

Trabajo Fin de Máster

Estudio detallado del potencial e integración efectiva
de las energías renovables en España
Apéndices

*An in-depth analysis of the renewable energy
potential and its effective integration in Spain
Appendix*

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Appendix I: Renewable Energies

Performance, Comparison 2014 – 2015.

2014

	Electricity renewable generation	
	Production [GWh]	Primary Energy Production [ktoe]
Hydraulic	42.916	3.361
Biomass	3.651	949
SUW	585	122
Wind energy	52.262	4.493
PV	8.198	705
Biogas	727	209
Thermo solar	5.455	2.142
TOTAL ELECTRIC AREA	113.793	11.981

	Cooling and heating sector	
	m2 thermo solar (low T)	Primary Energy production (ktoe)
Biomass and waste		4.005
Biogas		43
Thermo solar	3.345.965	259
Geothermal		18
TOTAL THERMIC AREA		4.325

	Transportation sector
Biofuels (Transportation)	Consumption (ktoe)
TOTAL BIOFUELS	969

RESUME	
Renewable energies total (ktoe)	17.275
Primary energy consumption (ktoe)	118.413
Renewable energies/Primary energy (%)	15

2015

	Electricity renewable generation	
	Production [GWh]	Primary Energy Production [ktoe]
Hydraulic (1)	27.870	2.397
Biomass	3.818	1.716
SUW	883	260
Wind energy	49.335	4.243
PV	8.198	705
Biogas	1.174	390
Thermo solar	5.680	390
TOTAL ELECTRIC AREA	96.958	11.941

	Cooling and heating sector	
	m2 thermo solar (low T)	Primary Energy production (ktoe)
Biomass and waste		3.936
Biogas		51
Thermo solar	3.589.220	277
Geothermal		20
TOTAL THERMIC AREA		4.284

	Transportation sector
Biofuels (Transportation)	Consumption (ktoe)
TOTAL BIOFUELS	1.018

RESUME	
Renewable energies total (ktoe)	17.243
Primary energy consumption (ktoe)	123.866
Renewable energies/Primary energy (%)	14

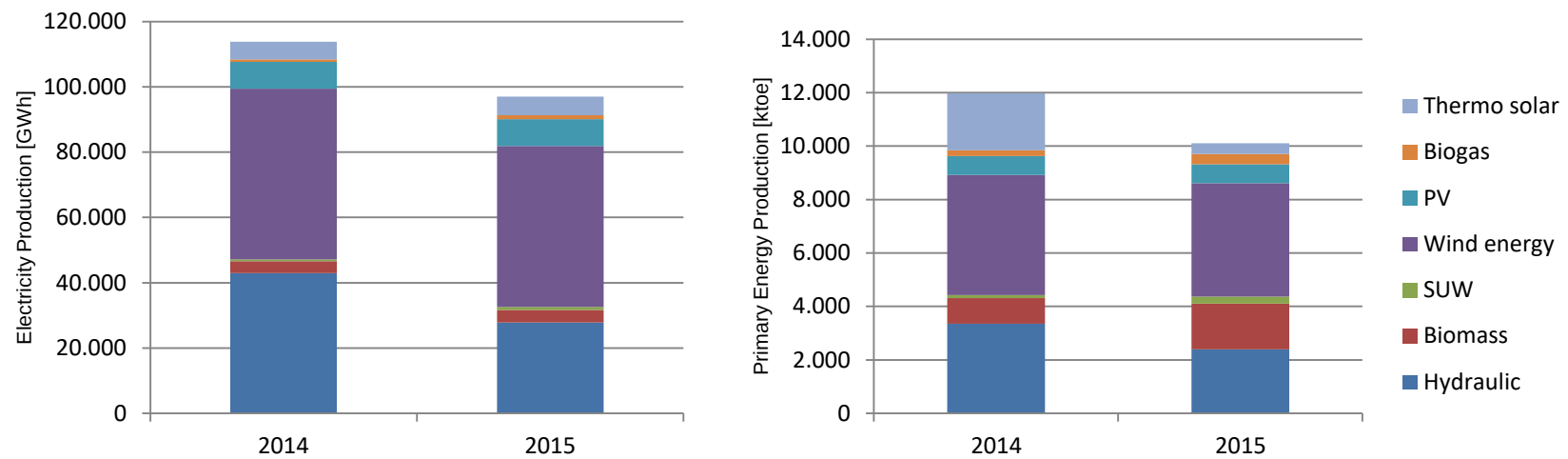


Figure Ap1.1 and Ap1.2. Renewable energy performance in the electricity sector, REE.

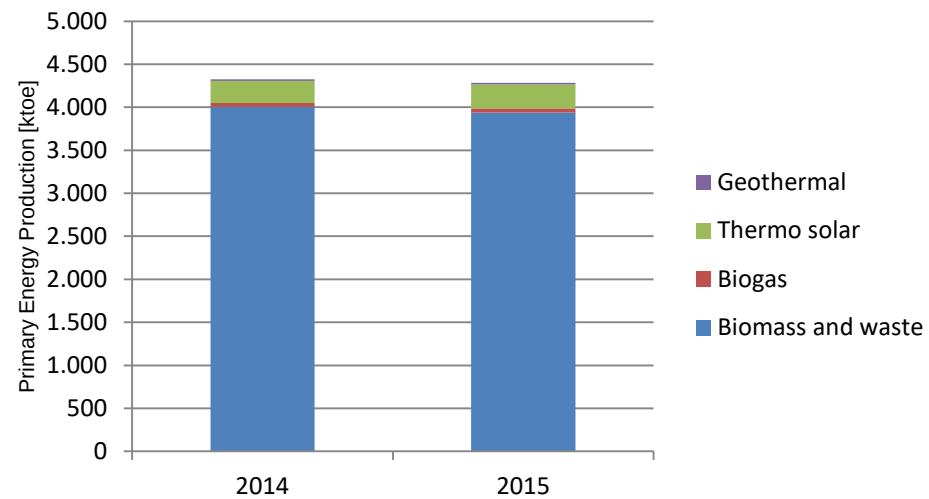


Figure Ap1.1 and Ap1.2. Renewable energy performance in the heating and cooling sector, REE.

Appendix II.Renewable capacity installed: resume

Region	Installed capacity [MW]									Number of District Heating Networks
	Wind Energy	Hydroelectric Energy	PV Energy	Thermosolar Energy	Biomass (Electricity)	Biogas (Electricity)	SUW (Electricity)	Wave Energy	Ocean - thermal	
Andalucía	3.337,7	641,2	870,0	950,0	267,5	21,4	*	*	4,5	3,0
Aragón	1.893,3	1.426,5	167,0	*	150,5	6,1	49,9	*	*	9,0
Asturias	512,5	656,1	1,0	*	78,0	9,3	*	*	*	6,0
Balear Islands	3,7	*	78,0	*	*	2,1	74,8	*	*	1,0
C. Valenciana	1.189,0	2.281,1	349,0	50,0	15,0	10,2	*	*	*	2,0
Canary Islands	165,1	1,2	166,0	*	*	3,7	*	*	*	0,0
Cantabria	38,3	1.416,3	2,0	*	*	2,9	9,9	*	*	3,0
Castilla - La Mancha	3.806,5	493,0	923,0	350,0	29,8	8,4	*	*	*	5,0
Castilla y León	5.560,0	3.312,0	494,0	*	38,3	8,4	*	*	*	42,0
Cataluña	1.267,1	2.429,3	265,0	22,5	4,0	49,8	51,5	*	*	87,0
Ceuta (Autonomous City)	*	*	*	*	*	*	*	*	*	0,0
Extremadura	*	1.946,2	561,0	850,0	36,0	0,0	*	*	*	5,0
Galicia	3.314,1	3.336,5	16,0	*	38,4	11,3	63,8	*	*	13,0
La Rioja	446,6	49,8	86,0	*	*	4,1		*	*	1,0
Madrid	*	60,4	67,0	*	*	42,6	29,8	*	*	12,0
Melilla (Autonomous city)	*	*	*	*	*	*	2,2	*	*	0,0
Murcia	262,0	38,4	440,0	31,4	6,4	5,9	*	*	*	0,0
Navarra	1.003,9	243,7	161,0	*	40,9	8,6	*	*	*	10,0
Basque Country	153,3	160,0	26,0	*	6,6	18,9	23,2	0,3	*	19,0
Total	22.953	18.492	4.672	2.254	711	214	305	0	5	218

* Nule or negligible in respect to the others.
 Own development.

TOP 5						
Wind Energy		PV		Biomass for District Heating		
Region	Capacity [MW]	Region	Capacity [MW]	Region	Capacity [MWt]	Number installed
Castilla y León	5.560,0	Castilla - La Mancha	923,0	Cataluña		89
Castilla - La Mancha	3.806,5	Andalucía	870,0	Castilla y León		42
Andalucía	3.337,7	Extremadura	561,0	Basque Country		19
Galicia	3.314,1	Castilla y León	494,0	Galicia		13
Aragón	1.893,3	Murcia	440,0	Madrid		12

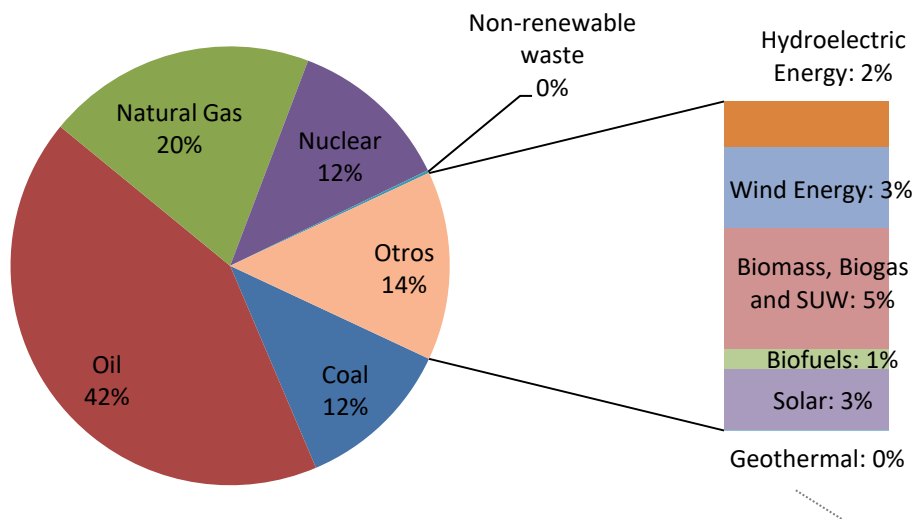
More detailed information can be found on the attached CD room: "Capacity installed.xlsx"
 Sources: [31] - [70]

Appendix III: Consumption primary and final energy 2015

Primary energy

Measured in ktoe	e-15	f-15	m-15	a-15	m-15	j-15	j-15	a-15	s-15	o-15	n-15	d-15	TOTAL
Coal	1.369	859	848	908	886	1.464	1.647	1.455	1.229	1.221	1.265	1.273	14.426
Oil	4.462	4.120	4.407	4.262	4.240	4.407	4.680	4.401	4.358	4.407	4.196	4.495	52.434
Natural Gas	2.673	2.408	2.211	1.822	1.749	1.694	1.964	1.707	1.790	2.007	2.139	2.426	24.590
Nuclear	1.427	1.282	1.414	1.277	967	1.031	1.314	1.360	1.332	1.118	1.082	1.320	14.927
Renewable Energies	1.487	1.603	1.664	1.365	1.658	1.461	1.530	1.405	1.266	1.238	1.329	1.236	17.243
Hydroelectric Energy	212	293	325	218	252	219	178	142	139	139	161	118	2.397
Wind Energy	435	526	429	345	424	253	272	287	264	354	337	317	4.243
Biomass	568	510	506	407	429	412	424	458	417	438	519	564	5.652
Thermal Biomass	370	344	319	255	244	229	224	255	219	236	316	376	3.388
Electric and Cogeneration Biomass	198	166	187	151	185	183	199	203	198	203	203	188	2.264
Biogas	37	33	36	36	37	39	38	37	36	38	36	38	441
Thermal Biogas	2	2	2	2	2	2	2	2	2	2	2	2	23
Electric and Cogeneration Biogas	35	31	34	34	35	37	36	36	34	36	35	36	418
SUW	21	19	22	14	20	24	24	22	23	24	24	23	260
Biofuels	76	78	81	84	85	88	91	89	88	89	85	86	1.018
Geothermal Energy	2	2	2	2	1	1	2	1	1	2	2	2	20
Solar Energy	136	142	264	260	410	426	502	368	298	154	165	87	3.213
PV	44	42	61	64	78	75	79	71	62	48	46	34	705
Thermoelectric	78	84	182	172	303	320	387	265	211	86	103	39	2.231
Thermo	14	16	21	24	28	31	35	32	25	21	16	14	277
Non-renewable waste	21	18	20	17	21	22	24	23	22	23	24	24	260
PRIMARY ENERGY CONSUMPTION 2015	11.417	10.242	10.530	9.627	9.537	10.079	11.143	10.329	9.984	10.054	10.074	10.851	123.867

Sources: MINETUR, CORES, ENAGAS, REE, CNMC.



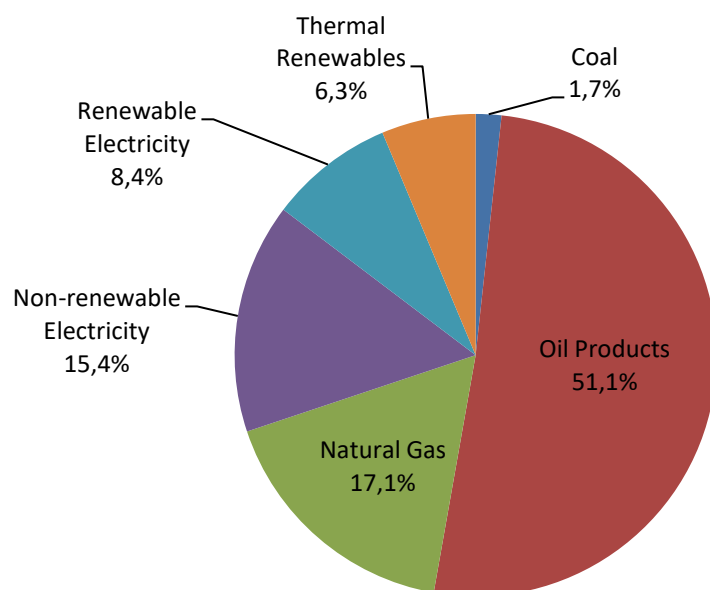
Energy source	ktoe
Coal	14.426
Oil	52.434
Natural Gas	24.590
Nuclear	14.927
Non-renewable waste	260
Hydroelectric Energy	2.397
Wind Energy	4.243
Biomass, Biogas and SUW	6.353
Biofuels	1.018
Solar	3.213
Geothermal	20
TOTAL	123.867

Fuentes: MINETUR, CORES, ENAGAS, REE, CNMC, y elaboración propia.

Final energy consumption

Measure Unit: ktoe	e-15	f-15	m-15	a-15	m-15	j-15	j-15	a-15	s-15	o-15	n-15	d-15	TOTAL
Coal	124	120	129	124	118	113	122	110	122	114	117	130	1.443
Oil Products	3.672	3.480	3.649	3.426	3.446	3.554	3.748	3.569	3.622	3.604	3.495	3.616	42.879
Natural Gas	1.732	1.615	1.422	1.067	996	905	908	843	957	1.125	1.298	1.475	14.344
Electricity	1.816	1.678	1.694	1.512	1.602	1.649	1.902	1.705	1.593	1.605	1.586	1.658	19.999
Renewable Energies	520	489	479	400	407	394	405	435	387	400	467	518	5.302
Biomass	424	390	370	287	289	270	273	308	268	284	359	412	3.936
Biogas	4	4	4	4	4	4	4	4	4	4	5	4	51
Biofuels	76	78	81	84	85	88	91	89	88	89	85	86	1.018
Thermosolar Energy	14	16	21	24	28	31	35	32	25	21	16	14	277
Geothermal Energy	2	2	2	2	1	1	2	1	1	2	2	2	20
FINAL ENERGY CONSUMPTION 2015	7.866	7.381	7.373	6.528	6.569	6.615	7.085	6.662	6.680	6.848	6.963	7.396	83.967

(1) Non-energetic usages included
Sources: MINETUR, CORES, ENAGAS, REE, CNMC.



Energy resource	ktoe
Coal	1.443
Oil Products	42.879
Natural Gas	14.344
Non-renewable Electricity	12.967
Renewable Electricity	7.031
Thermal Renewables	5.302
Biomass and Biogas	3.987
Biofuels	1.018
Thermo Solar Energy	277
Geothermal Energy	20
TOTAL	83.967

Sources: MINETUR, CORES, ENAGAS, REE, CNMC.

Final energy consumption comparison 2014/2015

	2014		2015		2015/2014
	[ktoe]	Structure [%]	[ktoe]	Structure [%]	Variation [%]
COAL	1.367	2	1.400	2	2,4
OIL PRODUCTS	38.642	47	39.511	47	2,2
GAS	14.293	17	13.896	17	-2,8
ELECTRICITY	19.513	24	19.999	24	2,5
ENERGÍAS RENOVABLES	5.109	6	5.301	6	3,8
Biomass	3.762	5	3.936	5	4,6
Thermal Biomass	3.362	4	3.388	4	0,8
Useful heat from	400	1	548	1	37,1
Cogeneration					
Biogas	101	0	51	0	-49,9
Thermal Biomass	23	0	23	0	0
Useful hear from	78	0	28	0	-64,6
Cogeneration					
Biofuels	969	1	1.018	1	5
Thermo Solar Energy	259	0	277	0	7,2
Geothermal Energy	19	0	20	0	4,9
FINAL ENERGETIC CONSUMPTION	78.925	95,1	80.107	95,4	1,5
Non Energetic usages					
Coal	0	0	43	0	
Oil Products	3.622	4	3.368	4	-7
Gas	485	1	448	1	-7,5
NON ENERGETIC CONSUMPTION TOTAL	4.107	5,3	3.859	5,3	-6
TOTAL	83.031	100	83.966	100	1,1

Source: IDAE, provisional data at June 2016.

fhgdhg

Appendix IV: Energetic products by sector

Industry sector

	COAL				OIL PRODUCTS					GASES	RENEWABLE ENERGIES						
Area	Hard coal, Anthracite and Aggregates	Coke	Coke oven and Blast furnace gases	Coal Tar	LPG	Gasoil	Gasoline	Fueloil	Petroleum Coke	Natural Gas	Thermal Solar Energy	Geothermal Energy	Biomass	Biogas	Biofuels		Electric Energy
Measure Unit:	kt	kt	kt	kt	kt	MI	MI	MI	MI	GWh	GWh	GWh	kt	GWh	kt	kt	GWh
Extractive (non energetic ones)	0	0	0	0	1	177	0	7	0	1.683	0	0	0	0	2	0	1.519
Feed, Beverage and Tobacco	5	21	0	0	30	194	0	97	0	8.889	10	1	659	328	2	0	10.903
Textile, Leather and Shoes	0	0	0	0	4	17	0	4	0	1.772	1	0	8	0	0	0	1.671
Paste, Paper and Printing	0	0	0	0	16	46	0	29	0	10.456	0	0	880	173	0	0	5.821
Chemicals	0	12	0	0	2	43	0	78	0	33.521	2	0	15	0	0	0	9.155
Non-ferrous Minerals	14	0	0	0	33	118	0	18	1.398	15.902	1	0	479	36	0	0	5.608
Steelmaking and Casting	932	482	519	0	15	20	0	59	0	5.383	0	0	0	0	0	0	12.310
Non-ferrous Metallurgy	0	31	0	0	6	12	0	35	0	1.363	3	0	0	17	0	0	9.362
Metal Processing	0	0	0	0	7	67	0	90	5	2.984	4	0	1	0	0	0	4.799
Transportation Equipment	0	0	0	0	7	26	0	0	0	1.532	2	0	0	0	0	0	3.468
Construction	0	0	0	0	6	214	0	18	0	9.729	0	0	42	0	4	0	2.390
Rest	0	0	0	0	1	48	1	12	0	8.517	2	0	1.108	27	0	0	4.651
Wood, Cork and Forniture	0	0	0	0	1	13	0	8	0	406	0	0	937	0	0	0	1.089
Others	0	0	0	0	0	35	1	4	0	8.111	2	0	172	27	0	0	3.562
TOTAL CONSUMPTION	951	545	519	0	128	982	1	447	1.403	101.731	27	1	3.193	581	8	0	71.657

Source: MINETUR / IDAE

Note: Non energetic usages excluded

Transportation sector

	OIL PRODUCTS					GASES	RENEWABLE ENERGIES		ELECTRICITY
Mean of Transport	LPG	Gasoline	Querosene	Gasoil	Fueloil	Natural Gas	Biodiesel	Bioetanol	Electric Energy
Measure Unit:	kt	MI	MI	MI	kt	GWh	kt	kt	GWh
Roads	35	5.675	0	21.959	0	593	855	291	--
Railways	0	0	0	87	0	--	--	--	2.082
Maritime	0	0	0	266	87	--	--	--	--
Air	0	4	6.425	0	0	--	--	--	--
Oil Pipelines	0	0	0	0	0	0	--	--	0
Other non especificed	0	3	0	197	0	389	8	0	2.077
TOTAL CONSUMPTION	35	5681	6425	22509	87	982	863	291	4159

Source: MINETUR / IDAE

Note: Non energetic usages excluded

Tertiary sector

	COAL	OIL PRODUCTS					GASES	RENEWABLE ENERGIES						ELECTRICITY
Area	Coals	LPG	Gasoline	Gasoil	Fueloil	Petroleum Coke	Natural Gas	Thermo Solar Energy	Geothermal Energy	Biomass (1)	Biogas (2)	Biofuels (3)		Electric Energy
												Biodiesel	Bioetanol	
Measure Unit:	kt	kt	MI	MI	kt	kt	GWh	GWh	GWh	kt	GWh	kt	kt	GWh
Offices	0	40	5	382	15	0	3.605	135	3					23.811
Hospitals	0	11	1	101	4	0	1.639	48	3					4.100
Commercial	0	30	4	285	11	0	7.980	15	1					24.024
Restaurants and Accomodations	0	9	1	86	3	0	881	174	5					5.932
Education	0	17	2	166	6	0	1.105	52	3					3.724
Other Services	0	11	1	100	4	0	1.641	173	28					8.719
TOTAL CONSUMPTION	0	118	15	1120	43	0	16851	598	44	219	131	2	1	70309

Source: MINETUR/IDAE.

Note: Non energetic usages excluded

^{(1) (2)} Final consumptions of biomass and biogas does not include the useful heat produced by cogeneration in the tertiary sector.

⁽³⁾ There is registration of biofuels in tertiary sector, but there is no breakdown by types.

Household sector

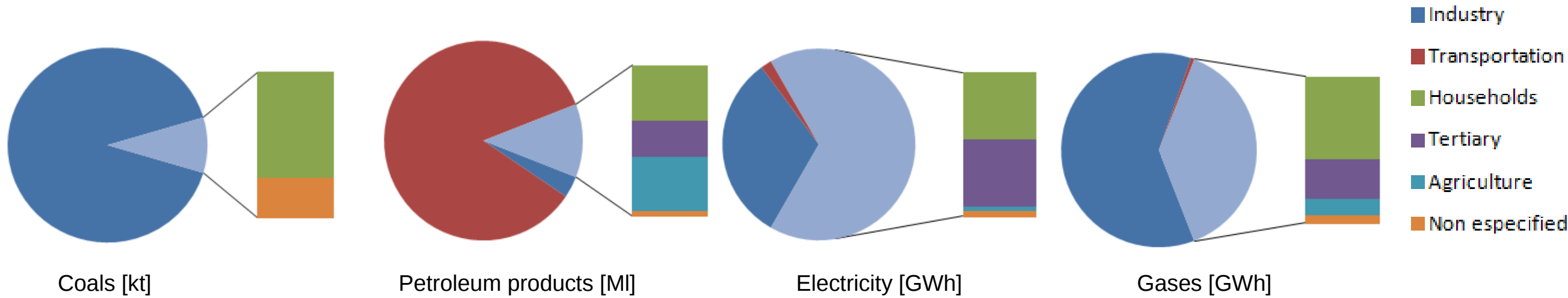
	COAL	OIL PRODUCTS		GASES	RENEWABLE ENERGIES					ELECTRICITY
Type of Usage	Coals	LPG	Gasoil	Natural Gas	Biomass	Solar Energy	Geothermal Energy	Biofuels		Electric Energy
								Biodiesel	Bioetanol	
Measure Unit	kt	kt	MI	GWh	kt	GWh	GWh	kt	kt	GWh
Heating	120	365	1.611	16.653	7.271	--	62	--	--	5.208
Hot water for sanitary uses	9	431	145	15.384	154	2.188	35	--	--	5.281
Kitchen	18	173	--	3.919	79	--	--	--	--	6.569
Lighting	--	--	--	--	--	--	--	--	--	8.305
Air-Conditioned	--	--	--	--	--	--	0	--	--	1.651
Household Appliances	--	--	--	--	--	--	--	--	--	43.698
Other Uses	--	--	--	--	--	--	--	1	0	--
TOTAL CONSUMPTION	147	970	1756	35956	7504	2188	98	1	0	70710

Source: MINETUR/IDAE.

Note: Non energetic usages excluded

1) Consumption by Uses has been modeled based on the SECH –SPAHOUSEC I Research and on MESH: Households consumption Statistics. The data are referred to households' consumption, in both primary and secondary ones.

Graphic representation: Distribution within the sectors



Households: Renewable energies achieve greater share.

SECTOR	Thermal Solar Energy	Geothermal Energy	Biomass	Biogas	Biofuels	
					Biodiesel	Bioetanol
Measure Unit	[GWh]	[GWh]	[kt]	[GWh]	[kt]	[kt]
Industry	27	1	3.193	581	8	0
Transportation	1	0	0	0	863	291
Diverse Usages	2.978	218	7.928	593	4	3
Households	2.363	124	7.502	0	1	0
Tertiary	598	44	219	131	2	1
Agriculture	17	51	193	89	1	2
Non especificed	0	0	13	372	0	0
TOTAL CONSUMPTION	3.006	219	11.121	1.174	875	294

Renewable sources within the different sectors, IDAE.

Appendix V: Potential Analysis

Wind Potential: On-shore and off-shore

ON-SHORE potential

(80 meters above sea level)

Region	Vavg > 6 [m/s]		Power density > 250 [W/m2]	
	[km2]	[%]	[km2]	[%]
Andalucía	20.981	24	24.332	28
Aragón	14.614	31	14.278	30
Asturias	2.436	23	4.208	40
Balearic Islands	1.423	28	1.519	30
Canary Islands	2.854	52	2.363	43
Cantabria	1.513	28	2.136	40
Castilla y León	16.907	18	12.536	13
Castilla - La Mancha	16.640	21	11.547	15
Cataluña	6.676	21	7.019	22
C. Valenciana	3.171	14	4.902	21
Extremadura	6.981	17	4.611	11
Galicia	14.199	48	16.498	56
Madrid	319	4	367	5
Murcia	1.361	12	1.378	12
Navarra	4.947	48	4.016	39
Basque Country	1.432	20	1.507	21
La Rioja	1.129	22	1.099	22
Ceuta *	19	100	99	100
Melilla *	9	63	14	99

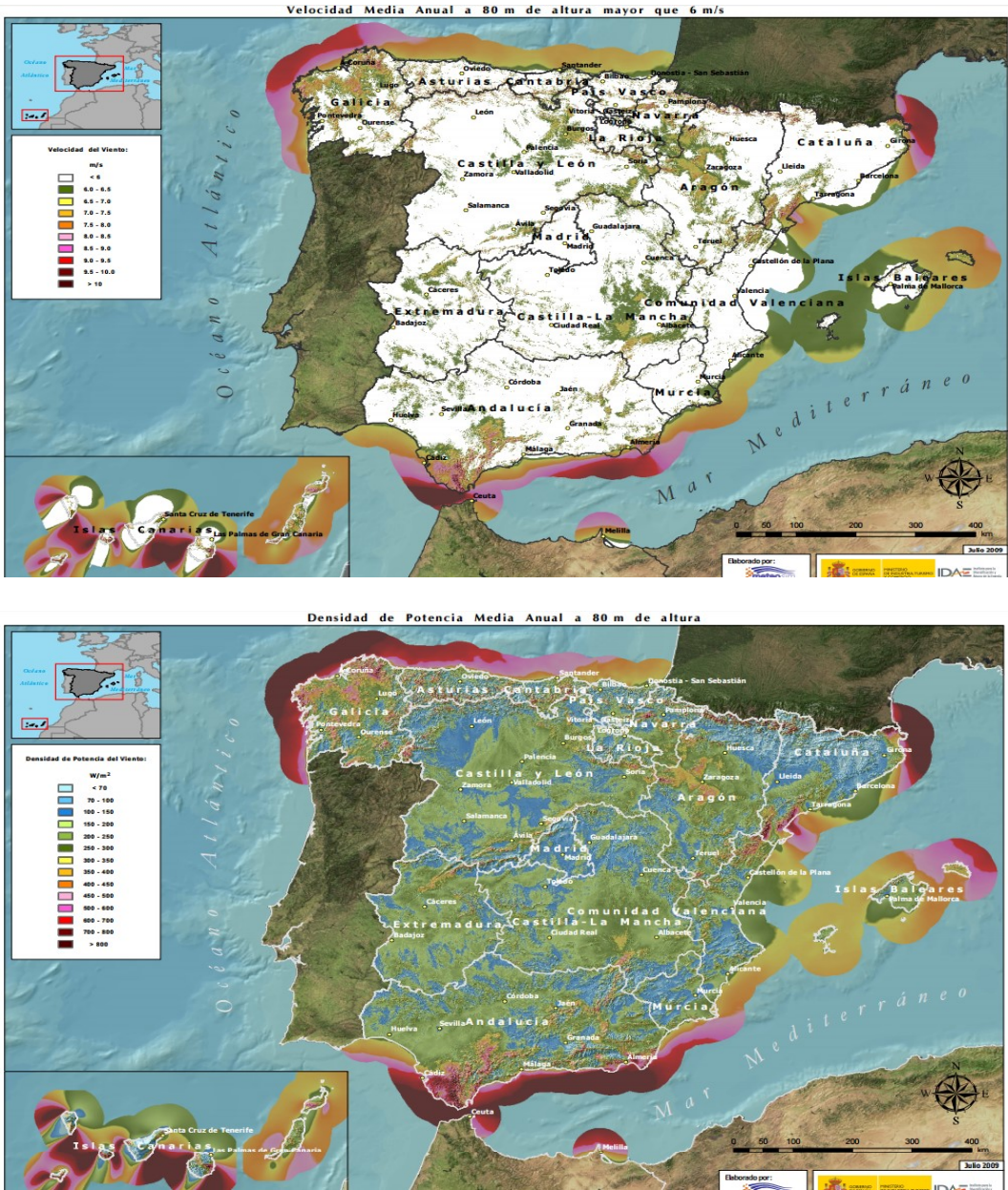
* Autonomous city

OFF-SHORE potential

Zoning	Available surface [km2]
Suitable	31
Conditionings	1.381
Exclusion	2.116

Distribution according Vavg, at 80m high		
Speed [m/s]	[km2]	[%]
<4,0	19	0
4,0-4,5	28	0
4,5-5	188	3
5-5,5	808	12
5,5-6	1.024	15
6-6,5	1.071	16
6,5-7	1.232	19
7-7,5	841	13
7,5-8	583	9
8-8,5	303	5
8,5-9	176	3
9-9,5	168	3
9,5-10	130	2
>10	53	1
TOTAL	6623	100
>7,5	1412	21,32

Wind speed and air power density at 80 meters above sea level



Final off-shore suitable zoning

Cantabrico littoral



Mediterranean littoral



Canary Islands



TOP 5 Regions regarding Wind Speed

Vavg > 6m/s (80mas) [km2 basis]			Vavg > 6m/s (80mas) [% basis]		
Region	km2	(%)	Region	km2	(%)
Andalucía	20.981	24	Canary Islands	2.854	52
Castilla y León	16.907	18	Galicia	14.199	48
Castilla - La Mancha	16.640	21	Navarra	4.947	48
Aragón	14.614	31	Aragón	14.614	31
Galicia	14.199	48	Cantabria	1.513	28

Appendix V. Solar energy potential

Hours of sun - Whole country

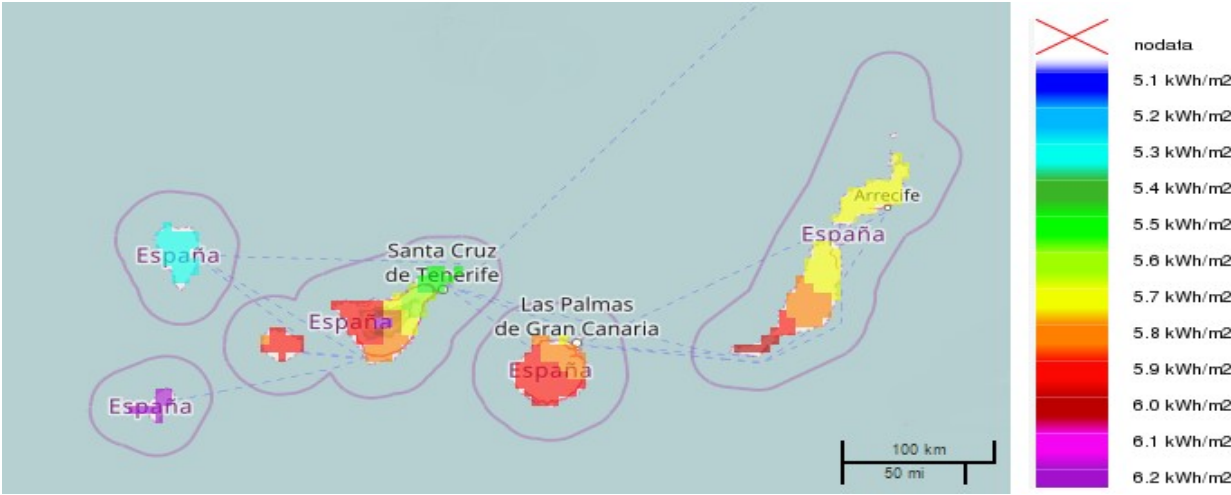
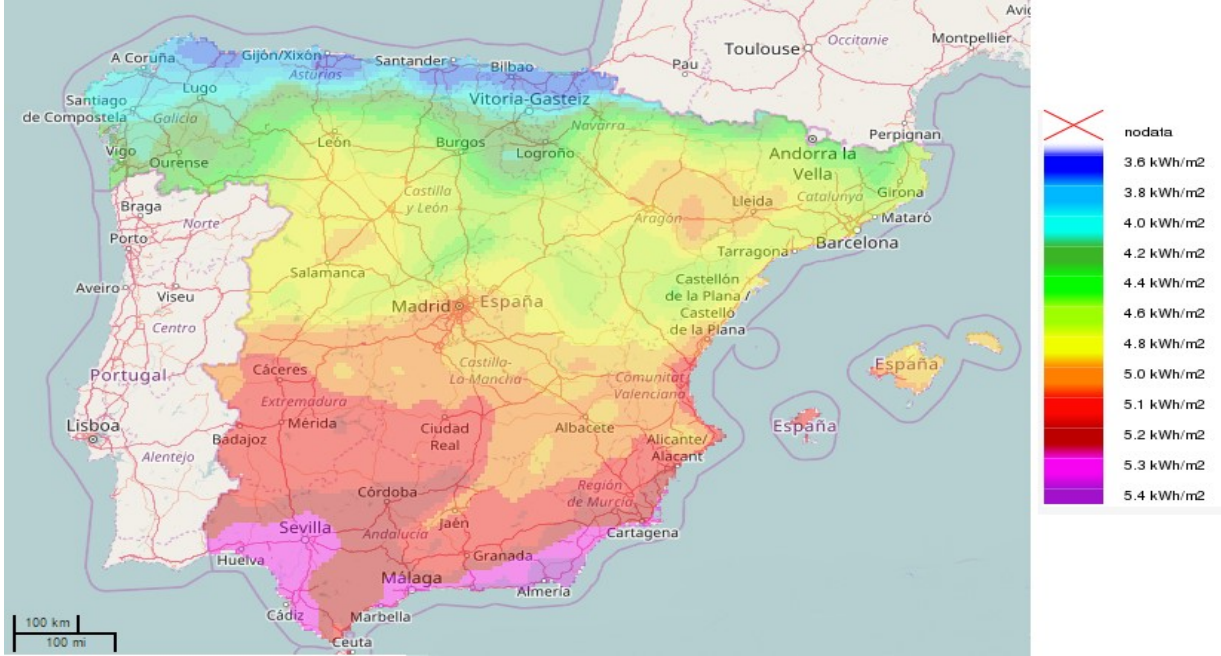
	Total winter sun hours	Average hours/day	WINTER AVG [kWh/month]	Total sun hours	Average hours/day	SUMMER AVG [kWh/month]
Andalucía	7.649	6,1	1.272,7	12.694	10,1	2.159
Aragón	2.820	5,2	473,3	5.148	9,5	859
Asturias	595	5,3	99,1	1.042	5,8	174
Balearic Islands	1.032	5,7	171,9	1.763	9,7	294
Canary Islands	2.196	6,2	369,2	3.019	8,3	503
Cantabria	631	3,5	105,1	1.116	6,2	186
Castilla y León	7.710	4,7	1.409,3	15.415	9,5	2.567
Castilla - La Mancha	5.593	5,2	786,3	10.076	9,7	1.493,7
Cataluña	3.833	5,3	638,5	6.328	8,8	1.029,0
C. Valenciana	3.237	6,0	539,2	5.113	9,5	832
Extremadura	1.034	5,7	172,3	1.906	10,6	318
Galicia	2.067	3,8	344,3	3.741	7,6	659
Madrid	1.012	5,6	170,3	1.812	10,1	302
Murcia	1.114	6,2	184,6	1.814	10,1	302
Navarra	660	3,7	109,9	1.401	7,8	233
Basque Country	1.859	3,4	305,8	3.402	6,3	567
La Rioja	763	4,3	127,1	1.447	8,0	277

Top 5 regions - Winter and summer

	Average hours/day	Winter avg [kWh/month]
Castilla y León	4,7	1.409,3
Andalucía	6,1	1.272,7
Castilla - La Mancha	5,2	786,3
Cataluña	5,3	638,5
C. Valenciana	6,0	539,2

	Average hours/day	Summer avg [kWh/month]
Castilla y León	9,5	2.567,2
Andalucía	10,1	2.158,6
Castilla - La Mancha	9,7	1.493,7
Cataluña	8,8	1.029,0
Aragón	9,5	859,2

Thermal annual maps [KwH/m²]



Sources: [58], [80], [81].

Appendix V. Biomass potential

Available biomass potential according to sources (t/year)										
Region	Existing forestal masses			Forestal masses subjected to implementation in forestal lands	Agricultural waste			Herbaceous masses subjected to implementation in agricultural lands	Woods masses subjected to implementation in agricultural lands	TOTAL (t/year)
	Wood waste	Full tree	Total		Herbaceous	Woods	Total			
Andalucía	209.375	1.649.219	1.858.594	1.231.669	2.518.996	4.957.623	7.476.619	2.961.107	1.127.133	14.655.122
Aragón	56.161	740.121	796.282	85.865	1.257.356	1.419.104	2.676.460	1.881.502	814.641	6.254.750
Asturias	280.944	829.081	1.110.025	1.384.360	0	378.173	378.173	0	0	2.872.558
Cantabria	181.728	505.452	687.180	472.133	41.213	6.518	47.731	4.891	6.194	1.218.129
Castilla -LM	74.165	1.313.048	1.387.213	203.519	2.060.321	1.073.376	3.133.697	3.831.473	1.233.273	9.789.175
Castilla y León	123.428	2.300.723	2.424.151	1.496.793	4.167.623	230.759	4.398.382	5.614.995	1.327.990	15.262.311
Cataluña	171.078	1.220.223	1.391.301	143.838	1.045.020	2.210.580	3.255.600	758.939	532.713	6.082.391
C Valenciana	38.809	234.648	273.457	104.654	52.487	2.223.407	2.275.894	77.440	71.104	2.802.549
Extremadura	91.283	1.451.860	1.543.143	1.433.327	898.837	982.766	1.881.603	1.075.765	880.174	6.814.012
Galicia	1.307.072	3.427.870	4.734.942	7.931.615	992.906	550.870	1.543.776	8.169	149.132	14.367.634
Balearic Islands	9.126	51.551	60.677	8.025	113.942	405.250	519.192	294.303	47.555	929.752
Canary Islands	1.182	24.498	25.680	8.863	310	179.767	180.077	485	397	215.502
La Rioja	7.516	112.853	120.369	17.315	229.865	217.358	447.223	146.657	48.874	780.438
Madrid	7.205	167.611	174.816	81.644	137.583	62.472	200.055	233.813	91.735	782.063
Murcia	14.137	63.819	77.956	4.407	56.376	1.028.553	1.084.929	142.168	52.882	1.362.342
Navarra	41.565	804.471	846.036	189.129	641.182	126.822	768.004	570.252	186.539	2.559.960
Basque Country	369.469	834.068	1.203.537	275.165	220.548	64.823	285.371	135.909	28.524	1.928.506
TOTAL	2.984.243	15.731.116	18.715.359	15.072.321	14.434.565	16.118.221	30.552.786	17.737.868	6.598.860	88.677.194

* humidity of 45%

Region	t/year
Castilla y León	15.262.311
Andalucía	14.655.122
Galicia	14.367.634
Castilla - La Mancha	9.789.175
Extremadura	6.814.012

Available potential biomass [t/year] and average costs				
Source		Biomass [t/year]	Biomass [toe/year]	Average costs [€/t]
Existing forestal masses	Waste of wood treatment plants	29.854.243	636.273	26,59
	Utilization of the whole tree	15.731.116	3.414.158	43,16
Agricultural waste	Herbaceous	14.434.566	6.392.631	20,97
	Woods	16.118.220		
Herbaceous masses subjected to		17.737.868	3.593.148	53,39
Wood masses subjected to		6.598.861	1.468	36,26
Wood masses subjected to		15.072.320	1.782.467	42,14
TOTAL SPANISH BIOMASS POTENTIAL		88.677.193	17.286.851	

Appendix VI: Regional subsidies

Apart from the national RES regulations, within the different “Comunidades Autónomas” (or different regions) different support schemes can be found. All of this subsidies policies are made according to the basic principles approved in the Law 38/2003, of 17th of November, “Ley General de Subvenciones y su Reglamento”, approved subsequently by the Real Decreto 887/2006.

Aragón

1. Ayudas en material de ahorro y diversificación energética, uso racional de la energía y aprovechamiento de los recursos autóctonos y renovables, e infraestructuras eléctricas y gasistas (BOA, Order 12th March 2015).

The subsidy amount of this call is 2.320.000 €, in accordance with:

Beneficiaries	Eligible measures	Amount (€)
Private companies and autonomous workers	Biomass, geothermal, PV and wind energy	1.420.000
Local corporations	Biomass, geothermal, PV and wind energy	620.000
Non-profit institutions, owner's community and individuals	Biomass $\geq$ 35kW and geothermal energy	120.000
Non-profit institutions, owner's community and individuals	Biomass $<$ 35kW and geothermal energy	160.000

According to the available budget, the individualized amount to grant is as follows:

- When the beneficiary is a non-profit institution, owner's community or individual: until a maximum of 30% of the remunerable cost of the inversion.
- When the beneficiary is a private company or autonomous worker: until a maximum of 40% of the remunerable cost of the inversion.
- When the beneficiary is a local corporation: until a maximum of 50% of the remunerable cost of the inversion.

Asturias

1. Convocatoria de subvenciones en régimen de concurrencia competitiva, para el uso de las energías renovables, y para las acciones de ahorro y eficiencia energética, para empresas privadas.

The subsidy amount of this call is 1.065.000 €, to be divided in Renewable Energies and Energy efficiency:

Renewable Energy	Distribution	Amount (€)
Biomass	81.8%	191.700
Isolated PV	4.6%	10.650
Geothermal	9%	21.300
Mini hydro & wind	4.6%	10.650

The beneficiaries can be private companies which promote the renewable usage and the energy efficiency but the ones which a partial or total placement is meant to be used as households.

Balearic Islands

1. Ayudas para el fomento de las instalaciones de energía solar fotovoltaica y de energía eólica para autoconsumo.

No further info.

Canary Islands

1. Ayudas a instalaciones de energías renovables (BOC, Feb 2015).

The subsidy amount of this call is 2.320.000 €, in accordance with the following distribution:

- Thermal biomass up to 250.000€.
- Thermosolar energy for biomass treatment up to 950.000€.
- Equipments for biomass treatment up to 120.000€.
- Isolated PV up to 200.000€.
- Isolated wind energy up to 80.000€.
- Small facilities for biogas collection and usage up to 100.000€.
- Geothermal energy up to 350.000€.
- Aerothermal energy up to 150.000€.
- Other facilities up to 200.000€.

In case of the given amount to a type activity is highly overweighed; it will be assigned to the following in order of prevalence.

Cantabria

1. Actuaciones de energías renovables y ahorro y eficiencia energética en Cantabria (BOC – Cantabria, Aug. 2016)

The subsidy amount of this call is 1.750.000 €, divided by:

- Legal persons and private companies up to 1.000.000€.
- Non-profit individuals up to 500.000€.

The remunerable investments that are taken into account are:

A. Low temperature thermosolar energy. Thermosolar systems for fluid heating up by solar capturing, with global losses coefficient up to 9W/(m² °C), for following thermal applications.

It will take as reference cost, in relation to the energetic objectives, a maximum investment of:

Category	Reference Costs	
Thermosolar energy systems	Up to 14kW (20m ²):	1.714 €/kWh (1.200€/m ²)
	More than 14kW (20m ²):	1.429 €/kWh (1.000€/m ²)
Visualization systems of produced energy	Up to 14kW (20m ²):	800€
	More than 14kW (20m ²):	1.200€
Telemonitoring systems	Between 14 kW (20m ²) and 70 kW (100m ²):	2.500€
	More than 70 kW (100m ²):	3.000€

B. PV, with up to 10kWp.

It is taken as reference cost, a maximum investment of:

- 6,00€/Wp in installations with accumulation.
- 3,00€/Wp for installations without accumulation.
- 400€ for the measurement equipment.

C. Mini Wind Energy, up to 10 kWp.

It is taken as reference cost, a maximum investment of:

- 6,00€/Wp in wind turbines with accumulation.
- 3,00€/Wp for wind turbines without accumulation.
- 400€ for the measurement equipment.

D. Thermal Biomass. It is thermal energy production for households, industry or fuel for buildings. In where, there are established three kinds of actuations:

- D.1. Facilities that have automatic boilers with a minimum performance of 85% maintaining at both nominal and 30% partial load and which also have a tank of exclusive use for the storage of biofuel of at least 1 m³ of capacity.
- Facilities with automatic boilers for low temperature (condensation) installations with a minimum of 95% performance maintained at both nominal and 30% partial loads and which also have a storage tank for biofuel storage of at least 1 m³ capacity.
- Facilities that have non-automatic boilers with a minimum performance of 75% at rated load, and which also have a place of exclusive use for storing biofuel.

It is taken as reference cost, a maximum investment of:

Actuation	Reference costs	
D.1	Up to 20kW (incl.)	600€/kW
	From 20kW to 50kW (incl.)	500€/kW
	From 50kW to 500kW (incl.)	400€/kW
	More than 500kW	300€/kW
D.2	Up to 20kW (incl.)	700€/kW
	More than 20kW	550€/kW
D.3		300€/kW
Measurement system	800€	

E. Geothermal energy. Systems based on geothermic exchange for thermal energy production.

It is taken as reference cost, a maximum investment of:

- 1.400€ por kW of the installed heat pump, for close circuit and vertical exchange.
- 1.100€ por kW of the installed heat pump, for close circuit and horizontal underground exchange.
- 400€ for measurement system of produced electric energy and 800€ for measurement system of thermal energy produced.

Gross of the remuneration.

The amount of the subsidy will be equal to 40% of the eligible cost of the investments executed.

Castilla – La Mancha

1. Aprovechamiento de energías renovables (Order 29/12/2015 Diario Oficial de Castilla – La Mancha).

This order affects:

- Thermal biomass.
- PV or mix Wind-PV, with and without accumulation.
- Geothermal.

Beneficiaries could be:

- Thermal biomass: individuals, owner's communities and municipalities.
- PV and mix PV-Wind: SMEs of private nature, municipalities of Castilla-La Mancha, individuals and owner's communities.
- Geothermal: individuals and owner's community.

From the total amount of available budget (973.150€), there can be found a division as follows:

Tech	Beneficiaries	Disaggregate amount [€]	Total amount [€]
Thermal Biomass	Town halls	100.000	350.000
	Individuals and owner's communities	250.000	
PV or mix PV-Wind	Town halls	82.000	473.150
	SMEs	291.150	
	Individuals and owner's communities	100.000	
Geothermal energy	Individuals and owner's communities	150.000	150.000
TOTAL			973.150

The remunerable investments that are taken into account as reference are:

- A) Thermal biomass installations. A maximum investment per unit of installed thermal power shall be taken as the reference cost:
 - o 200€/kW for installations with boiler.
 - o 100€/kW for installations with stoves or similar products.
- B) PV or mixed PV-Wind facilities. A maximum investment per unit of installed electrical power shall be taken as the reference cost:
 - o 5€/Wp for PV and 2€/W for Wind turbines, with accumulation.
 - o 3€/Wp for PV and 2€/W for Wind turbines, without accumulation.
- C) Geothermal facilities. It is considered as reference cost, the following maximum investments per unit of power with geothermal origin:
 - o 300 €/kW, for open circuit installations.
 - o 500 €/kW, for installations in closed circuit with interchanged interchange in horizontal.
 - o 900€/kW, for installations in closed circuit with vertical exchange with probes.
 - o 900 € / kW, for geothermal district networks.

Galicia

1. Subvenciones para el año 2016 a proyectos de energías renovables (Dec. 2015).

This resolution is made in order to regulate the granting of subsidies directed to the actions and renewable energy projects that use geothermal energy, aerothermal or solar thermal, which comply with the requirements and conditions set out in its articles and annexes.

The minimum investment for which the performance is expected to be eligible for 3,000€.

Beneficiaries

- Local authorities.
- Autonomic public sector.
- Individuals and non-profit institutions.
- SMEs, their groups and associations.

The maximum amount of aid will be calculated depending on the installed power (except for the case of solar panels with vacuum tube that will be by surface) and the type of installation, with the limits established in the Regulatory bases:

The aid intensity depending on the beneficiary will be:

- 40% for medium enterprises, with an increase of 10% for small businesses.
- 50% for individuals and non-profit institutions.
- 75% for public authorities.

The maximum amount of aid per project will be 50.000€ in the case of geothermal energy and 20.000€ in aerothermal and solar thermal.

The total amount of aid set for de minimis aid granted to a single company, a maximum of 3 years, is set at 200.000 €, except possibly for companies in the agricultural sector which is set in 15.000€ and for companies which transport goods by road is set to 100.000€.

2. Subvenciones para el año 2016 a proyectos de biomasa para empresas, autónomos, entidades sin ánimo de lucro y administración local y autonómica (Dec. 2015)..

The maximum amount of aid will be calculated depending on the installed power and type of facility, and will it have the following intensities per beneficiary:

Type Beneficiary - maximum intensity of aid

- Local authorities: 75%
- Autonomous public sector: 75%
- Non-profit entities (but not on economic activity): 50%
- Companies, their groups and associations, as well as non-profit entities undertaking economic activity. In the case of small business loans increased by 20 percentage points and in the case of medium enterprises by 10 percentage points: 45%

The maximum amount of aid per project will be 200.000€ and 1.000.000€ of the applicant.

Navarra

1. Subvenciones a entidades locales y entidades sin ánimo de lucro por inversiones en instalaciones de energías renovables.

2. Subvenciones a entidades locales que realicen inversiones en instalaciones térmicas que utilicen como combustible biomasa.

País Vasco

1. Ayudas biomasa 2016.

The grant reaches 700.000€, according to EVE, Ente Vasco de la Energía.

2. Producción Eléctrica con Energías Renovables 2016.

3. Geotermia 2016.

Appendix VII. Electricity generation by fuels

Source: IDAE.

NATIONAL ELECTRICITY PRODUCTION 2015 by fuels [GWh]			
	2014	2015	2015/2014
Hydroelectric Energy	35.855	23.993	-33,1%
Thermal Energy	136.474	151.837	11,3%
Nuclear Energy	57.305	57.277	0,0%
Anthracite	4.393	6.332	44,1%
Black Lignite	2.924	3.547	21,3%
Hard Coal	35.831	42.488	18,6%
Gas from syderurgy	1.347	1.381	2,5%
Natural Gas	23.309	27.966	20,0%
Oil Products	11.365	12.847	13,0%

Hydroelectric Energy	7.115	7.164	0,7%
Wind Energy	52.013	49.335	-5,1%
PV	8.218	8.198	-0,2%
Thermo Solar Energy	5.455	5.680	4,1%
Coal	635	563	-11,3%
Gas from Syderurgy	164	277	68,9%
Natural Gas	23.964	23.339	-2,6%
Oil Products	2.756	2.445	-11,3%
Biomass	3.821	3.818	-0,1%
Biogas	907	1.174	29,4%
RSU - Renewable	686	883	28,7%
RSU - Non-renewable	686	883	28,7%
Other sources	0	892	--
GROSS TOTAL PRODUCTION	278.750	280.481	0,6%

In-house consumption	10.369	11.267	8,7%
Pumping consumption	5.202	4.565	-12,2%
Import-Export	-3.406	-154	-95,5%
NATIONAL DEMAND (GWh bc)	259.773	264.494	1,8%