomass gasification (synthetic natural gas production) and the highly-anticipated Power-to-Methane technology, which allows the production of renewable gas by using renewable excess electricity to power water electrolysis. Together, these technologies provide a significant potential for Europe to succeed in its energy transition from fossil to renewable gas.

Bruno Deremince Technical and Project Officer European Biogas Association







FOREWORD



2016 was another challenging year for the various actors of the European pellet sector, in stark contrast with the situation in Asia where both wood pellet production and consumption continue to grow rapidly. Last year's growth rate was in fact the lowest we have experienced so far, with a slight decrease of EU-28 production with 0,4 % (+1 % for Europe), and a limited growth of EU-28 demand of +4,3% coupled with a decrease in heat device sales in most European countries.

In Europe, pellet demand for electricity production slightly decreased (-3.1 % for EU-28) from 2015 to 2016. 2017 will not witness any dramatic growth but 2018 will see more capacity coming online that will increase the consumption. Regarding the pellet heating sector, a third consecutive mild winter has negatively impacted the heating season 2015-2016. Fortunately, the heating season 2016-2017 was much more favourable, allowing the suppliers to clear their stock and improve their financial situation. Together with a slight increase in fossil fuel prices, this brought some optimism to the sector, materialised by a substantial rebound mainly in stove sales. The commercial heating sector, a great potential market for pellets, already shows some interesting developments in Eastern Europe and we hope for the same to happen in the rest of the region. We are now all looking forward to the heating season 2017-2018, the rather cold autumn we are currently experiencing allowing the industry to hope for good business.

However positive this is, it is still not enough as pellet heating remains a tiny part of the European energy mix, far from its rightful place. This technology presents great advantages at all levels of energy consumption, domestic, medium, or large scale, for the environment, for comfort and safety, and in terms of energy independence. We could go on for a while about the many benefits offered by wood pellets but we are all familiar with them, the short of it is simply that pellets are an exceptional way to move forward with the energy transition.

In this regard, the sum of our actions for the last 12 months is very positive and we must continue to advocate intensively to our customers, to governments and to the various stakeholders of the energy sector to make wood pellets a key player in national and European energy markets, and ultimately achieve the transition to a decarbonized European energy sector. In this endeavour, there are two major battles to be led in the near future.

The first one is air quality. In most European countries, air quality has indeed become a major issue, which it is set to remain for at least the next two decades. From one country to the next, situations may of course vary slightly; in Italy and France, pollution is mainly due to traffic and the burning of poor quality wood whereas in Poland, for instance, the use of coal is the main factor. Industry should strive to promote pellet heating as part of the solution to the problem of air quality, and consider this issue not as a threat but as a major opportunity for promotion, on which the whole sector should become very active.

The second battle concerns subsidies and economic support to renewables in general, and wood pellets in particular. In the past, we have experimented with several types of subsidies and while the financial support was good for the development of our industry, there were also some perverse effects to it. A better approach would be to achieve strong carbon taxes in Europe. This solution is costless for the states and a great incentive to switch from fossil fuels to renewables. The success of the Swedish experience, a leading force on this issue with now 120 €/t C eq., is striking and should be an inspiration for the rest of us. France started following this route in 2014 with the implementation of its own carbon tax, and the new government is now pushing to reach 100 €/t C eq. by 2023, an increase of 50% for fossil fuel prices. Unfortunately, or fortunately, carbon tax is a topic that can hardly be coordinated at the European level as it is linked to national tax systems. But with several valuable experiences already in place, there is plenty of opportunity for sharing knowledge and good practice, and I urge each of you to be active promoters of this solution.

In conclusion, the whole sector must speak with one voice to lead these battles. Through its large membership base and no less than seven dedicated working groups, AEBIOM is well-equipped to be this voice, so don't hesitate to join us if that's not already the case!

Eric Vial President European Pellet Council

8.1 OVERVIEW OF WORLD PELLET SECTOR

8.1.1 WORLD PELLET PRODUCTION



Kelvin Hong Chairman Great Resources, China



Christian Rakos Executive director ProPellets Austria

China – a major but unknown pellet market player?

According to the Chinese Renewable Energy Association, CREIA, China locally produced and used 9 million tonnes in 2016. Despite the difficulty to collect solid statistics, this would make China the world's largest user of pellets and a very important pellet producer. 80 % of these pellets are made of wood, which amounts to 7,2 million tonnes. The rest is made of straw or other agricultural residues. According to China's National Energy Administration's 13th five-year plan the use of pellets will reach 30 million tonnes by 2020, mostly locally produced. A characteristic of the Chinese pellet market is the use of a wide range of different raw materials, including agricultural residues and waste wood. There seem to be no standards and no quality certification in use in China yet.

A key driver for pellet use in China is its environmental policy. A decree published in 2013 prohibits the use of coal in industrial steam boilers smaller than 7 MW by the end of 2017. In addition, in urban areas also coal boilers up to 14 MW should be replaced. Total coal use in these units amounts to 80 million tonnes. While most boilers are replaced by natural gas boilers, there are also considerable opportunities for pellets. According to CREIA the levelized cost of steam from pellets is around 2,5 cent/kWh, compared to 4 cent/kWh for steam generated by using natural gas.

Consequently, in contrast to Europe pellet use in China is focused on commercial use in mid-sized steam boilers for diverse industries and for heating large buildings such as hospitals or schools. Interestingly, most conversions are carried out by ESCOs that plan, build and operate the pellet boilers and sell steam to their clients. The domestic use of pellets is less developed and mainly takes place in the western part of China where pellets are used in cook stoves and stoves.

Note: The three following figures (i.e. Figures 8.1 - 8.2 and Table 8.1) integrate the data one could collect over China to better appreciate how this fairly unknown market would impact the global figures. Due to a relative uncertainty of the Chinese data the rest of the report will not include it.

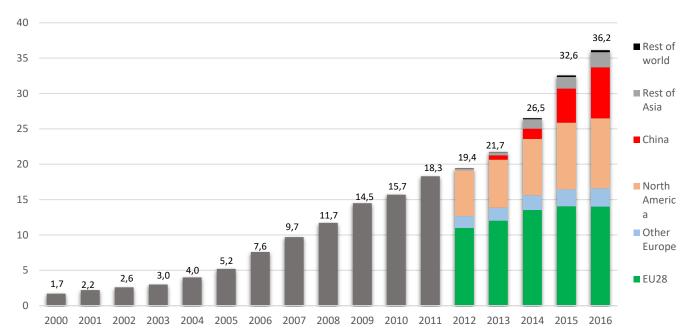


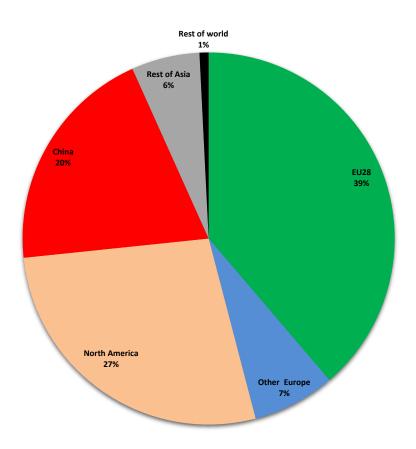
Figure 8.1 World pellet production overview 2000.2016 (million tonnes)

Sources: EPC survey, 2017; IEA Bioenergy Task 40; FAO; CREIA

Global pellet production continues to expand year after year, amounting to 36,1 million tonnes of pellets produced in 2016, showing a growth of 11% compared to 2015. With 16,6 million tonnes produced, the production in **Europe** stagnated while maintaining its position of the biggest producer, accounting for 39 % of world pellet production. This stagnation is mainly due to EU28 production, decreasing slightly (<1%) whereas the production in the rest of Europe¹ increased by 9% and reached 2,6 million tonnes. Production increased again in **North America** by 5%. **Asian countries** Thailand, Indonesia, Vietnam, Malaysia and China, have shown a massive growth rate of 45% altogether (31% China excluded).

¹ The list of countries corresponding to the different areas defined in the report are available in the appendix.

Figure 8.2 World wood pellet production shares in 2016 (%)



Source: EPC survey, 2017; IEA Bioenergy Task 40; FAO; CREIA

Table 8.1 Evolution of world wood pellet actual production in 2013.2016 (tonnes)

	2013	2014	2015	2016
Europe	13.793.606	15.533.640	16.431.329	16.590.960
North America	6.781.000	7.978.000	9.450.000	9.900.000
South America	61.500	49.390	75.000	125.350
Asia	1.042.296	2.763.200	6.455.035	9.341.000
Oceania		105.000	153.000	160.000
Total	21.678.402	26.429.230	32.564.364	36.117.310

Source: EPC survey, 2017; IEA Bioenergy Task 40; FAOstat; CREIA

Table 8.2 World wood pellet production (detailed) in 2015 and 2016

		2015		2016		
	Number of operating production plants	Production capacity (in tonnes)	Actual production (in tonnes)	Number of operating production plants	Production capacity (in tonnes)	Actual production (in tonnes)
EU28	613	21.634.175	14.057.175	634	20.509.965	14.000.038
Other Europe	475	3.952.000	2.374.154	534	4.041.000	2.590.922
Total Europe	1.088	25.586.175	16.431.329	1.168	24.550.965	16.590.960
Total outside Europe	1.018	23.748.510	16.133.035	1.157	30.449.000	19.526.350
AU	8	120.000	105.000	9	120.000	110.000
BR	13	200.750	75.000	12	265.000	125.350
CA	39	3.300.000	2.250.000	39	3.900.000	2.800.000
CN	798	7.187.760	4.824.000	894	10.728.000	7.200.000
ID	0	0	80.000	8	355.000	90.000
JP	6	138.000	126.035	6	138.000	126.000
KR	0	0	15.000	0	0	15.000
MY	0	0	160.000	25	850.000	310.000
TH	16	832.000	250.000	16	832.000	250.000
US	135	11.700.000	7.200.000	145	12.991.000	7.100.000
VN	0	0	1.000.000	0	0	1.350.000
NZ	3	270.000	48.000	3	270.000	50.000

Source: EPC survey, 2017; IEA Bioenergy Task 40; FAOstat; CREIA

8.1.2 WORLD PELLET CONSUMPTION

In 2016, the Global wood pellet consumption reached 27,8 million tonnes and observed growth of 6%.

Responsible for almost 80% of the world's wood pellet consumption with 22,3 million tonnes, **Europe** (mainly EU28) remains a massive pellet consumer. The overall growth of pellet consumption in Europe has been close to 5 % from 2015 to 2016, which is much lower than the 13% increase recorded during the previous period (2014.2015). With 16,6 million tonnes (14 million for EU28) of production, the Europe supplies 74% of its pellet use (65% for EU28).

In **North America**, wood pellet consumption has slightly declined. It has shown a decline of 5% between 2015.2016. With about 2,4 million tonnes used for heat (mostly domestic heat), **US** pellet consumption remains important, making it one of the largest pellet users outside the EU and one of the 10 largest pellet users worldwide. This consumption could dramatically increase should the US convert their coal-fired power plants to pellets in the frame of the Clean Power Plan, but this seems rather unsure, especially with the latest developments in the US with regards to climate policy.

Besides the European and North American markets, the **Asian market**, mainly South Korea and Japan, have suddenly become significant pellet users. The use of pellets in Asia is expected to expand further in the coming years.

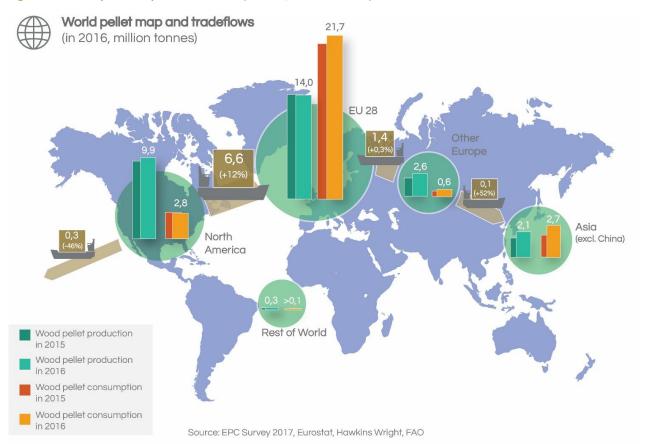


Figure 8.3 World pellet map and trade flow (in 2016, million tonnes)

Sources: EPC survey, 2017; Hawkins Wright; FAO; Eurostat.

Note: Asia does not include China

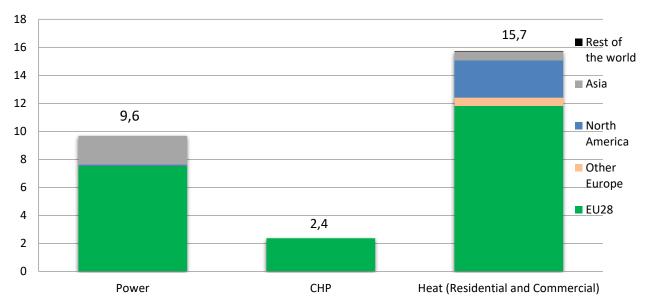
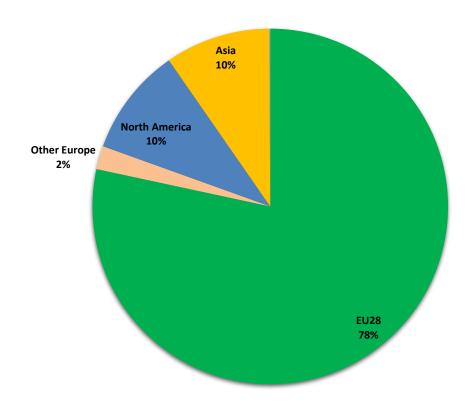


Figure 8.4 World wood pellet demand in 2016. power, CHP and heat (million tonnes)

Sources: EPC survey, 2017; Hawkins Wright Note: Asia does not include China

Figure 8.5 Distribution of world wood pellet consumption in 2016 (%)



Sources: EPC survey, 2017; Hawkins Wright Note: Asia does not include China

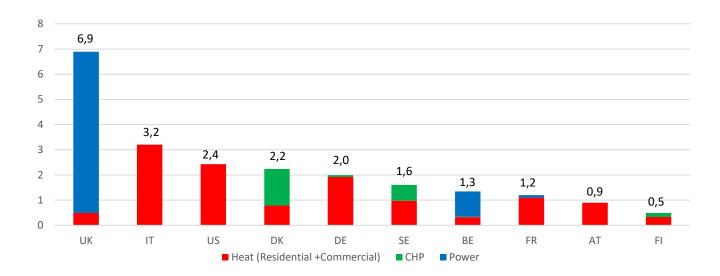
Table 8.3 Evolution of wood pellet consumption in different continents 2013-2016 (tonnes)

	2013	2014	2015	2016
Europe	18.150.890	18.819.160	21.311.701	22.300.688
North America	2.506.000	2.875.000	2.902.000	2.760.000
South America		58.000	90.000	
Asia			1.806.000	2.676.000
Oceania			22.500	27.500
Total	20.656.890	21.752.160	26.132.201	27.764.188

Sources: EPC survey, 2017; Hawkins Wright

Note: Asia does not include China

Figure 8.6 Top 10 wood pellet consuming countries by end-use in 2016 (million tonnes)



Sources: EPC survey, 2017; Hawkins Wright

Note: For UK, the split between residential and commercial not available. However, a significant share of wood pellet consumption goes to commercial scale thanks due to the Renewable Heat Incentive.

Table 8.4 World wood pellet consumption (detailed) in 2015 and 2016

	2015				2016					
	Residential	Commercial	СНР	Dedicated power	Total	Residential	Commercial	СНР	Dedicated power	Total
EU28	8.406.264	2.268.367	2.335.530	7.805.000	20.815.161	9.241.913	2.565.894	2.373.081	7.525.000	21.705.888
Other Europe	418.500	78.040	0	0	496.540	503.500	91.300	0	0	594.800
Total Europe	8.824.764	2.346.407	2.335.530	7.805.000	21.311.701	9.745.413	2.657.194	2.373.081	7.525.000	22.300.688
Total outside Europe	2.808.500	110.000	0	1.902.000	4.820.500	2.958.500	355.000	0	2.150.000	5.463.500
AU	5.000				5.000	10.000				10.000
BR	30.000	60.000			90.000					
CA	225.000	25.000		96.000	346.000	210.000	25.000		100.000	335.000
JP				376.000	376.000	136.000			350.000	486.000
KR				1.430.000	1.430.000	190.000			1.700.000	1.890.000
Other Asia							300.000			300.000
US	2.531.000	25.000			2.556.000	2.395.000	30.000			2.425.000
NZ	17.500				17.500	17.500				17.500

Sources: EPC survey, 2017; Hawkins Wright Note: Asia does not include China

8.1.3 WORLD PELLET TRADE

Europe, especially **EU28**, is the largest pellet importer in the world. The EU28 produces 14 million tonnes but consumes 21,7 million tonnes. The imported pellets are mainly sourced from **North America** and **European countries outside EU28**. The EU28 imports from North America significantly increased from 5,76 million tonnes in 2015 to 6,58 million tonnes in 2016. The imports from **European countries outside EU28** have also reached 1,4 million tonnes in 2016. The trade within Europe (import and export) is further detailed later in this report.

Besides Europe, Asia, especially South Korea and Japan, became very important pellet importers over a short period. In 2016, they imported together 2 million tonnes² mainly from Asia (Vietnam, Malaysia, Indonesia, Thailand) but also from Canada and Russia.

² Hawkins Wright 2017

8.2 SITUATION IN EUROPE

8.2.1 EUROPEAN WOOD PELLET PRODUCTION

With 16,6 million tonnes of pellets produced in 2016, **Europe** is the **largest producer** in the world amounting to nearly 57% of global production (With 14,0 million tonnes, EU28 accounts for 48%). After showing a continuous expansion over the last years, actual European production stagnated in 2016 with growth of only 1% (EU28 observed a slight decrease of 0,4%). As a majority of the European pellet production is used in the heating market, it has been strongly impacted by the contraction of the demand due to the mild winter of 2015.2016 and the decrease of sales of heating appliances. The use of pellets in the industrial market was also below the projections in 2016, further compounding the situation of overcapacity and oversupply of European pellet producers. Thankfully, the heating season 2016.2017 witnessed more favourable weather conditions allowing to rebalance the offer and the demand and offering most European pellet suppliers a chance to recover from 3 difficult consecutive years.

However, when looking at national level, the situation differs significantly with some countries experiencing a growth while others stagnate or even decrease. **Germany** remains the biggest producer with 1,9 million tonnes produced in 2016, followed by **Sweden** with 1,7 million tonnes. Among the Baltic States, **Latvia** and **Estonia** remain big market players respectively showing a production of 1,4 million tonnes and 1,2 million tonnes even though their production decreased in 2016 adapting the challenging 2016 market conditions. **France** experienced a continuous production growth over the years amounting to 1,2 million tonnes in 2016.

European/EU-28 wood pellet production (in 2016, tonnes, %) European production EU-28 production Actual production (in tonnes) > 1.500.000 > 1.000.000 < 1.000.000 < 600.000 < 300.000 < 99.999 Source: EPC Survey Production in top 5 EU-28 countries in 2016 19 1.7 1,2 1,2 < 0.1% -8,8% 10,8% +21,0%

Figure 8.7 Map of European wood pellet production in 2016

Source: EPC survey, 2017, FAO

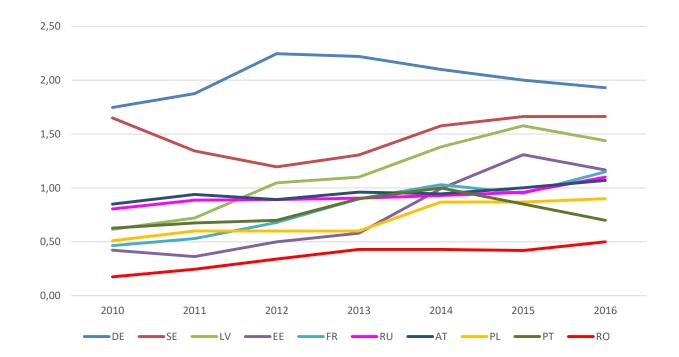


Figure 8.8 Trend of wood pellet production in 2010.2016 for the 10 largest producers of EU28 (million tonnes)

Germany: Production has grown over the years making Germany the biggest EU pellet producer. This evolution was mainly due to the growing local use of pellets for heating, even if Germany exports (decreasing) a part of its production to other EU countries. In 2016, the pellet production in Germany was lower than expected as the suppliers had to adapt to the difficult market conditions affecting the heating sector and because exports decreased significantly. German production was also impacted by the bankruptcy of the largest German producer, German pellets, in early 2016. German pellets production sites operated on a low level for some months before the new owners increased their production.

A most favourable heating season 2016.2017 coupled with sufficient raw material will most probably allow the production to grow by 15 to 20 percent in 2017.

Sweden: The pellet production of the second largest EU pellet producer has significantly fluctuated in the past, mainly due to the variable local pellet consumption. But for four consecutive years, Sweden has seen its production growing, reaching the highest production ever recorded in 2016. It can be observed that Sweden was producing pellets mainly for local use but is gradually developing its exports.

Latvia: Over a short period, pellet production in Latvia boomed making the country the 3rd largest pellet producer and the biggest exporter in the EU. In 2016, the actual production decreased to adapt to market conditions while the capacity slightly increased. The Latvian pellet producers, of whom the vast majority export pellets to large European industrial users, suffered from the slowdown in industrial demand while the conditions of the heating sector did not offer them an opportunity to make the most of their production capacity.

Latvian production still offers an important potential for further growth but production is only expected to show a limited increase in the near future despite its big potential.

Estonia: Very similarly to Latvia, the pellet production in Estonia grew dramatically over the past years, allowing Estonia to become the 4th largest producer in Europe. As the Estonian pellet producers are also largely producing pellets for export to European industrial users, they experienced the same difficulties as the Latvian producers and had to adapt their production. As for Latvia, production is expected to grow slowly in the coming years.

France: Over recent years, France witnessed a dramatic increase in its production to supply the growing local use of pellets for heating. The use of pellets and sales of heating appliances, especially stoves, is expected to follow this expansion in France, allowing local production to continue growing.

The potential for raw material remains high, signalling a bright future for further production expansion.

Russia: Late comer in the pellet business but showing an impressive potential for further growth, Russia is gradually becoming an important market player having the 3rd largest production capacity after Germany and Sweden. The actual production of 1.100.000 tonnes allows Russia to rank as the 6th largest producer in Europe but shows a rather low saturation of capacity. A steady growth is foreseen for pellet production in Russia in the coming years.

Austria: Having shown intense growth in the early stages of pellet history, the Austrian pellet production growth slowed down in recent years with lower pellet demand growth. Thankfully the heating season 2016.2017 improved the local demand and even created some tensions on the local supply. A slight increase of pellet production capacity is expected in 2017.

Poland: Initially, a significant part of the pellet production in Poland was made from agro-resources, mainly straw. Those agropellets were mostly used in local biomass power plants. The crash of green certificates strongly impacted this market. Recently, Poland increased its wood pellet production and exports either by converting agropellet production units to wood pellets or by building up new capacity. This trend is expected to continue in 2017 with the conversion of 5 straw pelleting plants to wood pellets.

Portugal: Having shown a continuous growth from 2010 to 2015, the Portuguese pellet production has witnessed a considerable contraction, mainly explained by the limited availability and high prices of raw material. Producers have adapted to this situation by reducing their production.

Romania: Romanian production grew rather drastically over the past years but slowed down in 2015 due to the unfavourable conditions of the pellet heating markets in the surrounding countries, but the industry recovered in 2016.

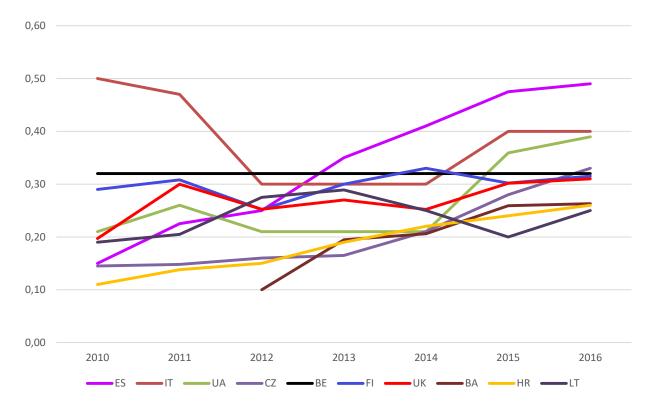


Figure 8.9 Trend of wood pellet production in 2010.2016 for the top 11.20 producers of EU28 (million tonnes)

Spain: Production in Spain is locally used in the heating sector. The sector suffered very badly from the previous heating seasons but the 2016.2017 season allowed the producers and traders to greatly recover and clear their stock. No major capacity increase is foreseen in the coming years but the sector will consolidate.

Italy: Italy remains the world's biggest domestic pellet user. Regarding the local pellet production, Italy has most likely reached its peak because of a lack of raw material. Italy shows a rather high forest potential, but the extraction is complex due to the limited accessibility of this wood, making any future noticeable growth of local pellet production very unlikely.

Ukraine: Ukrainian production grew significantly over the last years. Ukraine is showing a great potential in terms of biomass allowing the production to pursue its growth.

Czech Republic: Production in the Czech Republic is showing a continuous growth mainly due to the increase of the export demand but also thanks to the growing local demand for domestic heating. New production plants have recently been built in the Czech Republic.

Belgium: The production capacity has strongly increased since 2007 in Belgium. Nowadays, despite having a rather high use of industrial pellets, Belgium is still suffering from overcapacity as the sourcing of these pellets has progressively moved to North America, exclusively. All the Belgian producers are therefore targeting the heat sector (domestic and commercial) which is unfortunately slowing down mainly due to the mild winter. This situation has also created some overstock for some producers. The raw material availability and the competition for its use as well as the pressure from pellet imports are growing concerns for Belgian producers.

Finland: Production slightly decreased in 2015 to adapt to lower demand but in 2016 the pellet consumption recovered and the production adapted again. The long-term perspective for the Finnish market is still positive thanks to the pellet use with pellet peak up plants and a growing mid-scale sector.

United Kingdom: Despite the limited raw material potential of United Kingdom, local production increased overall in recent years most likely due to an encouraging growth in pellet use where the Renewable Heat Incentive subsidy scheme had a very positive impact. But the growth is still disappointing mainly due to fierce competition with imported pellets. The recent changes in this scheme will certainly affect boiler sales and hence the further growth of pellet production.

Bosnia Herzegovina: The production grew significantly in the past but plateaued in 2016 mainly due to the lack of competitiveness in price compared to other countries exporting to Italy.

Croatia: Within a few years, pellet production grew significantly in Croatia despite limited local use. Most of the Croatian pellets are exported to Italy.

Lithuania: The third Baltic country is not witnessing the same boom as Latvia and Estonia, but is seeing some additional investments being made. The production of pellets, mainly dedicated to export for industrial use, grew slightly in 2016. In 2017, two new plants, for an overall capacity of 220.000 t per annum will start producing pellets.

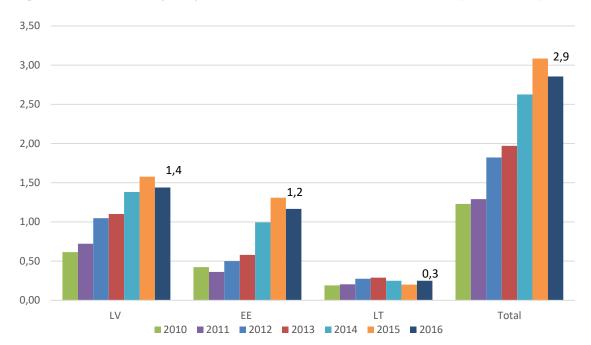


Figure 8.10 Trend of wood pellet production in 2010.2016 for the Baltics countries (million tonnes)



Wood pellets are being produced almost all over Europe. But two regions are noteworthy because they produce primarily for export rather than local consumption. These two regions are the Baltics and the Balkans. The Baltics are Europe's largest manufacturing base for industrial wood pellets, whilst in the Balkans almost all the pellets produced are for the residential market.

The Baltic States (Estonia, Latvia and Lithuania) together produce more than 3 million tons for export. However, what used to be a very diverse market with many pellet plants in the 50-100 000 million tonnes range making both industrial and residential wood pellets have witnessed consolidation resulting in a few industrial pellet producers dominating the landscape. Whilst this has made purchasing easier for the large utilities it has in turn made life more difficult for the wood industry in the region by reducing options for selling their sawdust and shavings. A lack of sales options drove raw material prices down. Slowly but surely this has resulted in small sawmills and wood industry participants looking at becoming niche suppliers for the residential wood pellets market. The investment required is not too onerous and the prospect of getting more for the waste they generate has meant an increase in the number of small producers. There are companies making containerized pellet plants that can be quickly erected and do not require expensive groundworks. Now we are witnessing an increase in raw material prices as volumes of sawdust that were formerly sold are being pelletized on the spot.

Arnold Dale Vice President Bioenergy Ekman

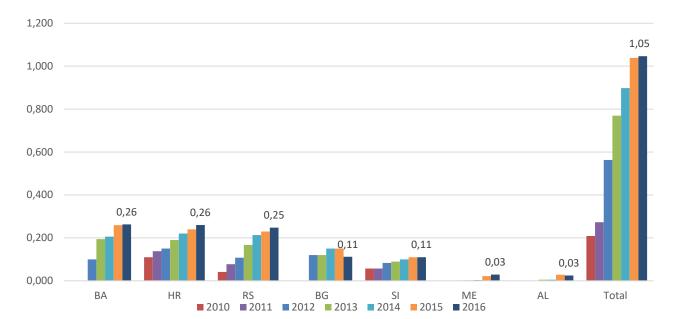


Figure 8.11 Trend of wood pellet production in 2010.2016 for the Balkan countries (million tonnes)



The pellet production recently boomed in the Balkans amounting to 1 million tonnes in 2016. The growth rate declined in 2016 due to a small decrease in pellet production witnessed in Albania, Bulgaria, and Slovenia. The appealing Italian market initiated this vast increase of production plants reaching 100 units in 2015 for exporting 80 % of its volume to Italy.

During the last two years, the exports to Italy decreased significantly due to limited competitiveness of Balkan producers. Most of the losses in export were anticipated by an increase in local demand. Due to the supply of local boilers and stoves and due to the local availability of pellets this enormous boom was invisible for the rest of the world. Within only 3 years, the pellet consumption per capita increased from practically 0 kg to 32 kg in 2016 in Kosovo, which is a higher demand than in Germany (27 kg per capita). Serbia currently exports more pellets to Macedonia and Kosovo than to Italy. In Serbia, more than 12.000 pellet stoves and boilers were sold in 2015 and there is still a significant increase. In most of the Balkan countries pellets replace old, low efficient wood stoves and coal boilers. This improves air quality remarkably. With current national growth rates Balkan countries will soon use their complete production locally, becoming a good example of local, sustainable heat production.

Dr. Martin Englisch General Manager BEA Institut für Bioenergie

8.2.2 RAW MATERIALS FOR EUROPEAN WOOD PELLET PRODUCTION

Within the data collection run by EPC, the partners³ 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)

As illustrated by the below figure, at European level, over 85% of wood pellets' raw material consists of wood industry residues and waste wood.

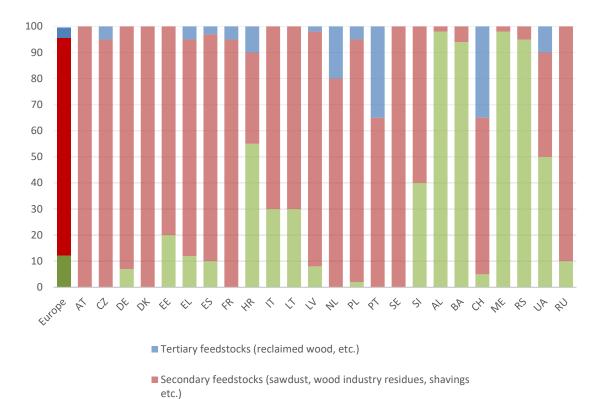


Figure 8.12 Estimate of the shares of raw materials used in local pellet production per European country (%)

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

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

Figure 8.13 Estimate of the shares of hard wood and soft wood in local pellet production in Europe (%)

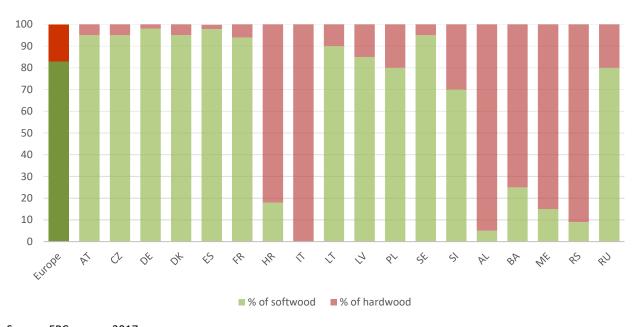


Table 8.5 European wood pellet production in 2016 compared to 2015

		2015		2016			
	Number of operating production plants	Production capacity (in tonnes)	Actual production (in tonnes)	Number of operating production plants	Production capacity (in tonnes)	Actual production (in tonnes)	
EU28	613	21.634.175	14.057.175	634	20.509.965	14.000.038	
AT	37	1.481.000	1.001.000	38	1.496.000	1.070.000	
BE	12	760.000	320.000	12	760.000	320.000	
BG	5	200.000	150.000	5	200.000	112.000	
CY	no data	no data	no data	no data	no data	no data	
CZ	22	380.000	280.000	25	400.000	330.000	
DE	54	3.200.000	2.000.000	55	3.200.000	1.930.000	
DK	5	250.000	150.000	5	300.000	150.000	
EE	18	1.440.000	1.308.500	19	1.500.000	1.167.364	
EL	14	130.000	40.000	16	140.000	50.000	
ES	79	1.250.000	475.000	82	1.600.000	490.000	
FI	28	623.500	302.000	29	623.500	315.000	
FR	50	1.800.000	950.000	52	1.800.000	1.150.000	
HR	16	300.000	240.000	18	340.000	260.000	
HU	6	145.000	3.140	6	122.000	3.139	
IE	1	40.000	31.000	1	40.000	31.000	
IT	30	450.000	400.000	30	450.000	400.000	
LT	9	350.000	200.000	11	360.000	250.000	
LU	1	50.000	50.000	1	50.000	50.000	
LV	27	1.750.000	1.577.000	28	1.850.000	1.438.337	
MT	no data	no data	no data	no data	no data	no data	
NL	4	350.000	265.500	4	350.000	200.000	
PL	50	1.050.000	870.000	52	1.100.000	900.000	
PT	26	1.941.875	850.000	25	1.941.875	700.000	
RO	22	750.000	420.000	22	750.000	500.000	
SE	65	2.236.185	1.662.525	65	2.236.185	1.663.198	
SI	14	130.000	110.000	18	140.000	110.000	
SK	10	200.000	100.000	10	200.000	100.000	
UK	8	376.615	301.510	8	376.615	310.000	
Other Europe	475	3.952.000	2.374.154	534	4.041.000	2.590.922	
AL	8	33.000	28.000	7	30.000	25.000	
BA	33	305.000	259.000	31	350.000	263.000	
BY	14	209.000	300.000	14	209.000	300.000	
СН	24	280.000	160.000	24	280.000	180.000	
ME	2	35.000	21.600	4	55.000	28.900	
NO	4	75.000	56.874	4	75.000	56.892	
RS	56	485.000	229.650	52	387.000	247.560	
RU	80	2.000.000	960.000	85	2.125.000	1.100.000	
UA	254	530.000	359.030	313	530.000	389.570	
_							

A consultation was carried out for the partners⁴ 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 (domestic and commercial), and countries mainly producing pellets for industrial use. Latvia, Estonia and Portugal are the only countries mainly producing for industrial use. For the remaining countries, most of the pellets produced go for the heat market. In Europe, 78% of pellets produced go to the heat market with 57% going to small scale appliances and 21% going to midscale appliances.

Belgium: A large part of the production was dedicated to local use in power plants from 2007 to 2011. However, utilities have increasingly sourced their pellets from abroad (mainly from North America). Consequently, Belgian producers have switched to the domestic heating market creating a severe overcapacity.

Portugal: The majority of the Portuguese pellets have been dedicated to the industrial users for years. But it can be noted that these trends are changing with market opportunities. Indeed, in 2015 some volumes could be sold to neighbouring countries for domestic heat while in 2016 the favourable dollar-euro exchange rate offered SPOT opportunities in the industrial market.

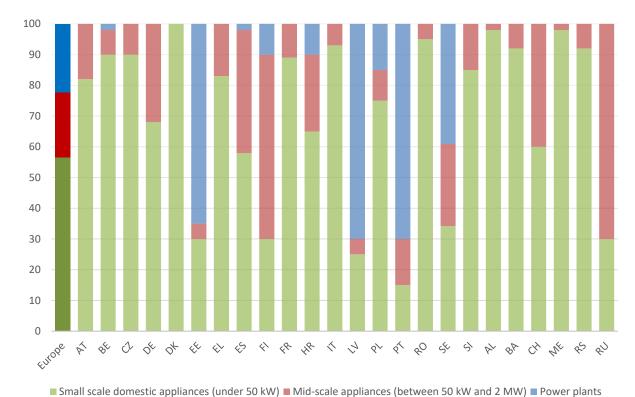


Figure 8.14 Estimate of European wood pellet producers' main markets by end-use in 2016 (percentage)

⁴ 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 producers⁵ have been collected every year since 2013 from the national pellet associations. When looking at the importance given to the different market obstacles as perceived by the pellet associations from 2013.2016, the relative importance of each parameter varied between the different years.

In 2013 the lack of demand was a minor concern but grew over the years to become the biggest concerns in 2014 and 2015 confirming the unfavourable market conditions for the European producers. In 2016, although there was an increased demand for pellets in the heat market in comparison with the last two years, it remains one of the major concerns of the producers.

The competition with importers was once again gaining importance in 2015. The fierce competition and price war that has been reported by some market players confirm the results of this survey. This remains true in 2016, although its relative importance is not the highest.

The price of raw material was perceived as the biggest concern in 2013 and it reduced its relative importance in the two following years. In 2016, it increased in importance once again, with some countries, like Poland, seeing a sudden increase in raw material prices due to rapid market changes in the country.

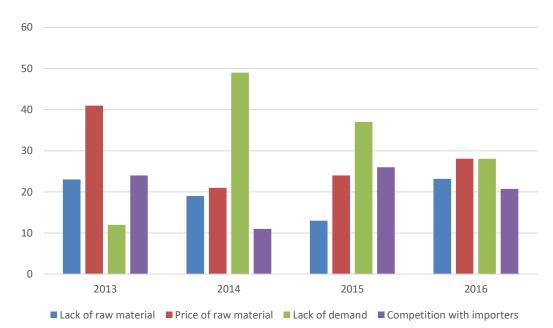


Figure 8.15 Evolution of European wood pellet producers' perception of the main difficulties 2013-2016 (%)

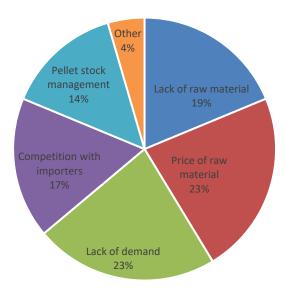
Source: EPC survey, 2017

Remark: For 2016, two additional criteria were surveyed. To make this graph, the figures obtained for the four perceived difficulties appearing in this graph were brought back to 100.

⁵ For this survey, only the national pellet associations were consulted. Not all of them have consulted the local producers.

A lack of demand has been identified as one of the biggest concerns in the past years. In the 2017 survey, pellet stock management was added as an additional difficulty. Although not identified as the biggest difficulty of this year, it is still a significant concern for the pellet producers in 2016.

Figure 8.16 European wood pellet producers' perception of the main difficulties in 2016 (%)

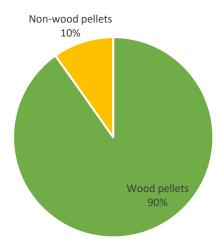


8.2.3 EUROPEAN NON.WOOD PELLET PRODUCTION

Despite the difficulties encountered by some EU producers to source wood, the **agropellet** market is not properly taking off as it has been stagnating at 10% of European pellet production. The main European agropellet producers are **Ukraine** (934.000 tonnes in 2016), **Poland** (450.000 tonnes in 2016) and the Czech Republic with 200.000 tonnes. These pellets, made of agricultural (by)products (e.g. straw, sunflower husks, etc.), are mainly used in industrial plants (power plants and CHP).

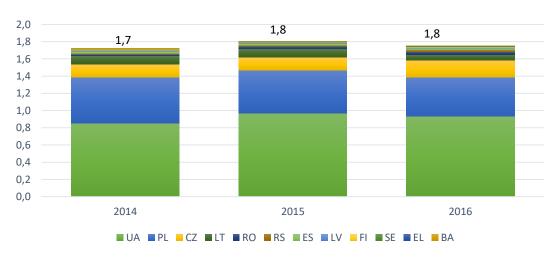
The biggest agropellet user is Poland, having used 1 million tonnes before the crash of the green certificate prices which has strongly impacted the market. No expansion of agropellet use is foreseen in some countries like **Austria** and **Switzerland** due to boiler emissions limitations.

Figure 8.17 European pellet production by raw material in 2016 (%)



Source: EPC survey, 2017

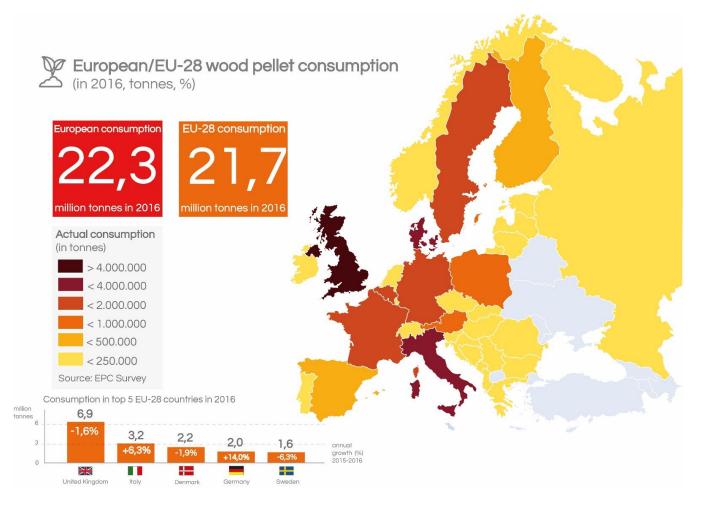
Figure 8.18 Evolution of the production of non-wood pellets in Europe (in million tonnes)



Source: EPC surveys, 2014.2017

8.2.4 EUROPEAN WOOD PELLET CONSUMPTION

Figure 8.19 Map of wood pellet consumption in Europe in 2016

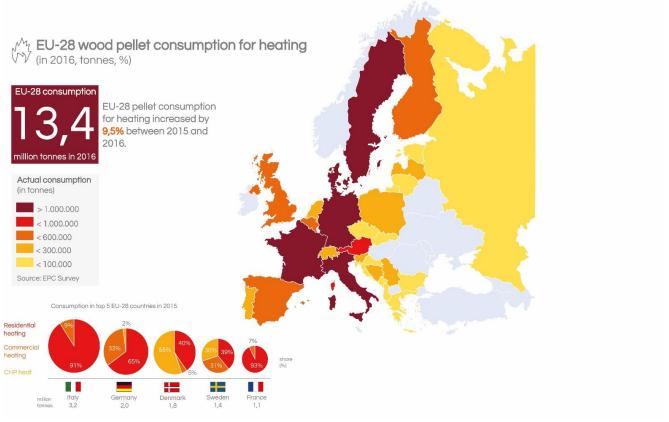


Sources: EPC survey, 2017, Hawkins Wright

The use of **pellets for electricity** production (from CHP and dedicated power plants) in the EU28 has shown a slight decrease of 3,1% mainly due to the decrease in the use of pellets for power in the **United Kingdom and a slight decrease of CHP in Denmark**. The use of **pellets for heat** (from CHP, domestic and commercial appliances) remains a strong sector which had seen a slowdown in recent years due to warm winters. However, as the last winter was colder than the previous ones, wood pellet use for the EU28 heat sector saw an increase of 9,5% between 2015.2016.

8.2.4.1 PELLET CONSUMPTION FOR HEATING

Figure 8.20 Map of wood pellet consumption for heating in Europe in 2016



Sources: EPC survey, 2017, Hawkins Wright

The use of pellets for producing **heat** remains a strong sector in the EU, showing a noticeable expansion over the years. While the EU pellet for power market relies on policy frameworks, the EU pellet for **heating market**, which is less "support-dependent", has shown to be stronger and more reliable.

From 2013 to 2016, Europe experienced three **consecutive mild winters**, leading to a rather disappointing growth of pellet consumption in the heat market. Thankfully, the last heating season was colder, resulting in pellet use for heat (residential and commercial excluding CHP) showing a growth of 10,6 % over the 2016-2017 period. This sudden rise in consumption generated some tensions in the supply leading to shortage in some areas and generating a price increase. 2017 volumes might even be more positive if Europe experiences at least a normal heating season 2017.2018.

Despite this market recovery, the contraction of pellet heating appliance sales (especially domestic boilers) that can be observed in most Europe is concerning as this will impact the future growth of pellet sales.

14 other 11,8 ■ PT 12 10,7 10,0 10,0 ■ PL 10 ■ BE 8,1 7,2 ■ FI ■ ES UK DK AT ■ SE ■ FR 2011 2012 2013 2014 2015 2016

Figure 8.21 Evolution of EU wood pellet consumption for domestic and commercial heating excluding CHP (million tonnes)

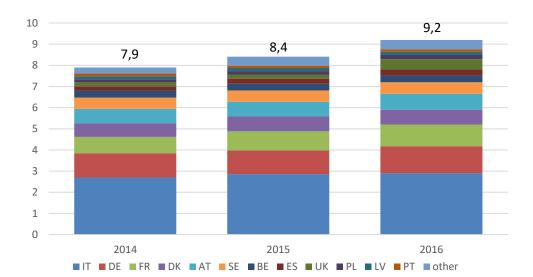


Figure 8.22 Evolution of domestic (<50kW) EU wood pellet consumption in EU (million tonnes)

Source: EPC survey, 2017

Pellet use in domestic heating appliances showed a growth of 9,5 % while the use of pellets in commercial heating appliances showed an increase of 13%. Even though the split between domestic and commercial uses could raise some concerns in terms of precision, the higher growth of pellet use for commercial heat is very encouraging as several analysts see this market as the future of the pellet industry (see Christian Rakos comment further on in this report).

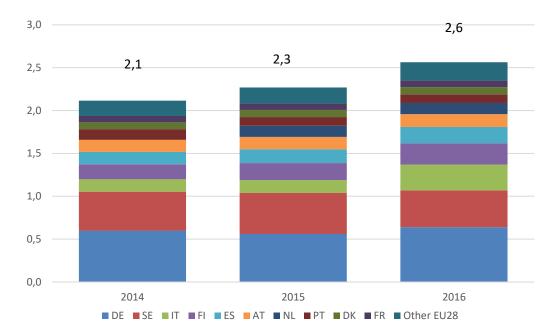


Figure 8.23 Evolution of commercial (>50kW) EU wood pellet consumption in 2016 (million tonnes)

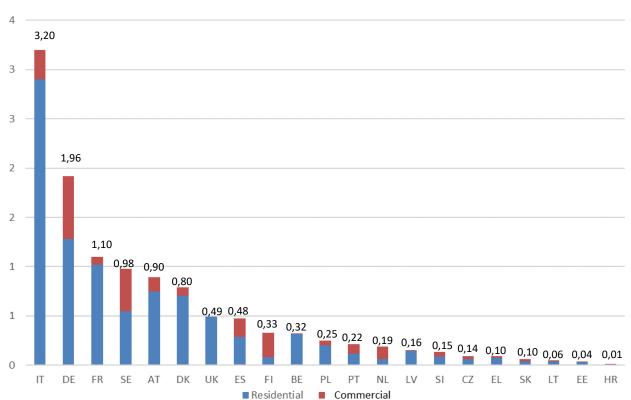


Figure 8.24 EU28 pellet consumption in heat production (excluding CHP) in 2016 (million tonnes)

Source: EPC survey, 2017

Note: For the UK, the split between residential and commercial was not available. However, a significant share of wood pellet consumption goes to commercial scale due to their national support scheme, RHI (Renewable Heat Incentive).

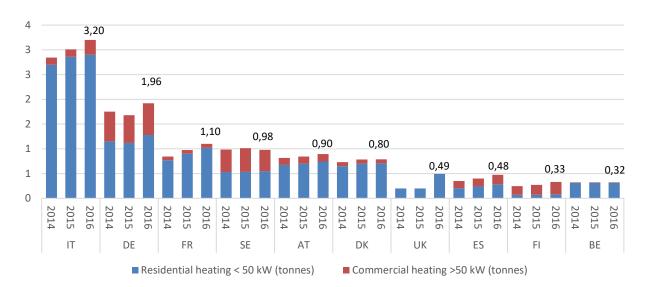


Figure 8.25 Evolution of wood pellet consumption for residential and commercial heating (excluding CHP) in the 10 highest consuming EU countries in 2014.2016 (million tonnes)

Note: For the UK, the split between residential and commercial was not available. However, a significant share of wood pellet consumption goes to commercial scale due to their national support scheme, RHI (Renewable Heat Incentive).

Even though each market has its specificities one can see that the more favourable market conditions of last heating season positively impacted the European pellet heat market. Unfortunately, for most markets having a long history of pellet use for heating (AT, DE, IT, SE, etc.) the sales of heating appliances are decreasing either showing a conjunctural problem or a structural problem. The latter would mean that the market is changing, requiring the sector to adapt by, among others, diversifying its market segments.

Italy: Italy remains the European champion of pellet use for heating with 3,2 million tonnes used in 2016. Even if a careful approach is needed for pellet use and appliance sales for this big and scattered market, it is sure that Italy will remain an extremely important player even if the annual sales of stoves tend to decrease. On the other hand, some interesting sales of domestic and commercial boilers are currently recorded in Italy, which may be signalling a market change. Germany: The end of 2016 witnessed a noticeable growth of pellet use in Germany and the sales of early 2017 were also encouraging due to the more favourable market conditions, even if the trends of heating appliance sales are creating some concerns.

France: In a short period, France became an important pellet market player showing a continuous growth of pellet use despite the difficult heating seasons experienced over the last years. The French market is also one of the few showing a continuous growth of pellet stove sales but unfortunately not for domestic pellet boilers.

Sweden: The Swedish heating market (CHP excluded) is showing a rather stable trend over the years but it can be noted that the CHP operators are suffering from a very low electricity price.

Austria: Having a long history of pellet use for heating, Austria is following a path very similar to Germany.

Denmark: The domestic heating market is showing encouraging continuous growth in Denmark.

United Kingdom: The split between domestic pellet heating and commercial pellet heating seems rather difficult to establish in the UK pellet market, but it is clear that the RHI support scheme allowed the pellet heat sector to take off in the UK, even favouring the commercial sector. Unfortunately, the brutal change of RHI is strongly affecting the sales of appliances and seriously damaging the entire UK pellet industry.

Spain: In a short period, Spain also became an important market player showing strong growth of pellet use for heating. As a consequence, Spain, which was some years ago a net pellet exporter, is since 3 years using as many pellets as they produce, even with some imports that can be observed depending on market conditions.

Finland: The Finnish heating market is showing strong and very constant growth over the years. The long-term perspective for the Finnish market is still positive thanks to the pellet use with pellet peak up plants and a growing mid-scale sector.

Belgium: Despite the difficulties in collecting precise data about the Belgian heating market, pellet sales benefited from the more favourable conditions of the last heating season but the sales of heating appliances, especially boilers, face difficulties in recovering after having experienced an important drop in 2016.

EPC ran a consultation to get the partners⁶ to identify the pellet quality classes most used in the residential heat market and commercial heat market for each European country.

Several observations can be made on the results below. Some countries are mainly or even exclusively using premium quality both for the residential and commercial markets. Some other countries use lower quality pellets only in the commercial sector while some countries are also using lower quality pellets even in the residential market.

100 90 80 70 60 50 40 30 20 10 0 ΑT CZ DE DK EL ES FR ΙT LV PT SE SI ВА CH RS ■ A1 ■ A2 ■ B ■ Out of B quality

Figure 8.26 Estimate of pellet quality class shares for residential heat market per European country (%)

Source: EPC survey, 2017



Figure 8.27 Estimate of pellet quality class shares for commercial heat market per European country (%)

⁶ For this survey, only the national pellet associations were consulted. Not all of them have consulted the local producers.

A consultation was carried out to identify the forms of delivery of pellets for the residential heat markets of the different European countries. **Germany**, **Finland** and **Switzerland** are similar in that they have a residential heat market mainly made of boilers equipped with a silo, with a capacity of several tonnes. This explains why these markets are mainly consuming bulk pellets.

Most of the other **European countries** are mainly using bagged pellets, and big bags for some of them, either because their residential appliances are mainly made of stoves (e.g. Italy) or because the boilers used are often not equipped with a separate large capacity storage.

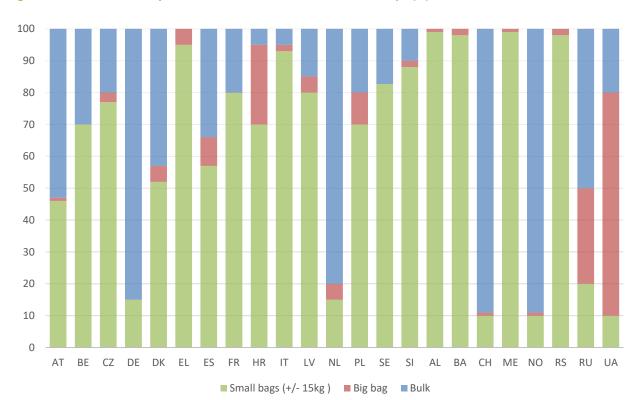


Figure 8.28 Forms of delivery used in the residential heat market in Europe (%)

Table 8.6 European wood pellet consumption for heating in 2016 compared to 2015 (tonnes)

		2015				2016		
	Residential	Commercial	2/3 CHP	Total	Residential	Commercial	2/3 CHP	Total
EU28	8.406.264	2.268.367	1.557.020	12.231.651	9.241.913	2.565.894	1.582.054	13.389.861
AT	700.000	145.000	0	845.000	745.000	150.000	0	895.000
BE	315.000	8.000	13.333	336.333	315.000	8.000	13.333	336.333
CZ	63.000	25.000	0	88.000	64.000	30.000	0	94.000
DE	1.120.000	560.000	43.333	1.723.333	1.280.000	640.000	46.667	1.966.667
DK	700.000	83.000	1.000.000	1.783.000	705.000	84.000	966.667	1.755.667
EE	28.000	8.000	0	36.000	30.000	10.000	0	40.000
EL	57.000	10.000	0	67.000	75.000	15.000	0	90.000
ES	240.000	160.000	0	400.000	285.000	190.000	0	475.000
FI	70.000	200.000	33.333	303.333	80.000	250.000	106.667	436.667
FR	900.000	75.000	0	975.000	1.020.000	80.000	0	1.100.000
HR	6.000	3.000	0	9.000	10.500	5.500	0	16.000
IT	2.860.000	150.000	0	3.010.000	2.900.000	300.000	0	3.200.000
LT	39.000	11.000	0	50.000	47.500	12.500	0	60.000
LV	143.000	7.000	0	150.000	148.000	7.000	0	155.000
NL	30.000	130.000	0	160.000	60.000	130.000	0	190.000
PL	160.000	50.000	0	210.000	200.000	50.000	16.667	266.667
PT	115.000	100.000	0	215.000	115.000	100.000	0	215.000
SE	535.264	478.367	467.020	1.480.651	549.370	428.894	418.721	1.396.985
SI	90.000	40.000	0	130.000	85.000	50.000	13.333	148.333
SK	35.000	25.000	0	60.000	35.000	25.000	0	60.000
UK	200.000		0	200.000	492.543		0	492.543
Other Europe	418.500	78.040	0	496.540	503.500	91.300	0	594.800
AL	20.000	1.000	0	21.000	22.500	1.200	0	23.700
ВА	73.000	8.200	0	81.200	117.500	11.000	0	128.500
СН	150.000	50.000	0	200.000	165.000	55.000	0	220.000
ME	4.800	940	0	5.740	12.600	1.000	0	13.600
RS	163.500	1.100	0	164.600	176.900	2.100	0	179.000
RU	7.200	16.800	0	24.000	9.000	21.000	0	30.000

Note: For the UK, the split between residential and commercial was not available. However, a significant share of wood pellet consumption goes to commercial scale due to their national support scheme, RHI (Renewable Heat Incentive).

8.2.5 EUROPEAN HEATING APPLIANCES MARKET

8.2.5.1 EUROPEAN STOVE MARKET

Collecting data on heating appliance sales is rather difficult but one can extract some trends. Generally, in 2014, 2015 and early 2016 the sales of stoves suffered in most of the 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 rather fast in most countries.

Italy: Italy remains the European champion having nearly 2.500.000 pellets stoves being installed. However, the annual sales showed a decrease. Fortunately, the sales started to recover by the end of 2016, mainly due to a rather rigorous winter, allowing optimistic projections for 2017. A support scheme, named "Conto Termico" has recently been launched. If the 2017.2018 heating season is cold, then the combination of these market drivers might lead to the replacement of old pellet stoves, generating all important hope in the sector.

France: Within a few years France became a very interesting market showing an impressive and continuous growth of the pellet stove sales. In 2016, the annual pellet stove sales reached 105.000 units, showing a growth of 15% from 2014, progressively reaching Italy showing 170.000 units a year. It is also noticeable that the stove sales continued to grow in 2014 and 2015 while most of the other markets witnessed a sales drop. As for the other markets, the severity of 2017.2018 winter and the price difference between fossil fuels and pellets will be an important driver. Thanks to the recent implementation of a carbon tax in France, the price difference should increasingly favour pellets over fossil fuels. The French carbon tax might become a real game changer as it was recently decided to increase the tax from 30 €/t C eq. in 2017 to 100 €/t C eq.

Spain: After having plateaued due to the unfavourable market conditions, 2016 was a good year in Spain witnessing a significant growth in stove sales. The market seems rather optimistic about the sales for the coming years.

Germany: The sales of stoves is slightly growing over the years in Germany but the overall results remain below industry expectations.

Serbia: unexpectedly Serbia is witnessing strong growth of pellet stove sales, confirming the boom of local pellet use in the Balkans previously reported in this report.

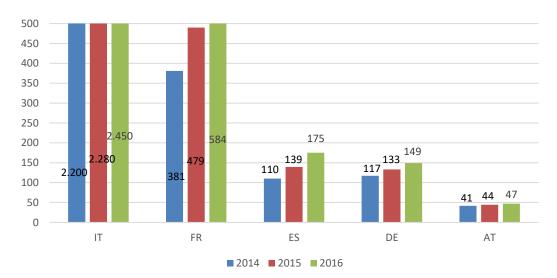


Figure 8.29 Evolution of total amount of installed pellet stoves (thousand units) in 2013.2016 in selected countries

Figure 8.30 Evolution of installed pellet stoves (thousand units) in 2003.2016 in some European countries with Italy in secondary axis

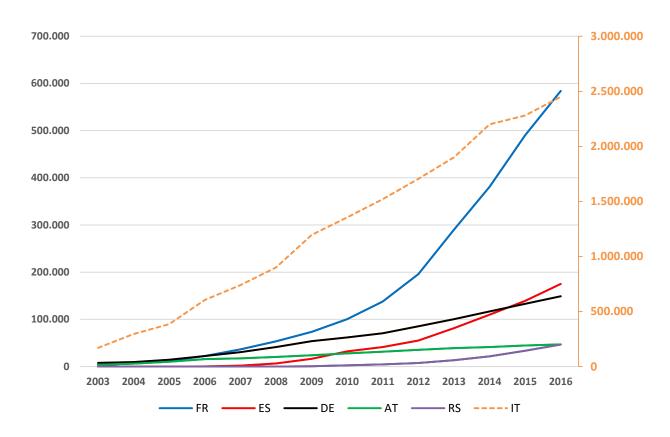
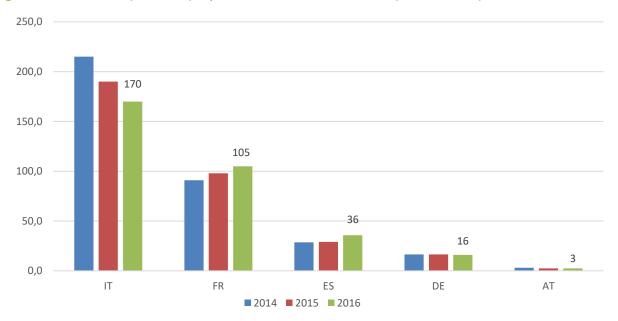


Figure 8.31 Annual sales (2014.2016) of pellet stoves in selected countries (thousand units)



8.2.5.2 EUROPEAN RESIDENTIAL BOILER MARKET

Contrary to the pellet stoves, acquiring a residential pellet boiler is seen by most individuals as an investment that should pay off within a reasonable time. Very low heating oil prices severely impacted the sector in most of the developed markets and the recovery seems difficult. Indeed, in these markets, the better heating season of 2016.2017 did not allow the sales to catch up, but one noticed an increasing interest of potential customers investing in a boiler, but this did not materialise in actual sales. Some other parameters, e.g. improving energetic performance of buildings and competition with other heating systems, are also impacting some markets questioning if the market will recover or if a structural change is occurring.

Three important countries where reliable data could be collected are showing very similar trends in terms of residential boiler sales:

Germany: Despite the existence of an incentive for pellet boilers, the growth in sales is still very restrained in Germany. Only a limited increase is expected in 2017.

Austria: Despite the long and strong history of its pellet industry, Austria is facing the same difficulties as Germany.

France: The sales of stoves showed impressive resistance to the recent difficult market conditions in France but the boilers have been strongly impacted and this market seem to be encountering difficulties to recover.

Italy, and especially Poland, are showing encouraging trends.

Italy: Despite being a "stove market" Italy is witnessing some sales of residential boilers and these sales recovered in late 2016 thanks to the rigorous winter. This trend is yet to be confirmed in 2017 and the recently launched scheme, named "Conto Termico", might have some positive impacts.

Poland: Sales of residential boilers are experiencing strong growth in Poland with 150 % growth from 2014 to 2016. This might confirm the boom of the Polish pellet industry both in terms of production and local use.

Figure 8.32 Evolution of total amount of installed residential pellet boilers (<50kW) in 2014.2016 (thousand units) in selected countries

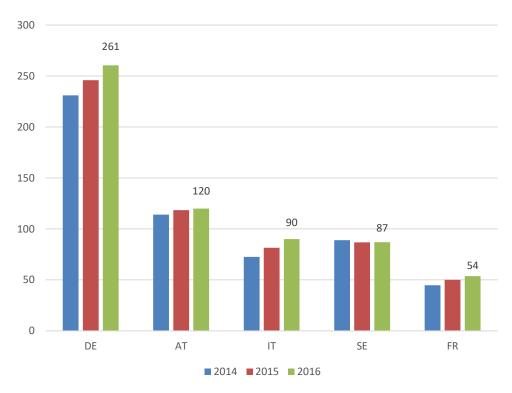
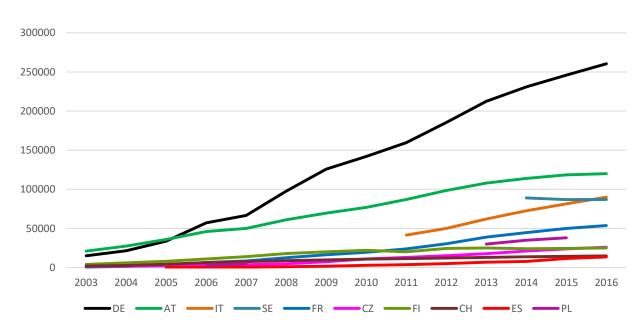


Figure 8.33 Evolution (2003.2016) of installed residential pellet boilers (<50kW) (thousand units) in European countries



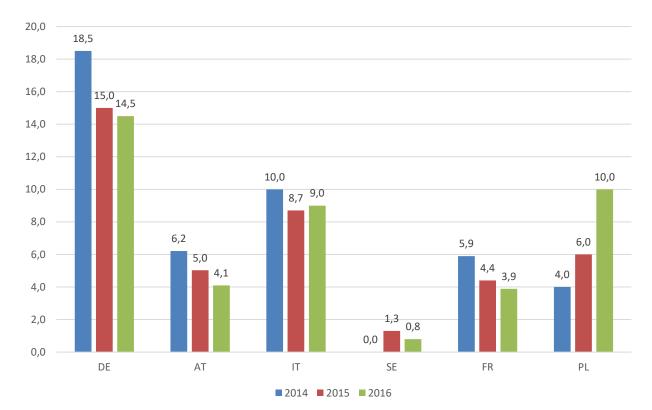


Figure 8.34 Annual sales (2014.2016) of residential pellet boilers (<50kW) in selected countries (thousand units)



Over the last 3-4 years the marketplace for domestic pellet boilers became more competitive all over the world. It is mainly the low oil prices that create this higher pressure and makes the environment more competitive.

However, with pellets being a commodity that is worldwide available, we are also expanding the horizon of application. Pellet in the early days was simply limited to small stoves and step by step established a position in the residential hydraulic boiler market over the last two decades. Over time it conquered also medium to large output sizes so that today multi-family homes or district heating is regularly done with pellets. Especially the fact that pellet boilers can run on high temperatures and, even during very cold outside temperatures, is a huge advantage compared to electricity based heating.

The newer developments are condensing pellet boilers with even lower dust emissions that fulfil today's expectations of highest efficiency and cleanliness. Fröling, as a pioneer, has a broad share of this still very new market by, offering condensing boilers for pellets and even log wood and chipped wood boilers.

Another area of activity where Fröling is staking a claim is the production of electricity on basis of wood pellets. With CHP units – in our case based on wood gasification technology – we see a market pattern that can be very different from the classic heating market as far as geography and customer types are concerned. This represents a very interesting complement to existing structures and makes us to believe strongly in the further growth potential of the pellets as a worldwide source of energy. Of course, availability and stability in quality and price are indispensable if we want to have a reliable fuel in the future.

Werner Emhofer Export Sales Manager Fröling

8.2.5.3 EUROPEAN COMMERCIAL BOILER MARKET

Pellets for commercial heat (dedicated heat boilers > 50 kW output used in residential buildings, public buildings, services, industry, etc.) remains a niche market for most areas in Europe, but is identified by several observers as key for establishing pellet use in the long run. Despite the difficulties in collecting reliable data, one can see some encouraging growth in some countries:

Spain: Sales of commercial heating appliances are progressing in Spain, confirming a growing interest for pellet use in this sector.

Poland: As for the sales of residential boilers, Poland is experiencing a strong growth in this market. A new subsidy programme was launched in 2017, bringing hope for further growth in the sector.

Unfortunately, the drop in residential boiler sales observed in Austria and Germany is also occurring in the commercial sector.

Italy: The commercial scale market is still a niche when compared to the residential market, but Italy is among the biggest markets in Europe. A deeper investigation recently performed showed that this market was bigger than expected. Hospitals and agroindustry were identified as the most promising sectors. One also observed that pellet solutions are gaining market shares against wood chips systems in Italy.

UK: Thanks to RHI, a boom occurred in the sales of commercial heating appliances in the UK but the recent brutal changes in the scheme stopped the sales.

Figure 8.35 Evolution of total amount of installed commercial pellet boilers (>50kW) in 2014.2016 (thousand units) in top 5 countries

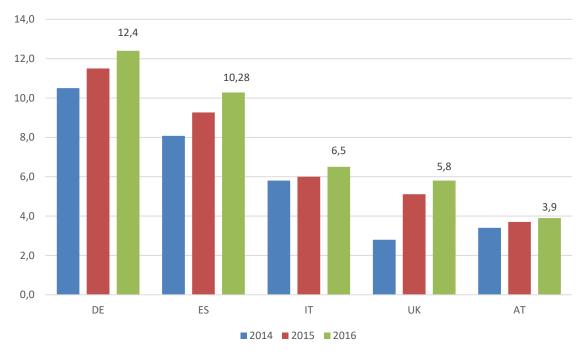


Figure 8.36 Evolution (2003.2016) of installed commercial scale pellet boilers (>50kW) (thousand units) in European countries

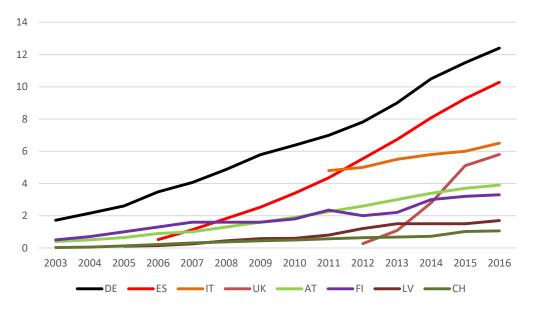
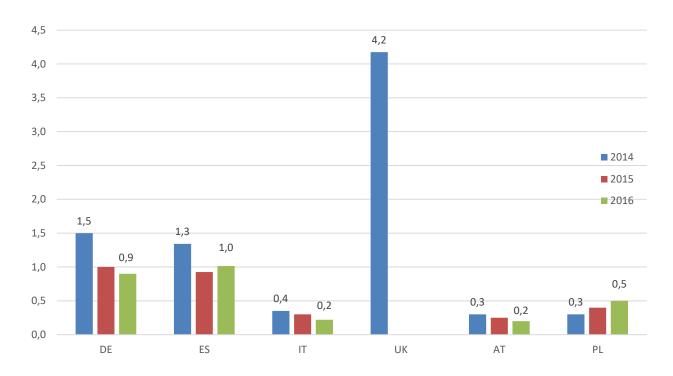


Figure 8.37 Top 5 countries with highest sales in commercial scale pellet boilers (>50kW) in 2014.2016 (thousand units)





The market for medium scale pellet boilers has seen more consistent growth recently than the market for domestic pellet heating systems. The total amount of installed systems grew between 2015 and 2016 by $10-20\,\%$ in most countries collecting data. Particularly high growth rates can be observed in eastern Europe, with especially high numbers in Poland. The success of pellets in Eastern European countries can coma as a surprise as these countries are generally not known for enthusiastic support of renewable energy. However, it is not primarily policy support that drives the use of pellets. It is the fact that pellets are a significantly more convenient and clean fuel than coal which is still predominant in the heat market of many of these countries.

While growth rates seem positive, it is still a fact that pellet boilers play a marginal role in the commercial heat market. Several reasons for this can be mentioned. The awareness of the need to make a contribution to climate protection is on the rise but still limited and often satisfied with cheap mitigation certificates. Energy costs for most companies are small compared to overall operational costs and have declined in recent years. The perception of risk associated with the change to a different fuel is also a barrier. It is interesting to notice that in China pellets are used almost exclusively in mid and large scale commercial heat applications. Energy service companies have played a critical role in this development. Could the lack of professional ESCOs offering competitive heat services to commercial clients be an explanation for the low market penetration of pellet heating in this segment? In Austria we have conducted several campaigns to promote the use of pellets in commercial heat applications. The success was very limited and our conclusion is that this will not change until prices for fossil fuels rise significantly as a result of CO₂ taxation.

> Christian Rakos Managing Director ProPellets Austria

Table 8.7 Annual sales of boilers and stoves in Europe (units)

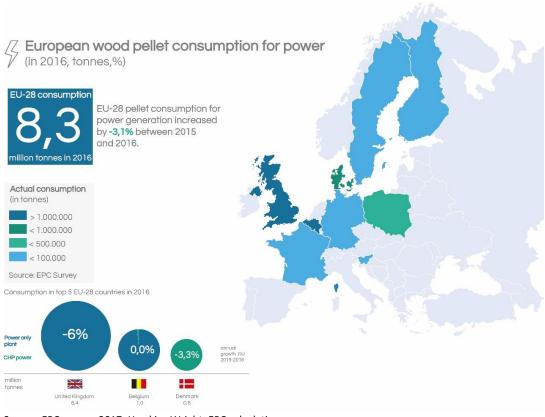
		Stoves		Reside	ntial boiler <	50 kW	Comme	rcial boiler	> 50 kW
	2015	2016	2020	2015	2016	2020	2015	2016	2020
AT	2.400	2.500	4.000	5.029	4.100	6.000	250	200	300
CZ	400	600	na	2.753	2.200	na	na	na	na
DE	16.500	16.000	na	15.000	14.500	na	1.000	900	na
EE	225	na	na	750	na	na	150	na	na
EL	3.000	2.000	3.000	1.000	1.000	2.000	200	200	100
ES	29.000	35.815	51.000	2.400	2.021	2.200	925	1.015	1.250
FI	100	200	500	500	500	700	100	100	200
FR	98.000	105.000	160.000	4.400	3.890	10.000	na	na	na
IE	250	na	na	50	na	na	na	na	na
IT	190.000	170.000	200.000	8.700	9.000	12.000	300	220	350
LT	na	10	40	na	700	2.800	na	na	na
LV	175	200	250	575	400	500	150	150	200
PL	na	na	na	na	10.000	na	400	500	na
RO	12	15	2.000	11	15	2.000	250	300	350
SE	na	900	na	1.300	800	na	na	100	na
SI	42	na	na	331	na	na	na	na	na
				Other	Europe				
CH	500	500	500	617	900	900	194	200	300
RS	11.910	13.230	na	4.820	2.160	na	17	53	na

Table 8.8 Total installed pellet boilers and stoves in Europe (units)

	Stoves			В	oiler < 50 k	W	:	Boiler > 50 kW		
	2015	2016	2020 estimate	2015	2016	2020 estimate	2015	2016	2020 estimate	
AT	44.500	47.000	62.000	118.500	120.000	145.000	3.700	3.900	5.000	
CZ	2.900	3.500	6.000	23.807	26.007	36.000	na	na	na	
DE	133.000	149.000	na	246.000	260.500	na	11.500	12.400	na	
EE	1.350	na	3.000	7.875	na	12.000	1.500	na	2.625	
EL	14.000	16.000	20.000	5.000	6.000	8.000	1.200	1.400	1.600	
ES	139.250	175.065	361.065	11.521	13.542	22.342	9.265	10.280	15.055	
FI	1.600	1.800	3.000	24.500	25.000	28.000	3.200	3.300	4.000	
FR	479.000	584.000	1.200.000	50.000	53.700	90.000	na	na	na	
IE	1.000	na	na	4.000	na	na	200	na	na	
IT	2.280.000	2.450.000	2.800.000	81.500	90.000	110.000	6.000	6.500	8.000	
LT	50	60	na	4.800	5.500	7.000	na	na	na	
LV	1.300	1.500	3.000	7.700	8.000	12.000	1.500	1.700	2.600	
PL	na	na	na	38.000	45.000	60.000	2.500	3.000	4.000	
RO	1.200	na	2.000	1.200	na	2.000	250	na	500	
SE	30.000	31.000	na	86.850	87.000	na	na	na	na	
SI	553	na	na	6.701	na	na	na	na	na	
UK	26.710	26.710	na	11.000	12.000	na	5.110	5.800	na	
				Other	Europe					
СН	10.400	10.800	12.650	14.300	14.900	17.400	1.020	1.060	1.250	
RS	33.490	46.720	60.000	5.940	8.100	12.000	37	70	200	
UA	na	na	na	727	950	3.000	1.059	1.342	6.082	

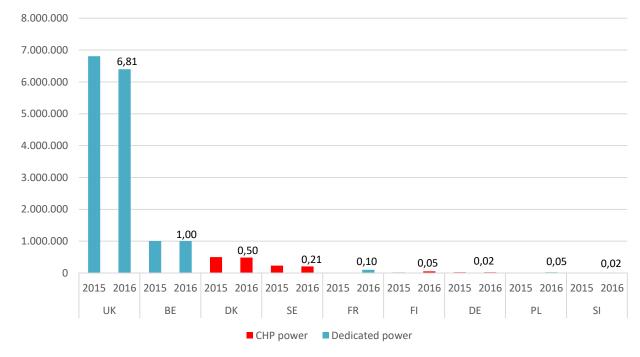
8.2.5.4 PELLET CONSUMPTION FOR ELECTRICITY PRODUCTION

Figure 8.38 Overview of pellet consumption for electricity production in Europe in 2016



Source: EPC survey, 2017; Hawkins Wright, EPC calculation

Figure 8.39 European pellet consumption for electricity production in 2016 (million tonnes)



Sources: (BE, DK, FR, FI PL, UK) Hawkins Wright; (DE, SI) EPC survey, 2017, EPC calculation



Fiona Matthews Research Manager (Bioenergy) Hawkins Wright Ltd.

The global wood pellet market endured a challenging 2016. Acute oversupply in both the industrial and heating sectors, combined with relatively warm temperatures and overrunning maintenance at Drax power station, pressured pellet mill operating rates and led to a record drop in industrial pellet prices.

Data from Hawkins Wright's *Outlook for Wood Pellets* report shows that global industrial pellet demand increased by +3% (+330kt) in 2016, much lower than the +21% growth in 2015 and +15% in 2014. Total global industrial demand in 2016 was 13.4Mt, compared to 13.0Mt in 2015. Demand for industrial pellets actually declined by 190kt in Europe in 2016, but this drop was offset by increased demand in Asia.

In Demark the major consumers of industrial pellets in 2016 were Dong's three converted CHP plants. Studstrup, Herning and Avedøre. which collectively used 1.2Mt of pellets. In addition, HOFOR's Amager CHP plant consumed just under 300kt of pellets. The other major industrial pellet user in Europe was Engie, which consumed approximately 1.0Mt of pellets at its Les Awirs and 'Max Green' plants converted coal plants in Belgium. The outlook for demand in Belgium has recently decreased due to the cancellation of a project by Graanul to convert the Langerlo coal plant to wood pellets.

Until 2013 the Netherlands was a major user of industrial pellets, but a hiatus in subsidy support for cofiring caused demand to drop to zero in 2015 and 2016. Four projects have been successful in obtaining support under the new SDE+ subsidy regime, with RWE's Amer #9 project expected to be online before the end of 2017. When all four projects become operational, total industrial pellet demand in the Netherlands is likely to reach 3.5Mt/y.

In Asia, demand for industrial pellets increased in both South Korea and Japan in 2016. Consumption in Japan increased by +52%, to 350kt, thanks in part to demand at Showa Shell Sekiyu's 49MW Kanagawa power plant, which started operating at the end of 2015. Pellet demand in South Korea, meanwhile, rose +21% to 1.7Mt in 2016, reversing the decline between 2014.2015. Gunjang Energy began operating its 250MW biomass plant, which cofires around 30% wood pellets, in mid.2016.

There is a healthy pipeline of new pellet-fired power projects in Asia – including both cofiring and new-build 100% biomass power plants – that will increase demand for pellets in South Korea and Japan over the coming decade. Current market intelligence indicates that by the late 2020's the Asian industrial pellet market could be comparable in size to that in Europe.

Table 8.9 Total European wood pellet consumption in 2016 compared to 2015 (tonnes)

			2015					2016		
	Residential	Commercial	СНР	Dedicated power	Total	Residential	Commercial	СНР	Dedicated power	Total
EU28	8.406.264	2.268.367	2.335.530	7.805.000	20.815.161	9.241.913	2.565.894	2.373.081	7.525.000	21.705.888
AT	700.000	145.000			845.000	745.000	150.000			895.000
BE	315.000	8.000	20.000	1.000.000	1.343.000	315.000	8.000	20.000	1.000.000	1.343.000
CZ	63.000	25.000			88.000	64.000	30.000			94.000
DE	1.120.000	560.000	65.000		1.745.000	1.280.000	640.000	70.000		1.990.000
DK	700.000	83.000	1.500.000		2.283.000	705.000	84.000	1.450.000		2.239.000
EE	28.000	8.000			36.000	30.000	10.000			40.000
EL	57.000	10.000			67.000	75.000	15.000			90.000
ES	240.000	160.000			400.000	285.000	190.000			475.000
FI	70.000	200.000	50.000		320.000	80.000	250.000	160.000		490.000
FR	900.000	75.000			975.000	1.020.000	80.000		100.000	1.200.000
HR	6.000	3.000			9.000	10.500	5.500			16.000
IT	2.860.000	150.000			3.010.000	2.900.000	300.000			3.200.000
LT	39.000	11.000			50.000	47.500	12.500			60.000
LV	143.000	7.000			150.000	148.000	7.000			155.000
NL	30.000	130.000			160.000	60.000	130.000			190.000
PL	160.000	50.000			210.000	200.000	50.000	25.000	25.000	300.000
PT	115.000	100.000			215.000	115.000	100.000			215.000
SE	535.264	478.367	700.530		1.714.161	549.370	428.894	628.081		1.606.345
SI	90.000	40.000			130.000	85.000	50.000	20.000		155.000
SK	35.000	25.000			60.000	35.000	25.000			60.000
UK	200.000			6.805.000	7.005.000	492.543			6.400.000	6.892.543
Other Europe	418.500	78.040	0	0	496.540	503.500	91.300	0	0	594.800
AL	20.000	1.000			21.000	22.500	1.200			23.700
ВА	73.000	8.200			81.200	117.500	11.000			128.500
СН	150.000	50.000			200.000	165.000	55.000			220.000
ME	4.800	940			5.740	12.600	1.000			13.600
RS	163.500	1.100			164.600	176.900	2.100			179.000
RU	7.200	16.800			24.000	9.000	21.000			30.000

Sources: EPC survey, 2017; Hawkins Wright; European wood pellet trade

-8,0 -6,0 -4,0 -2,0 0,0 2,0 4,0 6,0 8,0 ΑT BE BG CZ DE DK EE EL ES FI FR HR HU ΙE ΙT LT LU LV NLPLРТ RO SE SI SK -UK ■ Consumption ■ Export ■ Production ■ Import

Figure 8.40 EU28 Member States pellet balance by country in 2015 - production, consumption, export, import (million tonnes)

Source: EPC survey, 2017; Hawkins Wright; Eurostat; FAO

8.2.5.5 EU28 EXPORTING COUNTRIES

Latvia: Over the period 2011 to 2016, Latvia was the fastest growing country for exports showing an increase of almost 1 million tonnes which is equivalent to 160% growth. This incredible growth is due to several factors: very high wood resources, good location (Baltic sea) and logistics (harbour), flexible wood industry, low working costs and very limited local use. The export volumes mirror the production growth. This is because there is limited local demand. However, from 2015 onwards, the exports from Latvia stagnated mainly due to the industrial consumption which was lower than expected and the disappointing heating market price and demand (except for late 2016). Interestingly, Latvia exported more pellets than actually produced in 2016. Indeed, the production has been completed by some 2015 stocks and imports.

Estonia: This Baltic country shows very similar trends to Latvia with nearly 500.000 t increase or 125% from 2011 to 2016.

Austria: For years, Austria was a net pellet exporter. Traditional business relationships with Italy lead to an annual export of approximately 500.000t to Italy. Strong local demand in Austria and close ties to major Austrian sawmill industries in Germany, Czech Republic and Romania lead to significant imports from these countries to balance supply and demand.

Portugal: Over the years, Portugal became an important industrial pellet producer but no further increase is foreseen mainly due to insufficient raw material availability and its high price. Portuguese exports have been following a declining trend from 2013 onwards, because the production declined and the local use of pellets increased. In 2016 a strong dollar allowed some Portuguese producers to supply some utilities above the existing long-term contracts.

Germany: Since 2012, Germany saw its exports severely decreasing mainly because pellet production decreased while local consumption grew significantly. Exports were also facing fierce competition from other countries.

Poland: One can observe an increase in Polish exports again confirming the constant growth of this sector.

Croatia: A continuous growth in pellet exports can be observed in Croatia. This is due to a production increase and limited local consumption. It can be noted that the vast majority of pellets are sold in Italy.

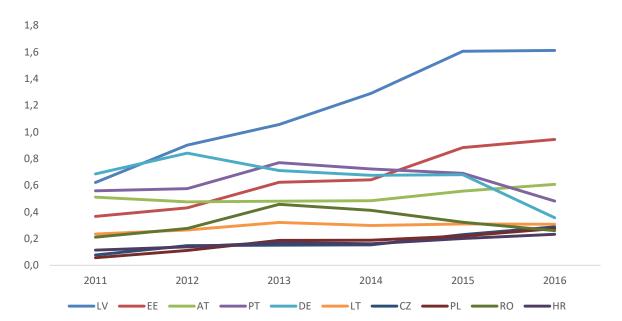


Figure 8.41 Top 10 of the EU28 wood pellet exporting countries 2011.2016 (million tonnes)

Figure 8.42 Division of total EU28 exports in 2016 (percentage)

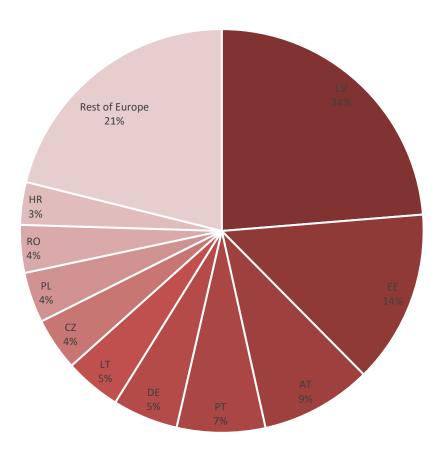


Table 8.10 Top 10 wood pellet exporting countries in the EU28 in 2011.2015 (tonnes)

		2012		2013		2014		2015		2016
	DK	436.771	DK	504.857	DK	492.887	DK	537.619	EE	634.876
	EE	130.040	EE	179.940	EE	306.500	EE	489.186	DK	572.750
LV	SE	103.898	UK	161.703	UK	304.320	UK	391.960	UK	294.369
	Rest of EU28	231.124	Rest of EU28	209.181	Rest of EU28	172.593	Rest of EU28	201.042	Rest of EU28	109.749
	Rest of the world	126	Rest of the world	250	Rest of the world	458	Rest of the world	643	Rest of the world	597,1
	DK	264.728	DK	375.956	DK	423.156	DK	257.360	DK	493.870
	SE	122.465	SE	119.640	IT	56.223	SE	49.408	UK	210.178
EE	UK	20.011	IT	43.735	SE	55.104	UK	48.131	NL	116.589
	Rest of EU28	18.200	Rest of EU28	83.821	Rest of EU28	106.284	Rest of EU28	11.854	Rest of EU28	123.275
	Rest of the world	5.022	Rest of the world	23	Rest of the world	72	Rest of the world	48	Rest of the world	115,3
	IT	404.455	IT	429.268	IT	440.114	IT	486.604	IT	550.796
	DE	53.102	DE	36.494	DE	28.575	DE	29.368	DE	21.584
AT	CZ	5.701	СН	8.119	СН	7.266	CZ	20.046	SI	17.102
	Rest of EU28	9.689	Rest of EU28	7.498	Rest of EU28	8.021	Rest of EU28	20.766	Rest of EU28	7.371
	Rest of the world	3.365	Rest of the world	1.420	Rest of the world	1.396	Rest of the world	2.344	Rest of the world	12.694
	DK	210.006	UK	277.251	UK	481.609	DK	172.448	UK	211.646
	NL	137.080	DK	252.076	DK	141.071	UK	155.807	DK	147.835
PT	UK	107.248	NL	70.059	ES	71.718	NL	138.802	ES	69.879
	Rest of EU28	121.097	Rest of EU28	170.504	Rest of EU28	54.816	Rest of EU28	91.808	Rest of EU28	52.308
	Rest of the world	20	Rest of the world	7	Rest of the world	43	Rest of the world	21	Rest of the world	235,5
	DK	178.196	AT	167.421	AT	201.240	UK	173.031	IT	120.094
	AT	166.986	DK	121.539	IT	166.847	AT	141.294	AT	83.813
DE	IT	160.223	IT	112.408	FR	89.445	IT	136.486	FR	59.165
	Rest of EU28	308.852	Rest of EU28	243.452	Rest of EU28	164.654	Rest of EU28	185.527	Rest of EU28	55.833
	Rest of the world	34.520	Rest of the world	75.408	Rest of the world	43.129	Rest of the world	52.749	Rest of the world	47.746
	IT	130.070	IT	159.211	IT	173.315	IT	137.574	IT	125.009
	DK	94.581	DK	77.547	DK	55.346	DK	49.352	LV	54.444
LT	DE	18.286	BE	31.272	BE	20.764	EE	27.647	UK	33.010
	Rest of EU28	21.891	Rest of EU28	53.238	Rest of EU28	48.549	Rest of EU28	95.210	Rest of EU28	94.002
	Rest of the world	170	Rest of the world	212	Rest of the world	227	Rest of the world	520	Rest of the world	1192
	AT	49.604	AT	57.507	IT	53.175	IT	114.493	IT	134.603
	IT	48.971	IT	40.765	AT	44.352	AT	64.882	AT	105.324
CZ	DE	28.081	DE	28.374	DE	38.982	DE	37.065	DE	33.015
	Rest of EU 28	20.741	Rest of EU 28	23.896	Rest of EU 28	16.727	Rest of EU 28	12.565	Rest of EU28	14.074
	Rest of the world	89	Rest of the world	105	Rest of the world	152	Rest of the world	1.109	Rest of the world	1.067
	DK	51.793	DE	80.362	DE	82.822	DE	85.631	DK	95.753
	DE	45.490	DK	69.265	DK	58.057	DK	70.953	DE	95.445
PL	CZ	6.121	IT	25.850	IT	29.729	IT	42.224	IT	65.280
	Rest of EU28	8.015	Rest of EU28	11.051	Rest of EU28	10.799	Rest of EU28	16.291	Rest of EU28	18.659
	Rest of the world	310	Rest of the world	297	Rest of the world	303	Rest of the world	513	Rest of the world	526,7
	IT	117.267	AT	205.191	AT	192.022	AT	120.887	AT	117.978
	AT	94.362	IT	167.123	IT	128.826	IT	101.027	IT	40.241
RO	EL	18.327	EL	28.047	BG	25.364	SI	35.544	BG	37.799
	Rest of EU28	46.540	Rest of EU28	56.856	Rest of EU28	65.818	Rest of EU28	65.217	Rest of EU28	64.290
	Rest of the world	205	Rest of the world	272	Rest of the world	886	Rest of the world	651	Rest of the world	799
	IT	120.281	IT	152.005	IT	139.122	IT	176.890	IT	205.764
	SI	16.978	SI	16.312	SI	11.031	SI	11.576	SI	13.482
HR	AT	692	AT	1.987	AT	8.278	AT	5.184	RO	6.702
	Rest of EU28	79	Rest of EU28	377	Rest of EU28	2.881	Rest of EU28	6.665	Rest of EU28	6.485
	Rest of the world	24	Rest of the world	23	Rest of the world	24	Rest of the world	48	Rest of the world	24

8.2.5.6 EU28 IMPORTING COUNTRIES

United Kingdom: It 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. After a rather steady growth period, the import growth decreased in 2016.

Denmark: It is the second largest pellet importer, mainly sourcing pellets from Latvia, Estonia and Russia. The imported volumes have been rather constant over recent years but are expected to grow continuously from 2017 with the conversion of two of the CHP units of Ørsted (previously Dong) as the local production will most likely not expand further.

Italy: It is the third largest importer of wood pellets with most of it being used in the residential heat market. These pellets are mainly sourced from Austria (even though the vast majority are not local), Croatia and Germany. Canada was an important supplier of pellets for Italy in 2013 and 2014 but this is no longer the case from 2015 onwards. This can be explained by the growth of capacity in Europe coupled with a strong Canadian dollar.

Belgium is the fourth largest importer with most pellets coming from North America. The drop in 2014 was mainly due to a decrease of industrial pellet use due to a temporary dispute with the regulator.

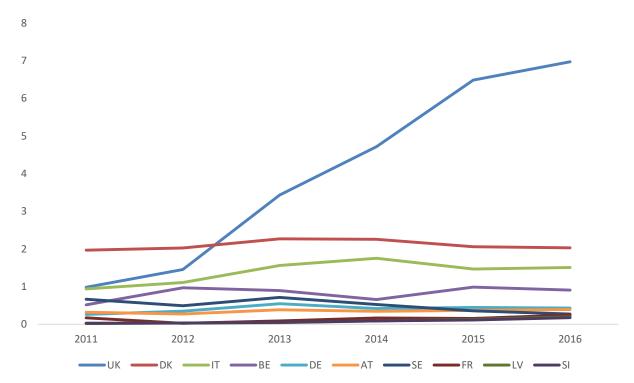
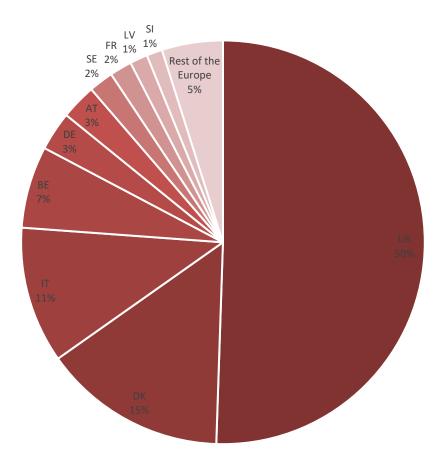


Figure 8.43 Top 10 of the EU28 wood pellet importing countries 2010.2015 (million tonnes)

Figure 8.44 Division of total EU28 imports (percentage)



Source: Eurostat

It can be noted that pellet imports are concentrated in four countries (UK, DK, IT, BE) representing 83% of total EU imports.

Table 8.11 Top 10 wood pellet importing countries in the EU28 with breakdown of origin in 2010.2015 (tonnes)

	2012	2	2013	3	2014	Į.	2015	5	2016	
	us	1.764.394	US	2.775.929	US	3.889.833	US	4.286.614	US	4.901.682
	CA	1.346.237	CA	1.963.270	CA	1.259.087	CA	1.474.785	CA	1.685.203
EU	RU	645.258	RU	701.722	RU	825.842	RU	786.214	RU	845.398
	Other non.EU28	4.588.223	Other non.EU28	655.456	Other non.EU28	571.972	Other non.EU	317.425	Other non.EU	674.354
	CA	854.602	US	1.573.493	US	2.894.916	US	3.527.986	USA	4.127.578
	US	475.337	CA	1.466.782	CA	889.353	CA	1.161.425	CA	1.384.774
UK	LV	101.783	LV	165.190	PT	439.537	LV	995.125	LV	936.256
	Rest of EU28	20.960	Rest of EU28	225.654	Rest of EU28	486.825	Rest of EU28	789.599	Rest of EU28	461.449
	Rest of the world	34.217	Rest of the world	1.068	Rest of the world	4.460	Rest of the world	44.746	Rest of the world	158.595
	LV	586.254	LV	705.984	LV	608.954	LV	601.771	EE	595.566
	RU	347.961	EE	363.127	EE	465.257	EE	552.114	LV	548.605
DK	EE	292.422	RU	333.964	RU	388.704	RU	333.085	RU	257.655
	Rest of EU28	701.738	Rest of EU28	750.347	Rest of EU28	561.747	Rest of EU28	551.896	Rest of EU28	1.119.189
	Rest of the world	71.864	Rest of the world	166.779	Rest of the world	104.211	Rest of the world	37.562	Rest of the world	385.914
	AT	313.933	AT	349.491	AT	395.014	AU	405.017	AT	458.810
	DE	137.445	CA	186.001	CA	229.435	HR	127.732	HR	150.035
т	HR	114.266	HR	129.338	US	179.966	DE	108.638	DE	107.445
	Rest of EU28	404.465	Rest of EU28	705.622	Rest of EU28	822.506	Rest of EU28	580.822	Rest of EU28	733.319
	Rest of the world	223.590	Rest of the world	385.510	Rest of the world	309.043	Rest of the world	418.029	Rest of the world	321.656
	us	571.933	US	587.619	US	422.774	US	628.970	CA	237.359
	CA	205.469	CA	160.151	CA	107.238	CA	227.940	RU	85.836
BE	UK	81.360	NL	78.160	NL	73.662	NL	65.440	USA	533.133
	Rest of EU28	108.640	Rest of EU28	67.144	Rest of EU28	49.145	Rest of EU28	25.581	Rest of EU28	49.114
	Rest of the world	3.068	Rest of the world	3.115	Rest of the world	4.557	Rest of the world	40.721	Rest of the world	86.871
	DK	86.966	DK	109.292	NL	73.966	RU	74.931	PL	104.449
	AT	40.164	NL	97.826	AT	52.517	PO	68.792	BE	72.773
DE	FR	32.569	BE	54.861	DK	51.048	DK	62.701	RU	53.538
-	Rest of EU28	118.555	Rest of EU28	210.258	Rest of EU28	147.719	Rest of EU28	199.969	Rest of EU28	172.407
	Rest of the world	69.213	Rest of the world	74.386	Rest of the world	69.740	Rest of the world	28.279	Rest of the world	27.742
	RO	103.724	RO	205.785	RO	190.941	RO	189.336	RO	190.011
	DE	86.619	DE	83.201	DE	66.314	DE	92.956	CZ	104.139
AT .	cz	57.721	cz	57.215	cz	53.289	CZ	70.645	DE	82.558
`'	Rest of EU28	19.415	Rest of EU28	28.053	Rest of EU28	30.398	Rest of EU28	12.521	Rest of EU28	10.202
	Rest of the world	4.694	Rest of the world	11.204	Rest of the world	3.003	Rest of the world	2.385	Rest of the world	5.313
	RU	211.298	RU	236.256	RU	220.984	RU RU	150.726	RU	136.809
	EE	101.314	EE	177.397	LV	80.925	LV	60.448	EE	84.247
SE .	DK	42.874	LV	63.542	EE		UK	57.230	DK	21.311
DE.	Rest of EU28	73.096	Rest of EU28	176.902	Rest of EU28	77.437 95.202	Rest of EU28	79.066	Rest of EU28	19.292
				58.543		47.364	Rest of the world			9.577
	Rest of the world	64.457	Rest of the world		Rest of the world			7.473		
	DE LU	17.087 4.648	EE DE	29.992 21.971	EE DE	34.689 32.321	DE BE	53.810	USA BE	94.989 78.788
-n								53.570		
R	BE Rest of EU28	2.022	BE Book of SU20	13.942	BE Dark of SU20	29.740	US	12.917	DE Dest of SU20	29.128
		1.072	Rest of EU28	22.653	Rest of EU28	39.157	Rest of EU28	15.999	Rest of EU28	41.455
	Rest of the world	719	Rest of the world	527	Rest of the world	729	Rest of the world	497	Rest of the world	559
	BY	28.314	BY	24.507	BY	46.761	BY	75.162	LT	70.590
	RU	4.797	RU	12.131	RU	29.081	RU	23.781	BY	62.977
.V	EE	657	LT	2.171	LT	6.162	LT	20.132	RU	48.112
	Rest of EU28	249	Rest of EU28	2.175	Rest of EU28	5.810	Rest of EU28	10.045	Rest of EU28	14.003
	Rest of the world	0	Rest of the world	344	Rest of the world	60	Rest of the world	65	Rest of the world	0
	HR	21.807	RO	20.392	RO	62.283	CZ	7.956	UA	7.309
	RO	3.354	HR	17.102	AT	7.202	UK	6.152	CZ	6.990
SI	UE	1.453	UK	2.343	HR	6.565	IT	3.120	PL	1.235
	Rest of EU28	4.419	Rest of EU28	5.915	Rest of EU28	3.900	Rest of EU28	2.502	Rest of EU28	470
	Rest of the world	29133	Rest of the world	72873	Rest of the world	82371	Rest of the world	6544	Rest of the wo	orld

8.2.6 EUROPEAN WOOD PELLET PRICE

8.2.6.1 EUROPEAN PRICE DEVELOPMENT OF RESIDENTIAL PELLETS

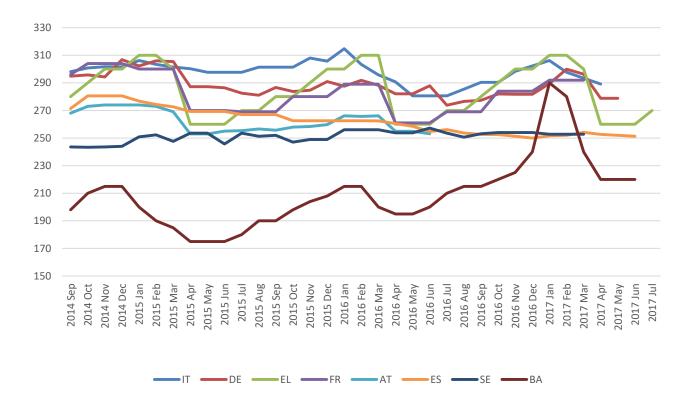
One can identify some common trends even though most of the countries have their own specificities.

The unfavourable market conditions occurring during the last three consecutive heating seasons impacted the residential pellet market as well as the price of residential pellets. With these mild winters, the demand for pellets for heat production decreased, leading to overproduction and overstocking. This situation has been exacerbated by fierce competition with external pellet importers in several countries. Consequently, the pellet price reached its lowest level for years in May-June-July 2016, well beyond the annual drop in prices occurring between the heating seasons.

Thanks to a good start of the 2016.2017 heating season, the production-demand could be rebalanced in most areas. Unfortunately, this situation led to some tensions in the supply or even lead to shortage in some countries. Logically, the price increased from that time, but one can highlight how fast and strong this recovery was, allowing the price to reach one of its highest levels since 2014 over a very short period in most countries. Quite differently, the price in some countries did not recover completely.

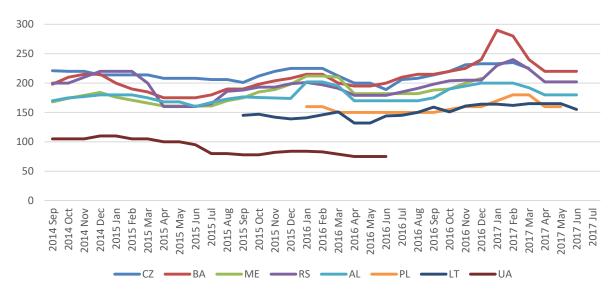
Spain shows a rather different trend: prices have been going down for years reaching their lowest level in December 2016. The price slightly recovered in the coldest moments of the heating season but went down again after this.

Figure 8.45 Estimation of bagged wood pellet prices in most expensive European countries between September 2014 and June 2017 (retail price, 1 pallet in €/t VAT incl.)



Note: IT, ES: quarterly prices

Figure 8.46 Estimation of bagged wood pellet prices in European countries with lowest prices between September 2014 and June 2017 (with: retail price, 1 pallet in €/t VAT incl.)



Note: IT, ES: quarterly prices

Source: EPC survey, 2017

Figure 8.47 Variation of bagged wood pellet prices between July 2016 and June 2017 (with: retail price, 1 pallet in €/t VAT incl.)

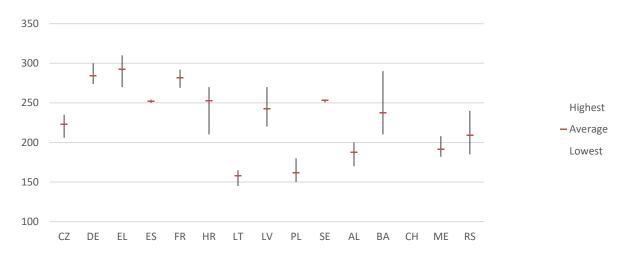


Table 8.12 Estimation of bagged wood pellet prices between September 2016 and July 2017 in Europe (with: retail price, 1 pallet in €/t VAT incl.)

	September 2016	October 2016	November 2016	December 2016	January 2017	February 2017	March 2017		May 2017	June 2017	July 2017
CZ	214	220	231	233	233	235	225				
DE	277	282	282	282	289	300	296	279	279		
EL	280	290	300	300	310	310	300	260	260	260	270
ES	253	250	250	250	254	254	254	251	251	251	
FR	269	284	284	284	292	292	292				
HR	245	250	270	270	270	270	250	220	220	230	230
IT		290			306						
LT	159	151	161	164	164	162	165	165	165	155	
LV	230	230	240	260	270	260	250	235	235	235	
PL	150	155	160	160	170	180	180	160	160		
SE	253	254	254	254	253	253	253				
				Othe	r Europe						
SI		245					253				
AL	175	190	195	200	200	200	192	180	180	180	
BA	215	220	225	240	290	280	240	220	220	220	
ME	188	190	200	208							
RS	198	204	205	205	230	240	224	202	202	202	

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.

400 380 360 340 320 300 280 260 240 220 200 2015 Jun 2015 Sep 2016 Jan 2016 Jun 2015 Feb 2015 Jul 2015 Aug 2015 Nov 2015 Dec 2016 Mar 2016 Apr 2016 Jul 2016 Sep 2017 Jan 2015 Mar 2015 Apr 2015 Oct 2016 Feb 2016 Oct 2016 Dec 2017 Mar 2015 May 2016 May 2016 Aug 2016 Nov

Figure 8.48 Estimation of bulk wood pellet prices in European countries with higher prices between September 2014 and June 2017 (with: delivered 6t, distance 100 km, delivery fees included. In €/t VAT incl.)

Note: IT, ES: Quarterly prices; CH, FI: missing values estimated using linear extrapolation

-FI

-SE

Source: EPC survey, 2017

−HR **−**

DE

Figure 8.49 Estimation of bulk wood pellet prices in selected markets in European countries with lower prices between September 2014 and June 2017 (with: delivered 6t, distance 100 km, delivery fees included. In €/t VAT incl.)

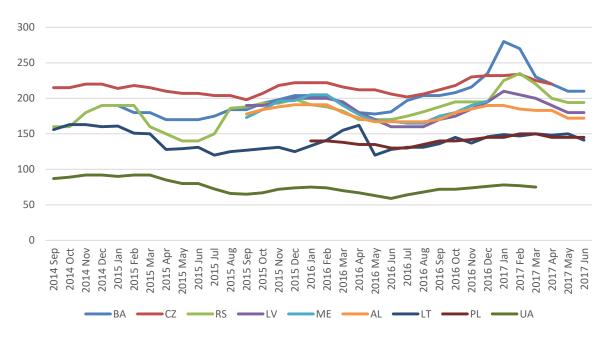


Figure 8.50 Variation of bulk wood pellet prices between July 2016 and June 2017 (with: delivered 6t, distance 100 km, delivery fees included. In €/t VAT incl.)

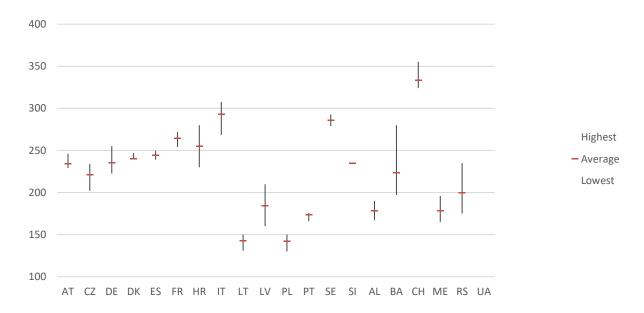


Table 8.13 Estimation of bulk wood pellet prices between September 2016 and June 2017 (with: delivered 6t, distance 100 km, delivery fees included. In €/t VAT incl.)

	2016 September	2016 October	2016 November	2016 December	2017 January	2017 February	2017 March	2017 April	2017 May	2017 June
AT	229	230	231	234	236	245	246	236	232	232
CZ	212	218	230	232	232	234	225	220		
DE	224	226	230	235	242	253	255	246	234	232
DK					240	240	240	240	240	240
ES	250	239	239	239	247	247	247	243	243	243
FR	254	267	267	267	272	272	272			
HR	260	270	280	280	270	260	260	240	240	230
IT	288	288	307	307	307	293	293	293		
LT	136	145	137	146	149	147	150	148	150	141
LV	170	175	185	195	210	205	200	190	180	180
PL	140	140	142	145	145	150	150	145	145	
PT					175	175	175	175	175	166
SE	290	290	290	288	279	279	279			
SI					235	235	235			
				Other E	urope					
AL	170	180	185	190	190	185	183	183	172	172
ВА	204	208	216	235	280	270	230	220	210	210
СН	327	327	327	334	340	355	337	337		
ME	175	180	190	196						
RS	188	195	195	195	225	235	220	200	194	194
UA	72	72	74	76	78	77	75	0	0	0

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.

Some countries are implementing a reduced **VAT rate** for pellets (orange font in the table below) but the situation has changed lately for some of them.

Austria: In January 2016, the VAT was increased from 10 % to 13% in 2016. The pellets price did not increase correspondingly, showing that most of the increase was absorbed by the producers and traders.

France: The VAT rate on pellets has gradually increased from 5,5 % before 2012 to 10% in 2014. No clear impact of sales has been noted and no further VAT increase is foreseen.

Italy: The VAT rate increased from 10 to 22 % in the second semester of 2014. This change showed a limited impact on end-user behaviour but had an impact on the pellet suppliers' profitability as most of the price increase was absorbed by the pellet producers and traders. In 2016, the sector attempted to reduce the VAT back to 10% but this was rejected by the government.

Latvia: In Latvia there is reverse VAT applied for B2B pellet trade to avoid any shadow economy while the VAT rate is of 12% for any B2C trade.

Table 8.14 VAT rate for wood pellets compared with general VAT rate applied in European countries in 2016 in percentage

	201	6
	Wood pellets	General
AT	13	20
BE	6	21
CZ	15	21
DE	7	19
DK	25	25
EE	20	20
EL	24	24
ES	21	21
FI	24	24
FR	10	20
HR	25	25
HU	27	27
IT	22	22
LT	21	21
LU	6	15
LV	12	21
NL	21	21
PL	23	23
PT	23	23
RO	na	na
SE	25	25
SI	22	22
UK	5	20
Other		
Europe		
AL	20	20
BA	17	17
CH	8	8
ME	19	19
RS	20	20

8.2.6.2 PRICE DEVELOPMENT OF INDUSTRIAL PELLETS



The Argus cif ARA spot wood pellet price started to climb in February after more than two years of near-continuous decline.

Weak demand, delays to planned projects, fluctuating political support and low prices for competing generation fuels had all weighed on wood pellet prices through much of 2015 and 2016. A strong US dollar to the Euro and increasing trans-Atlantic freight costs had added extra pressure for US producers delivering to the ARA region last year.

But new demand projects have come online, including Dong's two Danish CHP conversions in late 2016, while a cold winter compared to recent years boosted heating demand. The UK's Drax began trialling pellets at its fourth unit in March, although it will revert to coal-burn in winter 2017-2018. The stronger European demand has supported industrial wood pellet prices and Argus' cif ARA spot price rose by 29pc over the first eight months of this year.

Biomass consumption in Asia is also expanding, particularly in leading market South Korea and swiftly-growing Japan. Growth in both countries is supported by government policies. As biomass producers in North America — especially Canada — increasingly look to supply Asian buyers, the global wood pellet market is slowly becoming more integrated, with the potential for competition between buyers in Europe and Asia a possibility.

Forward cif ARA prices have also climbed since the start of the year as major new projects are expected to start up in the UK and the Netherlands later this year, supporting 2018 demand, with further projects in both countries planned in the next three years.

Laura Tovey Fall Editor Biomass Markets Argus Media

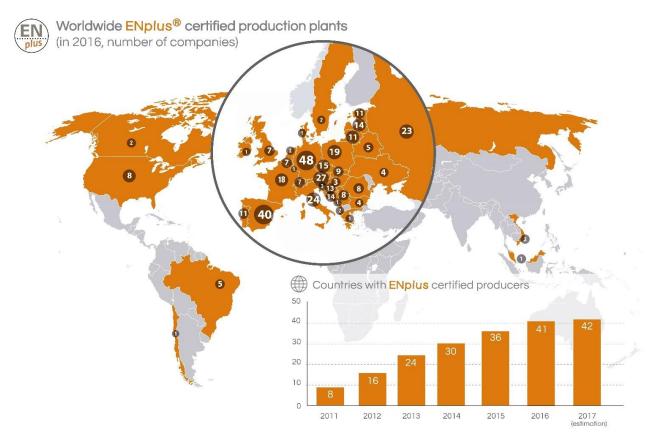


Figure 8.51 Development of Argus cif ARA wood pellet index (Nov 2015- August 2017)

Source: Argus Media

8.3 LATEST DEVELOPMENTS OF ENPLUS® CERTIFICATION

Figure 8.52 Worldwide ENplus certified producers



The EN*plus*® certification scheme ensures wood pellet quality for the customer by guaranteeing the quality of the pellets over the entire supply chain (i.e. producers and traders). This certification is governed and managed by the European Pellet Council with the support of National Associations, managing the certification on a national level.

Since its introduction, the number of countries with certified ENplus® producers has rapidly grown, reaching 42 countries with a total volume of 9,2 million tonnes of certified pellets produced according to the 2017 projections. According to the latest figures, there are several encouraging predictions for 2018. Continued growth is expected as in previous years and could be supported by a significant growth of ENplus® certified producers in countries such as Bulgaria, Belarus, Croatia, Poland and Russia.

The number of ENplus® certified producers worldwide once again a sizeable growth, now reaching 411 producers.

As a result of this continuous growth, the production of certified pellets is now estimated to reach more than 9 million tonnes by the end of 2017. This would result in a growth of approximately 13% compared to 2016.

With these results, ENplus® is well on its way to reaching the aim of harmonised pellet quality at a global level.

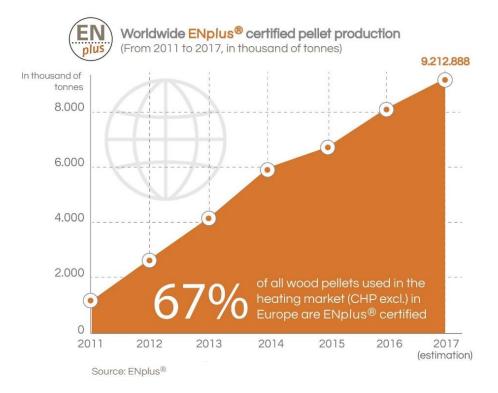


Figure 8.53 Worldwide ENplus certified pellet production

With more than 8,1 million tonnes of production certified in 2016, ENplus® covered around 70 % of the pellets being used in the European heating pellet sector (residential + commercial).

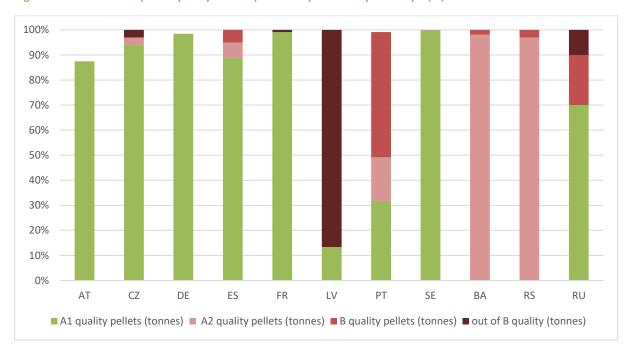
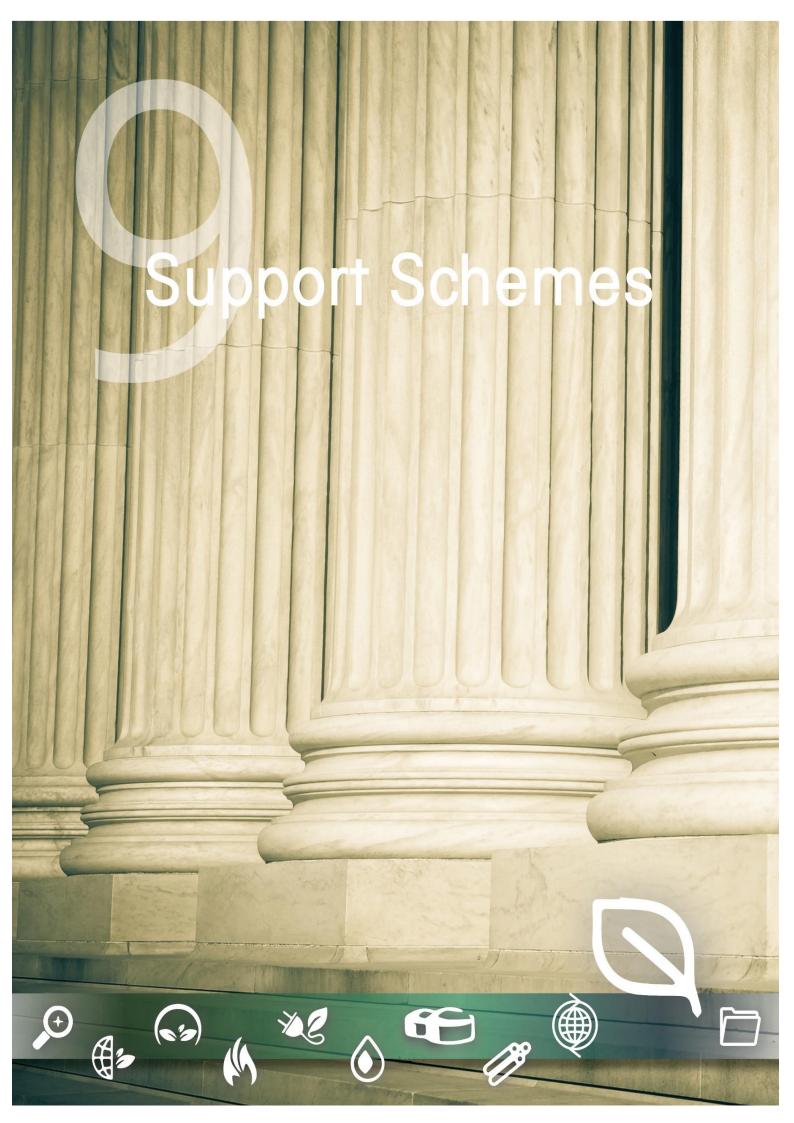


Figure 8.54 Estimate of pellet quality classes produced per country in Europe (%)



One of the aims of the European Commission's 2020 Climate and Energy Package¹ is to reach a 20% share of renewable energy generation in EU energy consumption by 2020, in a cost-effective and economically efficient manner. Individual EU Member States have targets set in EU legislation² and some have set additional national objectives. In addition, in October 2014 EU leaders agreed the 2030 policy framework for climate and energy³ which included a target to increase the share of renewable energy generation in EU energy consumption to 27%.

Schemes for renewable energy sources are a key mechanism to help achieve the renewables goal, but also attract high levels of interest in relation to the differences between EU Member States and the overall costs to consumers. The purpose is to encourage large scale take-up and deployment of renewable energy generation, energy efficiency and heating/cooling technologies amongst industrial, commercial and residential consumers. Large scale take-up of RES would help technologies to mature, learning rates to improve and integration of RES within traditional market arrangements to be tested and refined.

Categories of support

Support scheme means any instrument, scheme or mechanism applied by a Member State or a group of Member States, that promotes the use of energy from renewable sources by reducing the cost of that energy, increasing the price at which it can be sold, or increasing, by means of a renewable energy obligation or otherwise, the volume of such energy purchased. This includes, but is not restricted to, investment aid, tax exemptions or reductions, tax refunds, renewable energy obligation support schemes including those using green certificates, and direct price support schemes including feed-in tariffs and premium payments.

Price regulation measures influences income from energy produced by the RES installations. There are also mechanisms regulating total installed powers such as tender schemes and renewables obligation. Green certificates fall into both categories as the following table shows. They are used for quantitative regulation and enhance the profits of a green energy producer.

By type of main support focus instruments include those that affect an investment at its initial stage but do not directly stimulate energy production, such as investment subsidies and fiscal instruments that operate at the stage of investment planning and creation.

Another group comprises instruments that influence an installation's income provided that its operation is correct, that is if the income is correlated with energy production. This includes feed-in tariffs and the green pricing, as well as the renewables obligation within the framework of the green certificates system.

	Price regulation	Capacity driver		
Supporting investments	 Investment grants Fiscal instruments (tax incentives) Soft loans 	Tender scheme		
Supporting energy production	Feed-in tariffsFeed-in premium	Quota obligation		
	Green certificatesSubsidy			

¹ http://ec.europa.eu/clima/policies/package/index_en.htm

² Directive 2009/28/EC http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

³ http://ec.europa.eu/clima/policies/2030/index_en.htm

- Feed in tariff (FiT): A type of price-based policy instrument whereby eligible renewable energy generators are paid a fixed price at a guaranteed level (irrespective of the wholesale price) for the RES electricity produced and fed into the grid.
- Feed in premium (FiP) and contract for difference (CfD): A type of price-based policy instrument whereby eligible renewable energy generators are paid a premium price which is a payment in addition to the wholesale price. This premium can be fixed of floating; a floating premium would be calculated as the difference between an average wholesale price and a previously defined guaranteed price. In addition, under contract for difference, if the wholesale price rises above the guaranteed price, generators are required to pay back the difference between the guaranteed price and the wholesale price.
- Green certificates (GC): Power plant operators receive certificates for their green final energy, which they may sell to the actors obliged to fulfil the quota obligation. Selling the certificate provides an additional income on top of the common market price of the final energy sold. May have guaranteed minimum prices. The certificates can be traded separately from the energy produced.
- **Investment grants:** Public money paid to provide direct support to investment that increases the generation of renewable energy.
- **Subsidy** (Sub): Public money paid to provide direct support to producers of energy from renewables. In the following tables, this term excludes money paid for investment.
- **Soft loans:** A soft loan is a loan with an interest rate below the commercial rate and/or a longer repayment period.
- Call for tenders: A type of quantity based policy instrument whereby a tender is announced by the Government for the supply of electricity from renewable energy sources, which is then supplied on a contractual basis at the price resulting from the tender. Where tenders are coupled with other forms of support e.g. FIT, FIP or GCs, these other forms of support will be considered the primary supporting policy.
- Tax relief: A taxation policy where renewable energy generators pay lower excise tax rates than conventional energy generators.
- Quota obligation: Governments impose minimum shares of renewable energy on suppliers (or consumers and producers).
- Net metering (NM): Service to an electric consumer under which electric energy generated by that
 electric consumer from an eligible on-site generating facility and delivered to the local distribution
 facilities may be used to offset electric energy provided by the electric utility to the electric consumer
 during the applicable billing period

The purpose of this chapter is to collect comparable data on support for bioenergy in Europe to provide policy-makers, regulators and industry participants with information on support schemes for bioenergy, by technology and type of instrument.

To collect this data, on the type of support and related technologies, a survey was conducted among AEBIOM members in July-October 2015. In addition to questions about financial support given to bioenergy, members were asked for its opinion about the general attractiveness of their national support schemes in the different sector (i.e. electricity, heat and transport). Therefore, the evaluation below corresponds purely to the individual opinion of national expert and only evaluates the support schemes in each country, in any case the general attractiveness of the country for bioenergy investments which depend on many other factors (e.g. overall economic situation, feedstock availability, energy consumption, infrastructure, etc.). A total of 21 AEBIOM members, representing 21 countries have reviewed the tables on support schemes (providing complete and partial responses). Not feedback has been obtained from experts in Bulgaria, France, Hungary, Luxembourg, Malta, Slovenia and Slovakia.

It should be notice that the support schemes are constantly changing, therefore AEBIOM advises readers to contrast the information provided as follow with the relevant national body. The support schemes for biogas have not been included in this analysis.

9.1 Support schemes for bioheat

	Support	Eligible technology(s)	Description	More info
A	Grant	Individual biomass units up to 400 kW or >400 kW District heating; Biomass CHP; Biomass boiler; Costs for implementing quality management measures;	10 to 25% of investment costs	https://www.umweltfoerderung.at/b etriebe/nahwaermeversorgung-auf- basis-erneuerbarer- energietraeger.html
BE (Bruxelles)	Grant	The devices needed for the installation of biomass CHP plants as well as the installation itself.	The energy subsidies are defined each year and apply from 1 January to 31 December ; The energy subsidies of the Brussels Capital region are allocated according to the income level.	Minister of the Government of the Brussels-Capital Region, responsible for Environment and Energy
BE (Flanders)	Tender	Investment in green heat (without production of green electricity), biomethane or waste heat (installations > 1 MW), can apply for investment subsidy within a call system.		http://www.energiesparen.be/groen e-energie-en-wkk/prof/WKC
	Grant	biomass neat and CHP plants.	the size of the company	
	Grant	CO2 saving CHP plants (10% more than conventional electricity production).	30 % of investment costs	
	Grant	Households with taxable revenue under 93.000 € investing into a biomass heating boiler automatically filled, which correspond to the EN 303-5 requirements.	800-3440 €	Public Service of the Walloon region – Directorate General for Energy (DG04)
(Wallonia)	Tax relief	Households with an annual taxable revenue under 93.000 € investing in energy efficiency for their buildings, such as biomass heating systems.	2500-30.000 € 0% interest rate	Public Service of the Walloon region – Directorate General for Energy (DG04)

	Support scheme	Eligible technology(s)	Description	More info
	Grant	Aid to unique projects of local entities that favor the transition to a low carbon economy. Municipalities with a population of less than 20,000 habitants. Renewable energy use: biomass heat installations more than 40 kW, DH	FEDER co-financed 50-85% 50.000- 4.000.000 per project 5.000.000 € per municipality	http://www.idae.es/ayudas-y- financiacion/para-proyectos-de- inversion-que-favorezcan-el-paso- una-economia-baja-en
	Grant	Heat only plants or CHP in non ETS sectors (companies or public bodies)	40% of eligible costs	http://www.tem.fi/
Œ	Tax relief	Labor works for RES renovation in houses	2400,0 € Per year	http://www.tem.fi/
	Feed in tariff	CHP plants with (η>=50 for plants < 1 MVA and η>=75 for plants > 1 MVA)	20 €/MWh	
	Loan	Wood fueled heating plants; Housing works to improve energetic performance of at least 70%	0% of interest rate	http://www.developpement- durable.gouv.fr/
	Tender	Fonds chaleurs for biomass heat plants in industrial, agricultural and service sector	Call for tender expected to be renewed each year	http://www.ademe.fr/en
Æ			Payment calculated in accordance with successful tenderer's finance plan	
	Grant	Biomass fuels based stoves and boilers for households	3000 - 3500 €	
	Other market based support	Installation of boilers, heat pumps, stoves in buildings and individual housings	Reduces VAT rate for purchased commodities	
Ŧ		ddns oN	No support schemes for heat	
НО		ddns oN	No support schemes for heat	

9.2 Support schemes for bioelectricity

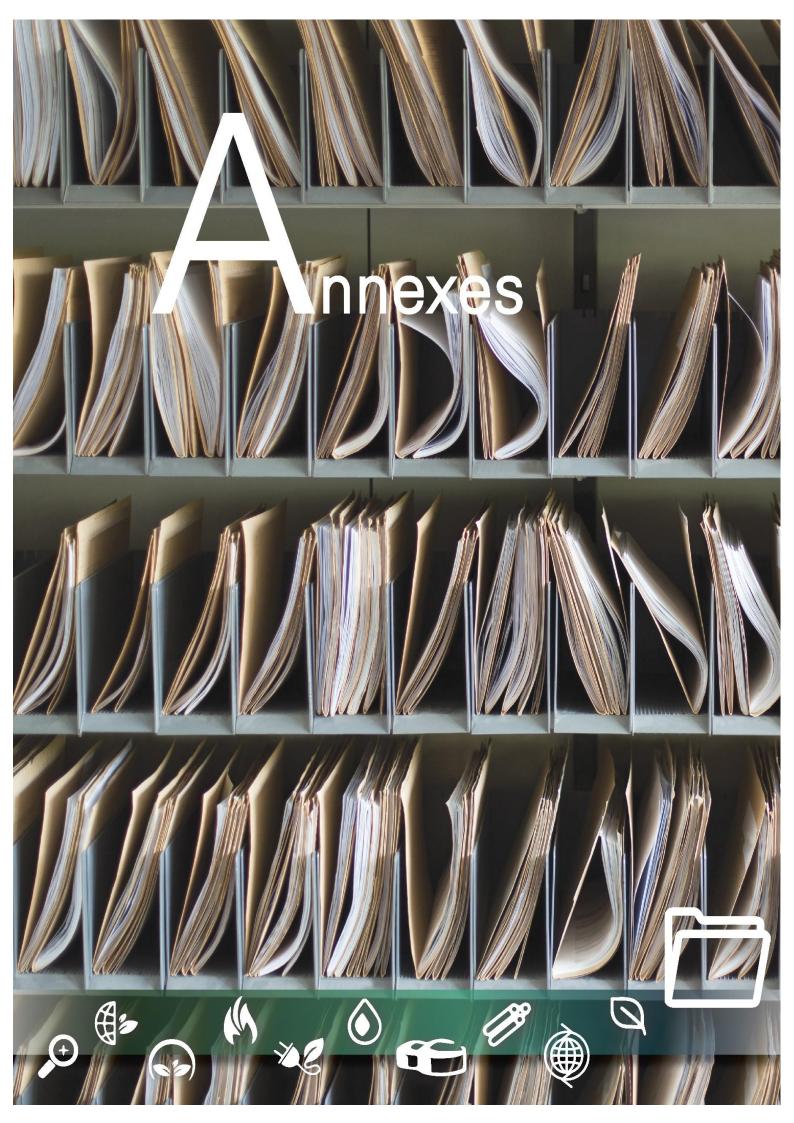
	* *			
	Support scheme	Eligible technology(s)	Description	More info
AT	Feed in tariff	Power plants registered as green plants	Valid for 13-15 years from the operation date of the plant 105,0-186,2 €/MWh	https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20009443
	Quota obligation	Only for installations ≤ 5kWe, provided the installation meets the sustainability criteria.	Valid for 5 years 65,00€ per green certificates	Brussels Regulatory Authority for Electricity and Gas Bruxelles-Capitale - Environment and Energy administration of the Brussels Capital region
BE (Bruxelles)	Grant	In biomass CHP and trigeneration plants.	30-40% of the eligible costs	Economy and Employment Administration of the Brussels-Capital region
	Quota obligation	For all biomass (also solid and gaseous) certain sustainability criteria should be met.	10 years 93 € per certificate	http://www.energiesparen.be/groene- energie-en-wkk/prof/berekening-GSC
(Flanders)	Net metering	Technologies with a capacity ≤10 kWel.	"terugdraaiende kWh-meter" Excess electricity injected into the grid and automatically deducted from the electricity consumed from the grid for example via a so called "terugdraaiende kWh-meter"	

	Support	Eligible technology(s)	Description	More info
	Feed in tariff (REFIT 3)	Biomass technologies who applied for this before 31/12.	Maximum 15 years; not beyond 2030 Biomass Combustion: 89k-99k €⁴ CHP: 126k-157k €	http://www.dccae.gov.ie/en-ie/energy/topics/Renewable- Energy/electricity/renewable- electricity-supports/Pages/REFIT- 3.aspx
	Feed in tariff	Capacities between 1 kW and 500 kWel	20 years; 180-257 €	Gestore Servizi Energetici-GSE
	Feed in tariff	Producers up to 1 MW		Gestore Servizi Energetici-GSE
	Feed in premium	Capacties > 500 kWe	20 years 180-257 €	Gestore Servizi Energetici-GSE
Ħ	Net metering	Plant capacities from 20 kW to 200 kW	Based on the balance of energy fed and consumes	
	Tax relief	Buildings with RES installations	A reduction in real estate tax (<i>imposta</i> municipale propria)	
	Tender	Capacities > 5 MW	20 years After undergoing a tendering process, plants will be eligible for receiving incentives in the form of a premium tariff	

evidence by 30 September 2017 that the project has funding arranged for the completion of the construction of the project and has contractually committed to the delivery of the turbine; 4 While applications for support under the scheme closed in December 2015, the Irish Government has extended the period allowed for project completion. Applicants must: a) provide and b) the installed capacity must be operational by 30 September 2019.

Consultation.aspx

The Irish Government launched a public consultation on the design of a new Renewable Electricity Support Scheme (RESS) on 4 September 2017. An economic assessment to underpin the new RESS included the production of renewable electricity from bioenergy using a range of technologies including: biomass combustion, biomass CHP, biomass LFG, anaerobic digestion, sewage gas and biogas/biomethane. More info at: http://www.dccae.gov.ie/en-ie/energy/consultations/Pages/Renewable-Electricity-Support-Scheme-Design-



10.1Reference tables

GENERAL COUNTRY INFORMATION

Table 10.1 Country codes

EU28	EU28
AT	Austria
BE	Belgium
BG	Bulgaria
HR	Croatia
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
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
BA	Bosnia Herzegovina
BY	Belarus
СН	Switzerland
ME	Montenegro
NO	Norway
RS	Republic of Serbia
UA	Ukraine
AU	Australia
BR	Brazil
CL	Chile
CA	Canada
AR	Argentina
US	United states of America
RU	Russia
KR	South Korea
CN	China
JP	Japan
KR	South Korea
ID	Indonesia
MY	Malaysia
TH	Thailand
VN	Vietnam
NZ	New Zealand

SYMBOLS AND ABBREVIATIONS AND DECIMAL PREFIXES

Table 10.2 Symbols and abbreviations

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

Table 10.3 Table decimal prefixes

10 ¹	Deca (da)	10-1	Deci (d)
10 ²	Hecto (h)	10-2	Centi (c)
10³	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 10.4 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 10.5 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 10.6 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=act ual value kWh/kg (q _{p,net,ar)}	Bulk density kg/loose m ³	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:

$$q_{p,net,ar} = q_{p,net,d} x [(100 - M_{ar})/100] - 0.02443 x M_{ar}$$

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 10.7 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 cor	npare 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 $\% = (100 - d/m) \times 100$

Table 10.8 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 10.9 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 \rightarrow 0,4 t rape seed \rightarrow 0,4 t rape seed \rightarrow 0,4 t biodiesel \rightarrow 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.) \rightarrow 0,382 m³ ethanol = 0,194 toe 1 t wheat (14% m.c.) \rightarrow 0,378 m³ ethanol = 0,192 toe 1 t sugar beet (16% sugar content) \rightarrow 0,107 m³ ethanol = 0,054 toe 1 t sugar cane (14% sugar content) \rightarrow 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 10.10 Emission factors for fossil fuels and main fertilizers

Emissio	n factors	Net GHG emitted [g CO ₂ eq/MJ]	CO ₂ [g/MJ]	CH₄ [g/MJ]	N₂O [g/MJ]
	Supply	16,67	11,38	0,21	3,61E-04
Natural gas	Combustion	55,08	55,08		
	Total	71,7	66,45	0,21	3,61E-04
	Supply	208,84	189,90	0,68	6,86E-03
EU el. Mix (LV)	Use	0,0	0,0	0,00	0,00
	Total	208,8	189,90	0,68	6,86E-03
	Supply	196,35	178,45	0,64	6,44E-03
EU el. Mix (MV)	Use	0,0	0,0	0,00	0,00
	Total	196,3	178,45	0,64	6,44E-03
	Supply	16,21	6,50	0,39	2,50E-04
Hard coal	Combustion	96,11	96,11		
	Total	112,3	102,62	0,39	2,50E-04
	Supply	1,73	1,68	1,44E-03	5,56E-05
Lignite	Combustion	115,0	115,0		
	Total	116,7	116,68	1,44E-03	5,56E-05
	Supply	12,70	-	-	-
Heavy fuel oil	Combustion	80,60	80,60	0	0,00
	Total	93,3	-	0,00	0,00
	Supply	20,70	-	-	-
Diesel	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 10.11 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 [gCO₂eq/MJ]	DEFAULT [gCO₂eq/MJ]
		1-500 km	5	6
	Forest residues	500-2500 km	7	8
	rorest residues	2500-10000 km	13	14
		Above 10000	21	25
	SRC (Eucalyptus)	2500-10000 km	24	26
		1-500 km	8	9
	SRC (Poplar- fertilized)	500-2500 km	10	11
S		2500-10000 km	15	17
Woodchips		Above 10000	24	28
рос	SRC	1-500 km	6	7
Š	(Poplar- Not fertilized)	500-2500 km	8	9
		2500-10000 km	13	15
		Above 10000	22	26
		1-500 km	5	6
	Stemwood	500-2500 km	7	8
	Stemwood	2500-10000 km	12	14
		Above 10000	21	25
		1-500 km	4	4
	Wood industry residues	500-2500 km	6	7
	Trood madding residues	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 10.12 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 CO₂ emissions from the combustion of biomass or other indirect effects.

	Forest biomass prod	uction system	Transport distance	TYPICAL [gCO₂eq/MJ]	DEFAULT [gCO ₂ eq/MJ]
			1-500 km	30	36
		Case 1	500-2500 km	30	36
		Case 1	2500-10000 km	32	38
			Above 10000 km	35	42
		Case 2a	1-500 km	16	19
	Forest residues		500-2500 km	16	19
	rorest residues		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
		Case 1	2500-10000 km	42	48
	SRC (Fucalyntus)	Case 2a	2500-10000 km	31	34
	(Eucalyptus)	Case 3a	2500-10000 km	21	22
			1-500 km	32	38
^		Case 1	500-10000km	34	40
ij			Above 10000 km	37	44
wood pellets of brigaettes	SRC Poplar (fertilized)		1-500 km	18	21
5		Case 2a	500-10000km	20	23
5			Above 10000 km	23	27
ט ב			1-500 km	8	9
<u> </u>		Case 3a	500-10000km	10	11
3			Above 10000 km	13	15
}			1-500 km	31	36
		Case 1	500-10000km	32	38
			Above 10000 km	36	42
			1-500 km	17	19
	SRC Poplar	Case 2a	500-10000km	18	21
	(No fertilized)		Above 10000 km	22	25
			1-500 km	6	7
		Case 3a	500-10000km	8	9
			Above 10000 km	11	13
			1-500 km	30	36
			500-2500km	30	36
		Case 1	2500-10000km	31	38
			Above 10000 km	35	42
			1-500 km	16	19
	Stemwood		500-2500km	16	18
		Case 2a	2500-10000km	17	20
			Above 10000 km	21	25
			1-500 km	5	6
		Case 3a	500-2500km	5	6

		2500-10000km	7	8
		Above 10000 km	10	12
		1-500 km	18	22
	Cons 1	500-2500km	18	21
	Case 1	2500-10000km	19	23
		Above 10000 km	23	27
	Case 2a	1-500 km	9	11
Wood		500-2500km	9	11
Industry residues	Case Za	2500-10000km	11	13
residues		Above 10000 km	14	17
		1-500 km	3	4
		500-2500km	3	4
	Case 3a	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 10.13 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 [gCO2eq/MJ]	DEFAULT [gCO₂eq/MJ]
		1-500 km	4	4
	Agricultural Residues with	500-2500 km	7	9
	density <0.2 t/m3 ¹	2500-10000 km	14	17
		Above 10000	27	32
SW		1-500 km	4	4
/ste	Agricultural Residues with	500-2500 km	5	6
al sy	density <0.2 t/m3 ²	2500-10000 km	8	9
Agricultural systems		Above 10000	14	17
<u>iż</u>	Channa allata	1-500 km	8	10
Agı	Straw pellets	500-10000 km	10	12
		Above 10000	14	16
	Bagasse briquettes	500-10000 km	5	6
	bagasse briquettes	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).

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

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).

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 10.14 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	Transport distance	TYP! [9		DEFA [%	
	production system	uistance	Heat	Electricity	Heat	Electricity
		1-500 km	93	89	91	87
	Forest residues	500-2500 km	90	85	88	82
	rorest residues	2500-10000 km	83	75	79	70
		Above 10000	69	55	63	46
	SRC (Eucalyptus)	2500-10000 km	64	48	61	43
		1-500 km	89	83	87	82
	SRC	500-2500 km	86	79	84	77
ips	(Poplar- fertilized)	2500-10000 km	79	69	76	64
Woodchips		Above 10000	65	49	59	40
۸٥٥	SRC	1-500 km	91	87	90	85
>	(Poplar- Not fertilized)	500-2500 km	88	83	87	80
		2500-10000 km	81	82	78	68
		Above 10000	67	52	62	44
		1-500 km	93	90	92	88
	Stemwood	500-2500 km	90	86	88	83
	Stelliwood	2500-10000 km	83	75	80	71
		Above 10000	69	55	64	47
		1-500 km	95	92	93	90
	Wood industry residues	500-2500 km	92	88	90	86
	wood industry residues	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 10.15 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 pro	oduction	Transport	TY	/PICAL [%]		AULT %]
	system		distance	Heat	Electricity	Heat	Electricity
			1-500 km	56	35	47	22
		Case 1	500-2500 km	56	35	47	22
		Case 1	2500-10000 km	54	32	44	18
			Above 10000 km	48	24	38	9
		Case 2a	1-500 km	77	66	72	59
	Forest residues		500-2500 km	77	66	72	59
	rolest lesiques		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
	CDC	Case 1	2500-10000 km	38	9	29	-4
S	SRC (Eucalyptus)	Case 2a	2500-10000 km	54	33	50	27
ving	(Eucalyptus)	Case 3a	2500-10000 km	69	54	67	52
Sa			1-500 km	53	31	44	18
33.0	SRC Poplar (fertilized)	Case 1	500-10000km	51	28	42	15
ij			Above 10000 km	45	20	36	6
ttes		Case 2a	1-500 km	73	60	69	54
dne			500-10000km	71	57	66	51
Wood pellets or briquettes – GHG Savings			Above 10000 km	66	50	60	41
o c		Case 3a	1-500 km	88	82	87	81
et			500-10000km	86	79	84	77
pe			Above 10000 km	80	71	78	68
000			1-500 km	55	34	46	22
≥		Case 1	500-10000km	53	31	44	18
			Above 10000 km	48	23	38	9
	ono n		1-500 km	76	64	72	58
	SRC Poplar	Case 2a	500-10000km	74	61	69	55
	(No fertilized)		Above 10000 km	68	54	63	45
			1-500 km	91	87	90	85
		Case 3a	500-10000km	89	84	87	81
			Above 10000 km	83	76	81	72
			1-500 km	56	35	47	23
		Core 1	500-2500km	56	36	47	23
		Case 1	2500-10000km	54	32	45	19
			Above 10000 km	48	25	38	10
	Stemwood		1-500 km	77	66	73	60
		0	500-2500km	77	66	73	60
		Case 2a	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
		1-500 km	74	61	68	54
	Case 1	500-2500km	74	62	68	54
	Case 1	2500-10000km	71	58	66	50
		Above 10000 km	66	51	60	41
	0 0.	1-500 km	87	80	84	77
Wood		500-2500km	87	81	84	77
Industry residues	Case 2a	2500-10000km	85	77	81	73
10014400		Above 10000 km	79	70	75	64
		1-500 km	95	93	94	92
	Case 3a	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 10.16 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	Transport distance	TYPICAL [%]		DEFAULT [%]	
	production system		Heat	Electricity	Heat	Electricity
		1-500 km	95	92	93	90
	Agricultural Residues with	500-2500 km	89	85	87	82
ings	density <0.2 t/m3 ¹	2500-10000 km	79	70	75	64
Savings	density voil tymo	Above 10000	61	42	53	31
GHG		1-500 km	95	92	93	90
9	Agricultural Residues	500-2500 km	93	90	92	88
E SE	with density <0.2 t/m3 ²	2500-10000 km	88	83	86	80
Agricultural systems		Above 10000	79	70	75	64
ls ls	C1	1-500 km	88	82	85	79
tur	Straw pellets	500-10000 km	86	79	83	75
<u>ic</u>		Above 10000	80	71	76	65
Agr	Bagasse briquettes	500-10000 km	93	89	91	87
	bagasse briquettes	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 10.17 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 ₂ eq/MJ]	DEFAULT [gCO ₂ eq/MJ]
ions	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
nise		Case 3	Open digestate	-26	12
G er		Case 5	Close digestate	-92	-86
Ĕ	Maize whole plant ⁴	Case 1	Open digestate	38	47
-			Close digestate	24	28
icit		Case 2	Open digestate	45	57
ecti			Close digestate	31	38
r el		Case 3	Open digestate	50	62
Biogas for electricity – GHG emissions			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).

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).

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.

³The 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

Table 10.18 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	Technolo	ogical option	TYPICAL [gCO₂eq/MJ]	DEFAULT [gCO ₂ eq/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

¹This 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.

²This 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

10.2 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 10.19 ENplus requirements for wood pellets

Property	Unit	EN <i>plus</i> A1	EN <i>plus</i> A2	EN <i>plus</i> 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⁾		\leq 1,0 ⁶⁾ (\leq 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/m ^{3 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 Temperature ¹⁾	°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

Source: ENplus Handbook

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

10.3Glossary

Arable land

Land worked regularly, generally under a system of crop rotation, which includes fallow land.

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 to liquid fuels produced from biomass. Biofuels cover bioethanol, biodiesel, biomethanol, biodimethylether, biooil. Liquid biofuels are mainly biodiesel and bioethanol/ETBE used as transport fuels. They can be made from new or used vegetable oils and may be blended with or replace petroleum-based fuels. The natural plant feedstock includes soya, sunflower and oil seed rape oils. Under some circumstances, used vegetable oils may also be used as feedstock for the process.

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.

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

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 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 (m³) 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 (m³) 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

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