WBA GLOBAL BIOENERGY STATISTICS 2018

Summary Report

www.worldbioenergy.org

WORLD BIOENERGY ASSOCIATION - THE GLOBAL VOICE OF BIOENERGY

Mission:

To promote the use of sustainable bioenergy globally & support the business environment for bioenergy

Together wih our members:

- We work for an increased use of biomass in the global energy system in the markets for heat, electricity and mobility

- We follow the principles of sustainable, efficient and economic biomass development

- We influence and inform the public opinion in favor of sustainable biomass solutions worldwide and individual countries

- We promote bioenergy as an important player in the global climate mitigation policy

- We cooperate with global institutions such as UNEP, UNFCCC, IPCC, IEA, IEA Bioenergy, IRENA, REN Alliance, FAO, REN21 etc. towards the target of 100% renewables

How we work

- **Office** in Stockholm, Sweden

- **Our board**: 19 members from 17 countries

- **Our members**: 200 members from 50 countries

- **Main areas**: Biomass potential, sustainability of biomass, pellets, small scale heat with biomass, combined heat and power, conventional and advanced biofuels, biogas, carbon neutrality of bio mass, bioenergy statistics, bioimass trade, bioenergy policy, traditional biomass etc.

- **Main activities**: Factsheets, statistics, position papers, policy reports, workshops, equipment directory, press releases, networking, presentations in conferences and exhibitions etc.

What kind of membership is possible

Full members

Associations on regional, national or international level (fee between 300 and 5000 euros annually depending on situation and size)

Associated members

Companies, energy agencies, research institutes, consultants working in the field of bioenergy (fee between 300 and 5000 euros annually depending on situation and size)

Individual members

Individuals interested in global development of bioenergy as a sustainable and renewable energy source (fee 50 euros annually)

Benefits of WBA membership

- Strengthening of the voice in favour of biomass on a global scale

- Exchange of information and experience between the bioenergy sector worldwide

- Possible cooperation in working groups and projects

- Access to the new global studies and information about bioenergy

We invite you to join WBA!

Contact us at info@worldbioenergy.org or call us at +46 (0)8 441 70 84

1. GLOBAL OVERVIEW

1.1 ENERGY SUPPLY

Table 1 Total primary energy supply of energy sources globally

	Total	Coal	Oil	Natural Gas	Nuclear	Renewables	Renewables (%)
2000	420	96.8	153	86.7	28.3	54.8	13.0%
2005	481	125	168	98.8	30.2	59.4	12.3%
2010	539	153	173	115	30.1	67.8	12.6%
2015	571	161	181	123	28.1	77.8	13.6%
2016	576	156	184	127	28.5	80.6	14.0%

All values in EJ. Source: IEA Key World Energy Statistics

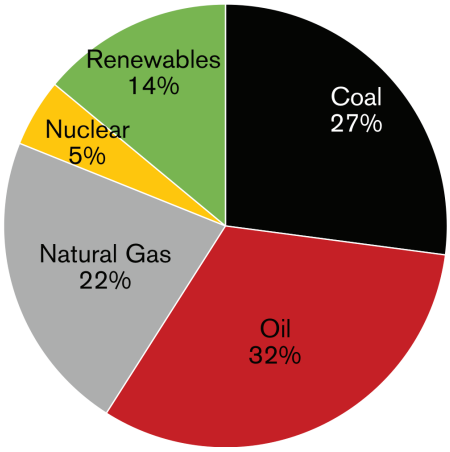

Figure 1 Total energy supply globally in 2016

Table 2 Total primary energy supply of energy sources in continents in 2016

	Total	Coal	Oil	Natural Gas	Nuclear	Renewables	Renewables (%)
Africa	34.8	4.53	8.29	4.83	0.16	17.0	48.8%
Americas	141	16.9	55.2	40.0	10.6	17.8	12.7%
Asia	276	114	80.8	42.7	5.18	32.6	11.8%
Europe	119	18.5	37.4	37.9	12.5	12.5	10.5%
Oceania	6.26	1.88	2.04	1.62	0.00	0.72	11.5%
World	576	156	184	127	28.5	80.6	13.6%

All values in EJ. Source: IEA Key World Energy Statistics

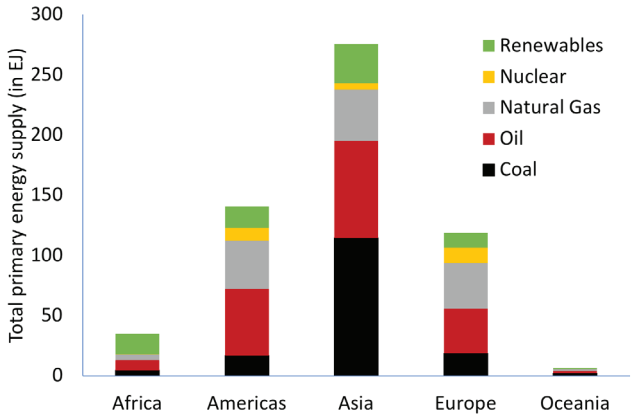

Figure 2 Total primary energy supply in continents in 2016

1.2 ENERGY TRADE

Table 3 Total imports of energy in 2016

	Total	Coal	Oil	Gas	Renewables	Electricity
Africa	7.92	0.32	6.50	0.96	0.00	0.15
Americas	40.5	1.67	32.0	6.14	0.70	0.49
Asia	105.4	24.4	72.1	14.0	0.37	0.31
Europe	68.8	6.86	42.6	17.0	2.38	1.65
Oceania	2.40	0.02	2.17	0.21	0.00	0.00

All values in EJ. Source: IEA Key World Energy Statistics

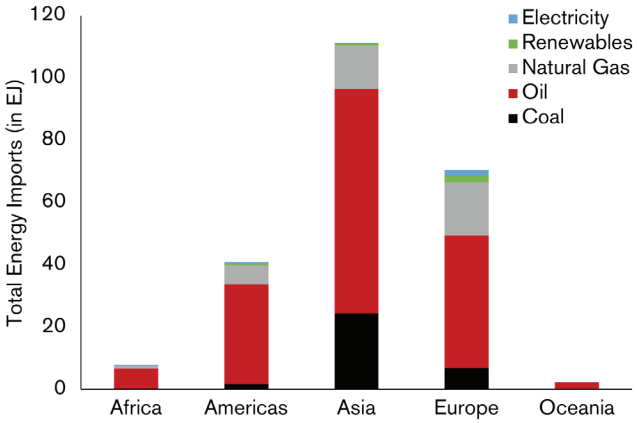

Figure 3 Energy imports in 2016 globally

Table 4 Total exports of energy in 2016

	Total	Coal	Oil	Gas	Renewables	Electricity
Africa	19.6	2.23	14.0	3.22	0.15	0.13
Americas	43.2	4.62	31.4	6.43	0.78	0.50
Asia	90.7	10.7	70.4	9.36	0.29	0.25
Europe	68.6	6.71	41.4	18.2	2.21	0.35
Oceania	13.0	10.6	0.64	1.80	0.00	0.00

All values in EJ. Source: IEA Key World Energy Statistics

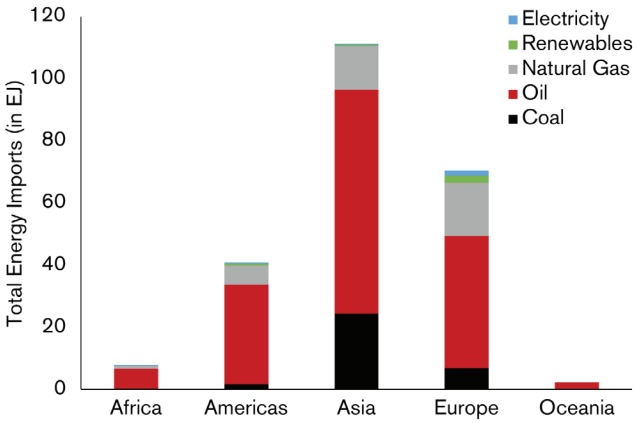

Figure 4 Energy exports in 2016 globally

1.3 ENERGY CONSUMPTION

Table 5 Gross final energy consumption of energy sources

	Total	Coal	Oil	Gas	Nuclear	Renewables	Renewables (%)
2000	269	43.3	115	55.7	7.63	47.4	17.6%
2005	302	57.3	125	61.1	8.20	50.6	16.7%
2010	335	70.6	129	69.8	8.23	56.7	16.9%
2015	358	74.6	138	73.3	7.68	63.4	17.7%
2016	368	76.6	140	76.9	8.15	66.0	17.9%

All values in EJ. Source: IEA Key World Energy Statistics

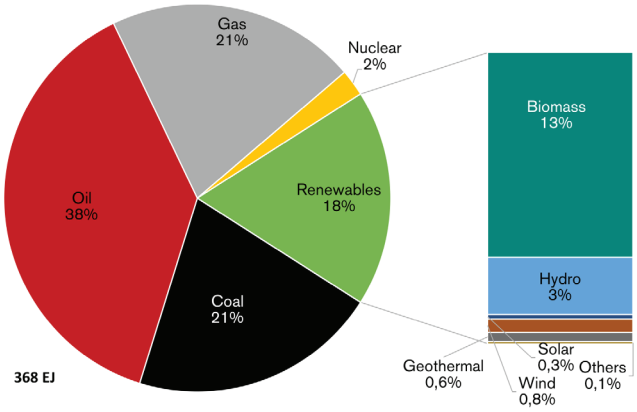

Figure 5 Gross final energy consumption globally in 2016

Table 6 Gross final energy consumption in continents in 2016

	Total	Coal	Oil	Natural Gas	Nuclear	Renewables	Renewables (%)
Africa	24.2	1.52	6.87	1.96	0.04	13.8	57.1%
Americas	89.1	6.54	41.7	23.9	3.02	13.9	15.6%
Asia	159	59.3	49.9	23.6	1.34	24.8	15.6%
Europe	70.8	8.31	23.2	25.6	3.67	9.66	13.6%
Oceania	3.76	0.63	1.91	0.77	0.00	0.45	12.0%
World	361	76.3	138	75.8	8.07	62.7	17.3%

All values in EJ. Source: IEA Key World Energy Statistics

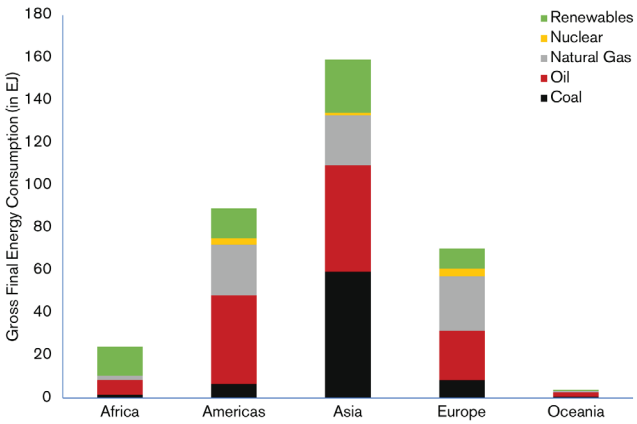

Figure 6 Gross final energy consumption of energy sources in 2016

1.4 RENEWABLE ENERGY

Table 7 Total primary energy supply of renewables globally

	Total	Biomass	Hydro	Geothermal	Solar PV	Solar Thermal	Wind	Tide, Ocean etc.
2000	54.8	42.8	9.43	2.19	0.00	0.22	0.11	0.002
2005	59.4	45.9	10.6	2.25	0.01	0.30	0.37	0.002
2010	67.8	50.8	12.4	2.62	0.12	0.66	1.23	0.002
2015	77.8	55.4	14.0	3.10	0.89	1.37	3.02	0.004
2016	80.5	56.5	14.6	3.37	1.18	1.41	3.45	0.004

All values in EJ. Source: IEA Key World Energy Statistics

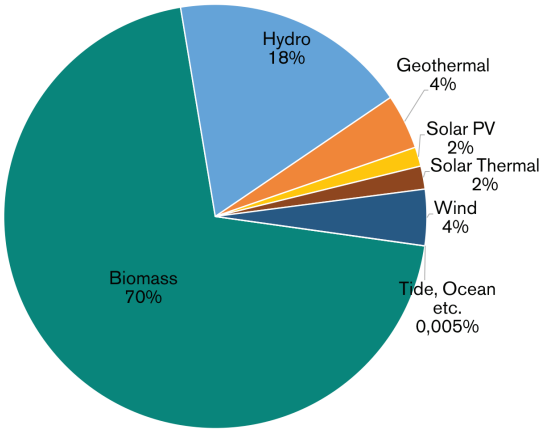

Figure 7 Total primary energy supply of all renewables in 2014

Table 8 Total primary energy supply of renewables in continents in 2014

	Total	Biomass	Hydro	Geothermal	Solar PV	Solar Thermal	Wind	Tide, Ocean etc.
Africa	16.9	16.3	0.42	0.15	0.01	0.01	0.04	0.000
Americas	16.7	10.7	4.99	0.66	0.20	0.16	1.14	0.000
Asia	31.4	21.8	6.09	1.92	0.58	1.04	1.12	0.002
Europe	11.4	7.38	2.98	0.44	0.39	0.18	1.10	0.002
Oceania	0.65	0.28	0.15	0.20	0.01	0.02	0.05	0.000
World	77.1	56.5	14.6	3.37	1.18	1.41	3.45	0.004

All values in EJ. Source: IEA Key World Energy Statistics

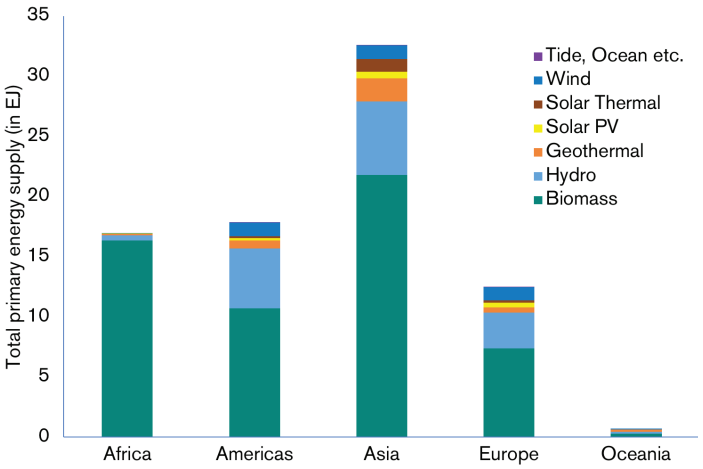

Figure 8 Total primary energy supply of renewables in 2016 (in EJ)

Table 9 Electricity generation from renewables

	Total	Biomass	Hydro	Geothermal	Solar PV	Solar Thermal	Wind	Tide, Ocean etc.
2000	2 950	164	2 700	52.0	0.98	0.53	31.3	0.55
2005	3 413	227	3 019	58.3	3.97	0.60	104	0.52
2010	4 347	372	3 531	68.1	32.4	1.65	341	0.51
2015	5 682	528	3 978	80.4	247	9.42	838	1.01
2016	6 119	571	4 170	81.7	328	10.5	958	1.03

All values in TWh. Source: IEA Key World Energy Statistics

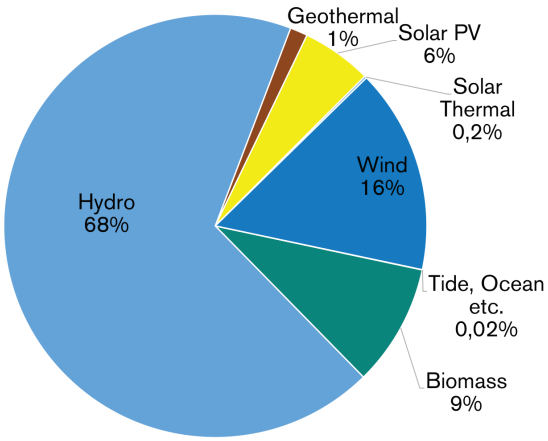

Figure 9 Electricity generation from renewables globally in 2016

Table 10 Electricity generation from renewables in 2016 in continents

	Total	Biomass	Hydro	Geothermal	Solar PV	Solar Thermal	Wind	Tide, Ocean etc.
Africa	137	1.91	116	4.20	3.31	0.90	10.3	0.00
Americas	1 951	162	1 386	28.7	54.8	3.70	316	0.02
Asia	2 351	152	1 697	29.2	160	0.29	311	1.00
Europe	1 468	208	827	12.2	108	5.58	307	0.50
Oceania	66.9	4.23	37.9	7.43	2.38	0.00	15.0	0.00
World	5 973	528	4 064	81.7	328	10.5	959	1.52

All values in TWh. Source: IEA Key World Energy Statistics

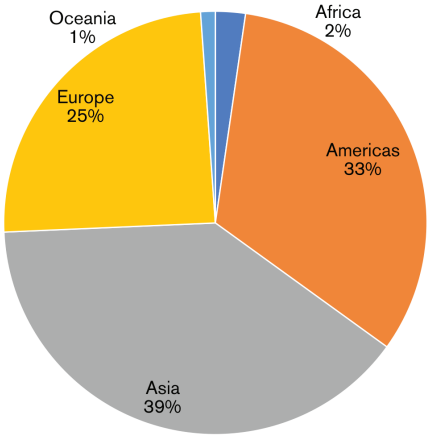

Figure 10 Electricity generation from renewables in 2016

Table 11 Derived heat generation from renewables globally

	Total	Biomass	Geothermal	Solar Thermal
2000	432 419	414 081	18 314	24.0
2005	554 103	530 237	23 811	55.0
2010	807 324	781 020	26 112	192
2015	975 672	940 492	34 251	929
2016	1 099 129	1 053 861	43 704	1 564

All values in EJ. Source: IEA Key World Energy Statistics

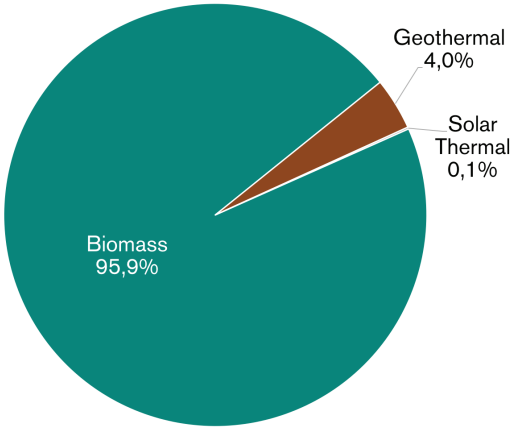

Figure 11 Derived heat generation from renewables in 2016

Table 12 Derived heat generation from renewables in 2016

	Total	Biomass	Geothermal	Solar Thermal
Africa	0.00	0.00	0.00	0.00
Americas	48 991	48 991	0.00	0.00
Asia	71 195	71 195	0.00	0.00
Europe	855 486	820 306	34 251	929
Oceania	0.00	0.00	0.00	0.00
World	975 672	940 492	34 251	929

All values inTJ. Source: IEA Key World Energy Statistics

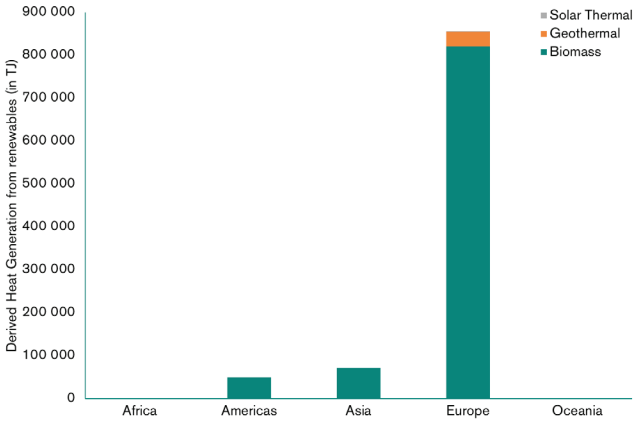

Figure 12 Derived heat from generation renewables in 2016

Table 13 Direct heat generation from renewables globally

	Total	Biomass	Geothermal	Solar Thermal
2000	38.0	37.6	0.16	0.21
2005	39.2	38.7	0.22	0.30
2010	40.7	39.8	0.27	0.64
2015	42.5	40.9	0.36	1.25
2016	44.0	44.0	0.00	0.00

All values in EJ. Source: IEA Key World Energy Statistics

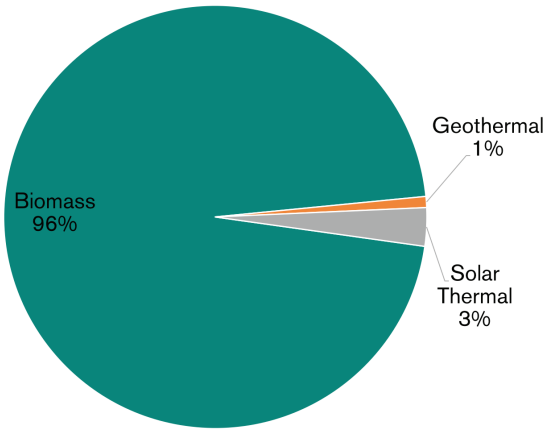

Figure 13 Direct heat generation from renewables in 2016

Table 14 Direct heat generation from renewables in continents in 2016

	Renewables	Biomass	Geothermal	Solar Thermal
Africa	12.8	12.8	0.00	0.01
Americas	6.05	5.91	0.01	0.13
Asia	24.1	22.9	0.27	0.97
Europe	3.41	3.28	0.04	0.08
Oceania	0.24	0.21	0.01	0.01
World	46.7	45.1	0.33	1.20

All values in EJ. Source: IEA Key World Energy Statistics

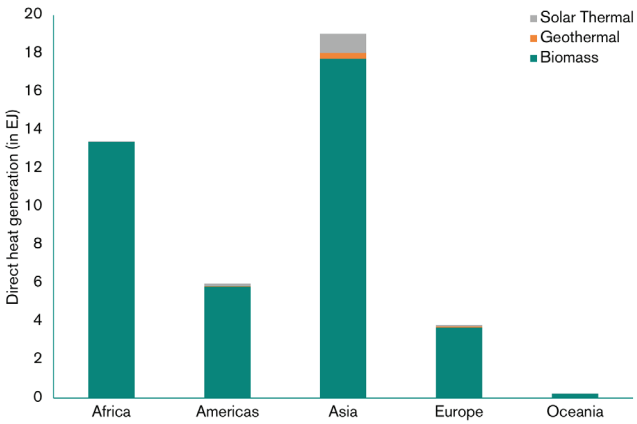

Figure 14 Direct heat generation from renewables in continents

2. BIOENERGY SUPPLY

OVERVIEW

Table 15 Total primary energy supply of biomass

	Total	Municipal Waste	Industrial Waste	Solid Biomass	Biogas	Liquid Biofuels
2000	42.8	0.74	0.47	40.9	0.28	0.42
2005	45.9	0.94	0.40	43.2	0.50	0.85
2010	50.8	1.15	0.68	45.7	0.84	2.45
2015	55.4	1.37	0.80	48.7	1.30	3.26
2016	56.5	1.43	1.03	49.1	1.31	3.59

All values in EJ. Source: IEA Key World Energy Statistics

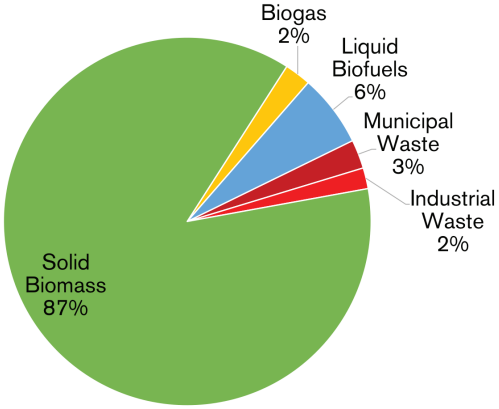

Figure 15 Total primary energy supply of biomass in 2016

Table 16 Total primary energy supply of biomass in continents in 2015

	Total	Municipal Waste	Industrial Waste	Solid Biomass	Biogas	Liquid Biofuels
Africa	16.3	0.00	0.00	15.8	0.00	0.00
Americas	10.7	0.30	0.06	7.64	0.19	2.52
Asia	21.8	0.20	0.36	20.5	0.40	0.35
Europe	7.38	0.87	0.37	4.52	0.70	0.91
Oceania	0.28	0.00	0.00	0.23	0.02	0.02
World	56.5	1.37	0.80	48.7	1.31	3.79

All values in EJ. Source: IEA Key World Energy Statistics

Figure 16 Total primary energy supply of biomass in continents in 2015

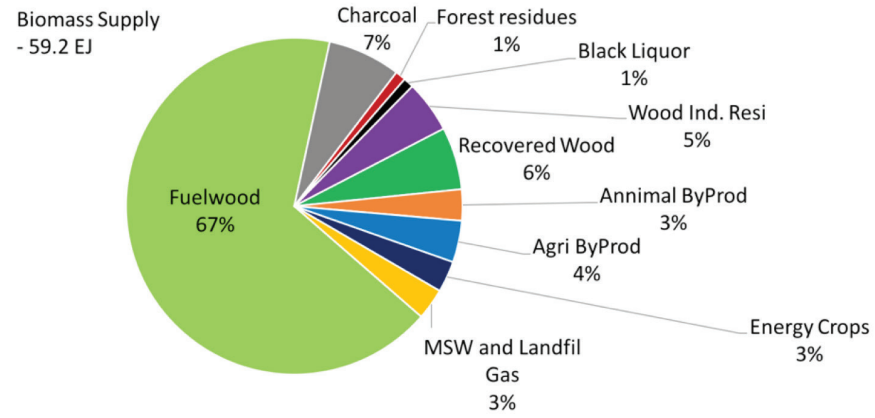

Figure 17 Biomass feedstock sources

2.1 LAND

Table 17 Land area globally

	Arable Land	Permanent Crops	Permanent meadows and pastures	Primary Forests	Other Naturally Regenerated Forests	Planted Forests
2000	1 400	138	3 417	1 299	2 533	224
2005	1 406	148	3 386	1 284	2 495	254
2010	1 388	159	3 322	1 288	2 450	277
2015	1 426	165	3 275	1 277	2 429	293

All values in million ha. Source: FAOSTAT

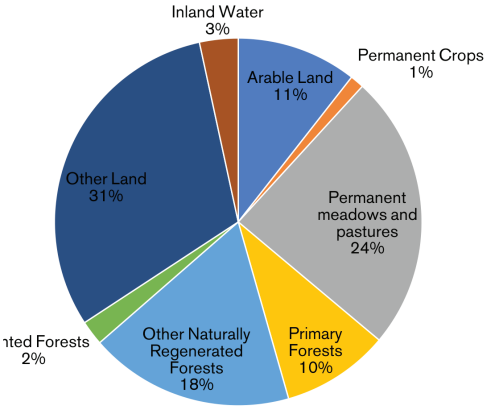

Figure 18 Land area globally in 2015

2.2. AGRICULTURE

Table 18 Agriculture area in continents in 2015

	Arable Land	Permanent Crops	Permanent meadows and pastures	Permanent Pastures and Meadows
Africa	235	33.9	861	861
Americas	371	27.8	826	826
Asia	496	86.5	1 082	1 082
Europe	276	15.1	176	176
Oceania	47.3	1.53	331	370
World	1 426	165	3 275	3 316

All values in million ha. Source: FAOSTAT

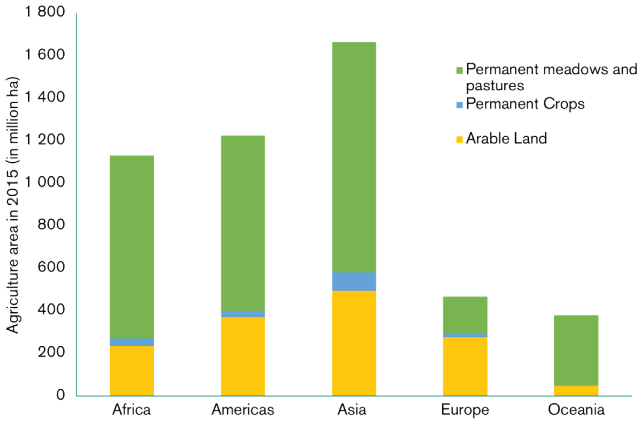

Figure 19 Agriculture area in continents in 2015

CROPS

Table 19 Area harvested

	World		Africa		Americas		Asia		Europe		Oceania	
	2000	2016	2000	2016	2000	2016	2000	2016	2000	2016	2000	2016
Barley	54.4	46.9	4.11	3.55	7.66	5.08	11.5	9.78	27.6	24.3	3.51	4.16
Cassava	17.0	23.5	11.0	17.0	2.51	2.27	3.40	4.18	13.4	17.7	0.02	0.03
Maize	137	188	24.2	36.6	57.3	70.1	41.8	63.5	1.77	0.58	0.10	0.08
Millet	37.1	31.7	19.6	20.0	0.18	0.17	15.5	10.9	8.13	5.79	0.04	0.04
Oats	12.7	9.43	0.12	0.14	2.91	2.19	0.85	0.49	4.68	5.06	0.66	0.83
Olives	8.35	10.7	2.27	3.50	0.07	0.13	1.33	1.92	4.61	8.12	0.00	0.03
Rapeseed	25.9	33.7	0.06	0.11	5.53	8.92	14.2	14.2	0.61	0.67	1.46	2.36
Rice, paddy	154	160	7.56	12.5	7.64	6.12	138	140	8.58	3.58	0.14	0.03
Rye	9.8	4.40	0.02	0.05	0.33	0.34	0.9	0.37	0.23	0.40	0.04	0.05
Sorghum	41.1	44.8	21.2	30.5	7.09	6.01	12.0	7.29	1.08	5.04	0.62	0.52
Soybeans	74.3	122	0.90	1.98	54.6	94.6	17.7	19.9	4.18	3.07	0.06	0.03
Sugar beet	6.01	4.56	0.11	0.32	0.62	0.48	1.09	0.70	0.00	0.00	0.49	0.49
Sugar cane	19.4	26.8	1.29	1.57	8.71	13.9	8.89	10.8	11.3	18.1	0.16	0.02
Sunflower seed	21.2	26.2	0.86	2.23	4.94	2.34	3.93	3.54	55.2	62.5	12.2	11.3
Wheat	215	220	8.14	8.87	41.4	36.9	98.0	100	3.51	4.16	0.00	0.00
Sugarcane	19.4	27.1	1.30	1.48	8.76	14.2	8.85	11.0	0.00	0.00	0.49	0.43

All values in million ha. Source: FAOSTAT

Table 20 Yields of major crops

	World		Africa		Americas		Asia		Europe		Oceania	
	2000	2016	2000	2016	2000	2016	2000	2016	2000	2016	2000	2016
Barley	2.45	3.01	0.52	1.30	2.93	3.69	1.52	2.04	3.04	3.64	2.01	2.25
Cassava	10.4	11.8	8.66	9.25	12.3	13.4	14.5	21.3	4.70	6.62	11.3	9.8
Maize	4.32	5.64	1.81	1.93	5.85	7.81	3.56	5.11	0.90	1.64	5.75	8.17
Millet	0.75	0.89	0.65	0.68	1.18	1.70	0.84	1.23	2.05	2.43	1.46	1.02
Oats	2.06	2.44	0.83	1.31	2.32	2.89	1.81	2.14	2.25	2.33	1.65	1.62
Olives	1.87	1.81	0.71	1.06	3.45	4.25	2.45	1.65	2.55	2.75	1.83	2.29
Rapeseed	1.53	2.04	1.11	1.61	1.49	2.28	1.25	1.63	5.25	6.34	1.22	1.25
Rice, paddy	3.89	4.64	2.31	2.60	4.15	5.88	3.95	4.75	2.11	3.08	7.99	9.37
Rye	2.05	2.94	1.49	1.88	1.84	2.36	1.56	2.55	3.35	3.11	0.57	0.60
Sorghum	1.36	1.43	0.87	0.98	3.28	3.84	0.94	1.09	1.78	2.08	3.40	3.44
Soybeans	2.17	2.76	1.05	1.07	2.47	3.10	1.31	1.45	40.7	60.4	1.87	2.14
Sugar beet	41.6	60.7	51.9	55.4	58.6	73.8	34.5	55.7	98.5	82.6	86.2	73.7
Sugar cane	64.6	70.6	66.7	58.6	65.6	74.7	62.1	67.0	1.18	1.91	1.05	1.09
Sunflower seed	1.25	1.81	1.07	1.00	1.65	1.95	1.03	1.72	3.32	4.00	1.84	2.01
Wheat	2.72	3.41	1.75	2.60	2.67	3.43	2.60	3.25	2.01	2.25	0.00	0.00
Sugarcane	64.7	69.5	66.3	64.4	65.5	71.1	62.6	67.8	98.5	81.0	86.2	76.4

All values in tons/ ha. Source: FAOSTAT

Table 21 Production quantities of crops

	World		Africa		Americas		Asia		Europe		Oceania	
	2000	2016	2000	2016	2000	2016	2000	2016	2000	2016	2000	2016
Barley	133	141	2.12	4.61	22.4	18.8	17.5	20.0	84.0	88.6	7.05	9.36
Cassava	176	277	95.4	157	30.8	30.3	49.5	89.3	0	0	0.18	0.25
Maize	592	1 060	43.8	70.6	335	547	149	324	63.1	117	0.60	0.63
Millet	27.7	28.4	12.7	13.6	0.21	0.29	13.1	13.4	1.59	0.96	0.06	0.04
Oats	26.1	23.0	0.10	0.18	6.74	6.32	1.54	1.06	16.7	14.1	1.09	1.35
Oil, palm	22.2	0.00	1.85	0.00	1.32	0.00	18.7	0	0.00	0	0.37	0
Olives	15.7	19.3	1.61	3.70	0.24	0.54	3.27	3.17	10.5	11.8	0.00	0.08
Rapeseed	39.6	68.9	0.07	0.18	8.23	20.3	17.7	23.1	11.7	22.3	1.78	2.95
Rice, paddy	599	741	17.5	32.5	31.7	36.0	545	668	3.18	4.22	1.12	0.28
Rye	20.1	12.9	0.03	0.10	0.61	0.81	1.35	0.94	18.1	11.1	0.02	0.03
Sorghum	55.8	63.9	18.4	29.8	23.3	23.1	11.3	7.96	0.76	1.25	2.12	1.80
Soybeans	161	335	0.95	2.12	135	293	23.2	28.8	1.92	10.5	0.10	0.06
Sugar beet	250	277	5.79	17.6	36.5	35.7	37.7	38.9	170	185	0.00	0
Sugar cane	1 253	1 891	86.1	91.7	572	1 041	552	722	0.11	0.01	42.1	36.2
Sunflower seed	26.5	47.3	0.93	2.23	8.13	4.56	4.06	6.09	13.3	34.4	0.17	0.03
Wheat	585	749	14.3	23.1	110	127	255	327	183	250	22.4	22.7

All values in million tonnes. Source: FAOSTAT

2.3. FORESTRY

AREA

Table 22 Forest area in 2015

	Primary Forests	Other Naturally Re-generated Forests	Planted Forests
Africa	135	473	16.3
Americas	720	814	58.3
Asia	117	347	129
Europe	278	652	85.5
Oceania	26.9	142	4.4
World	1 277	2 429	293

All values in million ha. Source: FAOSTAT

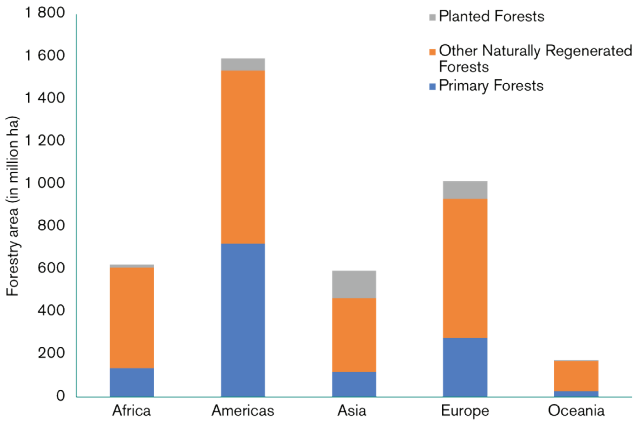

Figure 20 Forest land area in 2015

WOOD FUEL

Table 23 Wood fuel production globally

	World	Africa	Americas	Asia	Europe	Ocenia	EU - 28
2000	1 772	542	314	808	94.8	12.7	70.8
2005	1 799	589	300	792	107	11.5	76.0
2010	1 824	631	290	764	127	10.7	89.4
2015	1 872	666	307	732	157	10.0	109
2016	1 889	673	323	727	157	9.93	107
2017	1 892	673	325	727	158	10.0	108

All values in million m^3. Source: FAOSTAT

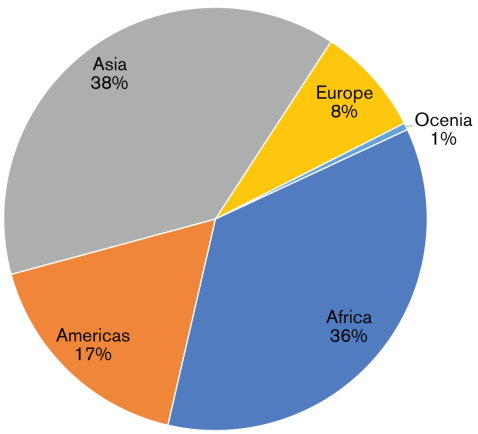

Figure 21 Wood fuel production globally

2.4. WASTE

Table 24 Energy recovery from waste globally

	Total	Energy from MSW	Energy from Industrial Waste
2000	1.20	0.74	0.47
2005	1.34	0.94	0.40
2010	1.83	1.15	0.68
2015	2.17	1.37	0.80

All values in EJ. Source: IEA Key World Energy Statistics

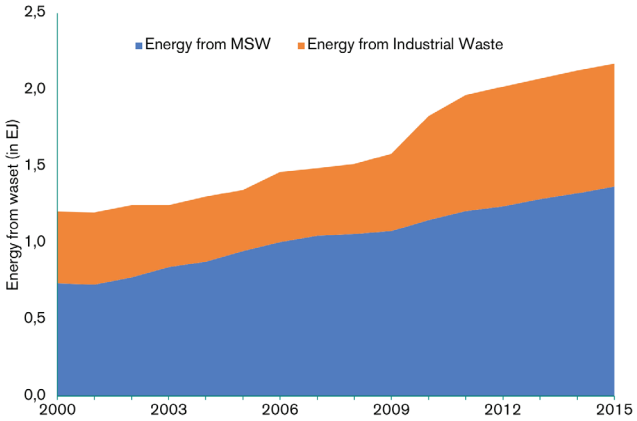

Figure 22 Energy recovery from waste globally

Table 25 Energy recovery from waste in continents in 2015

	Total	Energy from MSW	Energy from Industrial Waste
World	2.17	1.37	0.80
Africa	0.00	0.00	0.00
Americas	0.36	0.30	0.06
Asia	0.56	0.20	0.36
Europe	1.24	0.87	0.37
Oceania	0.00	0.00	0.00

All values in EJ. Source: IEA Key World Energy Statistics

3. BIOMASS TO ELECTRICITY

OVERVIEW

Table 26 Electricity generation from biomass

	Total	Municipal Waste	Industrial Waste	Solid Biomass	Biogas	Liquid Biofuels
2000	164	34.3	15.3	102	13.1	0.00
2005	227	46.2	11.8	146	21.0	1.98
2010	372	60.6	20.7	239	46.2	5.07
2015	528	71.4	22.8	344	82.5	7.62

All values in TWh. Source: IEA Key World Energy Statistics

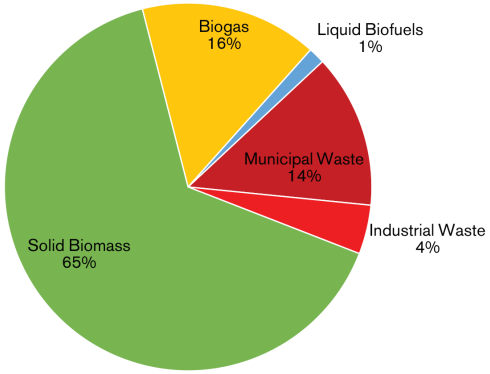

Figure 23 Electricity generation from biomass in 2015

Table 27 Electricity generation from biomass in continents in 2015

	Total	Municipal Waste	Industrial Waste	Solid Biomass	Biogas	Liquid Biofuels
World	528	71.4	22.8	344	82.5	7.62
Africa	1.91	0.00	0.00	1.88	0.04	0.00
Americas	162	16.8	2.33	127	15.6	0.22
Asia	152	11.6	13.9	121	3.73	1.89
Europe	208	43.1	6.52	91.2	61.3	5.51
Oceania	4.23	0.00	0.00	2.49	1.74	0.00

All values in TWh. Source: IEA Key World Energy Statistics

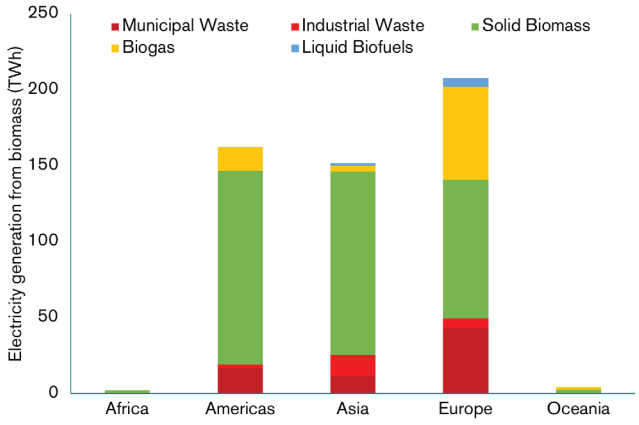

Figure 24 Electricity generation from biomass in continents in 2015

4. BIOMASS TO HEAT

Table 28 Derived heat generation from biomass globally

	Total	Municipal Waste	Industrial Waste	Solid Biomass	Biogas	Liquid Biofuels
2000	414 081	125 141	74 975	208 995	4 931	39.0
2005	530 237	152 549	82 630	284 745	6 615	3 698
2010	781 020	206 212	126 337	426 477	12 296	9 698
2015	940 492	265 300	138 958	498 795	32 948	4 491

All values in TJ. Source: IEA Key World Energy Statistics

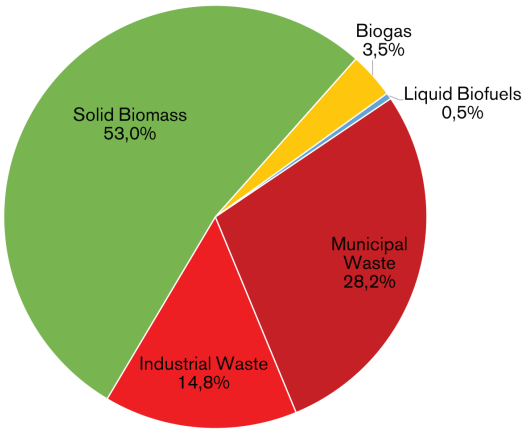

Figure 25 Derived heat generation from biomass in 2015

Table 29 Derived heat generation from biomass in continents in 2014

	Total	Municipal Waste	Industrial Waste	Solid Biomass	Biogas	Liquid Biofuels
World	940 492	265 300	138 958	498 795	32 948	4 491
Africa	0	0	0	0	0	0
Americas	48 991	13 763	4 300	27 400	3 528	0
Asia	71 195	12 847	39 998	16 167	2 183	0
Europe	820 306	238 690	94 660	455 228	27 237	4 491
Oceania	0	0	0	0	0	0

All values in EJ. Source: IEA Key World Energy Statistics

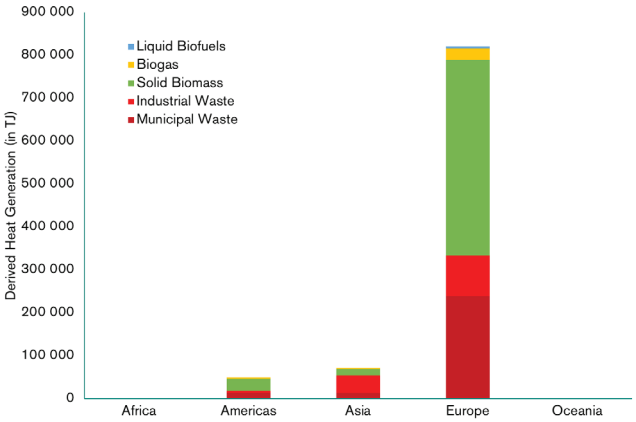

Figure 26 Derived heat generation from biomass in 2015

5. BIOMASS TO LIQUID BIOFUELS

OVERVIEW

Table 30 Liquid biofuels production globally

	Total	Bioethanol	Biodiesel	Other Biofuels
2000	15.9	12.2	0.78	2.97
2005	34.1	24.5	3.42	6.16
2010	94.4	60.5	18.9	15.0
2015	125	82.0	28.9	14.6
2016	132	85.6	32.6	13.6
2017	143	-	-	-

All values in billion litres. Source: IEA Key World Energy Statistics and REN21 GSR 2018

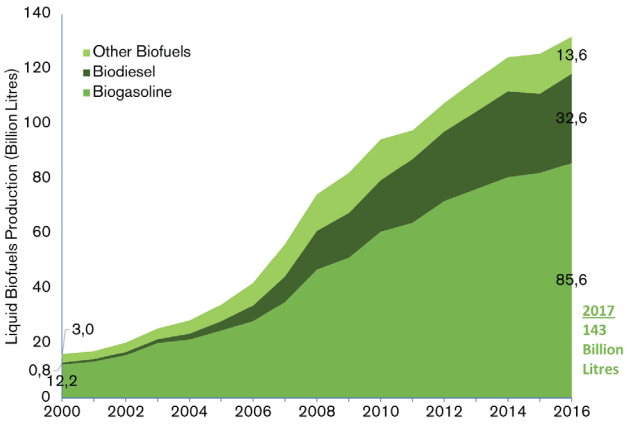

Figure 27 Liquid biofuels production globally

Table 31 Liquid biofuels production in continents in 2016

	Total	Biogasoline	Biodiesel	Other Biofuels
Africa	0.07	0.07	0.00	0.00
Americas	101	72.1	12.5	16.0
Asia	13.9	5.95	7.48	0.47
Europe	19.3	4.42	13.7	1.13
Oceania	0.29	0.2	0.06	0.00

All values in billion litres. Source: IEA Key World Energy Statistics

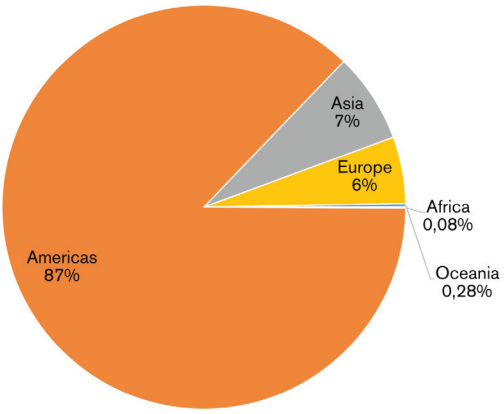

Figure 28 Liquid bioethanol production in 2016

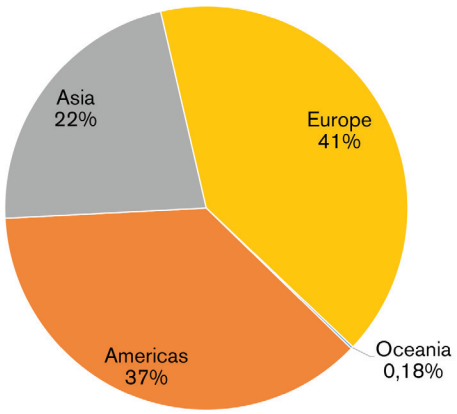

Figure 29 Liquid biodiesel production in 2016

6. SPECIAL SECTORS

6.1. BIOGAS

Table 32 Biogas production globally

	Biogas (Billion m³)	Biogas (EJ)
2000	13.2	0.28
2005	23.1	0.50
2010	38.7	0.84
2015	60.0	1.30
2016	60.8	1.31

Source: IEA Key World Energy Statistics

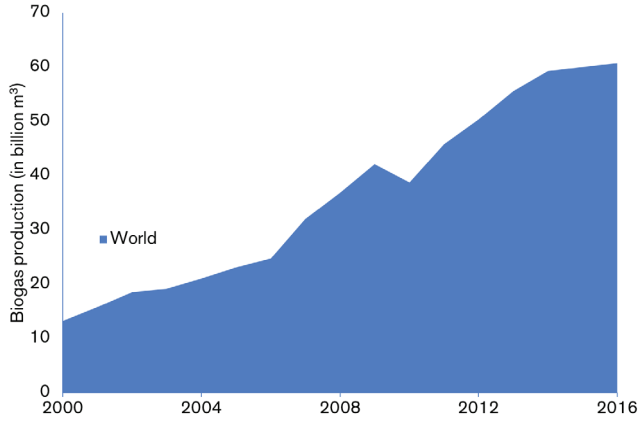

Figure 30 Biogas production during 2000 - 2016

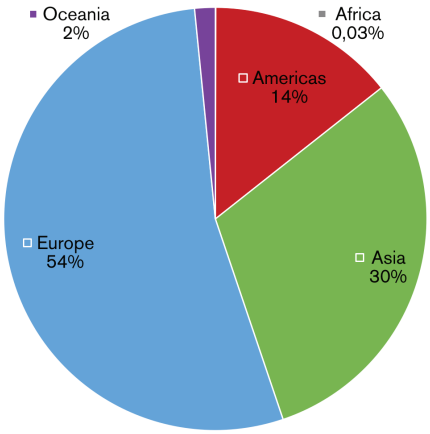

Figure 31 Biogas production in continents in 2016

6.2. PELLETS

Table 33 Pellet production globally

	World	Africa	Americas	Asia	Europe	Oceania
2012	19.7	0.09	6.72	0.30	12.5	0.03
2013	22.3	0.04	7.64	0.62	14.0	0.03
2014	26.0	0.04	8.91	1.50	15.4	0.14
2015	28.0	0.03	9.44	1.99	16.3	0.15

All values in million tonnes. Source: FAOSTAT

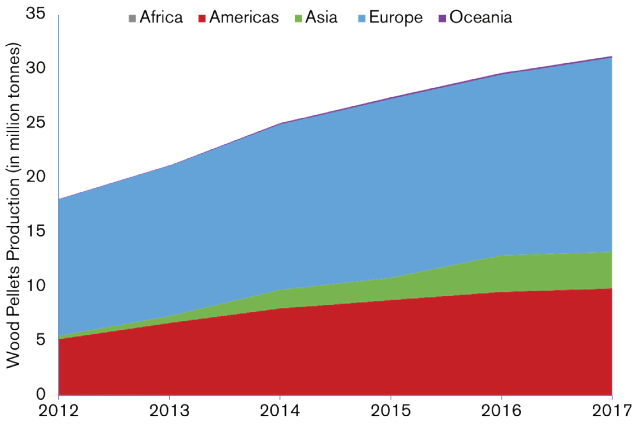

Figure 32 Pellets production during 2012 - 2017

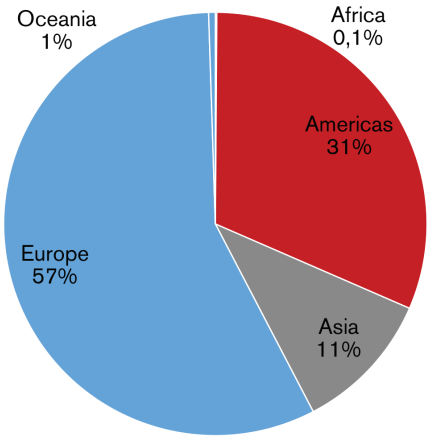

Figure 33 Pellet production globally in 2017

6.3. CHARCOAL

Table 34 Charcoal production globally

	World	Africa	Americas	Asia	Europe	Oceania
2012	37.0	20.4	9.67	6.54	0.30	0.04
2013	38.1	21.4	9.77	6.57	0.30	0.04
2014	40.2	22.2	9.87	7.73	0.38	0.04
2015	42.5	23.0	11.1	7.89	0.46	0.04
2016	43.2	23.8	11.0	7.87	0.50	0.03
2017	44.0	24.5	10.9	8.01	0.51	0.03

All values in million tonnes. Source: FAOSTAT

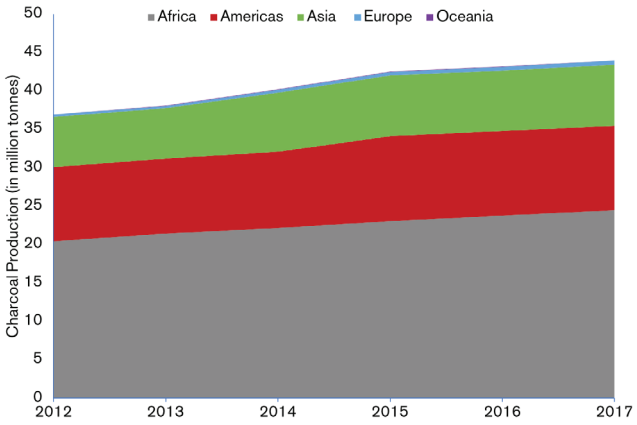

Figure 34 Charcoal production during 2012 - 2017

7. RENEWABLE JOBS

Table 35 Renewable energy jobs (2012 - 2017)

	Total	Hydro	Solar	Bioenergy	Wind	Others
2012	7.14	1.41	2.25	2.40	0.75	0.33
2013	8.22	1.74	2.77	2.50	0.83	0.38
2014	9.34	1.66	3.26	2.99	1.03	0.40
2015	9.70	1.63	3.71	2.88	1.08	0.40
2016	9.79	1.52	3.92	2.74	1.16	0.45
2017	10.4	1.51	4.18	3.06	1.15	0.45

All values in million jobs. Source: IRENA

Table 36 Renewable energy jobs in 2017

	World	Americas	Asia	Europe
Total	10 343	1 888	5 216	1 268
Hydro	1 804	231	728	148
Solar	4 206	303	3 351	140
Bioenergy	3 055	1 181	557	660
Wind	1 148	140	576	344
Geothermal	93	35	4	25

All values in million jobs. Source: IRENA

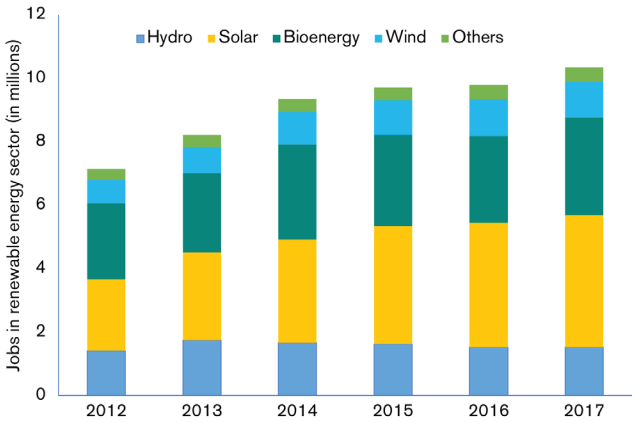

Figure 35 Renewable energy jobs in continents in 2017

APPENDIX

GEOGRAPHICAL INFORMATION

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

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

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

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

Oceania: Australia, New Zealand

GLOSSARY

Advanced biofuels: Advanced biofuels or second generation biofuels are liquid fuels with the conversion technology still in R&D, pilot or demonstration phase. However, in the past few years, commercial plants have started production. They include hydro treated vegetable oil, biofuels from lignocellulose biomass and algae based biofuels.

Agriculture area: Agricultural area, this category is the sum of areas under a) arable land - land under temporary agricultural crops (multiple-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years).

Arable land: Arable land is the land under temporary agricultural crops (multiple-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years).

Biodiesel: Biodiesel is a liquid fuel produced predominantly from vegetable oil or animal fats.

Bioenergy: Bioenergy is energy produced from biomass (including biological origin fraction of municipal waste) and used directly as fuel or processed into liquids or gases.

Bioethanol: Bioethanol is ethanol produced from biomass and/or biodegradable fraction of waste.

Biogas: Biogas is the gas obtained from anaerobic fermentation of biomass in landfills, sewage etc. – comprising primarily of methane and carbon dioxide.

Biomass: Biomass is any organic matter derived from plants, animals or algae.

Combined Heat and Power (CHP): CHP plants are designed to cogenerate heat and electricity from a variety of plants, sizes and technologies.

Derived heat: Derived heat covers the total heat production in heating plants and in combined heat and power plants.

Direct heat: Direct heat from biomass is the heat produced and used from direct combustion of biomass. It excludes the heat production from power plants. It is calculated as:

Biomass for direct heating=Total primary energy supply of Biomass - Biomass use for electricity - Biomass use for biofuels

District heat: District heating is the concept of using surplus heat from power plants for heating residential, public and/or commercial buildings as well as meeting industrial demands for low temperature heat.

Electricity only: Electricity plants refers to plants which are designed to produce electricity only.

Forest area: Forest area is the land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ.

Gross Final Energy Consumption: GFEC (Gross Final Energy Consumption): It is the sum of: Total final energy consumption, Consumption of electricity and heat by the transformation sector, including the energy industry own use, Losses in transmission and distribution of electricity and heat

Heat only: Heat plants, refers to plants (including heat pumps and electric boilers) designed to produce heat only.

Land area: Land area is the total area of the country excluding area under inland water bodies.

Liquid biofuels: Liquid biofuels includes bioethanol, biodiesel and other liquid biofuels.

Municipal wastes: Municipal waste consists of products that are combusted directly to produce heat and/or power and comprises of wastes from household, industry, hospitals and other sources which are collected by local authorities for incineration.

Other land: Other land is the land not classified as Agricultural land and Forest area. It includes built-up and related land, barren land, other wooded land, etc.

Pellets: Wood pellets are mostly produced from sawdust and wood shavings compressed under high pressure. They are cylindrical in shape and usually 6-10 mm in diameter.

Permanent crops: Permanent crops are sown or planted once, and then occupy the land for some years and need not be replanted after each annual harvest, such as cocoa, coffee and rubber.

Permanent meadows and pastures: Permanent meadows and pastures is the land used permanently (five years or more) to grow herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land).

Pyrolysis oil: Pyrolysis Oil is a dark-brown, free- owing liquid made from plant material by a process called fast pyrolysis, whereby biomass particles are rapidly heated to ~500 °C in the absence of oxygen, vapourized, and the vapours then quenched into the Pyrolysis Oil liquid, also known as bio-oil.

Renewable municipal waste: Municipal waste – renewable consists of the biodegradable part of municipal waste products that are combusted directly to produce heat and/or electricity. It comprises waste produced by the residential, commercial and public services sectors that is collected by local authorities for disposal in a central location, including biodegradable hospital waste.

Roundwood: Roundwood comprises all wood obtained from removals, i.e. the quantities removed from forests and from trees outside the forest, including wood recovered from natural, felling and logging losses during the period, calendar year or forest year.

Torrefaction or torrefied biomass: Torrefaction is the thermal treatment of various woody and agricultural residue feedstock in which biomass is heated to 250 – 300 °C and at atmospheric pressures.

Total Primary Energy Supply: TPES (Total Primary Energy Supply): It is the energy content of the energy sources and is calculated as production + imports – exports +/- international bunkers +/- stock changes.

Traditional biomass: Traditional biomass refers to the use of fuel wood, charcoal, animal dung and agricultural residues in stoves with low efficiencies.

Vegetable oils: It includes the production and consumption of coconut oil, cottonseed oil, olive oil, palm oil, palm kernel oil, peanut oil, rapeseed oil, soybean oil and sunflower seed oil.

Vegetal waste: Mainly crop residues (cereal straw from maize, wheat, paddy rice, etc.) and food processing wastes (rice hulls, coconut husks, ground nut shells, etc.) used for fuel. Bagasse is excluded.

Wood charcoal: Wood charcoal is wood carbonised by partial combustion or the application of heat from external sources.

Wood Fuel: Roundwood that will be used as fuel for purposes such as cooking, heating or power production. It includes wood harvested from main stems, branches and other parts of trees (where these are harvested for fuel) and wood that will be used for charcoal production (e.g. in pit kilns and portable ovens). It also includes wood chips to be used for fuel that are made directly (i.e. In the forest) from roundwood. It excludes wood charcoal. It is reported in cubic metres solid volume underbark (i.e. excluding bark).

GENERAL DATA

USEFUL CONVERSIONS

Table A1 Energy units conversion

To:	TJ	Gcal	Mtoe	Mbtu	GWh
From:					
TJ	1	238.8	2.388E-05	947.8	0.2778
Gcal	4.1868E-03	1	1E-06	3.968	1.163E-03
Mtoe	4.1868E+04	1E+08	1	3.97E+07	11 630
Mbtu	1.0551E-03	0.252	2.52E-08	1	2.931E-04
GWh	3.6	860	8.6E-05	3 412	1

(Source: IEA)

Table A2 Average density and energy content values for bioenergy

	Density	Unit	Energy content	Unit
Bioethanol	0.79	kg/l	23.4	MJ/l
Biodiesel	0.88	kg/l	35.2	MJ/l
Adv. Biof.	0.84	kg/l	29.3	MJ/l
Biogas			21.6	MJ/Nm^3
Pellets	600	kg/m3	17.3	MJ/kg
Charcoal			30	GJ/ton

(Source: WBA)

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