

Technical analysis and comparison of underlying scenarios for the forthcoming European Commission White Paper on a 2030 framework for climate and energy policies

Draft -- Preliminary data

Background data to Draft Working Paper "Technical analysis and comparison of underlying scenarios for the forthcoming European Commission White Paper on a 2030 climate and energy policy framework"

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Draft Technical Report

Primary energy consumption (in PJ)

(w/o net electricity imports)

		2030										
		EC 2014 - Reference	EC 2014 - GHG40	EC 2014 - GHG40EE	EC 2014 - GHG40EE RES 30	EC 2014 - GHG45EE RES 35	GP/EREC 2012 - e[r]	IEA 2013 - NPS	IEA 2013 - 450 Scenario	EC 2011 - Diversified Supply	EC 2011 - Energy Efficiency	EC 2011 - High RES
Actual												
Solids	11,722	7,268	6,469	7,486	7,196	5,161	3,256	7,327	5,108	5,001	5,512	4,549
Oil	25,833	21,643	20,994	19,262	19,479	19,262	12,407	16,705	13,398	21,461	20,752	21,524
Natural gas	18,497	16,518	14,371	13,049	12,058	11,728	15,694	18,506	14,486	15,329	14,549	14,808
Nuclear	9,904	8,424	8,424	7,750	6,570	3,454	852	8,918	10,551	8,390	6,763	6,104
Renewables	7,672	13,341	13,874	12,807	14,541	17,343	23,593	13,691	16,161	14,115	13,291	16,207
TOTAL	73,629	67,194	64,131	60,355	59,844	56,947	55,802	65,147	59,704	64,295	60,867	63,191

		2050										
		EC 2014 - Reference	EC 2014 - GHG40	EC 2014 - GHG40EE	EC 2014 - GHG40EE RES 30	EC 2014 - GHG45EE RES 35	GP/EREC 2012 - e[r]	IEA 2013 - NPS	IEA 2013 - 450 Scenario	EC 2011 - Diversified Supply	EC 2011 - Energy Efficiency	EC 2011 - High RES
Actual												
Solids	11,722	5,183	5,546	4,561	3,213	3,213	760			3,212	1,858	980
Oil	25,833	20,712	7,871	7,664	7,664	7,456	2,931			7,320	7,013	7,361
Natural gas	18,497	16,483	10,384	8,571	7,582	7,582	3,063			11,810	10,748	8,810
Nuclear	9,904	9,041	10,577	8,769	5,334	3,797	0			7,813	6,118	1,827
Renewables	7,672	16,555	23,839	13,244	23,177	24,005	36,911			20,913	19,768	28,311
TOTAL	73,629	67,973	58,217	42,809	46,970	46,054	43,665			51,067	45,505	47,290

Shares in primary energy consumption

(w/o net electricity imports)

		2030										
		EC 2014 - Reference	EC 2014 - GHG40	EC 2014 - GHG40EE	EC 2014 - GHG40EE RES 30	EC 2014 - GHG45EE RES 35	GP/EREC 2012 - e[r]	IEA 2013 - NPS	IEA 2013 - 450 Scenario	EC 2011 - Diversified Supply	EC 2011 - Energy Efficiency	EC 2011 - High RES
Actual												
Solids	16%	11%	10%	12%	12%	9%	6%	11%	9%	8%	9%	7%
Oil	35%	32%	33%	32%	33%	34%	22%	26%	22%	33%	34%	34%
Natural gas	25%	25%	22%	22%	20%	21%	28%	28%	24%	24%	24%	23%
Nuclear	13%	13%	13%	13%	11%	6%	2%	14%	18%	13%	11%	10%
Renewables	10%	20%	22%	21%	24%	30%	42%	21%	27%	22%	22%	26%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

		2050										
		EC 2014 - Reference	EC 2014 - GHG40	EC 2014 - GHG40EE	EC 2014 - GHG40EE RES 30	EC 2014 - GHG45EE RES 35	GP/EREC 2012 - e[r]	IEA 2013 - NPS	IEA 2013 - 450 Scenario	EC 2011 - Diversified Supply	EC 2011 - Energy Efficiency	EC 2011 - High RES
Actual												
Solids	16%	8%	10%	11%	7%	7%	2%			6%	4%	2%
Oil	35%	30%	14%	18%	16%	16%	7%			14%	15%	16%
Natural gas	25%	24%	18%	20%	16%	16%	7%			23%	24%	19%
Nuclear	13%	13%	18%	20%	11%	8%	0%			15%	13%	4%
Renewables	10%	24%	41%	31%	49%	52%	85%			41%	43%	60%
TOTAL	100%	100%	100%	100%	100%	100%	100%			100%	100%	100%

Share of renewable energy sources in final energy demand

	2010	2020	2030	2040	2050
EC 2014 - Reference	12%	21%	24%	27%	29%
EC 2014 - GHG40	12%		27%		51%
EC 2014 - GHG40EE	12%		26%		51%
EC 2014 - GHG40EE RES 30	12%		30%		59%
EC 2014 - GHG45EE RES 35	12%		35%		62%
GP/EREC 2012 - e[r]	12%	23%	42%	66%	90%
IEA 2013 - NPS	12%	17%	21%		
IEA 2013 - 450 Scenario	12%	18%	28%		
EC 2011 - Diversified Supply	12%	21%	28%	40%	55%
EC 2011 - Energy Efficiency	12%	21%	28%	41%	57%
EC 2011 - High RES	12%	21%	31%	51%	75%

Share of renewable energy sources in electricity generation

	2010	2020	2030	2040	2050
EC 2014 - Reference	19%	35%	43%	48%	50%
EC 2014 - GHG40	19%		47%		53%
EC 2014 - GHG40EE	19%		46%		55%
EC 2014 - GHG40EE RES 30	19%		53%		70%
EC 2014 - GHG45EE RES 35	19%		66%		76%
GP/EREC 2012 - e[r]	19%	44%	68%	83%	96%
IEA 2013 - NPS	19%	33%	41%		
IEA 2013 - 450 Scenario	19%	36%	50%		
EC 2011 - Diversified Supply	19%	37%	51%	54%	59%
EC 2011 - Energy Efficiency	19%	37%	53%	60%	64%
EC 2011 - High RES	19%	37%	60%	75%	83%

Share of renewable energy sources in heating and cooling

	2010	2020	2030	2040	2050
EC 2014 - Reference	14%	21%	24%	26%	27%
EC 2014 - GHG40	14%		26%		49%
EC 2014 - GHG40EE	14%		26%		46%
EC 2014 - GHG40EE RES 30	14%		31%		54%
EC 2014 - GHG45EE RES 35	14%		35%		54%
GP/EREC 2012 - e[r]	14%	25%	43%	65%	91%
IEA 2013 - NPS					
IEA 2013 - 450 Scenario					
EC 2011 - Diversified Supply	14%	21%	24%	32%	44%
EC 2011 - Energy Efficiency	14%	21%	23%	32%	45%
EC 2011 - High RES	14%	21%	27%	38%	53%

Share of renewable energy sources in the transport sector

	2010	2020	2030	2040	2050
EC 2014 - Reference	5%	10%	12%	13%	14%
EC 2014 - GHG40	5%		13%		68%
EC 2014 - GHG40EE	5%		14%		68%
EC 2014 - GHG40EE RES 30	5%		15%		72%
EC 2014 - GHG45EE RES 35	5%		16%		75%
GP/EREC 2012 - e[r]	5%	6%	17%	54%	85%
IEA 2013 - NPS	5%	9%	13%		
IEA 2013 - 450 Scenario	5%	10%	23%		
EC 2011 - Diversified Supply	5%	11%	19%	43%	62%
EC 2011 - Energy Efficiency	5%	11%	19%	45%	64%
EC 2011 - High RES	5%	11%	20%	50%	73%

Total energy-related CO₂ emissions (in MtCO₂)

	2009/2010/2011	2020	2030	2040	2050
EC 2014 - Reference	3761	3249	2860	2494	2348
EC 2014 - GHG40	3761		2607		771
EC 2014 - GHG40EE	3761		2587		743
EC 2014 - GHG40EE RES 30	3761		2525		739
EC 2014 - GHG45EE RES 35	3761		2296		845
GP/EREC 2012 - e[r]	3529	2826	1807	879	197
IEA 2013 - NPS	3499	3157	2702		
IEA 2013 - 450 Scenario	3499	2936	1985		
EC 2011 - Diversified Supply	3690	3093	2457	1482	648
EC 2011 - Energy Efficiency	3690	3063	2419	1429	628
EC 2011 - High RES	3688	3087	2395	1455	670

Total energy-related CO₂ emissions (index, 2009/2010/2011 = 100)

	2009/2010/2011	2020	2030	2040	2050
EC 2014 - Reference	100	86	76	66	62
EC 2014 - GHG40	100		69		20
EC 2014 - GHG40EE	100		69		20
EC 2014 - GHG40EE RES 30	100		67		20
EC 2014 - GHG45EE RES 35	100		61		22
GP/EREC 2012 - e[r]	100	80	51	25	6
IEA 2013 - NPS	100	90	77		
IEA 2013 - 450 Scenario	100	84	57		
EC 2011 - Diversified Supply	100	84	67	40	18
EC 2011 - Energy Efficiency	100	83	66	39	17
EC 2011 - High RES	100	84	65	39	18

Total energy-related CO₂ emissions (index, 1990 = 100)

	2009/2010/2011	2020	2030	2040	2050
EC 2014 - Reference	90	78	69	60	56
EC 2014 - GHG40	90		63		19
EC 2014 - GHG40EE	90		61		18
EC 2014 - GHG40EE RES 30	90		59		18
EC 2014 - GHG45EE RES 35	90		54		20
GP/EREC 2012 - e[r]	87	70	45	22	5
IEA 2013 - NPS	86	78	67		
IEA 2013 - 450 Scenario	86	72	49		
EC 2011 - Diversified Supply	92	77	61	37	16
EC 2011 - Energy Efficiency	92	76	60	35	16
EC 2011 - High RES	91	77	59.4	36	17

Electricity sector CO₂ emissions (in MtCO₂)

(apparently some differences between studies in sector differentiation)

	2009/2010/2011	2020	2030	2040	2050
EC 2014 - Reference	1337	1042	788	517	399
EC 2014 - GHG40	1337		646		32
EC 2014 - GHG40EE	1337		764		60
EC 2014 - GHG40EE RES 30	1337		693		72
EC 2014 - GHG45EE RES 35	1337		504		152
GP/EREC 2012 - e[r]	1468	1080	658	335	54
IEA 2013 - NPS	1285	1082	831		
IEA 2013 - 450 Scenario	1285	963	484		
EC 2011 - Diversified Supply	1275	965	598	270	19
EC 2011 - Energy Efficiency	1275	963	609	284	27
EC 2011 - High RES	1272	958	523	250	53

Electricity sector CO₂ emissions (index, 2009/2010/2011 = 100)

	2009/2010/2011	2020	2030	2040	2050
EC 2014 - Reference	100	78	59	39	30
EC 2014 - GHG40	100		48		2
EC 2014 - GHG40EE	100		57		4
EC 2014 - GHG40EE RES 30	100		52		5
EC 2014 - GHG45EE RES 35	100		38		11
GP/EREC 2012 - e[r]	100	74	45	23	4
IEA 2013 - NPS	100	84	65		
IEA 2013 - 450 Scenario	100	75	38		
EC 2011 - Diversified Supply	100	76	47	21	1
EC 2011 - Energy Efficiency	100	76	48	22	2
EC 2011 - High RES	100	75	41	20	4

Industry CO₂ emissions (in MtCO₂)

(apparently some differences between studies in sector differentiation)

	2009/2010/2	2020	2030	2040	2050
EC 2014 - Reference	676	644	605	541	525
EC 2014 - GHG40	676		569		210
EC 2014 - GHG40EE	676		575		205
EC 2014 - GHG40EE RES 30	676		569		189
EC 2014 - GHG45EE RES 35	676		539		221
GP/EREC 2012 - e[r]	452	374	255	147	27
IEA 2013 - NPS					
IEA 2013 - 450 Scenario					
EC 2011 - Diversified Supply	655	563	511	371	197
EC 2011 - Energy Efficiency	655	569	529	364	195
EC 2011 - High RES	655	562	505	362	187

Industry CO₂ emissions (index, 2009/2010/2011 = 100)

	2009/2010/2	2020	2030	2040	2050
EC 2014 - Reference	100	95	90	80	78
EC 2014 - GHG40	100		84		31
EC 2014 - GHG40EE	100		85		30
EC 2014 - GHG40EE RES 30	100		84		28
EC 2014 - GHG45EE RES 35	100		80		33
GP/EREC 2012 - e[r]	100	83	56	33	6
IEA 2013 - NPS					
IEA 2013 - 450 Scenario					
EC 2011 - Diversified Supply	100	86	78	57	30
EC 2011 - Energy Efficiency	100	87	81	56	30
EC 2011 - High RES	100	86	77	55	29

Residential & tertiary CO₂ emissions (in MtCO₂)

(apparently some differences between studies in sector differentiation)

	2009/2010/2	2020	2030	2040	2050
EC 2014 - Reference	704	585	517	482	458
EC 2014 - GHG40	704		460		133
EC 2014 - GHG40EE	704		382		92
EC 2014 - GHG40EE RES 30	704		398		92
EC 2014 - GHG45EE RES 35	704		387		96
GP/EREC 2012 - e[r]	696	579	377	210	64
IEA 2013 - NPS					
IEA 2013 - 450 Scenario					
EC 2011 - Diversified Supply	712	573	468	294	114
EC 2011 - Energy Efficiency	712	542	432	254	98
EC 2011 - High RES	713	574	481	289	108

Residential & tertiary CO₂ emissions (index, 2009/2010/2011 = 100)

	2009/2010/2	2020	2030	2040	2050
EC 2014 - Reference	100	83	73	68	65
EC 2014 - GHG40	100		65		19
EC 2014 - GHG40EE	100		54		13
EC 2014 - GHG40EE RES 30	100		57		13
EC 2014 - GHG45EE RES 35	100		55		14
GP/EREC 2012 - e[r]	100	83	54	30	9
IEA 2013 - NPS					
IEA 2013 - 450 Scenario					
EC 2011 - Diversified Supply	100	80	66	41	16
EC 2011 - Energy Efficiency	100	76	61	36	14
EC 2011 - High RES	100	80	67	41	15

Transport CO₂ emissions (in MtCO₂)

(apparently some differences between studies in sector differentiation)

	2009/2010/2	2020	2030	2040	2050
EC 2014 - Reference	1045	978	951	954	966
EC 2014 - GHG40	1045		932		396
EC 2014 - GHG40EE	1045		865		386
EC 2014 - GHG40EE RES 30	1045		865		386
EC 2014 - GHG45EE RES 35	1045		865		377
GP/EREC 2012 - e[r]	913	793	517	187	51
IEA 2013 - NPS	888	802	692		
IEA 2013 - 450 Scenario	888	757	510		
EC 2011 - Diversified Supply	1048	993	880	547	319
EC 2011 - Energy Efficiency	1048	989	849	528	309
EC 2011 - High RES	1048	993	886	554	323

Transport CO₂ emissions (index, 2009/2010/2011 = 100)

	2009/2010/2	2020	2030	2040	2050
EC 2014 - Reference	100	94	91	91	92
EC 2014 - GHG40	100		89		38
EC 2014 - GHG40EE	100		83		37
EC 2014 - GHG40EE RES 30	100		83		37
EC 2014 - GHG45EE RES 35	100		83		36
GP/EREC 2012 - e[r]	100	87	57	20	6
IEA 2013 - NPS	100	90	78		
IEA 2013 - 450 Scenario	100	85	57		
EC 2011 - Diversified Supply	100	95	84	52	30
EC 2011 - Energy Efficiency	100	94	81	50	30
EC 2011 - High RES	100	95	84	53	31

Share of electricity from CCS

	2010	2020	2030	2040	2050
EC 2014 - Reference	0%	0%	0%	3%	7%
EC 2014 - GHG40	0%		0%		15%
EC 2014 - GHG40EE	0%		0%		11%
EC 2014 - GHG40EE RES 30	0%		0%		8%
EC 2014 - GHG45EE RES 35	0%		0%		3%
GP/EREC 2012 - e[r]	0%	0%	0%	0%	0%
IEA 2013 - NPS					
IEA 2013 - 450 Scenario					
EC 2011 - Diversified Supply	0%	1%	1%	15%	24%
EC 2011 - Energy Efficiency	0%	0%	1%	10%	20%
EC 2011 - High RES	0%	1%	1%	3%	7%

Primary energy intensity (index, 1995=100)

	2010	2020	2030	2040	2050
EC 2014 - Reference	80	65	54	47	41
EC 2014 - GHG40	80		51		35
EC 2014 - GHG40EE	80		48		30
EC 2014 - GHG40EE RES 30	80		48		28
EC 2014 - GHG45EE RES 35	80		45		28
GP/EREC 2012 - e[r]	80	58			26
IEA 2013 - NPS	80	65	52		
IEA 2013 - 450 Scenario	80	62	47		
EC 2011 - Diversified Supply	80	62	48	38	28
EC 2011 - Energy Efficiency	80	61	45	34	25
EC 2011 - High RES	80	62	47	35	26

Use of biomass (in Mtoe)

	2010	2020	2030	2040	2050
EC 2014 - Reference	106		178		
EC 2014 - GHG45EE RES 35	106		223		
GP/EREC 2012 - e[r]	106	142	154	150	144
IEA 2013 - NPS	106	166	199		
IEA 2013 - 450 Scenario	106	169	225		
EC 2011 - Diversified Supply	106	164	173	226	271
EC 2011 - Energy Efficiency	106	160	163	217	260
EC 2011 - High RES	106	163	189	268	320

Use of biomass - more detailed (in Mtoe)

	2010	2030			
	Actual	GHG45EE RES35	High RES	New Policy Scenario	energy [r]evolution
Domestic production	99	191	181		
Net imports	7	32	8		
Domestic + net imports	106	223	189	199	154

EU ETS carbon price (in €₂₀₁₀/tCO₂)

	2010	2020	2030	2040	2050
EC 2014 - Reference	11	10	35	78	100
EC 2014 - GHG40	11		40		264
EC 2014 - GHG40EE	11		22		158
EC 2014 - GHG40EE RES 30	11		11		152
EC 2014 - GHG45EE RES 35	11		14		85
GP/EREC 2012 - e[r]	11	19	30	42	57
IEA 2013 - NPS	11	15	25		
IEA 2013 - 450 Scenario	11	26	71		
EC 2011 - Diversified Supply	11	26	54	98	273
EC 2011 - Energy Efficiency	11	15	26	90	241
EC 2011 - High RES	11	26	36	93	289

Oil price (in €₂₀₁₀/boe)

	2010	2020	2030	2040	2050
EC 2014 - Reference	60	89	93		110
GP/EREC 2012 - e[r]	60	93	126	126	126
IEA 2013 - NPS	60	84	90		
IEA 2013 - 450 Scenario	60	83	78		
EC 2011 - Diversified Supply	60	67	63	61	55
EC 2011 - Energy Efficiency	60	67	63	61	55
EC 2011 - High RES	60	67	63	61	55

Oil price (in \$₂₀₁₀/boe)

	2010	2020	2030	2040	2050
EC 2014 - Reference	80	115	121		143
GP/EREC 2012 - e[r]	80	120	164	164	164
IEA 2013 - NPS	80	110	117		
IEA 2013 - 450 Scenario	80	107	101		
EC 2011 - Diversified Supply	80	87	81	79	72
EC 2011 - Energy Efficiency	80	87	81	79	72
EC 2011 - High RES	80	87	81	79	72

Natural gas price (in €₂₀₁₀/boe)

	2010	2020	2030	2040	2050
EC 2014 - Reference	38	62	65		63
GP/EREC 2012 - e[r]	38	85	99	113	133
IEA 2013 - NPS	38	50	51		
IEA 2013 - 450 Scenario	38	48	43		
EC 2011 - Diversified Supply	38	49	48	44	39
EC 2011 - Energy Efficiency	38	49	48	44	39
EC 2011 - High RES	38	49	48	44	39

Coal price (in €₂₀₁₀/boe)

	2010	2020	2030	2040	2050
EC 2014 - Reference	16	23	24		31
GP/EREC 2012 - e[r]	16	23	28	33	34
IEA 2013 - NPS	16	16	16		
IEA 2013 - 450 Scenario	16	15	13		
EC 2011 - Diversified Supply	16	20	21	19	17
EC 2011 - Energy Efficiency	16	20	21	19	17
EC 2011 - High RES	16	20	21	19	17

Results of representative polls in six EU countries asking which technologies should be used to reduce GHG emissions

	Greece	Romania	Netherlands UK	Germany	Norway
Nuclear energy	2.18	3.45	3.7	4.12	3.05
CCS	4.97	5.03	4.2	4.49	4.14
Energy efficient appliances	6.22	6.13	6.04	6.03	5.86
Wind energy	6.59	6.32	6.21	5.95	6.11
Solar energy	6.75	6.38	6.39	6.17	6.27

Source: Pietzner et al. 2010, p. 38.

Employment in 2030 by sector

	000 of persons			% change compared to Reference scenario	
	Reference	GHG40	GHG40EE RES30	GHG40	GHG40EE RES30
Agriculture	9391	9402	9407	0.1%	0.2%
Extraction industries	500	479	498	-4.2%	-0.4%
Basic manufacturing	14839	14913	14944	0.5%	0.7%
Engin. and transport equipment	15277	15367	15429	0.6%	1.0%
Utilities	2280	2301	2308	0.9%	1.2%
Construction	16599	16708	16890	0.7%	1.8%
Distribution and retail	35314	35348	35452	0.1%	0.4%
Transport	9411	9455	9471	0.5%	0.6%
Communications, publishing, TV	20307	20384	20440	0.4%	0.7%
Business services	41048	41225	41293	0.4%	0.6%
Public services	66735	66797	66814	0.1%	0.1%
Total employment	231701	232379	232947	0.3%	0.5%

Change over Reference scenario in life years lost due to PM2.5 in the year 2030

	GHG40	GHG40EE RES30	GHG45EE RES35
Change in life years lost (in mln.)	-4.2	-11	-13

Reduced pollution control & damage reduction costs compared to Reference scenario (in billion €₂₀₁₀/year)

	GHG40	GHG40EE RES30	GHG45EE RES35
Low estimate	7.2	16.7	22
High estimate	13.5	33.3	41.5