Supplementary information

IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION COMMUNICATION COM(2018) 773

A Clean Planet for all - A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy

This document provides the data of the graphs as presented in the 'In-depth analysis in support of the Commission Communication COM(2018)773 A Clean Planet for all - A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy'

The in-depth analysis can be found on:
https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf

EUROPEAN COMMISSION

Brussels, 28 November 2018

IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION COMMUNICATION COM(2018) 773

A Clean Planet for all
A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy

Disclaimer
For reason of editorial process minor differences can exist between data
as included in this document and those used for the graphs in the in-depth analysis.

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Figure 3: EU greenhouse gas emissions by sector 1990-2017

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy supply	1869	1821	1755	1685	1679	1681	1706	1654	1660	1611	1638	1680	1692	1740
Energy use in manufacturing industry	841	799	763	735	733	750	741	733	698	679	686	669	649	654
Industrial processes and product use	517	483	464	455	483	498	500	505	482	443	456	441	437	451
Transport	787	795	819	824	830	843	870	881	909	928	924	937	948	957
Other energy use	854	900	840	854	805	809	874	823	807	794	769	815	782	799
Agriculture	542	512	489	476	470	472	472	469	466	464	458	451	445	441
Waste	236	240	242	243	243	244	243	241	237	232	229	225	221	216
International aviation	69	67	73	77	81	86	90	94	101	109	115	113	110	115

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy supply	1722	1713	1719	1728	1650	1519	1543	1518	1510	1433	1346	1333	1280	1276
Energy use in manufacturing industry	646	636	628	631	604	501	536	519	497	488	480	484	474	483
Industrial processes and product use	467	466	465	476	451	377	394	390	377	376	382	377	374	379
Transport	977	976	983	993	968	941	935	923	893	886	894	911	931	946
Other energy use	798	794	786	710	758	735	782	687	703	707	615	643	663	663
Agriculture	441	434	430	433	430	425	420	420	418	421	428	430	430	432
Waste	207	200	194	187	179	173	166	160	156	149	143	141	138	136
International aviation	123	131	136	141	142	131	132	135	133	135	137	141	148	150

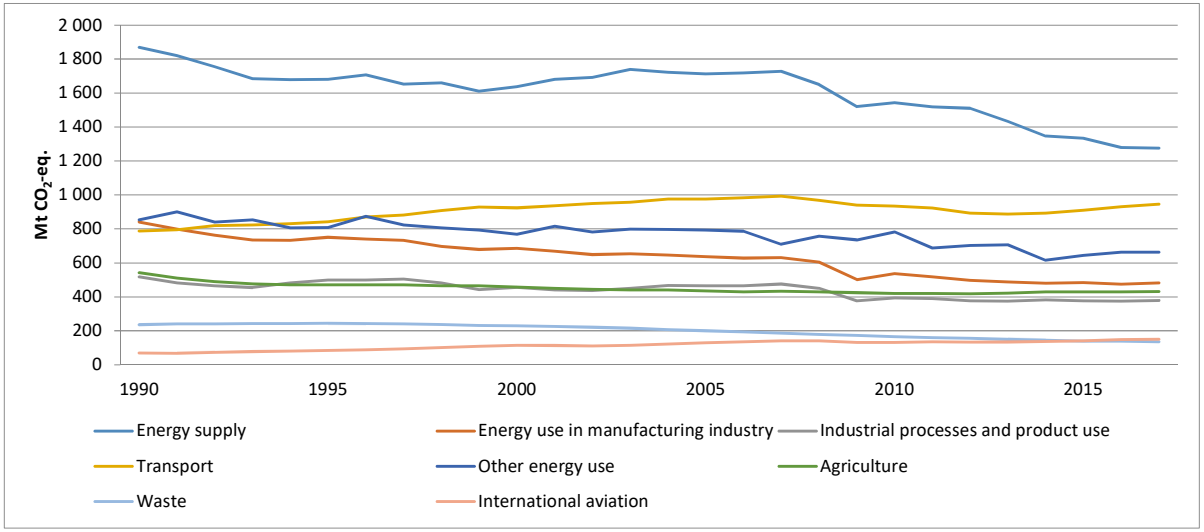


Figure 4: Primary and final energy consumption in the EU

EU28	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Primary Energy Consumption	1570	1573	1539	1547	1531	1567	1627	1609	1620	1609	1618	1658	1655	1692	1707	1713
Target 2020	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483
PEC linear trajectory																1713
Final Energy Consumption	1085	1091	1066	1070	1064	1083	1131	1119	1127	1128	1133	1156	1145	1177	1189	1193
Target 2020	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086
FEC linear trajectory																1193

EU28	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Primary Energy Consumption	1722	1694	1693	1599	1658	1595	1586	1571	1508	1532	1543	1565			
Target 2020	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483	1483
PEC linear trajectory	1697	1681	1665	1649	1633	1617	1602	1586	1571	1556	1541	1526	1512	1497	1483
Final Energy Consumption	1194	1174	1179	1116	1163	1109	1109	1108	1063	1086	1108	1119			
Target 2020	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086	1086
FEC linear trajectory	1185	1178	1171	1163	1156	1149	1142	1135	1127	1120	1113	1107	1100	1093	1086

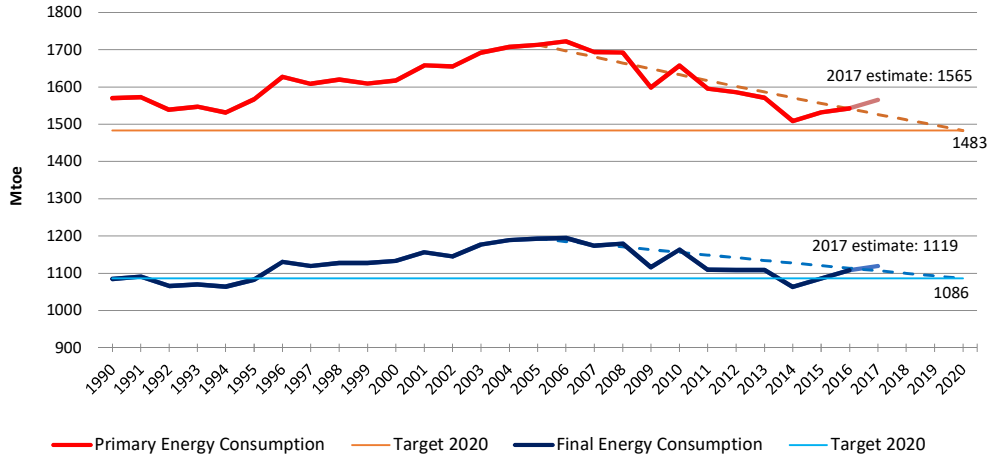


Figure 6: Share of renewable energy in gross final energy consumption in the EU

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2020	2030
Share of renewables in gross final energy demand	9.0%	9.5%	10.5%	11.1%	12.4%	12.9%	13.2%	14.4%	15.2%	16.1%	16.7%	17.0%		
												17.0%	20.0%	
													20%	32.0%

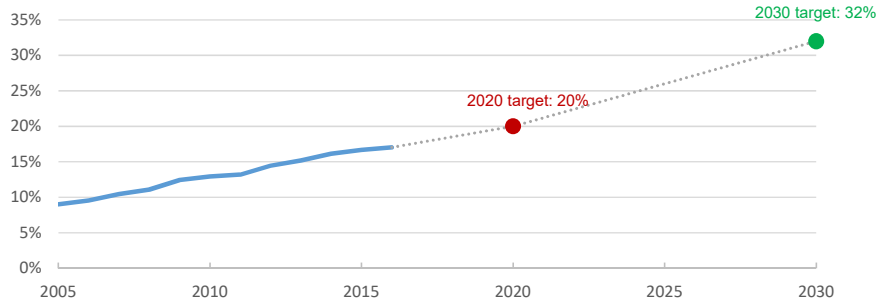


Figure 7: Primary energy production in the Baseline

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Solids	164	145	131	110	80	61	42	22	12
Oil	97	75	71	56	43	30	19	10	2
Natural gas	159	107	106	91	76	61	56	54	51
Nuclear	237	221	189	170	164	174	159	146	153
Hydro	32	29	32	31	33	31	32	32	32
Biomass & Waste	126	144	159	173	175	153	155	160	162
Wind	13	26	42	57	82	99	124	151	164
Solar and others	4	13	16	32	42	48	52	59	67
Geothermal	6	20	3	4	8	8	12	19	19

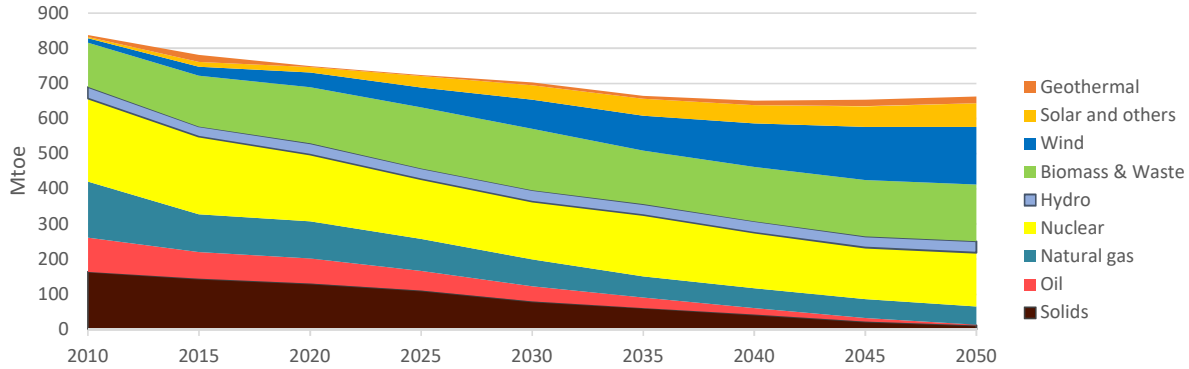


Figure 8: Gross electricity generation in the Baseline

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Solids	829	792	751	607	395	298	180	92	37
Oil	87	61	24	24	20	13	8	10	8
Natural Gas	799	530	585	537	492	565	593	632	637
Nuclear	917	857	773	695	677	730	681	647	688
Hydro	408	371	375	362	380	366	370	372	376
Biomass & waste	143	201	208	269	325	289	274	254	268
Wind	149	302	487	664	955	1149	1440	1761	1905
Solar, tidal etc.	23	108	147	307	412	430	475	546	641
Geothermal	10	13	7	7	9	9	10	17	17

Note: Electricity produced is shown by type of capacity.

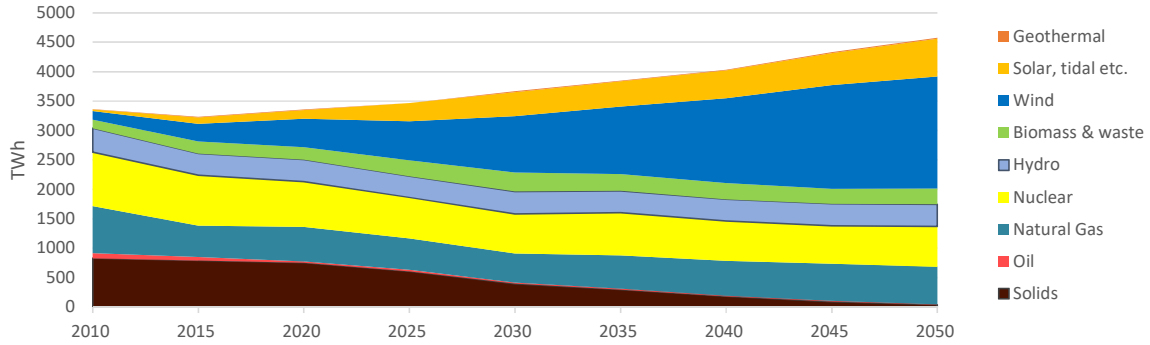


Figure 9: Final Energy demand by sector

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Industry	291	276	294	284	258	255	253	253	254
Residential	320	276	293	265	224	202	195	197	192
Tertiary	189	176	188	175	151	143	144	153	156
Transport	364	358	359	341	321	302	290	282	280

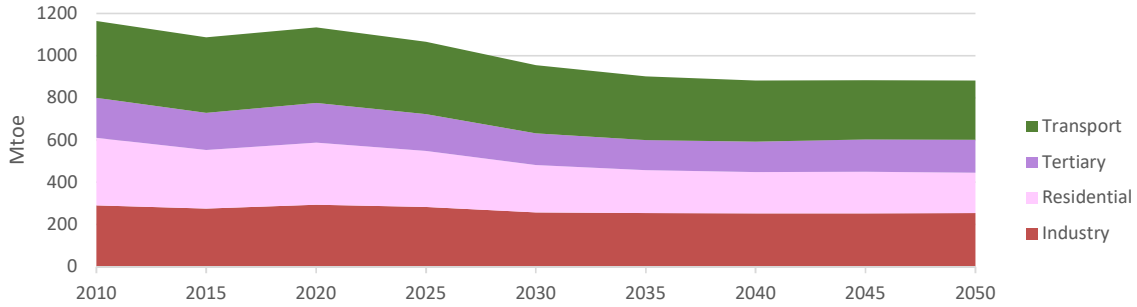


Figure 10: Final Energy demand by fuel/energy carrier

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Solids	50	46	45	38	28	20	15	12	10
Oil	458	430	414	368	312	276	251	235	228
Gas	272	237	264	235	192	178	170	167	155
Heat	54	46	50	49	42	39	40	40	41
Electricity	244	237	251	261	278	292	307	331	349
Other	85	90	109	113	103	97	99	100	98

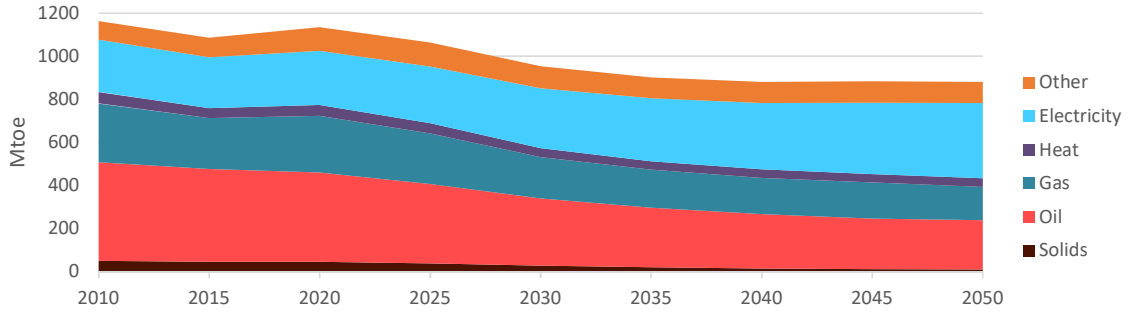
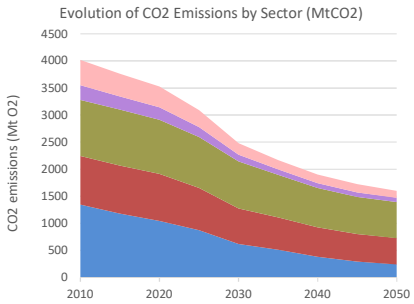


Figure 11: Carbon dioxide emissions by sector

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Residential	467	423	387	310	213	174	158	152	130
Transport	1037	1030	999	941	869	785	726	684	667
Tertiary	268	246	231	184	122	99	89	85	78
Industry	901	888	868	778	659	595	544	509	484
Power	1344	1180	1043	875	617	514	384	294	244

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Residential	12%	11%	11%	10%	9%	8%	8%	9%	8%
Transport	26%	27%	28%	30%	35%	36%	38%	40%	42%
Tertiary	7%	7%	7%	6%	5%	5%	5%	5%	5%
Industry	22%	24%	25%	25%	27%	27%	29%	30%	30%
Power	33%	31%	30%	28%	25%	24%	20%	17%	15%



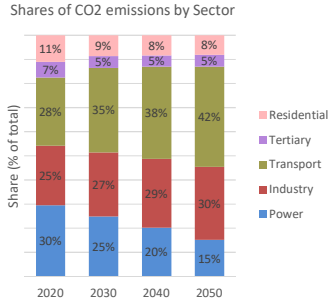
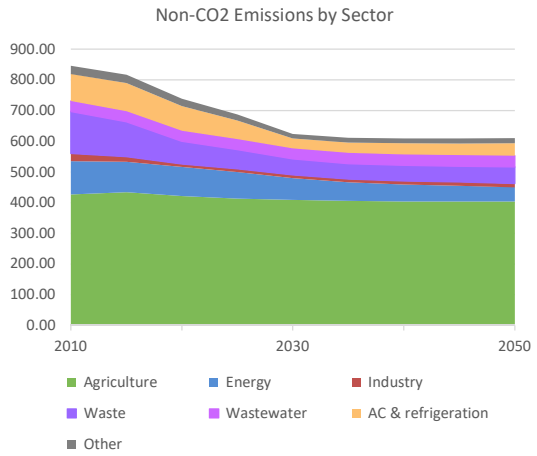


Figure 12: Baseline projections of non-CO2 emissions by sector and by gas (MtCO2eq)

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Agriculture	427.16	434.32	421.13	412.79	409.00	406.34	404.23	404.12	404.24
Energy	107.83	99.03	94.94	87.10	71.36	60.12	54.86	51.12	45.80
Industry	25.19	16.18	9.68	10.04	10.41	10.84	11.30	11.74	12.20
Waste	136.74	113.87	73.95	62.48	51.41	49.31	51.35	51.55	53.79
Wastewater	34.10	34.14	34.57	34.87	35.16	35.51	35.87	36.17	36.38
AC & refrigeration	88.26	91.83	79.67	60.00	31.73	33.79	35.73	38.27	40.79
Other	27.00	26.72	23.89	20.62	15.18	15.52	15.87	16.19	16.52

	2010.00	2015.00	2020.00	2025.00	2030.00	2035.00	2040.00	2045.00	2050.00
CH4	480.94	450.50	393.36	366.79	341.38	331.43	329.32	327.20	326.03
N20	248.54	246.40	240.36	239.87	235.25	229.80	227.23	226.23	224.90
F-gases	116.80	119.19	104.11	81.23	47.63	50.19	52.67	55.73	58.80



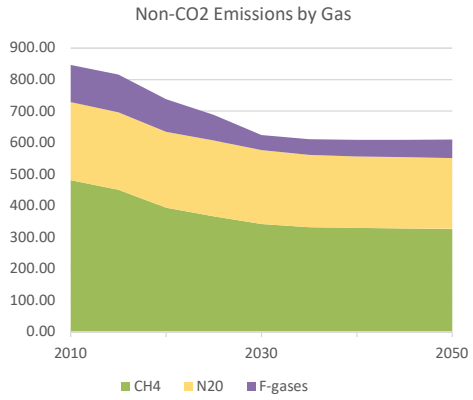


Figure 13: Evolution of the emissions and removals from land use, land use change and forestry

	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Settlements and Other land	103.1	101.2	96.7	94.5	92.8	89.8	86.6	82.2	78.5	71.7	65.1
Wetland	77.1	74.9	69.2	68.7	68.2	68.1	68.0	65.9	63.8	58.2	52.5
Cropland	65.4	61.0	56.7	56.3	55.8	55.7	55.6	53.5	51.4	45.8	40.1
Grassland	-9.5	-8.4	-7.3	-6.4	-5.5	-4.5	-3.4	-2.1	-0.8	-0.8	-0.8
Forest land	-376.6	-340.2	-377.8	-363.0	-329.2	-319.2	-308.0	-294.9	-278.5	-274.5	-272.0
Harvested Wood Products	-410.3	-394.6	-411.5	-391.0	-359.0	-349.7	-338.6	-324.7	-307.6	-303.9	-301.4
Net LULUCF Sink	-307.2	-293.4	-314.8	-296.5	-266.2	-260.0	-252.1	-242.5	-229.1	-232.2	-236.3

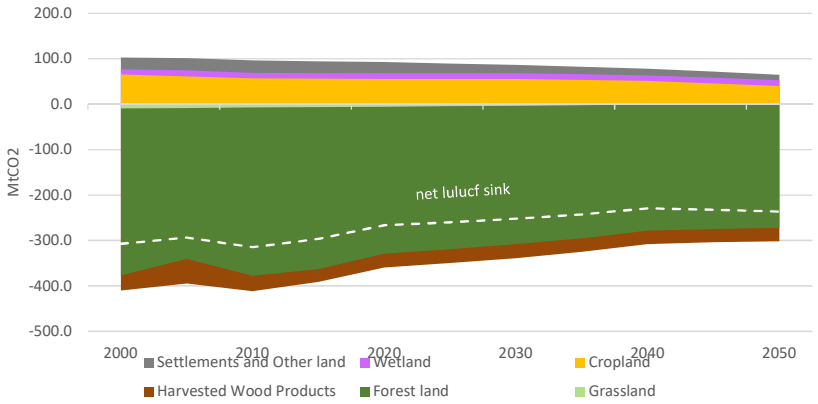
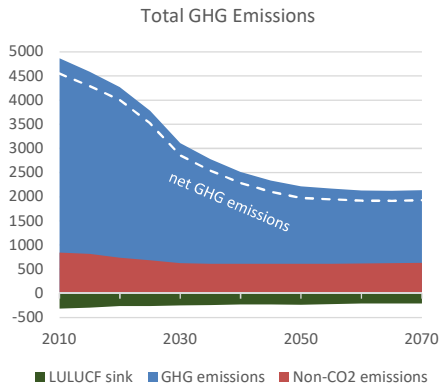


Figure 14: Total GHG emissions and split ETS/non-ETS (MtCO2eq)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
GHG emissions	5340	4866	4586	4271	3780	3108	2781	2513	2335	2214	2168	2131	2126	2133
CO2 emissions	4410	4020	3770	3533	3092	2484	2170	1904	1726	1604	1557	1515	1502	1500
Non-CO2 emissions	930	846	816	738	688	624	611	609	609	610	611	616	623	633
LULUCF sink	-293	-315	-297	-266	-260	-252	-243	-229	-232	-236	-222	-214	-210	-206
Net GHG emissions	5047	4551	4289	4004	3520	2856	2539	2284	2103	1978	1946	1917	1916	1927

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
ETS sectors	2501	2175	2015	1866	1629	1278	1118	950	836	772	738	708	702	703
Non-ETS sectors	2839	2691	2570	2405	2151	1830	1664	1563	1499	1442	1430	1424	1424	1430
Total	5340	4866	4586	4271	3780	3108	2781	2513	2335	2214	2168	2131	2126	2133



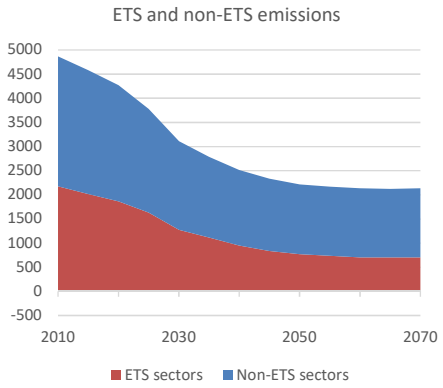


Figure 17: Changes in primary energy consumption in 2050 (% change)

		vs 2005	vs 2030	vs Baseline
2030		-26%		
	Baseline	-35%	-12%	0%
	EE	-50%	-33%	-24%
	CIRC	-45%	-27%	-16%
	ELEC	-40%	-20%	-9%
2050	H2	-36%	-14%	-3%
	P2X	-22%	5%	20%
	COMBO	-35%	-13%	-1%
	1.5TECH	-31%	-8%	5%
	1.5LIFE	-42%	-22%	-11%

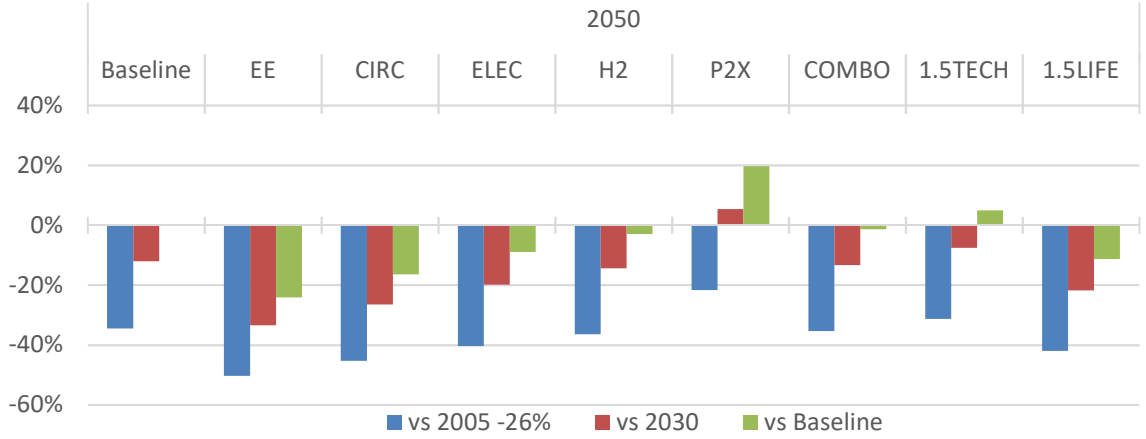


Figure 18: Gross inland consumption

		non-energy use (oil)	non-energy use (other)	solids	fossil liquids	natural gas	nuclear	e-liquids	e-gas	renewables	total (Mtoe)
	2000	5.6%	0.9%	18.9%	32.7%	22.0%	14.1%	0.0%	0.0%	5.7%	1728
	2015	5.1%	0.8%	17.0%	29.3%	21.1%	13.6%	0.0%	0.0%	13.0%	1628
	2030	7.3%	1.4%	9.5%	25.0%	19.6%	11.8%	0.0%	0.0%	25.4%	1395
2050	Baseline	8.9%	1.7%	2.1%	20.2%	19.0%	12.2%	0.0%	0.0%	36.0%	1255
	EE	11.3%	2.1%	0.2%	12.5%	8.8%	14.6%	0.0%	0.0%	50.5%	983
	CIRC	9.5%	1.8%	0.1%	11.5%	8.2%	15.3%	0.0%	0.0%	53.7%	1056
	ELEC	9.7%	1.8%	0.1%	10.9%	9.1%	15.4%	0.0%	0.0%	53.0%	1154
	H2	9.1%	1.7%	0.4%	10.4%	8.1%	15.8%	0.0%	0.0%	54.5%	1222
	P2X	7.5%	1.4%	0.3%	8.1%	7.4%	13.7%	3.7%	6.2%	51.7%	1475
	COMBO	9.0%	1.7%	0.4%	8.1%	4.4%	15.9%	1.5%	4.0%	55.0%	1239
	1.5TECH	7.1%	1.2%	0.2%	3.1%	3.7%	16.6%	3.2%	3.5%	61.4%	1285
	1.5LIFE	8.0%	1.4%	0.1%	4.0%	2.5%	17.1%	1.8%	3.8%	61.2%	1099

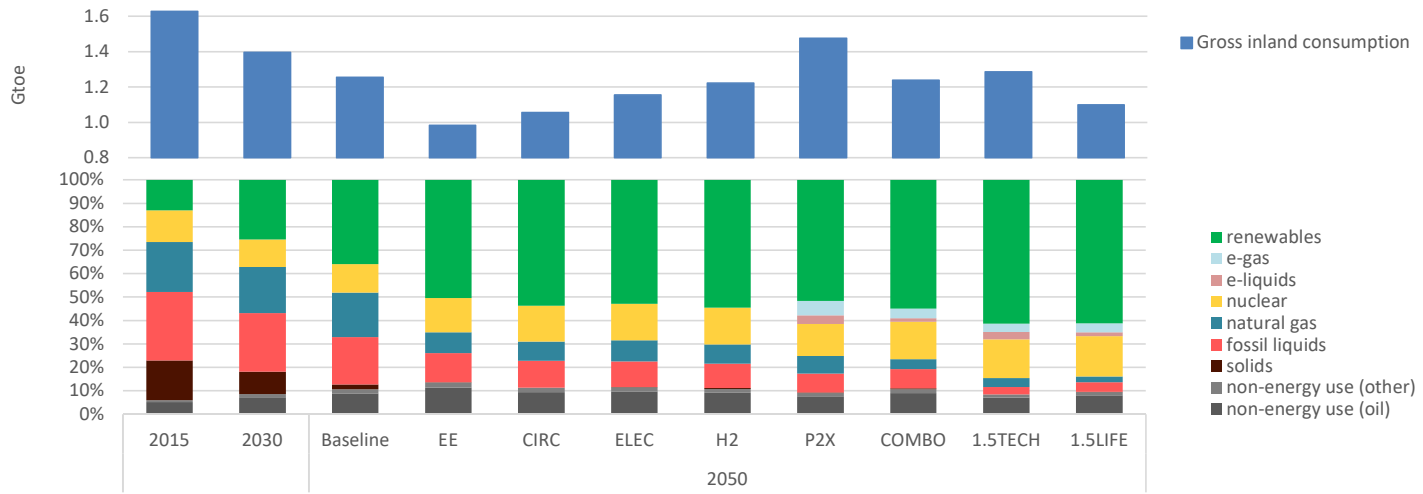


Figure 19: Changes in sectoral final energy consumption (% change vs 2005)

		Services	Industry	Transport	Residential	Total
2030		-18%	-22%	-13%	-28%	-20%
	Baseline	-15%	-23%	-24%	-38%	-26%
	EE	-39%	-35%	-43%	-56%	-44%
	CIRC	-25%	-33%	-43%	-46%	-38%
	ELEC	-22%	-23%	-42%	-46%	-35%
2050	H2	-20%	-24%	-38%	-41%	-32%
	P2X	-21%	-25%	-31%	-41%	-30%
	COMBO	-28%	-31%	-38%	-50%	-38%
	1.5TECH	-36%	-33%	-45%	-54%	-43%
	1.5LIFE	-39%	-41%	-50%	-57%	-47%

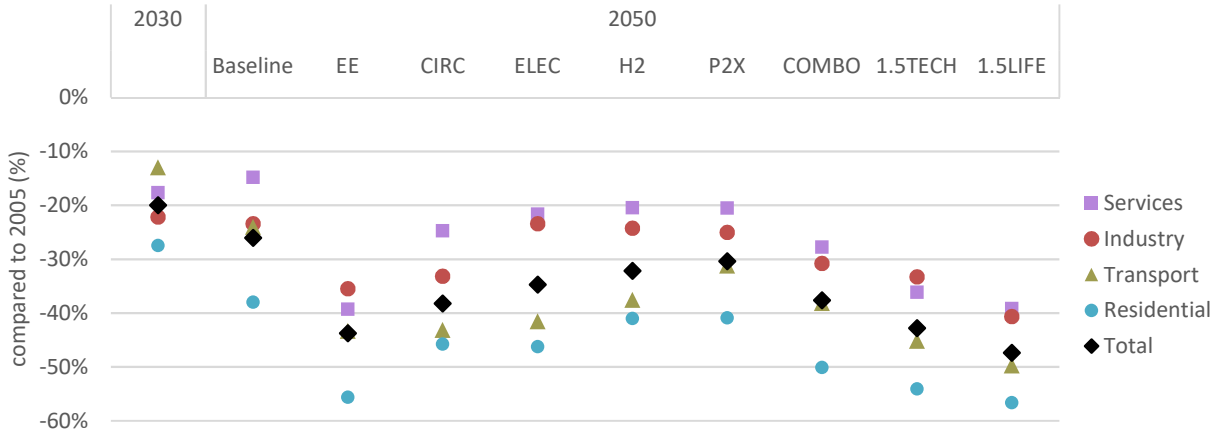


Figure 20: Share of energy carriers in final energy consumption

		solids	fossil liquids	e-liquids	natural gas	e-gas	hydrogen	heat distributed	biomass	other RES	electricity	total
	2000	63	490	0	268	0	0	45	48	1	217	1132
	2015	49	430	0	237	0	0	46	84	3	237	1086
	2030	28	312	0	192	0	0	42	93	9	278	954
	Baseline	10	228	0	155	0	6	41	78	14	349	881
	EE	1	112	0	77	0	8	31	109	11	323	672
	CIRC	1	111	0	73	0	9	41	138	13	352	738
	ELEC	1	115	0	72	0	10	42	112	12	415	779
2050	H2	2	116	0	55	0	133	38	111	13	341	809
	P2X	3	107	54	58	85	15	38	115	14	342	831
	COMBO	3	91	19	29	49	42	36	109	11	355	744
	1.5TECH	1	35	41	15	45	68	32	94	10	343	684
	1.5LIFE	1	38	20	13	41	61	31	106	10	307	628

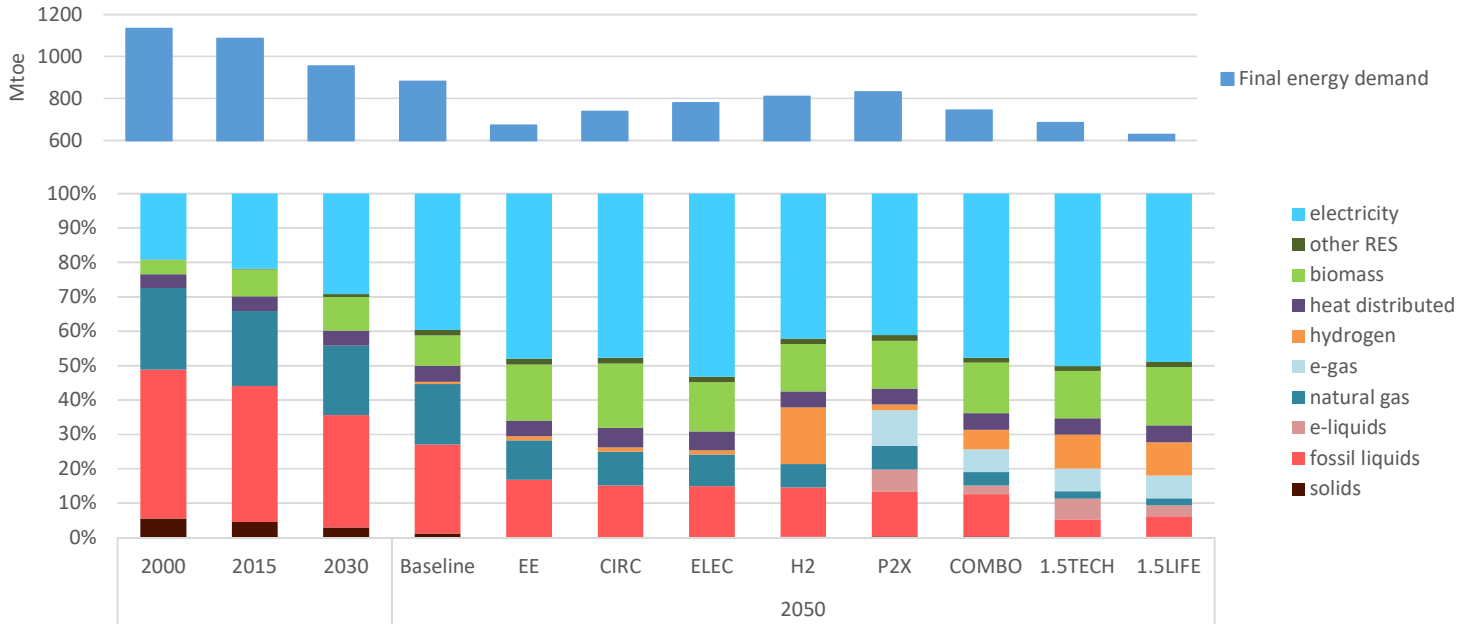
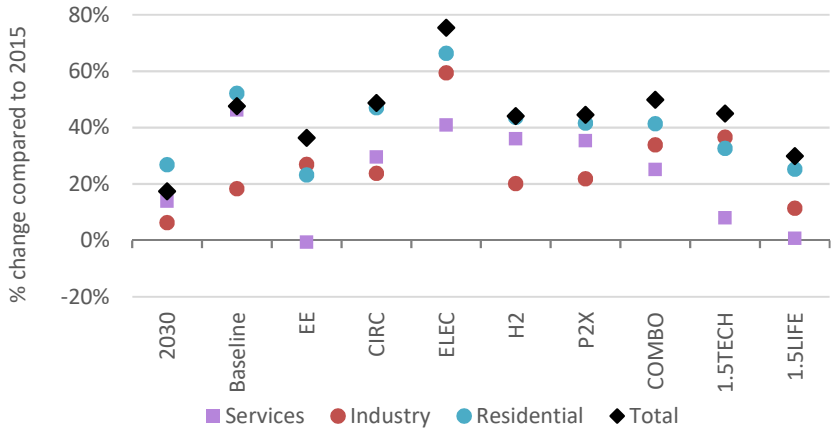


Figure 21: Changes in final electricity consumption in 2050 compared to 2015

		Services	Industry	Residential	Total	Transport
	2030	14%	6%	27%	17%	2
	Baseline	46%	18%	52%	48%	6
	EE	-1%	27%	23.2%	36%	10
	CIRC	30%	24%	47%	49%	8
	ELEC	41%	59%	66%	75%	10
2050	H2	36%	20%	44%	44%	6
	P2X	35%	22%	42%	45%	7
	COMBO	25%	34%	41.4%	50%	9
	1.5TECH	8%	37%	33%	45%	10
	1.5LIFE	1%	11%	25%	30%	9



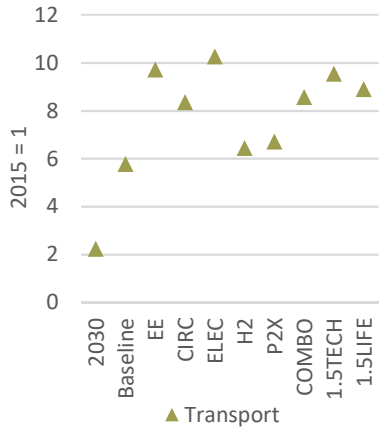


Figure 22: Increase in gross electricity generation compared to 2015

	2030	2050	2070
Baseline	13%	42%	62%
EE	14%	34%	55%
CIRC	14%	50%	68%
ELEC	13%	78%	106%
H2	13%	103%	150%
P2X	14%	137%	193%
COMBO	14%	107%	138%
1.5TECH	14%	146%	159%
1.5LIFE	14%	102%	116%

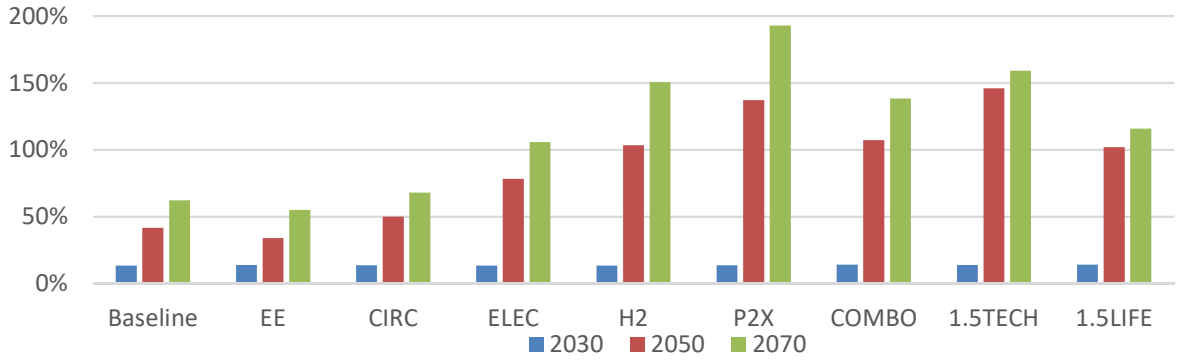


Figure 23: Shares in power generation

	Renewables (all)	Wind & solar	Nuclear	Fossil fuels
2000	15%	1%	31%	54%
2015	30%	13%	26%	44%
2030	57%	37%	18%	24%
Baseline 2(	73%	56%	15%	12%
Decarb. 20	83%	69%	13%	4%

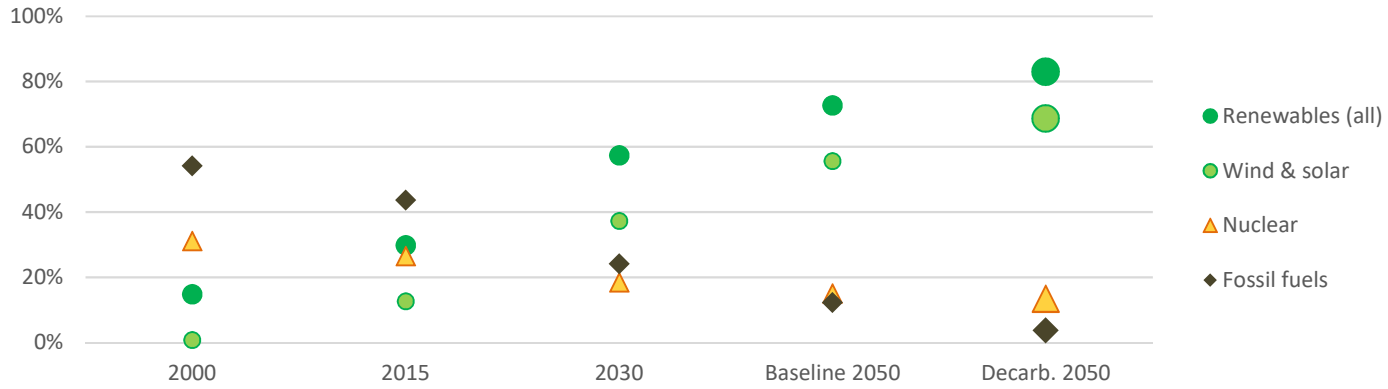


Figure 24: Power generation capacity

GW		Wind onshore	Wind offshore	Solar	Other renewables	Nuclear	Fossil fuels	Fossil fuel (CCS)	BECCS
	2000	12.7	0.0	0.2	150.0	136.6	381.4	0.0	0.0
	2015	130.4	11.0	94.7	196.1	122.0	430.6	0.0	0.0
	2030	262.9	88.4	320.5	197.7	96.5	302.7	0.0	0.0
	Baseline	440.9	142.9	441.5	209.6	86.8	254.2	1.1	0.0
	EE	457.3	222.5	492.6	211.1	99.3	166.4	0.0	1.1
	CIRC	501.4	253.0	543.8	217.4	106.7	200.2	1.0	1.3
	ELEC	560.2	304.6	683.0	226.6	112.9	248.5	0.3	1.9
2050	H2	635.3	362.2	803.9	225.8	114.1	166.4	0.4	1.1
	P2X	753.2	423.3	966.4	244.0	116.9	161.1	4.2	1.3
	COMBO	684.9	373.6	828.4	235.2	116.9	160.1	1.1	3.2
	1.5TECH	758.7	451.4	1,029.8	244.8	121.3	118.2	16.7	49.1
	1.5LIFE	693.8	396.1	769.8	237.2	114.8	119.1	2.5	2.6

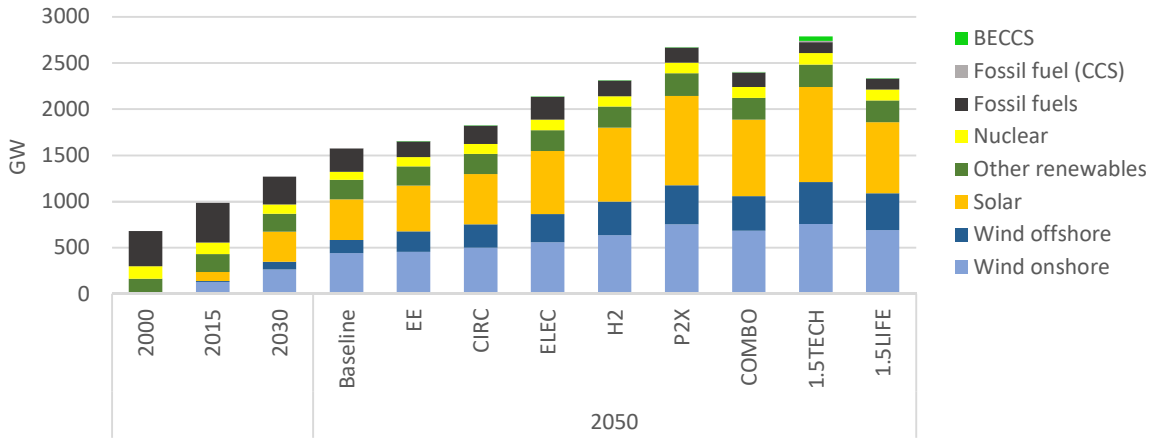
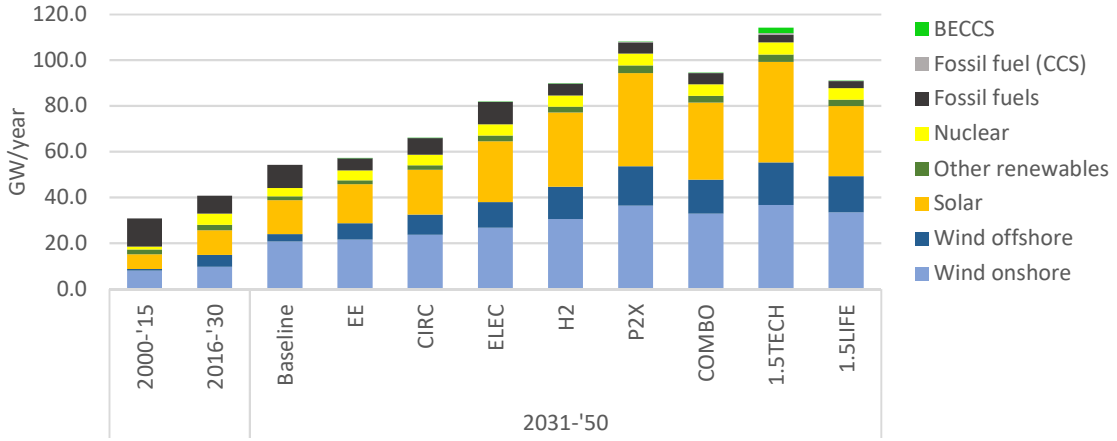


Figure 25: Newly installed power generation capacities*

GW	Elec, new capacities	Wind onshore	Wind offshore	Solar	Other renewables	Nuclear	Fossil fuels	Fossil fuel (CCS)	BECCS
	2000-'15	7.9	0.7	6.4	2.2	1.3	12.3	0.0	
	2016-'30	9.6	5.2	10.9	2.3	4.9	7.8	0.0	
	Baseline	20.7	3.3	14.9	1.7	3.6	10.1	0.1	0.0
	EE	21.5	7.2	17.1	1.7	4.2	5.4	0.0	0.1
	CIRC	23.7	8.7	19.6	2.0	4.6	7.3	0.0	0.1
	ELEC	26.7	11.3	26.6	2.5	4.9	9.8	0.0	0.1
2031-'50	H2	30.5	14.2	32.5	2.4	5.0	5.1	0.0	0.1
	P2X	36.3	17.2	40.7	3.4	5.1	5.0	0.2	0.1
	COMBO	32.9	14.8	33.8	2.9	5.1	4.9	0.1	0.2
	1.5TECH	36.6	18.7	43.9	3.3	5.3	3.1	0.8	2.5
	1.5LIFE	33.4	15.8	30.6	2.9	5.0	3.0	0.1	0.1



*The reported capacities in Figure 25 include all new investments in power generation capacities, including new construction, life-time extension, refurbishment and retrofitting / adding auxiliary equipment.

Figure 26: Electricity storage in 2050

	Pumped hydro	Batteries	Hydrogen	e-gas
2030	37	34	0	0
Baseline	56	119	0	0
EE	73	151	77	0
CIRC	74	171	74	0
ELEC	76	198	65	0
H2	46	126	185	0
P2X	60	160	166	60
COMBO	60	145	95	1
1.5TECH	48	128	105	0
1.5LIFE	44	113	88	0

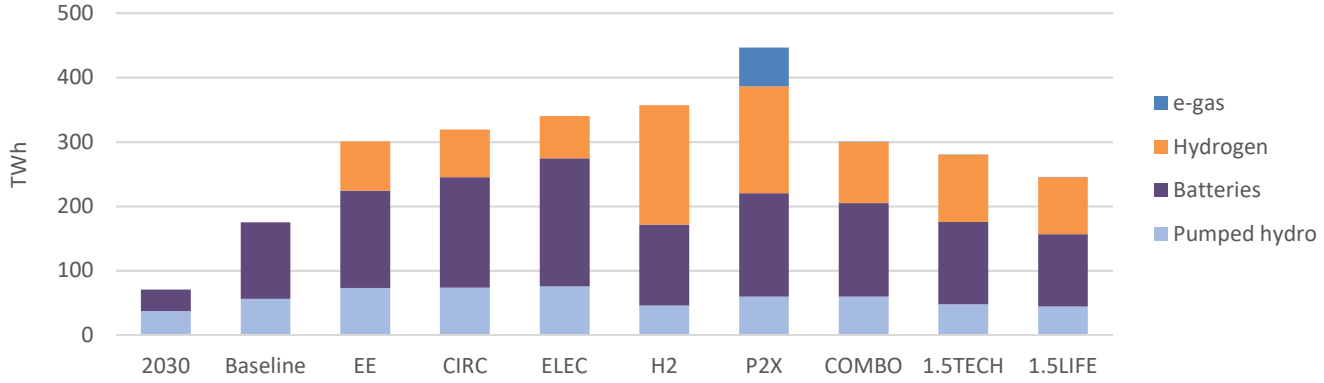


Figure 27: Electricity storage and new fuel production capacities (2050)

	Pumped hydro	Batteries	Hydrogen	PtG	PtL
2015	47				
2030	51	29	2	0	0
Baseline	59	139	18	0	0
EE	64	109	57	0	0
CIRC	66	124	56	0	0
ELEC	70	178	64	0	0
H2	54	97	341	0	0
P2X	56	91	454	142	79
COMBO	58	99	352	76	28
1.5TECH	51	69	511	80	59
1.5LIFE	53	54	403	71	29

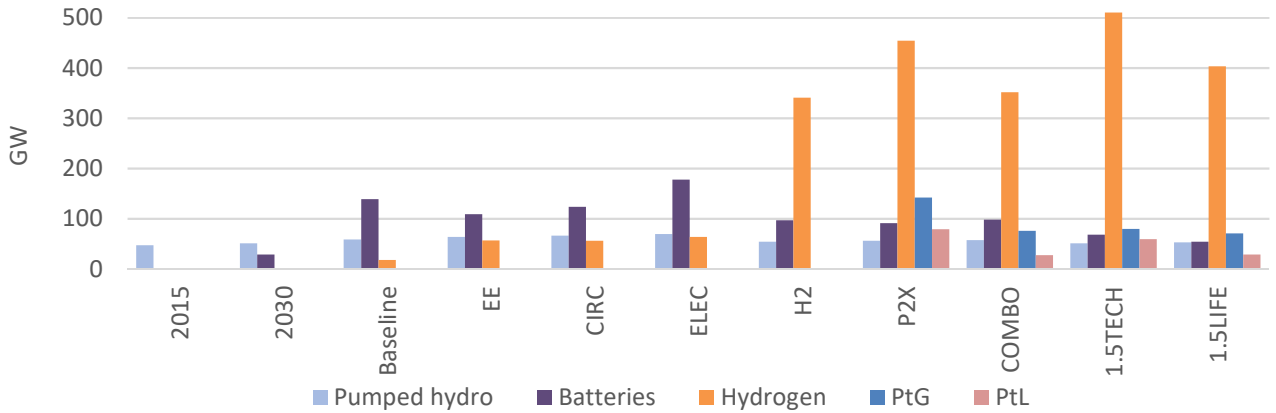


Figure 28: Consumption of natural gas by sector

		Non-energy	Power	Industry	Residential & services	Transport	Other energy
	2015	14	98	86	148	3	10
	2030	18	81	65	117	10	0
2050	Baseline	20	80	64	75	16	4
	EE	20	6	38	38	1	4
	CIRC	18	10	33	39	1	3
	ELEC	20	30	39	31	1	3
	H2	20	41	19	32	4	3
	P2X	20	54	23	25	11	-3
	COMBO	20	24	10	11	7	0
	1.5TECH	15	31	4	7	4	1
	1.5LIFE	15	13	4	7	3	1

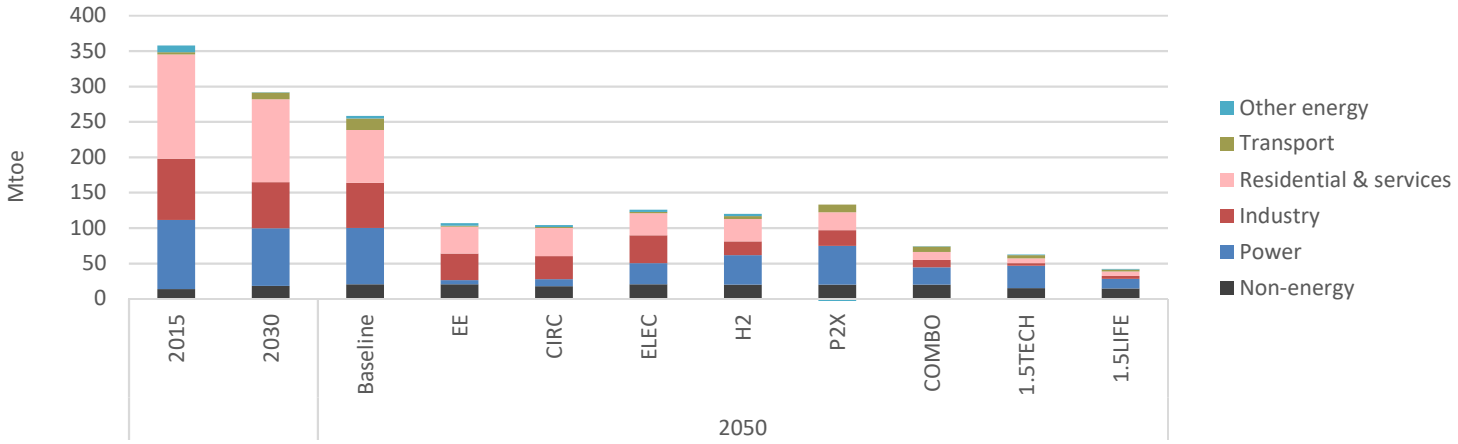


Figure 29: Consumption of biogas and gas from waste by sector

		Power & heat	Industry	Residential & services	Transport
	2015	13	0	2	0
	2030	24	6	0	0
2050	Baseline	28	5	0	2
	EE	26	12	8	0
	CIRC	34	20	17	1
	ELEC	37	14	7	0
	H2	39	12	6	2
	P2X	39	20	13	7
	COMBO	38	15	9	7
	1.5TECH	48	10	7	6
	1.5LIFE	31	12	7	4

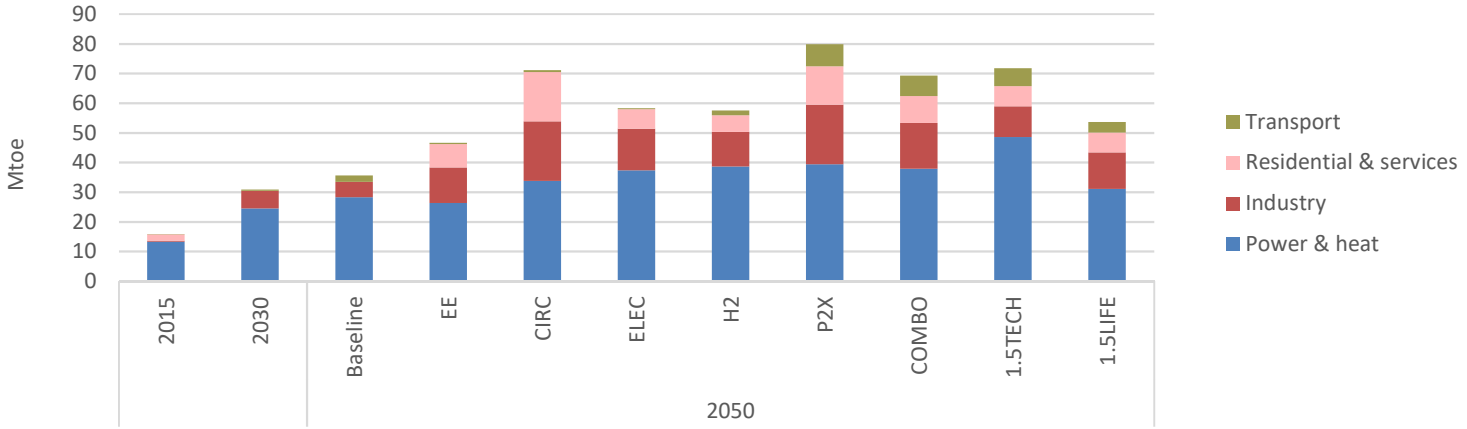


Figure 30: Consumption of e-gas by sector in 2050

	Power	Industry	Residential & services	Transport
P2X	6	30	39	16
COMBO	1	17	20	12
1.5TECH	0	11	22	12
1.5LIFE	0	12	21	8

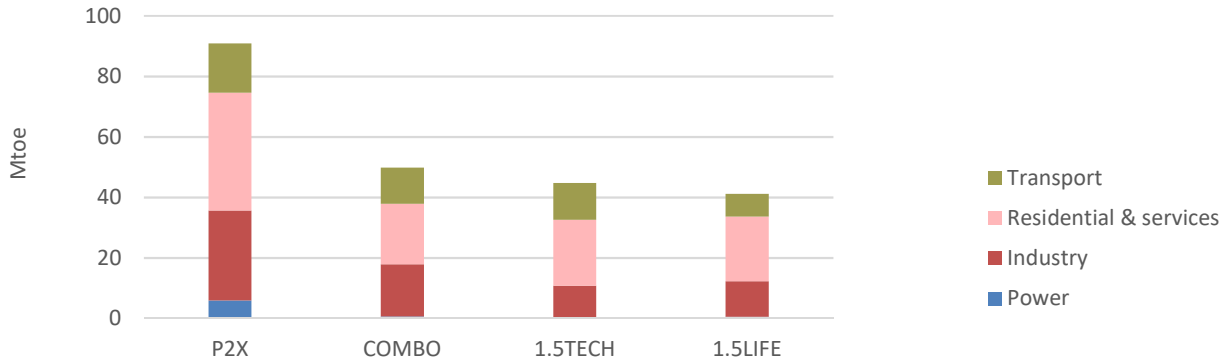


Figure 31: Total gas consumption per gas type

		natural gas	biogas and waste gas	e-gas
	2015	358	16	0
	2030	292	31	0
2050	Baseline	258	36	0
	EE	107	47	0
	CIRC	104.2	71	0
	ELEC	126	58	0
	H2	120	57	0
	P2X	130	80	91
	COMBO	74	69	50
	1.5TECH	63	72	45
	1.5LIFE	42	54	41

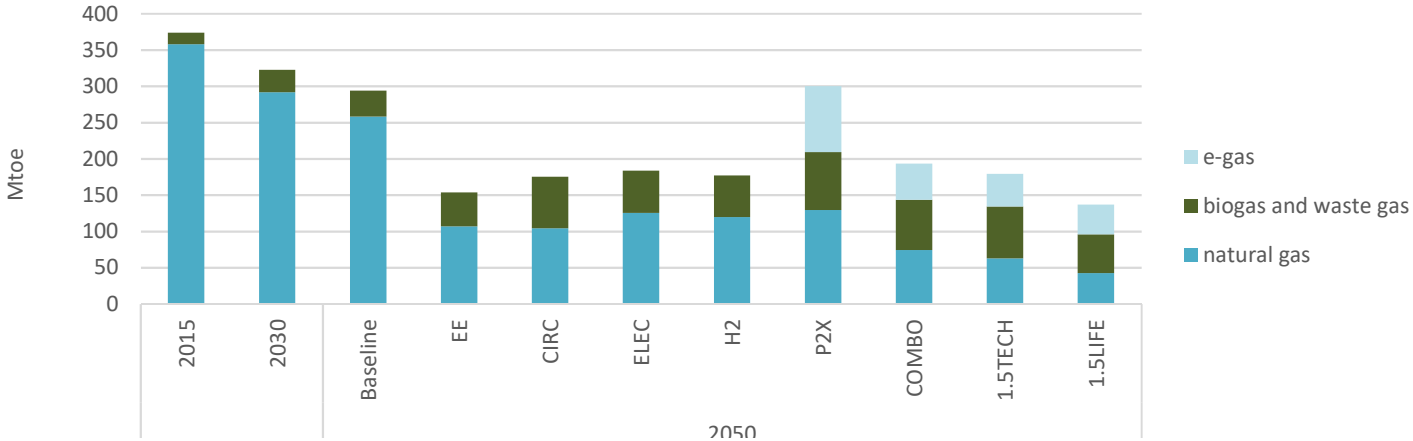


Figure 32: Consumption of hydrogen by sector in 2050

	Power sector (storage)	Industry	Residential & services	Transport
Baseline	0	0	0	6
EE	7	0	0	8
CIRC	6	0	0	9
ELEC	6	0	0	10
H2	13	48	37	48
P2X	12	5	0	9
COMBO	8	15	7	20
1.5TECH	9	29	7	32
1.5LIFE	8	26	7	28

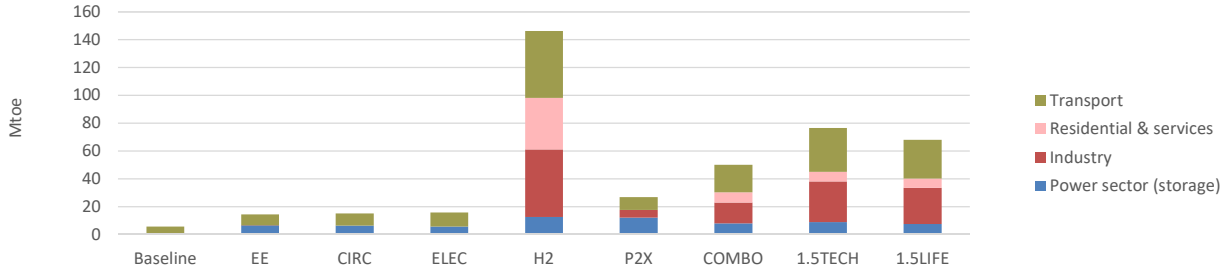


Figure 33: Consumption of gaseous fuels

		Natural gas	Carbon-free gases	Hydrogen
	2015	358	16	0
	2030	292	31	0
2050	Baseline	258	36	6
	EE	107	47	14
	CIRC	104	71	15
	ELEC	126	58	16
	H2	120	57	146
	P2X	130	171	27
	COMBO	74	119	50
	1.5TECH	63	116	77
	1.5LIFE	42	95	68

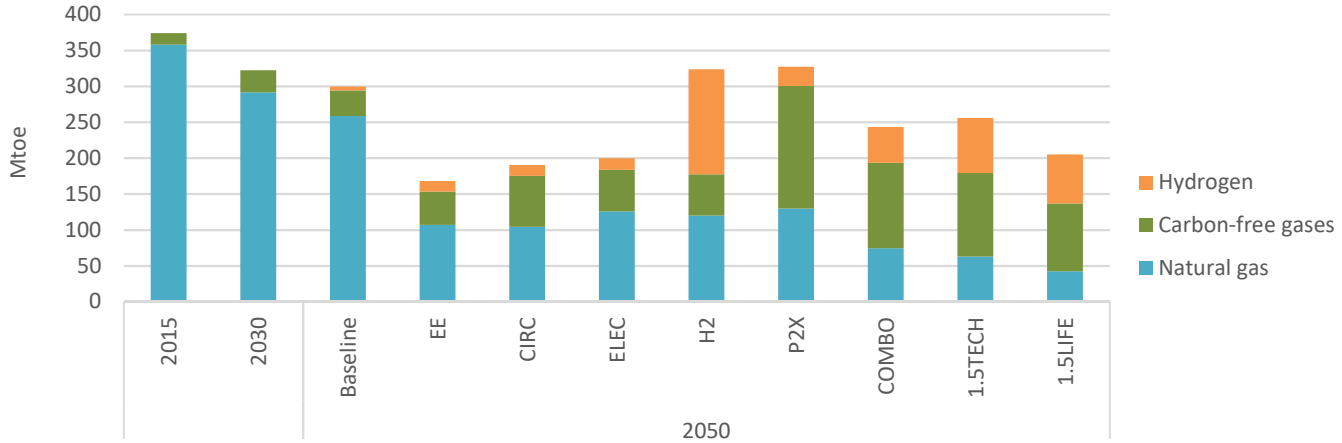


Figure 34: Consumption of new fuels by sector in 2050

		Power sector	Industry	Residential & services	Transport
hydrogen	Baseline	0.0	0.0	0.0	5.7
	EE	6.6	0.0	0.0	7.8
	CIRC	6.4	0.0	0.0	8.8
	ELEC	5.6	0.0	0.0	10.2
	H2	12.7	48.2	37.1	48.1
	P2X	12.2	5.5	0.0	9.1
	COMBO	8.1	14.8	7.3	19.8
	1.5TECH	9.0	29.1	6.9	31.7
	1.5LIFE	7.6	25.8	6.8	28.1
e-gas	P2X		29.8	38.9	16.3
	COMBO		17.2	20.1	11.9
	1.5TECH		10.7	21.8	12.2
	1.5LIFE		11.7	21.4	7.6
e-liquids	P2X				54.3
	COMBO				19.0
	1.5TECH				40.7
	1.5LIFE				19.6

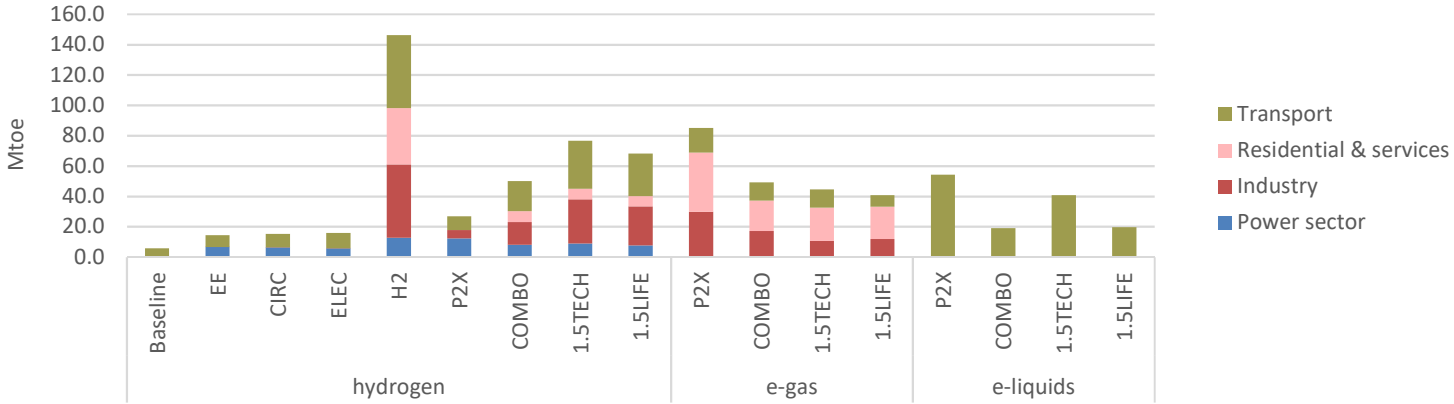


Figure 35: Energy imports

		Oil	Natural gas	Coal	Biomass
	2015	535.7	247.0	111.5	5.9
	2030	462.4	220.5	53.8	15.1
2050	Baseline	425.2	214.4	15.6	7.4
	EE	289.6	99.0	1.0	10.0
	CIRC	276.4	97.6	0.7	12.9
	ELEC	292.9	115.3	0.9	11.4
	H2	294.2	111.4	3.3	11.1
	P2X	287.5	119.8	3.4	11.1
	COMBO	269.3	72.9	3.7	12.4
	1.5TECH	190.8	66.6	1.4	14.8
	1.5LIFE	190.6	46.8	1.1	13.8

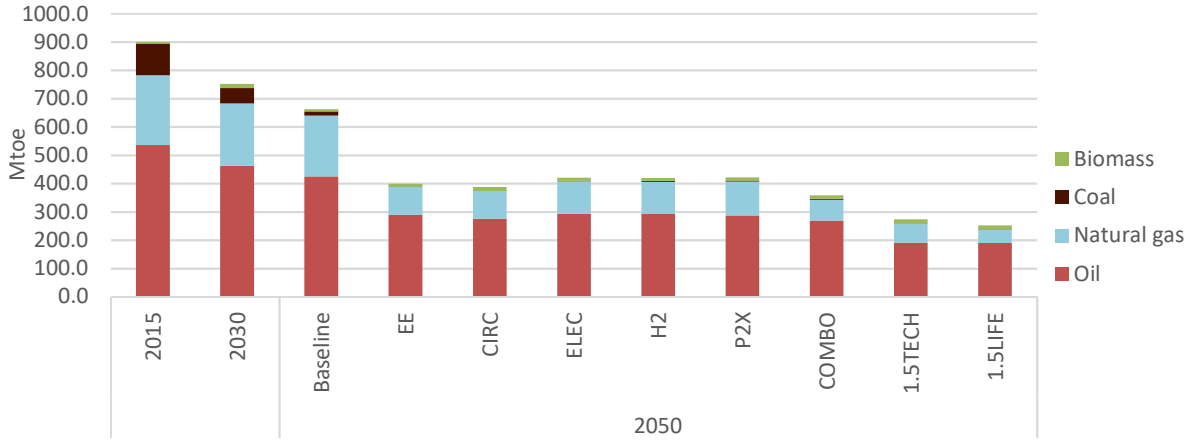


Figure 36: Energy import dependency

		Oil	Natural gas	Coal	Total
	2015	96%	69%	42%	55%
	2030	91%	74%	40%	52%
2050	Baseline	100%	81%	59%	50%
	EE	100%	79%	57%	38%
	CIRC	100%	79%	61%	34%
	ELEC	100%	80%	57%	34%
	H2	100%	80%	73%	33%
	P2X	100%	81%	74%	27%
	COMBO	100%	78%	77%	27%
	1.5TECH	100%	82%	74%	20%
	1.5LIFE	100%	77%	72%	22%

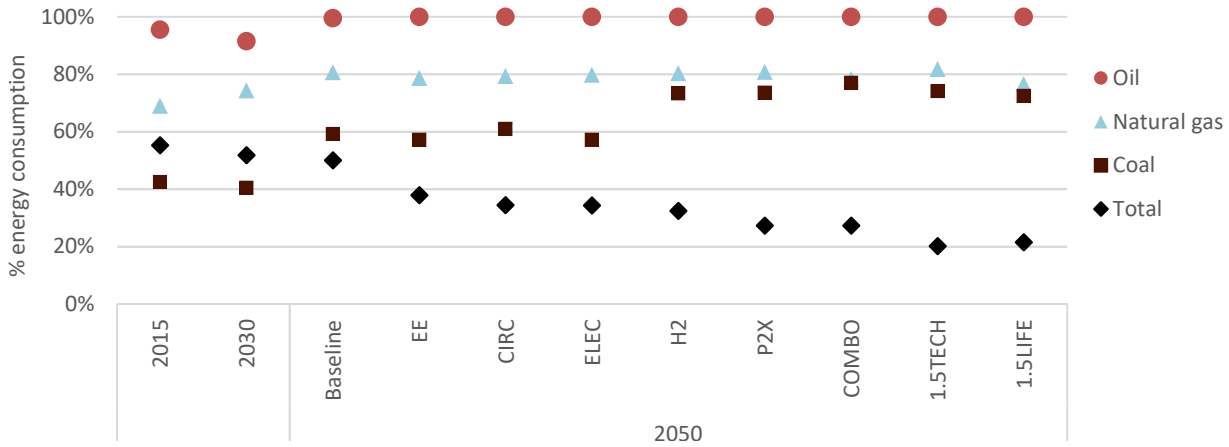


Figure 39: Evolution of the energy consumption in buildings in 2050 (compared to 2005)

		Appliances & lighting	Heating & cooling	Total energy
Residential	2030	22%	-35%	-28%
	Baseline	46%	-50%	-38%
	EE	23%	-67%	-56%
	CIRC	40%	-58%	-46%
	ELEC	43%	-59%	-46%
	H2	42%	-53%	-41%
	P2X	41%	-53%	-41%
	COMBO	39%	-63%	-50%
	1.5TECH	32%	-67%	-54%
	1.5LIFE	30%	-69%	-57%
Services	2030	28%	-25%	-14%
	Baseline	96%	-38%	-10%
	EE	22%	-55%	-39%
	CIRC	67%	-45%	-22%
	ELEC	79%	-43%	-18%
	H2	78%	-41%	-16%
	P2X	78%	-41%	-16%
	COMBO	60%	-47%	-25%
	1.5TECH	34%	-52%	-35%
	1.5LIFE	33%	-57%	-38%

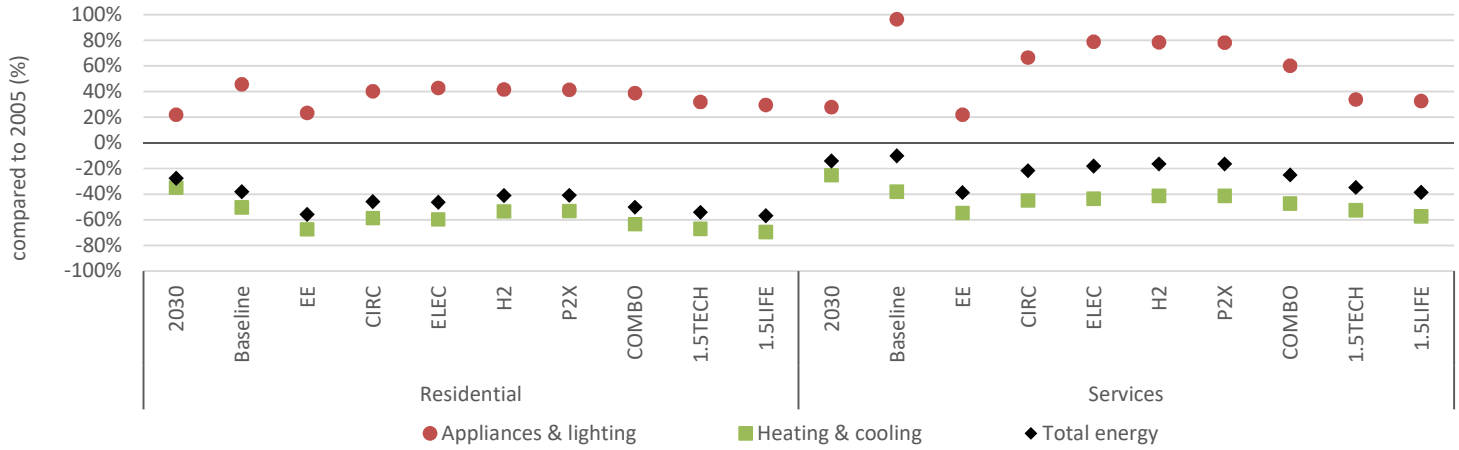


Figure 40: Useful energy consumption for space heating in buildings

		Services	Residential
	2015	91	106
	2030	70	72
2050	Baseline	55	45
	EE	50	40
	CIRC	53	44
	ELEC	54	44
	H2	54	44
	P2X	53	44
	COMBO	52	42
	1.5TECH	50	41
	1.5LIFE	50	40

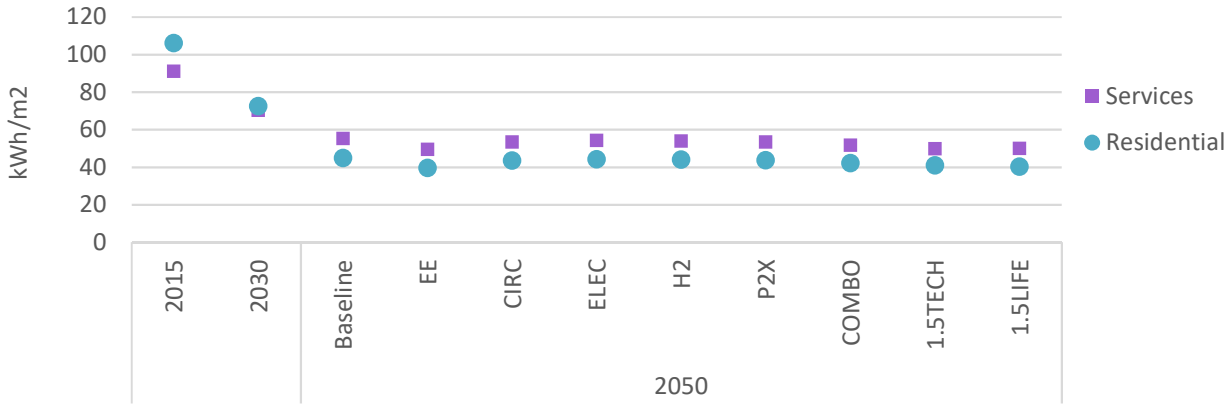


Figure 41: Average yearly renovation rate

		Residential	Services
	2016-'30	1.8%	1.4%
	Baseline	1.4%	1.2%
	EE	1.8%	1.6%
	CIRC	1.5%	1.4%
	ELEC	1.5%	1.3%
2031- '50	H2	1.5%	1.3%
	P2X	1.5%	1.3%
	COMBO	1.6%	1.4%
	1.5TECH	1.7%	1.5%
	1.5LIFE	1.7%	1.5%

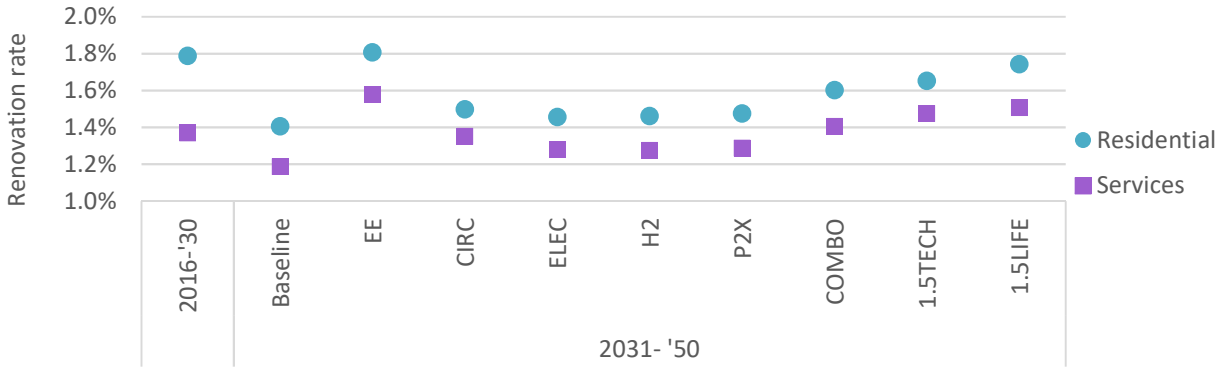


Figure 42: Share of electricity in final energy demand buildings

		Services	Residential
	2015	49%	25%
	2030	64%	39%
2050	Baseline	79%	54%
	EE	78%	61%
	CIRC	80%	60%
	ELEC	83%	68%
	H2	79%	54%
	P2X	78%	53%
	COMBO	81%	63%
	1.5TECH	80%	64%
	1.5LIFE	79%	64%

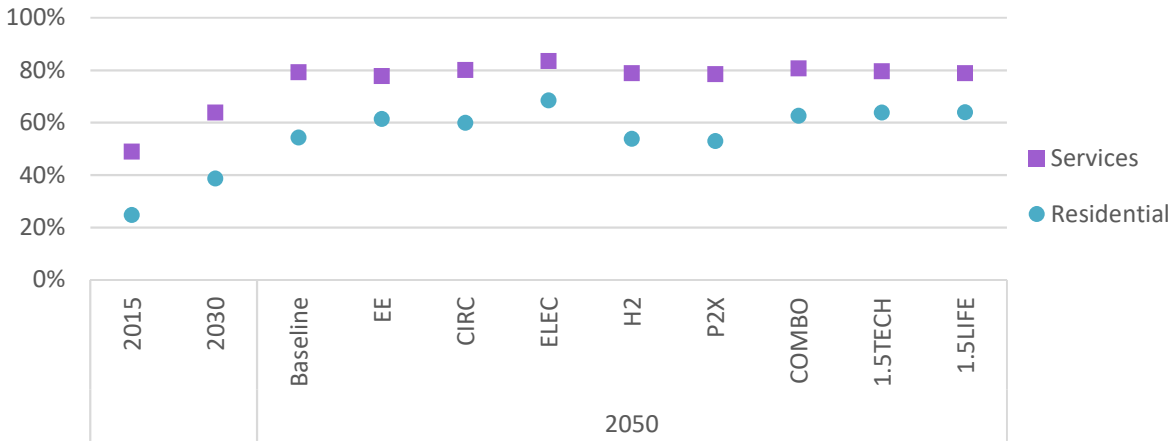


Figure 43: Share of electricity in space heating in buildings

		Services	Residential
	2015	13%	5%
	2030	29%	14%
2050	Baseline	48%	24%
	EE	44%	30%
	CIRC	49%	30%
	ELEC	60%	44%
	H2	48%	23%
	P2X	47%	22%
	COMBO	51%	32%
	1.5TECH	51%	34%
	1.5LIFE	48%	32%

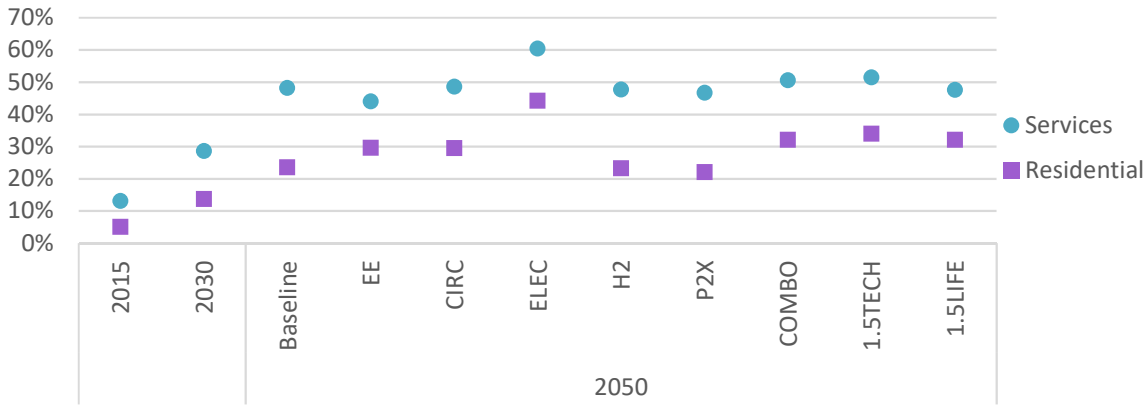


Figure 44: Non-electricity fuel consumption in buildings

		oil & coal	natural gas	biogas	e-gas	hydrogen	solid biomass	district heating	other RES
	2015	60.5	143.2	1.8	0.0	0.0	45.0	30.0	2.8
	2030	8.4	113.7	0.0	0.0	0.0	30.2	24.8	6.5
2050	Baseline	0.6	71.5	0.0	0.0	0.0	13.9	19.9	9.6
	EE	0.4	34.8	7.3	0.0	0.0	9.8	14.3	6.2
	CIRC	0.5	37.0	15.6	0.0	0.0	12.4	16.8	8.1
	ELEC	0.4	28.4	6.0	0.0	0.0	11.1	17.8	8.8
	H2	0.5	30.4	5.4	0.0	35.4	12.7	17.2	8.7
	P2X	0.5	23.8	12.4	37.2	0.0	12.8	17.2	8.7
	COMBO	0.5	10.6	8.5	18.7	6.8	11.3	15.9	6.9
	1.5TECH	0.5	6.2	6.3	20.1	6.4	10.5	14.3	6.6
	1.5LIFE	0.4	6.1	6.1	19.7	6.2	9.3	13.6	6.1

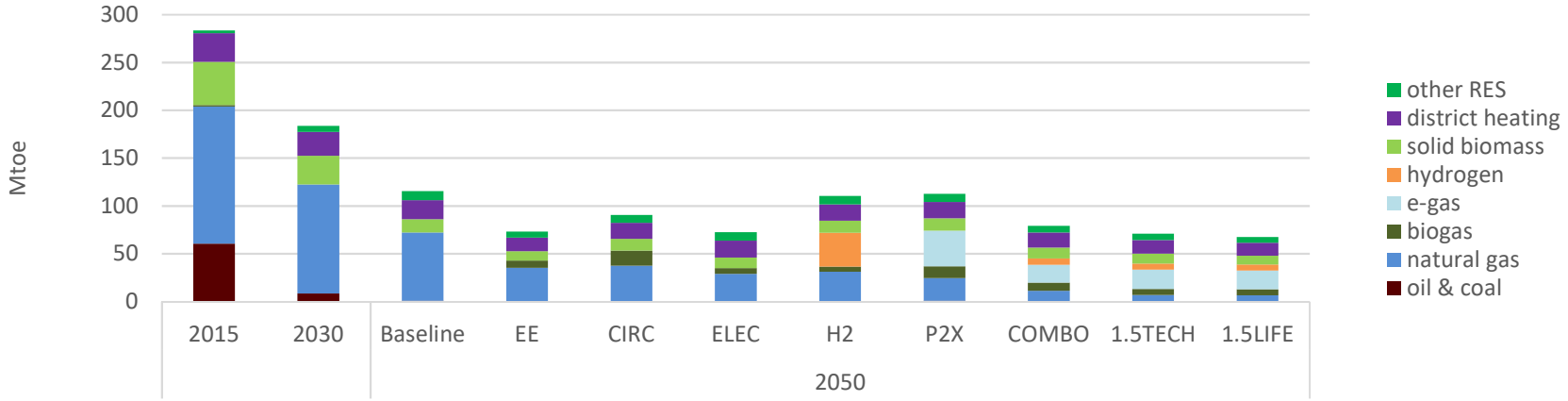


Figure 45: Passenger transport activity in the Baseline (average growth rates per year) and in the -80% to net zero scenarios (% changes to the Baseline in 2050)

Passenger transport	Annual growth rates		
	'95-'15	'15-'30	'30-'50
Road	1.0%	0.7%	0.6%
Rail	1.2%	2.1%	1.2%
Aviation	2.8%	2.3%	1.6%
Inland navigation	-0.5%	1.2%	0.5%

Passenger transport				
EE	Road	Rail	Aviation	Inland navigation
CIRC	-5%	11%	-3%	8%
ELEC	-3%	4%	-2%	5%
H2	-1%	1%	-3%	3%
P2X	-2%	2%	-3%	3%
COMBO	-3%	2%	-3%	4%
1.5TECH	-1%	5%	-3%	5%
1.5LIFE	-3%	2%	-3%	3%
	-4%	9%	-18%	7%

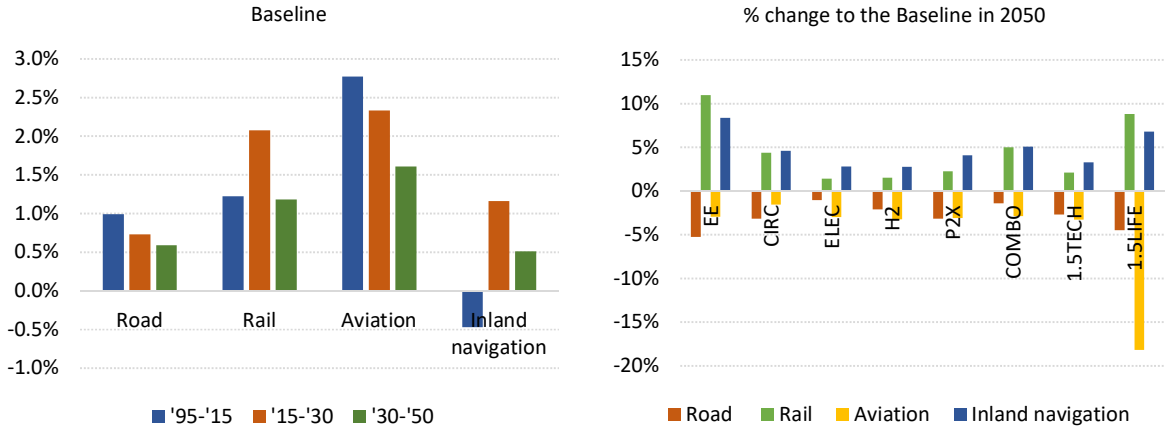
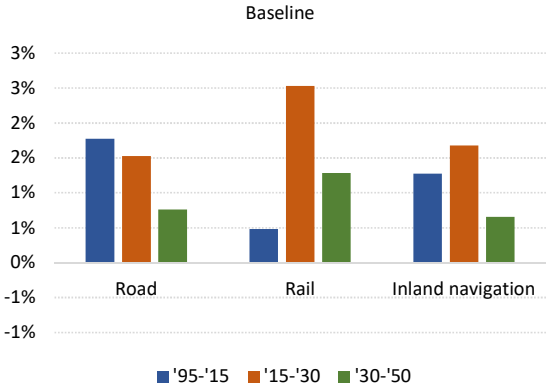


Figure 46: Inland freight transport activity in the Baseline (average growth rates per year) and in the scenarios reaching -80% to net zero emissions by 2050 (% changes to the Baseline in 2050)

	'95-'15	'15-'30	'30-'50
Road	1.8%	1.5%	0.8%
Rail	0.5%	2.5%	1.3%
Inland navigation	1.3%	1.7%	0.7%

	Road	Rail	Inland navigation
EE	-10.6%	15.1%	13.5%
CIRC	-6.0%	5.7%	2.7%
ELEC	-2.1%	3.4%	2.1%
H2	-1.0%	2.5%	2.1%
P2X	-2.6%	2.5%	1.9%
COMBO	-3.2%	8.3%	5.5%
1.5TECH	-4.8%	4.4%	2.4%
1.5LIFE	-6.2%	9.4%	6.7%



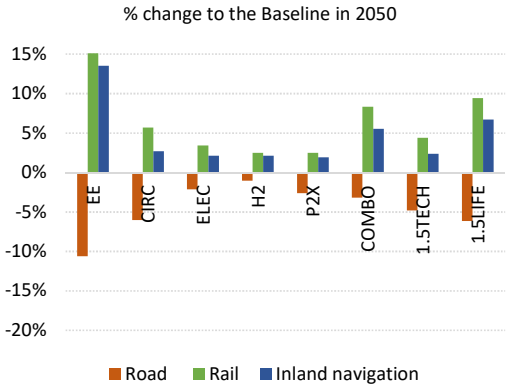


Figure 47: EU international maritime activity in the Baseline and scenario variants

% change relative to 2015

		Activity
2030		21%
2050	Baseline	51%
	H2Mar50	43%
	H2Mar70	43%
	1.5LIFEMar	37%

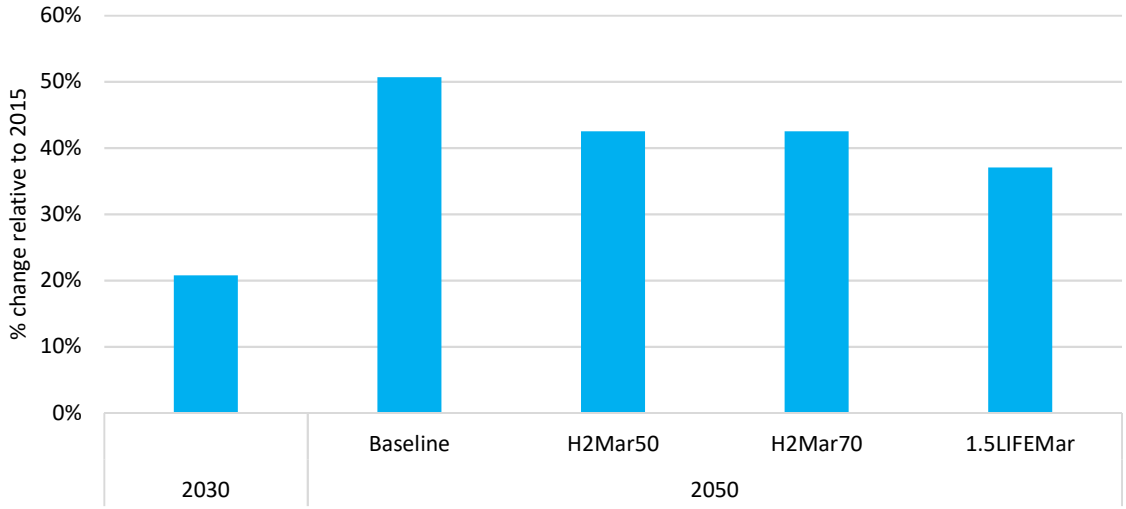


Figure 48: Projections for global international shipping activity

G ton-miles

		Oil freight	Coal freight	Gas freight (LNG)	Chemicals freight	Iron freight	Other industrial products	Containers	Grains freight
2015		12276	7069	1512	979	6525	15112	8659	2175
2030	POLES refere	13829	12787	2219	1688	7013	26792	14678	3149
	POLES 2C	13127	8918	2116	1664	6909	26406	14465	3125
2050	POLES refere	16139	17391	4455	2774	3112	44635	23391	3809
	POLES 2C	7675	4869	2424	2703	3034	43494	22795	4424

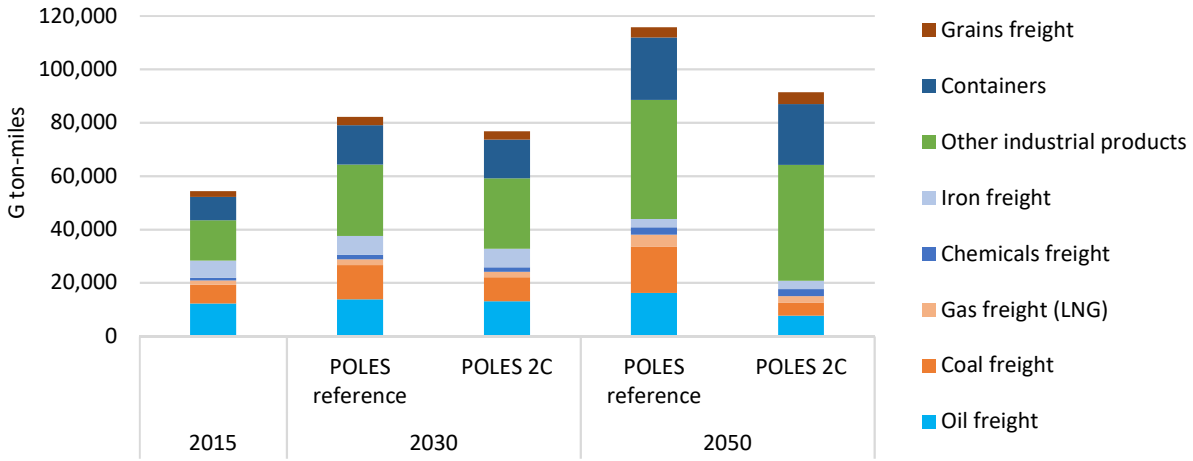


Figure 49: Shares in total cars stock by drivetrain technology in the Baseline and scenarios reaching -80% to net zero emissions by 2050

Share in total vehicle stock (in %)

		ICE gasoline	ICE diesel	ICE gaseous	Plug-in hybrid	Electric	Fuel cell
2015		54%	42%	4%	0%	0%	0%
2030		40%	41%	5%	6%	8%	0%
2050	Baseline	18%	20%	4%	19%	35%	4%
	EE	6%	6%	0%	25%	58%	5%
	CIRC	7%	7%	0%	25%	57%	4%
	ELEC	6%	6%	0%	24%	57%	7%
	H2	8%	8%	0%	17%	51%	16%
	P2X	14%	18%	2%	12%	48%	4%
	COMBO	6%	6%	2%	24%	56%	7%
	1.5TECH	1%	1%	1%	2%	80%	16%
	1.5LIFE	1%	1%	1%	2%	80%	16%

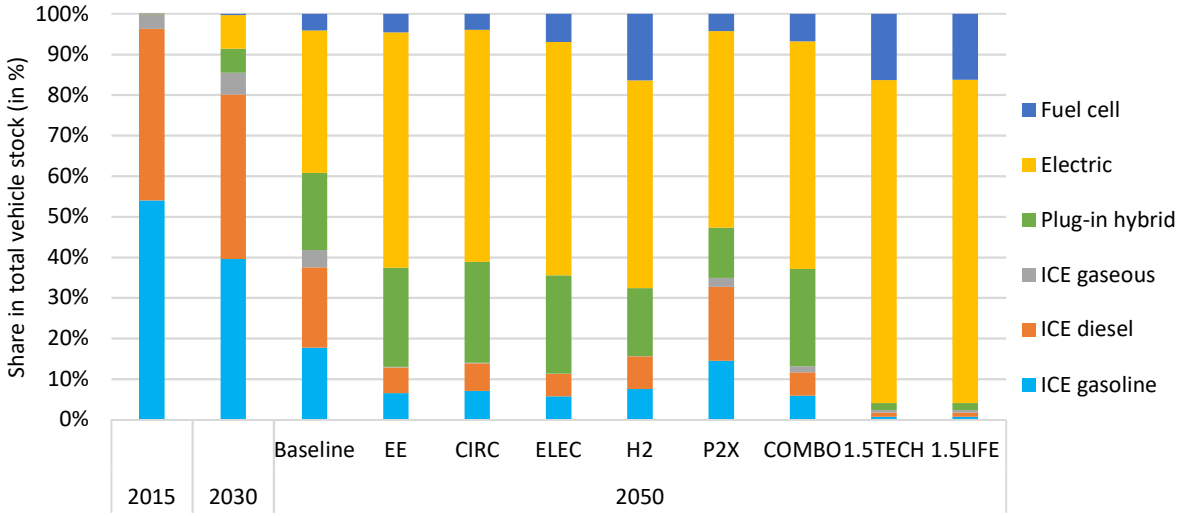


Figure 50: Shares in total light commercial vehicle stock by drivetrain technology in the Baseline and scenarios reaching -80% to net zero emissions by 2050

Share in total vehicle stock (in %)

		ICE gasoline	ICE diesel	ICE gaseous	Plug-in hybrid	Electric	Fuel cell
2015		9%	90%	0%	0%	0%	0%
2030		4%	84%	0%	6%	6%	0%
2050	Baseline	3%	51%	0%	19%	26%	1%
	EE	2%	26%	0%	23%	43%	7%
	CIRC	2%	28%	0%	22%	41%	7%
	ELEC	1%	23%	0%	25%	44%	6%
	H2	1%	19%	0%	16%	19%	45%
	P2X	2%	40%	0%	17%	34%	6%
	COMBO	1%	23%	0%	25%	44%	6%
	1.5TECH	0%	5%	0%	3%	78%	14%
	1.5LIFE	0%	5%	0%	3%	79%	13%

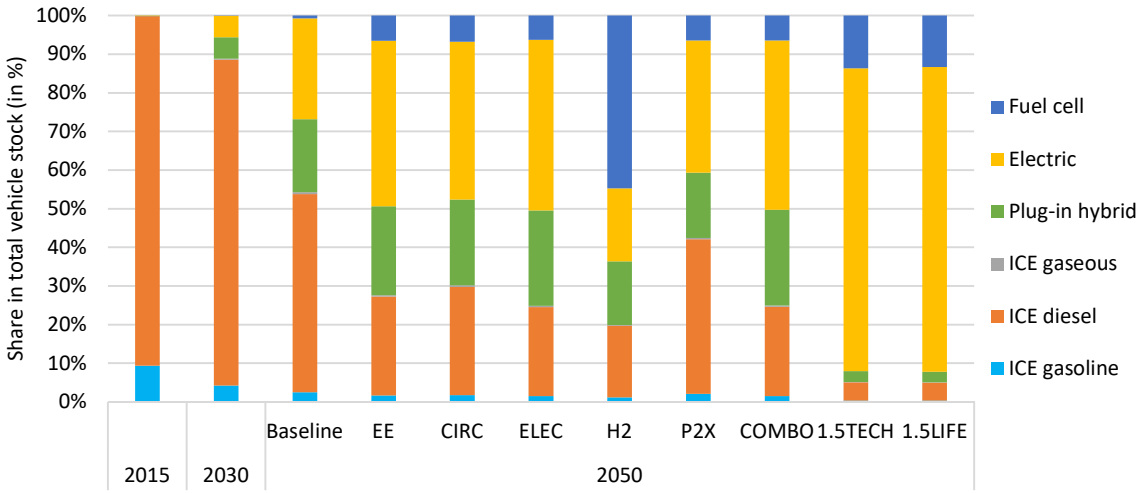


Figure 51: Shares in total heavy goods vehicles stock by drivetrain technology in the Baseline and scenarios reaching -80% to net zero emissions by 2050

Share in total vehicle stock (in %)

		ICE diesel	ICE gaseous	Hybrid	Electric	Fuel cell
2015		100%	0%	0%	0%	0%
2030		81%	5%	14%	0%	0%
2050	Baseline	51%	18%	29%	1%	1%
	EE	53%	0%	29%	17%	1%
	CIRC	58%	0%	33%	6%	3%
	ELEC	51%	0%	28%	20%	1%
	H2	47%	14%	24%	0%	15%
	P2X	37%	35%	22%	3%	3%
	COMBO	39%	32%	19%	4%	6%
	1.5TECH	32%	34%	20%	8%	6%
	1.5LIFE	41%	19%	29%	6%	5%

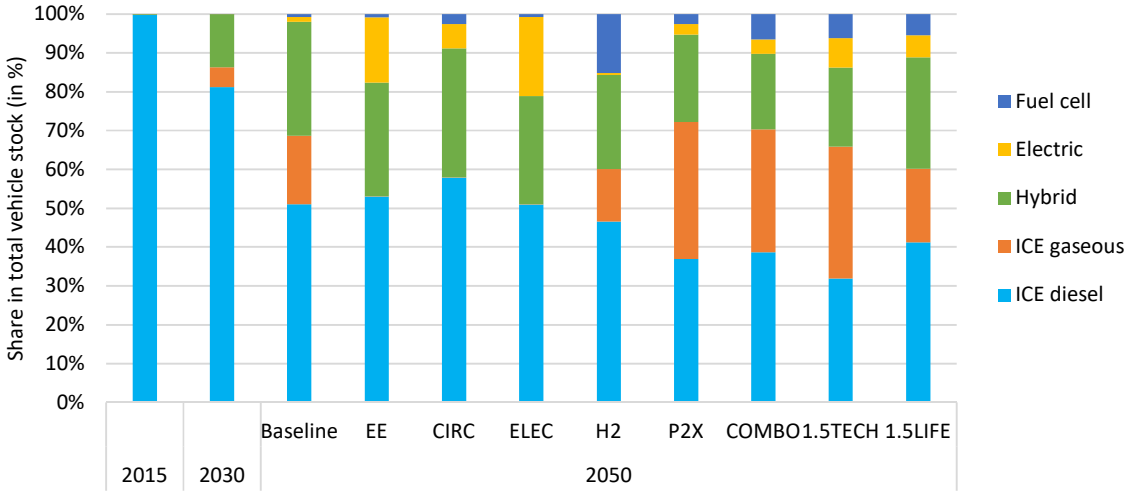


Figure 52: Aviation fuels mix in the Baseline and scenarios reaching -80% to net zero emissions by 2050 in 2050

Mtoe

		jet fuels	e-liquids	liquid biofuel	electricity
2015		53.3	0.0	0.0	0.0
2030		57.3	0.0	0.0	0.0
2050	Baseline	63.2	0.0	1.8	0.0
	EE	46.6	0.0	12.7	0.5
	CIRC	46.2	0.0	15.1	0.1
	ELEC	46.8	0.0	12.7	0.5
	H2	47.5	0.0	12.9	0.0
	P2X	46.8	8.5	5.1	0.0
	COMBO	44.6	3.3	11.9	0.4
	1.5TECH	23.9	19.8	13.7	1.2
	1.5LIFE	22.4	5.0	23.0	0.3

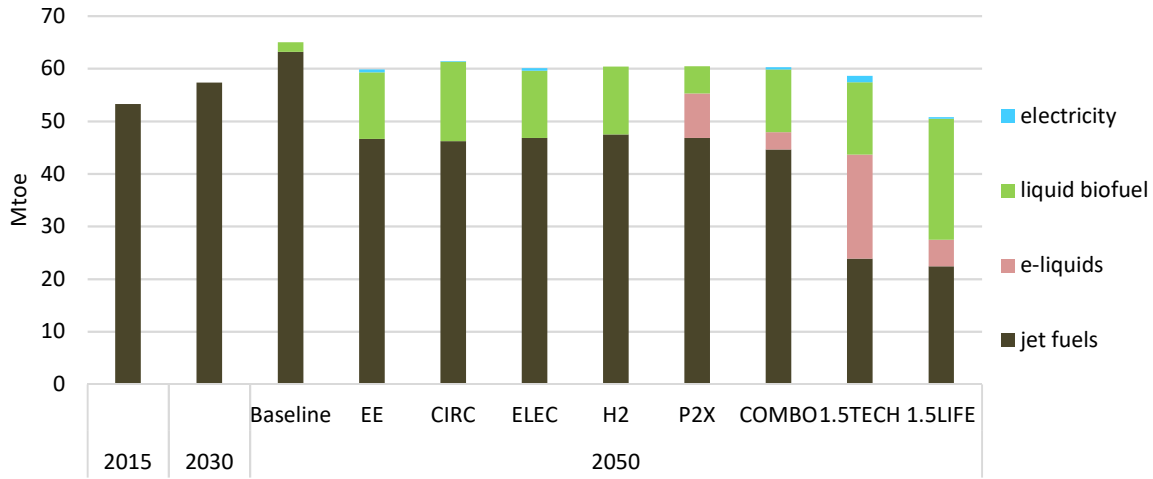


Figure 54: EU international maritime fuel mix in the Baseline and decarbonisation variants

Mtoe

		marine diesel oil	heavy fuel oil	liquid biofuels	natural gas	e-gas	e-liquids	hydrogen	other liquids
2015		11.6	43.1	0.0	0.0	0.0	0.0	0.0	0.1
2030		14.3	40.3	0.0	5.2	0.0	0.0	0.0	0.1
2050	Baseline	19.4	43.1	0.0	7.4	0.0	0.0	0.0	0.0
	H2Mar50	6.8	14.7	21.5	7.9	0.0	0.0	7.8	0.0
	H2Mar70	3.4	7.2	30.1	7.7	0.0	0.0	7.7	0.0
	1.5LIFEMar	0.9	1.8	27.0	5.3	5.1	8.3	1.9	0.0

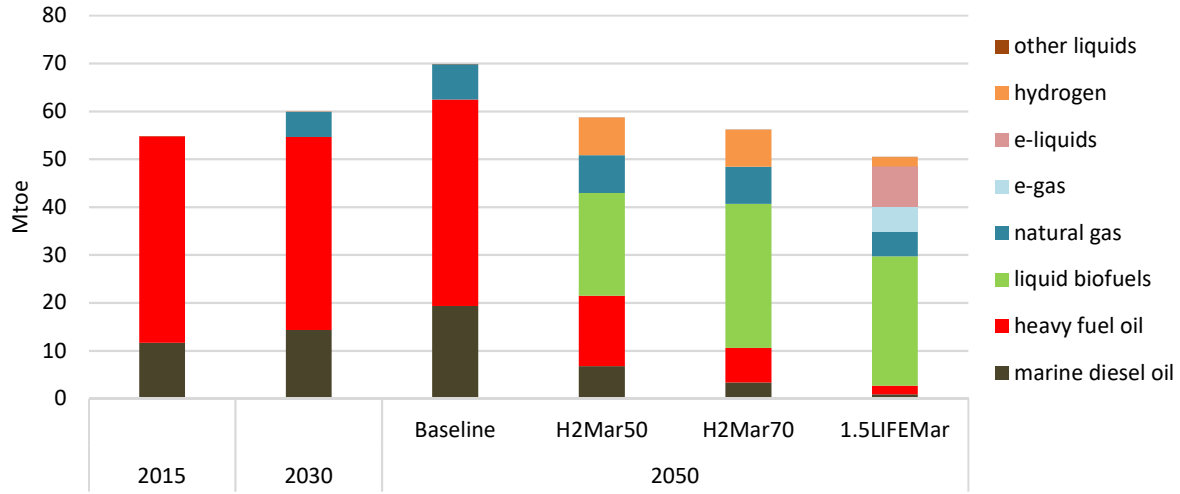


Figure 55: Energy demand of global international shipping

Mtoe

		gas	oil	liquid biofuels	hydrogen
2030	POLES reference	116.4	330.1	2.4	2.1
	POLES 2C	67.6	217.8	14.9	10.1
2050	POLES reference	223.4	314.5	9.6	12.8
	POLES 2C	45.7	97.9	101.5	71.8

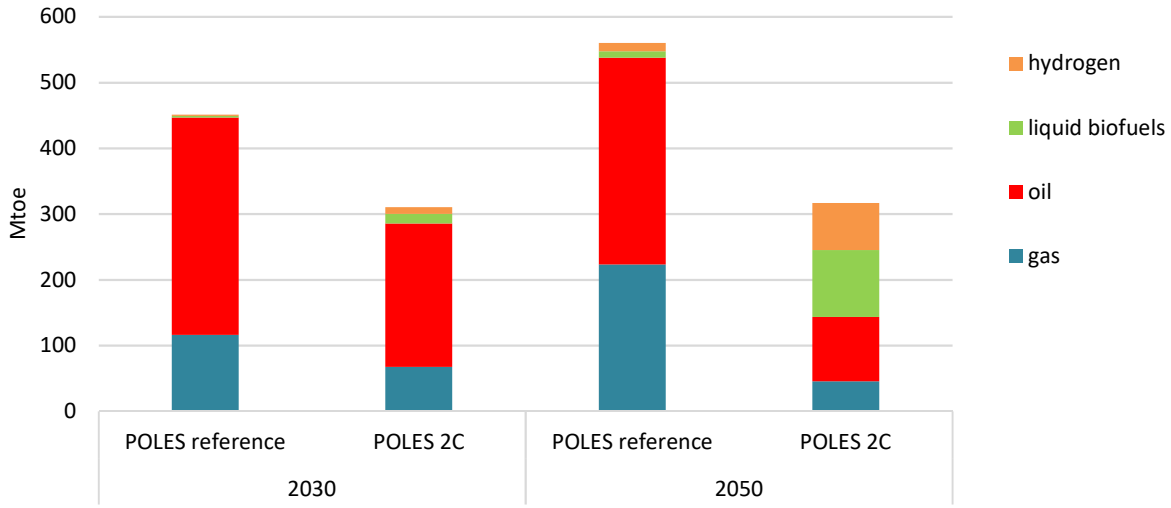


Figure 56: Change in energy consumption per mode in 2050 compared to 2005

		Total	Road	Rail	Air	Inland navigation
2030	2030	-13%	-18%	16%	15%	-13%
2050	Baseline	-24%	-35%	22%	30%	-7%
	EE	-43%	-57%	31%	20%	2%
	CIRC	-43%	-57%	24%	23%	-5%
	ELEC	-42%	-54%	21%	20%	-6%
	H2	-38%	-50%	20%	21%	-6%
	P2X	-31%	-42%	21%	21%	-5%
	COMBO	-38%	-50%	25%	21%	-3%
	1.5TECH	-45%	-58%	20%	17%	-6%
	1.5LIFE	-50%	-61%	26%	2%	-3%

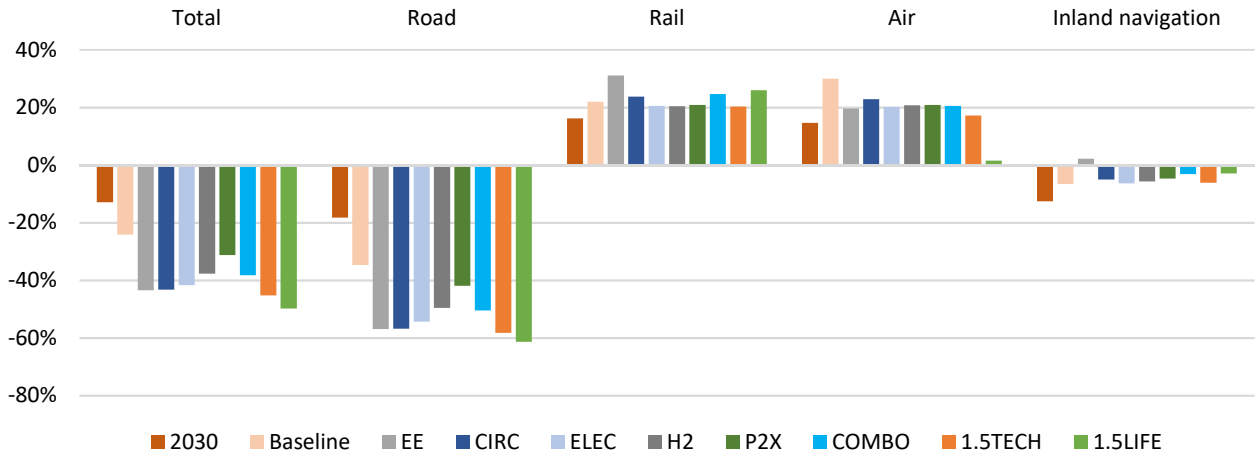


Figure 57: Fuels consumed in the transport sector in 2050

Mtoe

		oil products	e-liquids	liquid biofuel	natural gas	biogas	e-gas	hydrogen	electricity
2015		337.8	0.0	16.4	1.7	0.1	0.0	0.0	4.8
2030		279.0	0.0	18.1	8.6	0.3	0.0	0.4	12.2
2050	Baseline	207.5	0.0	15.7	15.2	2.3	0.0	5.7	31.4
	EE	105.9	0.0	39.3	0.9	0.3	0.0	7.8	52.9
	CIRC	103.4	0.0	48.6	1.0	0.6	0.0	8.8	45.4
	ELEC	106.7	0.0	39.7	0.8	0.3	0.0	10.2	55.8
	H2	102.8	0.0	37.4	3.4	1.6	0.0	48.1	35.0
	P2X	93.5	54.3	24.1	10.4	7.4	16.3	9.1	36.5
	COMBO	80.1	19.0	34.6	7.0	6.9	11.9	19.8	46.6
	1.5TECH	25.7	40.7	28.2	4.2	6.0	12.2	31.7	51.9
	1.5LIFE	29.7	19.6	44.5	2.5	3.5	7.6	28.1	48.4

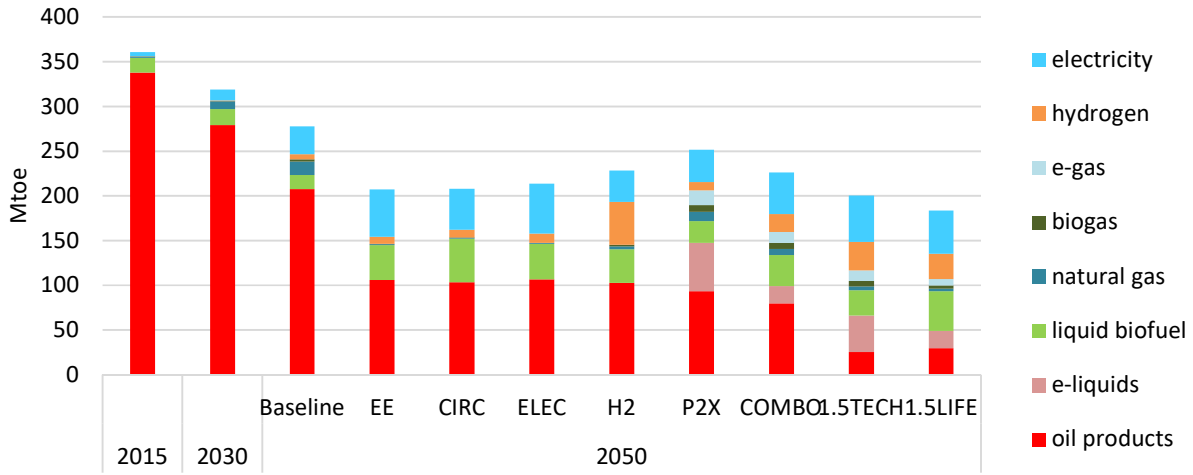


Figure 58: CO2 emissions from transport in 2050 (in MtCO2)

Mt of CO2

		cars	heavy goods vehicles	other road transport	rail	aviation	inland navigation	total
2005		543.2	199.0	151.6	9.7	150.2	21.2	1075
2030		359.4	188.3	121.5	7.7	172.4	17.1	866
2050	Baseline	190.8	179.5	82.7	4.0	190.0	17.7	665
	EE	54.1	90.4	22.9	1.6	140.2	14.6	324
	CIRC	51.6	85.5	26.1	1.7	138.9	12.4	316
	ELEC	52.6	95.5	22.4	1.5	140.8	13.4	326
	H2	52.9	88.0	17.1	1.8	142.8	12.9	315
	P2X	68.0	62.1	27.3	1.1	140.8	8.1	307
	COMBO	38.1	57.1	16.1	1.1	134.1	9.2	256
	1.5TECH	0.8	9.7	0.8	0.1	71.7	1.8	85
	1.5LIFE	1.6	19.9	1.4	0.4	67.3	3.8	94

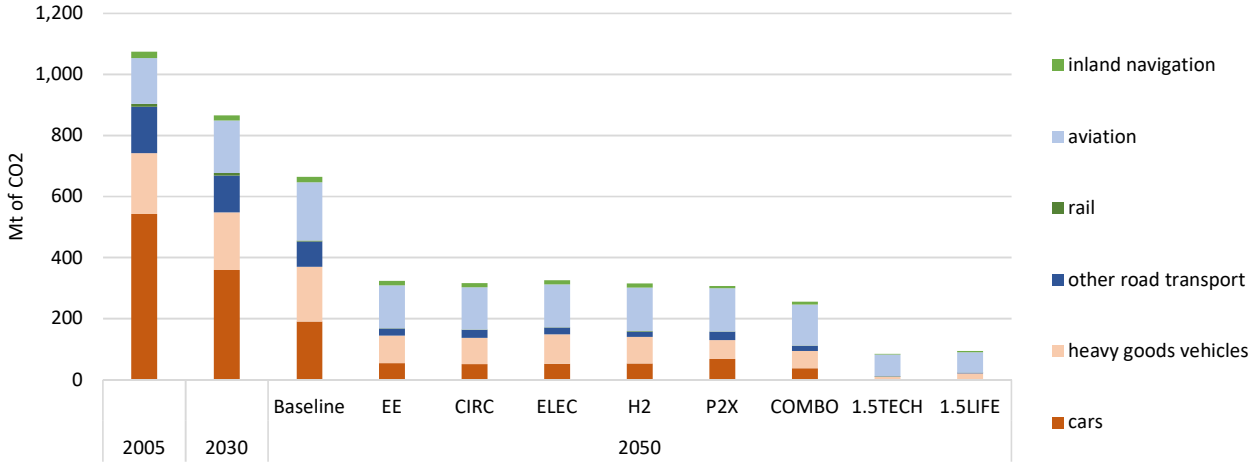
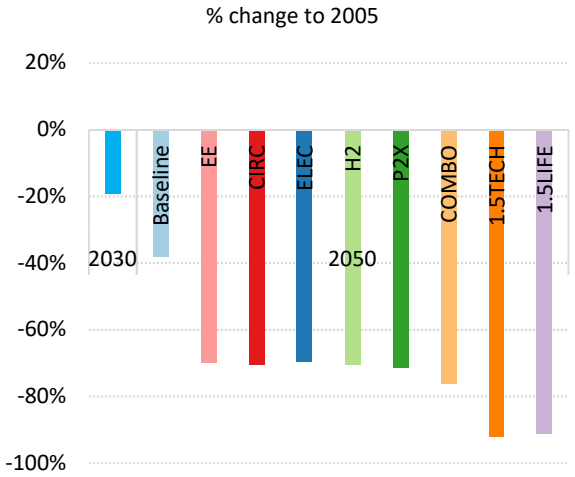


Figure 59: CO2 emissions from transport in 2050 relative to 2005 (left) and to 1990 (right)

		% difference to 2005
2030		-19%
2050	Baseline	-38%
	EE	-70%
	CIRC	-71%
	ELEC	-70%
	H2	-71%
	P2X	-71%
	COMBO	-76%
	1.5TECH	-92%
	1.5LIFE	-91%

		% difference to 1990
2030		4%
2050	Baseline	-21%
	EE	-61%
	CIRC	-62%
	ELEC	-61%
	H2	-62%
	P2X	-63%
	COMBO	-69%
	1.5TECH	-90%
	1.5LIFE	-89%



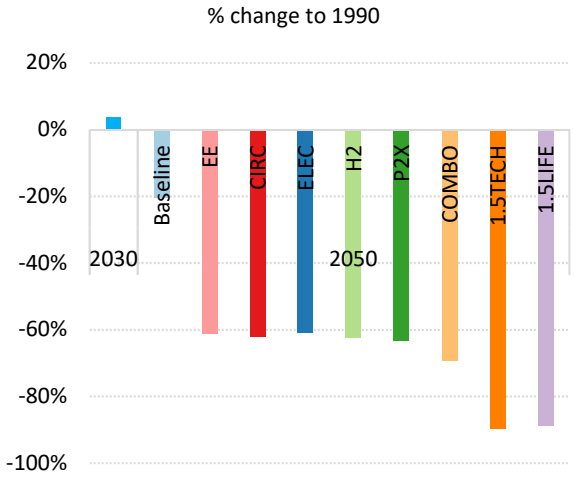


Figure 60: Air transport emissions (MtCO2) in the Baseline and scenarios reaching -80% to net zero emissions by 2050

Mt of CO2

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Baseline	150	148	160	169	175	172	173	179	183	190
EE	150	148	160	169	175	172	163	156	144	140
CIRC	150	148	160	169	175	172	163	156	143	139
ELEC	150	148	160	169	175	172	163	157	145	141
H2	150	148	160	169	175	172	162	156	145	143
P2X	150	148	160	169	175	172	168	162	141	141
COMBO	150	148	160	169	175	172	163	159	136	134
1.5TECH	150	148	160	169	175	172	159	144	107	72
1.5LIFE	150	148	160	169	175	172	151	108	95	67

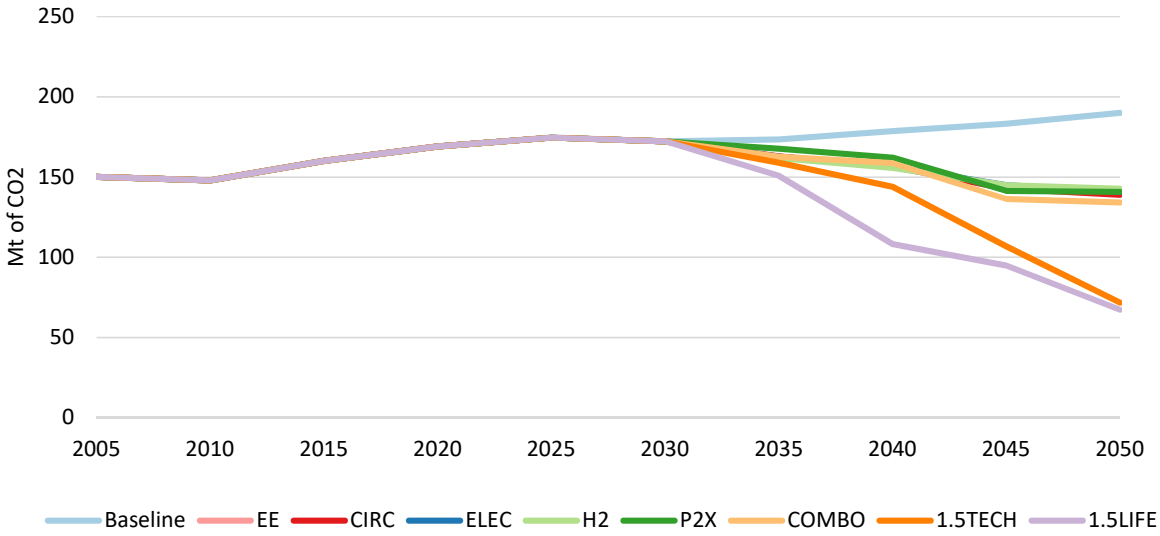


Figure 61: Emissions reductions at EU level in the maritime decarbonisation variants

Mt of CO2

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Baseline	162	158	176	179	183	187	193	200	208	217
H2Mar50	162	158	176	179	181	181	168	143	109	87
H2Mar70	162	158	176	179	181	180	165	139	105	52
1.5LIFEMar	162	158	176	179	181	178	161	129	51	21

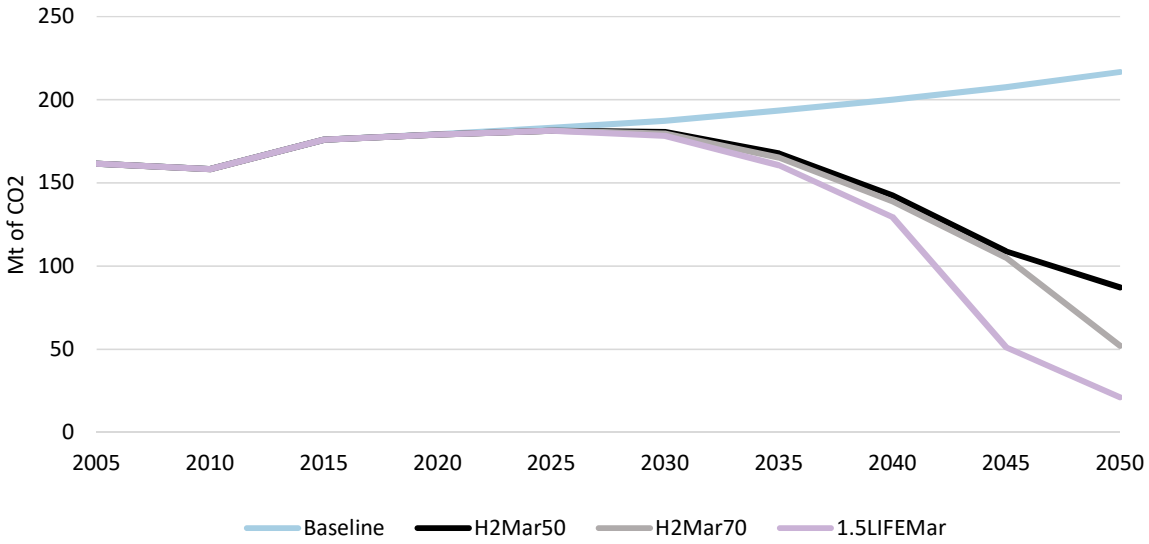


Figure 62: Emissions reductions at global level in POLES

Mt of CO2

	2010	2020	2030	2040	2050
POLES-JRC reference	866	1139	1326	1468	1526
POLES-JRC 2C	866	1134	853	598	419

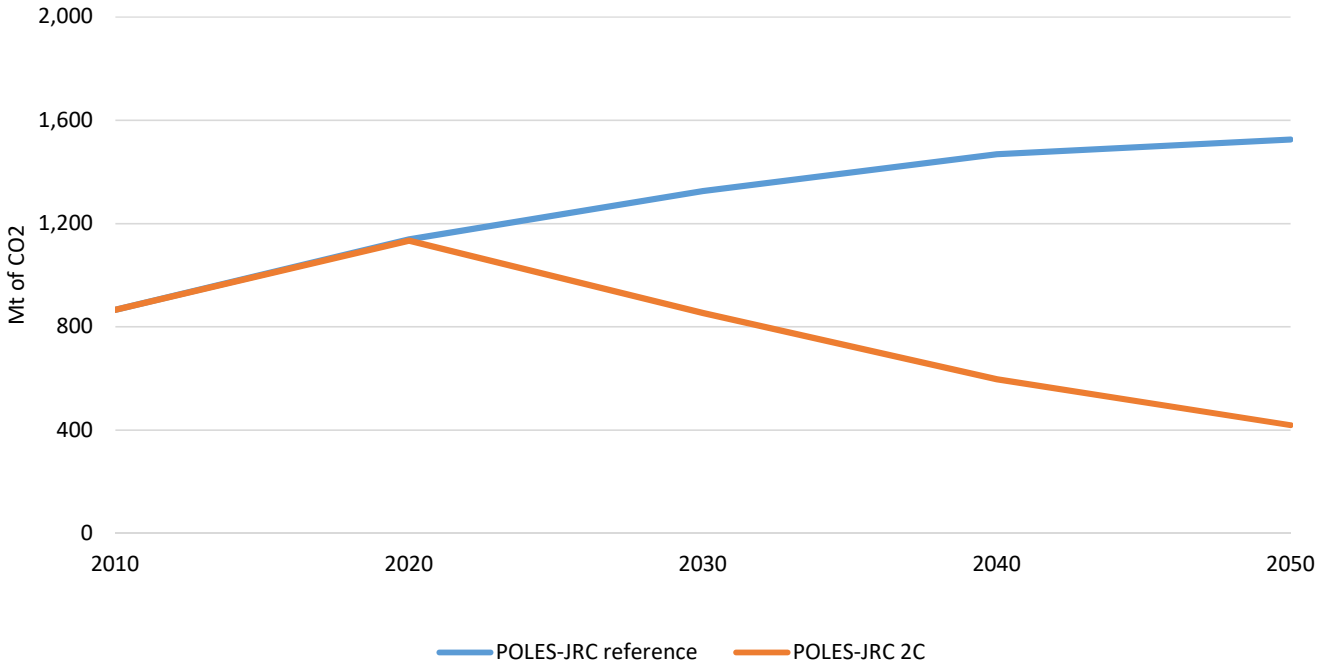


Figure 68: Total final energy consumption in industry by scenario compared to 2015

Baseline	ELEC	H2	P2X	EE	CIRC	COMBO	1.5 TECH	1.5 LIFE
-11%	-11%	-12%	-13%	-25%	-22%	-19%	-22%	-31%

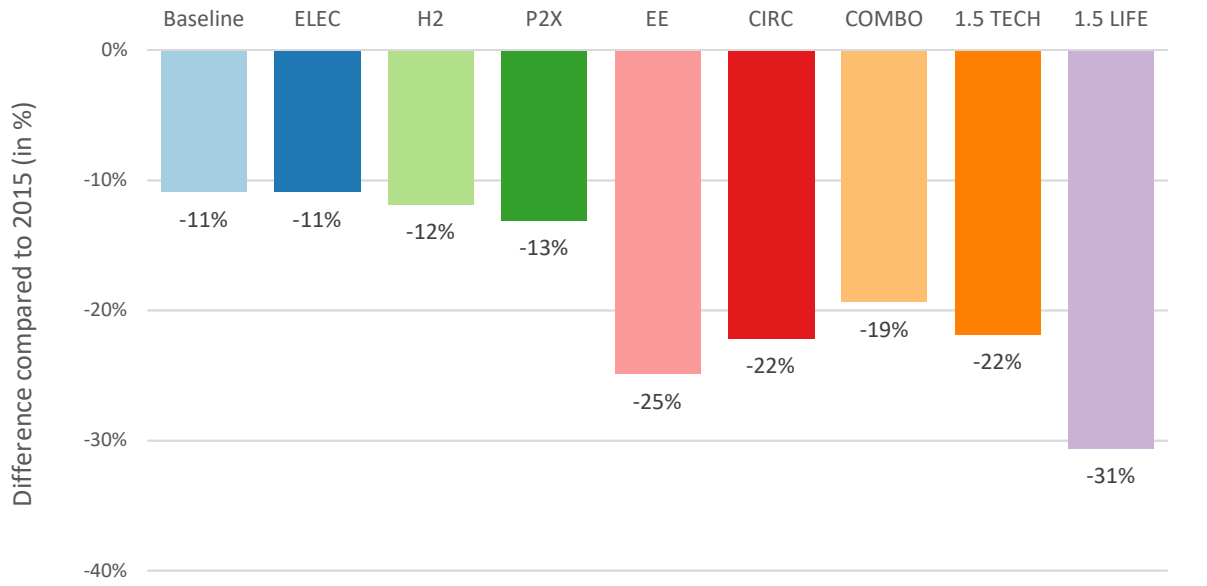


Figure 69: Differences in final energy consumption in industry compared to Baseline in 2050

	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5LIFE
Egas	0.0	0.0	29.8	0.0	0.0	17.2	10.7	11.7
Hydrogen	0.0	48.2	5.5	0.0	0.0	14.8	29.1	25.8
Electricity	35.6	1.6	3.1	7.4	4.7	13.5	15.8	-5.9
Biomass	4.2	3.7	8.6	1.9	9.5	-2.3	-7.6	-8.2
Reduced Demand	0.1	2.7	5.2	39.8	32.1	24.4	32.7	56.9
Natural Gas (incl. coal gas)	-24.4	-44.5	-41.2	-25.9	-31.2	-53.2	-60.1	-59.8
Steam	2.6	-1.1	-1.0	-4.7	2.4	-1.1	-3.9	-3.7
Solids	-9.1	-7.3	-7.2	-8.8	-9.3	-7.2	-8.8	-9.0
Fossil Based Liquids	-7.9	-3.3	-2.8	-9.6	-8.2	-5.1	-6.9	-7.2
Other (solar, geothernal)	-1.0	0.0	0.0	-0.1	-0.1	-0.9	-1.0	-0.6

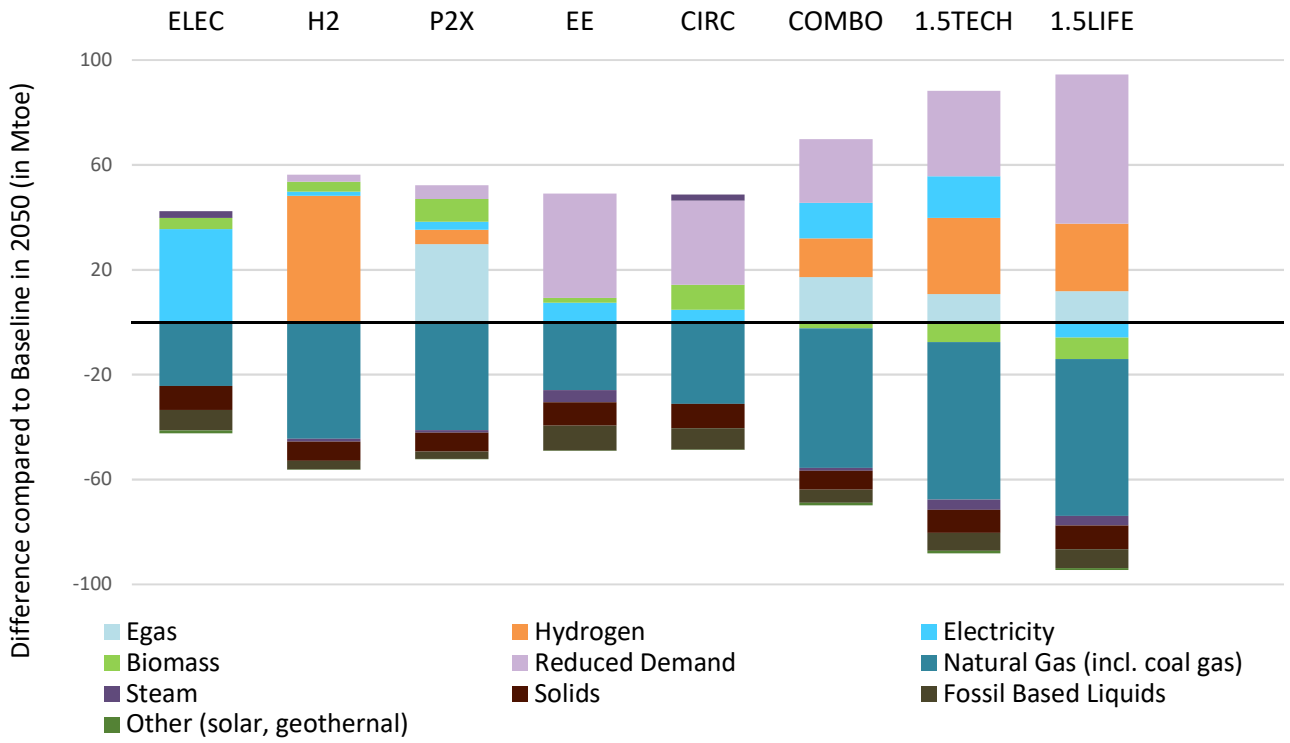


Figure 70: Carbon intensity in industry

	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Baseline	1.8	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.9	0.9	0.8	0.8	0.8
ELEC	1.806	1.780	1.686	1.499	1.285	0.940	0.659	0.504	0.407	0.323	0.299	0.286	0.284
H2	1.8	1.8	1.7	1.5	1.3	1.1	0.7	0.5	0.3	0.2	0.1	0.1	0.1
P2X	1.8	1.8	1.7	1.5	1.3	1.1	0.7	0.5	0.3	0.2	0.2	0.1	0.1
EE	1.8	1.8	1.7	1.5	1.3	1.0	0.7	0.6	0.5	0.4	0.4	0.3	0.3
CIRC	1.8	1.8	1.7	1.5	1.3	0.9	0.6	0.5	0.4	0.3	0.3	0.3	0.3
COMBO	1.8	1.8	1.7	1.5	1.3	1.1	0.7	0.4	0.2	0.1	0.1	0.1	0.1
1.5TECH	1.8	1.8	1.7	1.5	1.3	1.0	0.4	0.2	0.1	0.1	0.1	0.1	0.1
1.5LIFE	1.8	1.8	1.7	1.5	1.3	1.0	0.5	0.2	0.1	0.1	0.1	0.1	0.1

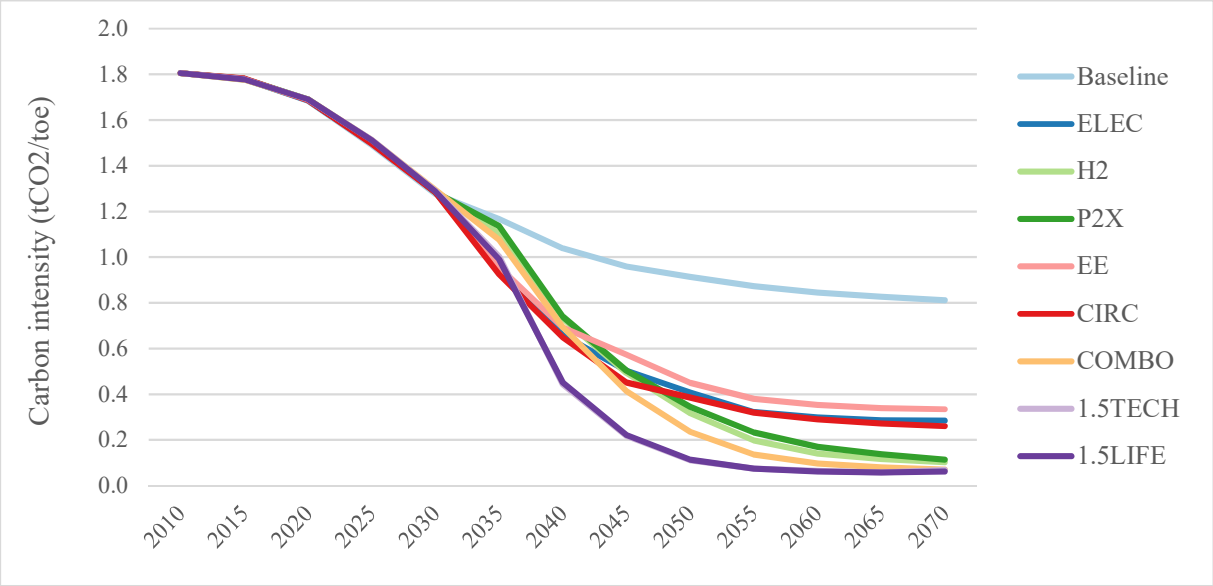


Figure 71: Total remaining industrial GHG emissions by scenario and energy carrier in EU28

	Process emissions	Coal	Fuel oil	Natural gas	Other fossil	Waste non-RES	Captured emissions	Total net
2015	163.3	144.2	63.2	206.2	177.2	6.7	-	760.8
CCS	167.7	70.0	14.0	127.9	59.9	11.6	- 293.5	157.6
CleanGas	104.2	34.0	9.5	25.0	33.4	10.0	-	216.0
BioCycle	95.1	41.1	8.2	55.6	40.4	5.5	-	245.9
Electric	102.1	28.6	9.1	73.5	36.2	6.1	-	255.7
Mix80	80.3	24.3	8.4	69.2	33.5	5.8	-	221.5
Mix95	75.6	8.1	3.8	3.9	15.4	2.2	- 45.6	63.4

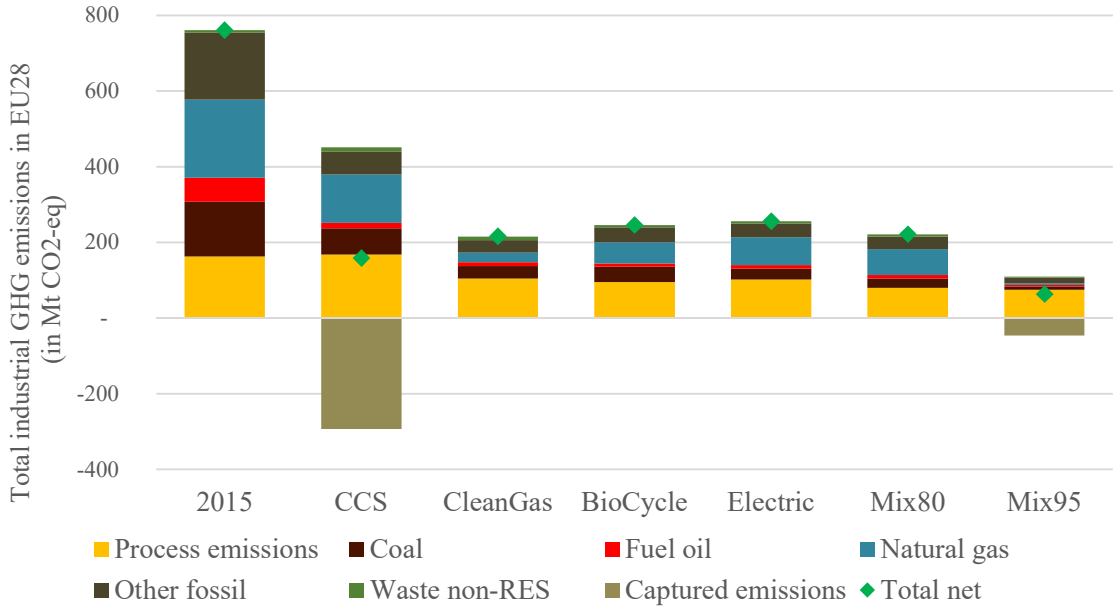


Figure 72: Remaining (gross) process emissions by sector and process in 2050 before possible CO2 capture

Row Labels 1	Row Labels 2	Aluminum, primary	Ammonia	Blast furnace and converter	Bricks	Calcium carbide	Carbon black	Clinker calcination-dry	Container glass	Electric arc furnace	Fiber glass	Flat glass	Houseware, sanitary ware
Chemical industry	3a CCS	-	27.1	-	-	0.0	3.0	-	-	-	-	-	-
	3b CleanGas	-	5.4	-	-	0.0	3.0	-	-	-	-	-	-
	3c BioCycle	-	14.7	-	-	0.0	3.0	-	-	-	-	-	-
	3d Electric	-	5.4	-	-	0.0	3.0	-	-	-	-	-	-
	4a Mix80	-	4.1	-	-	0.0	3.0	-	-	-	-	-	-
	4b Mix95	-	-	-	-	0.0	3.0	-	-	-	-	-	-
Iron and steel	3a CCS	-	-	0.8	-	-	-	-	-	0.8	-	-	-
	3b CleanGas	-	-	0.2	-	-	-	-	-	0.8	-	-	-
	3c BioCycle	-	-	0.5	-	-	-	-	-	0.9	-	-	-
	3d Electric	-	-	0.2	-	-	-	-	-	0.8	-	-	-
	4a Mix80	-	-	0.1	-	-	-	-	-	0.9	-	-	-
	4b Mix95	-	-	-	-	-	-	-	-	0.9	-	-	-
Non-ferrous metal	3a CCS	3.4	-	-	-	-	-	-	-	-	-	-	-
	3b CleanGas	3.4	-	-	-	-	-	-	-	-	-	-	-
	3c BioCycle	3.1	-	-	-	-	-	-	-	-	-	-	-
	3d Electric	3.4	-	-	-	-	-	-	-	-	-	-	-
	4a Mix80	3.1	-	-	-	-	-	-	-	-	-	-	-
	4b Mix95	3.1	-	-	-	-	-	-	-	-	-	-	-
Non-metallic mineral pr	3a CCS	-	-	-	2.4	-	-	67.3	1.3	-	0.3	2.8	1.8
	3b CleanGas	-	-	-	2.4	-	-	17.8	1.3	-	0.3	2.8	1.8
	3c BioCycle	-	-	-	2.4	-	-	14.3	1.2	-	0.4	2.8	1.8
	3d Electric	-	-	-	2.4	-	-	12.5	0.3	-	0.3	0.6	1.8
	4a Mix80	-	-	-	2.4	-	-	14.3	0.2	-	0.3	0.6	1.8
	4b Mix95	-	-	-	2.4	-	-	14.3	0.2	-	0.3	0.6	1.8

Row Labels 1	Row Labels 2	Less-carbon cement - 30%	Lime burning	Low-carbon cement - 50%	Nitric acid	Other glass	Poly ethylene	Sinter	Soda ash	Technical, other ceramics	Tiles, plates, refractories	Zinc, primary
Chemical industr	3a CCS	-	-	-	0.0	-	3.5	-	1.4	-	-	-
	3b CleanGas	-	-	-	0.0	-	3.5	-	1.4	-	-	-
	3c BioCycle	-	-	-	0.0	-	2.4	-	1.4	-	-	-
	3d Electric	-	-	-	0.0	-	3.5	-	1.4	-	-	-
	4a Mix80	-	-	-	0.0	-	2.8	-	1.4	-	-	-
	4b Mix95	-	-	-	0.0	-	2.8	-	1.4	-	-	-
Iron and steel	3a CCS	-	-	-	-	-	-	4.3	-	-	-	-
	3b CleanGas	-	-	-	-	-	-	0.8	-	-	-	-
	3c BioCycle	-	-	-	-	-	-	2.7	-	-	-	-
	3d Electric	-	-	-	-	-	-	0.8	-	-	-	-
	4a Mix80	-	-	-	-	-	-	0.5	-	-	-	-
	4b Mix95	-	-	-	-	-	-	-	-	-	-	-
Non-ferrous met	3a CCS	-	-	-	-	-	-	-	-	-	-	4.2
	3b CleanGas	-	-	-	-	-	-	-	-	-	-	4.2
	3c BioCycle	-	-	-	-	-	-	-	-	-	-	4.0
	3d Electric	-	-	-	-	-	-	-	-	-	-	4.2
	4a Mix80	-	-	-	-	-	-	-	-	-	-	4.0
	4b Mix95	-	-	-	-	-	-	-	-	-	-	4.0
Non-metallic min	3a CCS	-	37.6	-	-	0.3	-	-	-	3.1	2.2	-
	3b CleanGas	16.5	22.6	10.2	-	0.3	-	-	-	3.1	2.2	-
	3c BioCycle	3.3	22.6	8.2	-	0.3	-	-	-	3.1	2.2	-
	3d Electric	16.5	22.6	10.2	-	0.3	-	-	-	3.1	2.2	-
	4a Mix80	3.3	22.6	8.2	-	0.3	-	-	-	3.1	2.2	-
	4b Mix95	3.3	22.6	8.2	-	0.3	-	-	-	3.1	2.2	-

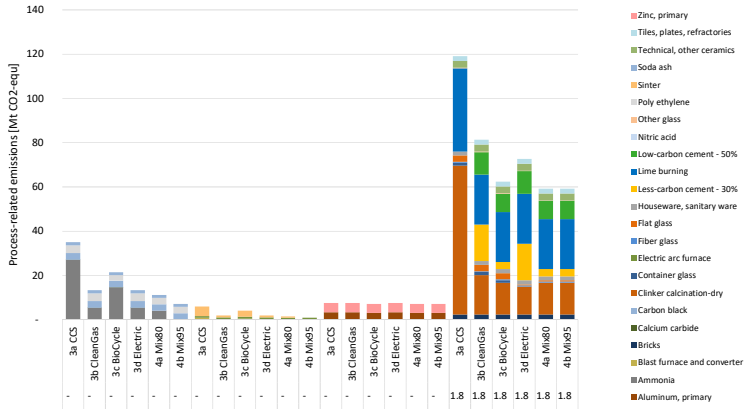


Figure 73: Industrial electricity demand in final energy in 2050, including production of feedstocks, clean gas and hydrogen

Year	Electricity f	Electricity f	Electricity f	Electricity for hydrogen feedstock
3a CCS	1124.3	1.3	0.0	0.0
3b CleanGa	1127.0	153.0	823.4	693.4
3c Biocycle	949.2	0.6	0.0	0.0
3d Electric	1718.0	0.9	0.0	693.4
4a Mix80	1529.9	83.2	0.0	548.9
4b Mix95	1539.2	104.7	616.1	686.1

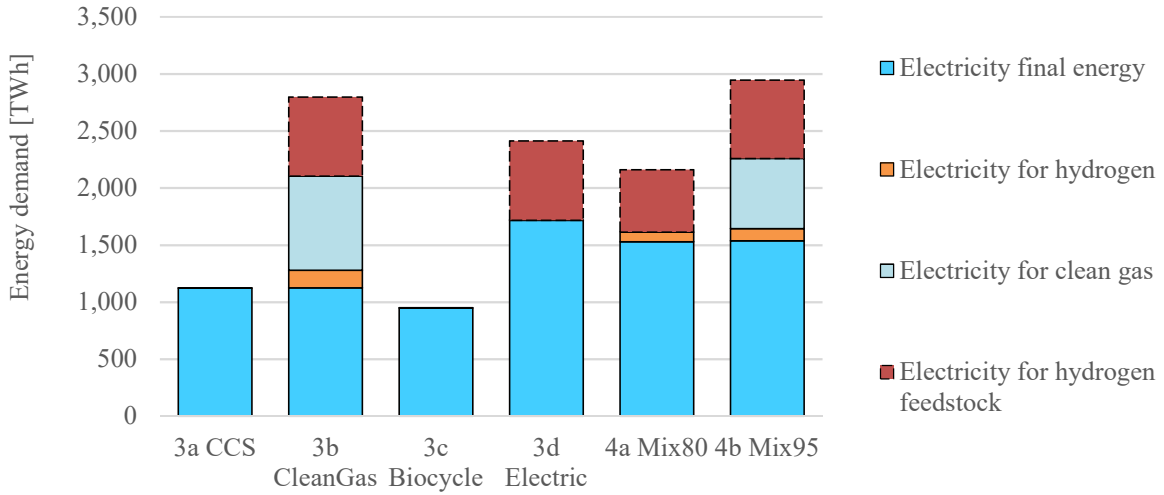


Figure 74: Example of technologies and mitigation potential in the agriculture sector

		< 100 €/t CO_2eq	< 200 €/t CO_2eq
Other	Rice cultivation	1.1	0.0
	ban waste burning	2.6	0.0
	Histosols left fallow	0.0	14.5
Anaerobic Digestion	Pigs	1.9	0.0
	dairy cows and cattle	1.1	0.0
Breeding & Feed management	Sheep	2.3	0.0
	non-dairy cattle	15.2	1.3
	dairy cows	16.1	0.0
Reducing fertilizers & Nitrification Inhibitors	farmarea < 30 ha	13.1	4.7
	farmarea 30 to 150 ha	19.6	8.4
	farmarea > 150 ha	17.9	7.3

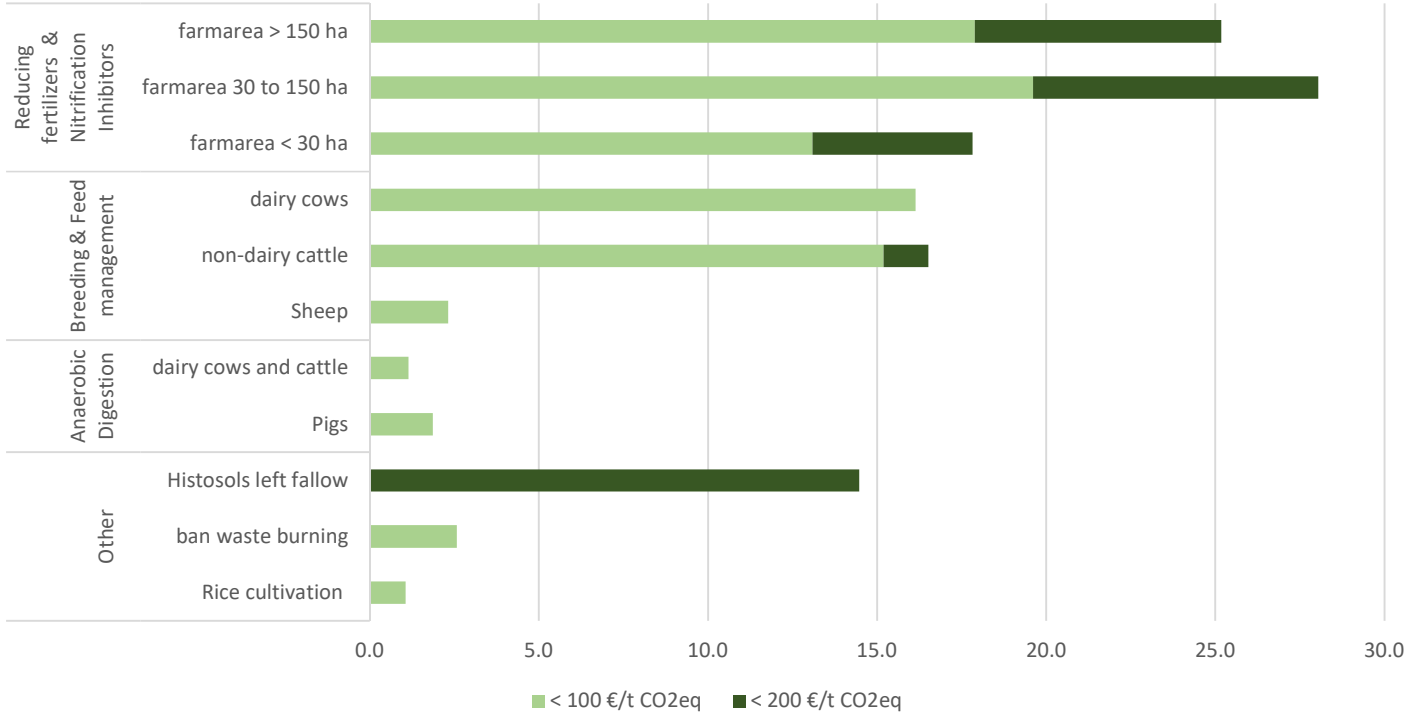


Figure 75: Historical EU meat consumption

	Total Meat	Pigmeat	Poultry Meat	Bovine Meat
1960				
1961	52	24	5	17
1962	54	24	6	18
1963	54	24	6	19
1964	55	25	7	18
1965	57	26	7	18
1966	58	26	7	19
1967	60	27	8	20
1968	61	28	8	20
1969	62	28	8	21
1970	65	28	9	21
1971	67	30	9	21
1972	68	32	10	20
1973	70	32	11	21
1974	72	33	11	21
1975	72	34	11	21
1976	73	33	12	22
1977	74	34	13	22
1978	77	36	13	22
1979	79	38	13	22
1980	80	38	14	22
1981	79	38	14	21
1982	79	38	14	21
1983	79	39	14	21
1984	80	39	14	21
1985	80	39	14	21
1986	81	40	15	21
1987	83	41	15	22
1988	84	42	16	21
1989	84	41	16	21
1990	85	41	16	22
1991	85	41	16	22
1992	83	40	17	20
1993	83	41	17	19
1994	81	40	17	18
1995	81	40	18	18
1996	82	41	18	18
1997	81	40	19	17
1998	85	42	20	17
1999	84	42	19	17
2000	84	41	20	17
2001	84	41	21	16
2002	84	41	21	17
2003	84	42	21	17
2004	83	40	21	17
2005	83	41	21	17
2006	83	41	20	17
2007	84	42	21	17
2008	84	41	21	17
2009	83	40	22	16
2010	83	41	21	16
2011	82	40	22	16
2012	83	40	23	15
2013	81	39	23	15

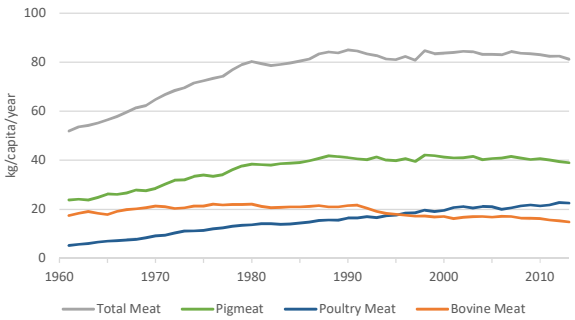
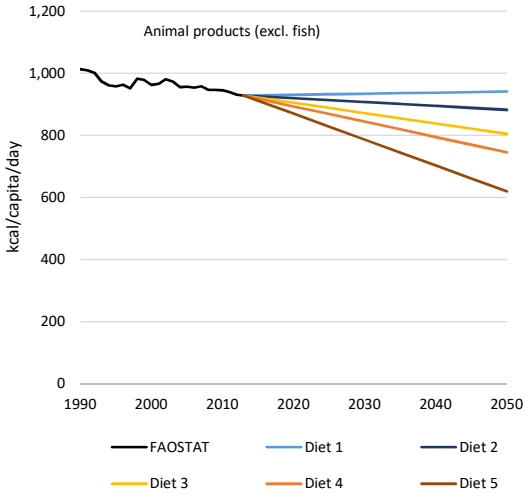


Figure 76: Animal based calorific consumption for different diet assumptions

Year	Animal Products	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
1990	1,013					
1991	1,009					
1992	1,001					
1993	973					
1994	961					
1995	958					
1996	963					
1997	951					
1998	982					
1999	978					
2000	962					
2001	966					
2002	981					
2003	973					
2004	955					
2005	957					
2006	954					
2007	958					
2008	946					
2009	946					
2010	945					
2011	939					
2012	931					
2013	928	928	928	928	928	928
2015		929	926	921	918	911
2020		930	919	905	893	870
2025		932	913	888	869	828
2030		934	907	871	844	786
2035		936	901	855	819	745
2040		937	894	838	794	703
2045		939	888	821	770	661
2050		941	882	805	745	620

	2050 Bovine mea	2050 Sheep & gc	2050 Milk	2050 Pig meat	2050 Poultry me	2050 Eggs
Faostat 2013	73	18	410	289	82	47
Baseline	67	21	445	301	95	53
Diet 1	48	14	424	303	96	53
Diet 2	48	14	424	260	84	50
Diet 3	48	14	301	304	96	53
Diet 4	48	14	301	261	84	50
Diet 5	48	14	301	187	60	36



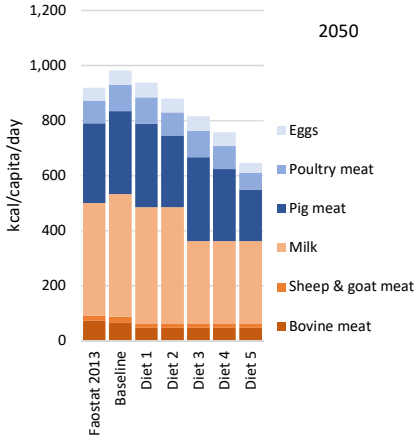


Figure 77: Potential impacts on GHG emissions due to dietary changes

	2020	2025	2030	2035	2040	2045	2050
Diet 1	0	-3	-6	-10	-14	-22	-29
Diet 2	0	-6	-12	-18	-23	-33	-43
Diet 3	0	-10	-20	-32	-43	-60	-76
Diet 4	0	-14	-27	-41	-54	-73	-91
Diet 5	0	-16	-31	-48	-65	-86	-108

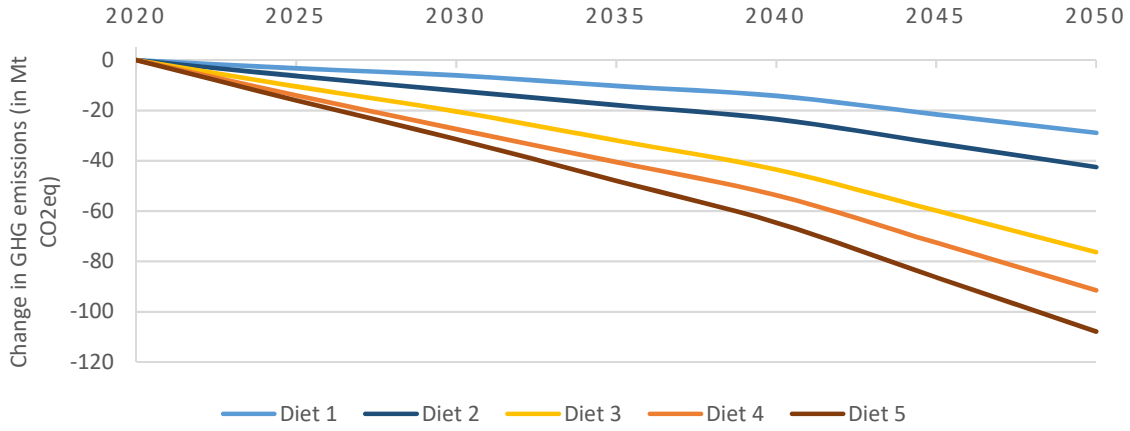


Figure 78: Example of reduction potential in the agriculture

Baseline

	2010	2015	2020	2030	2040	2050
CH4	230	232	219	209	206	207
N2O	197	202	202	200	198	197

Technical Mitigation

	2010	2015	2020	2030	2040	2050
CH4	230	232	218	196	174	165
N2O	197	202	202	200	121	111

Consumer preference changes as in DIET4

	2010	2015	2020	2030	2040	2050
CH4	230	232	219	200	185	175
N2O	197	202	202	188	173	163

Consumer preference changes + Technical Mitigation

	2010	2015	2020	2030	2040	2050
CH4	230	232	218	188	156	139
N2O	197	202	202	188	105	91

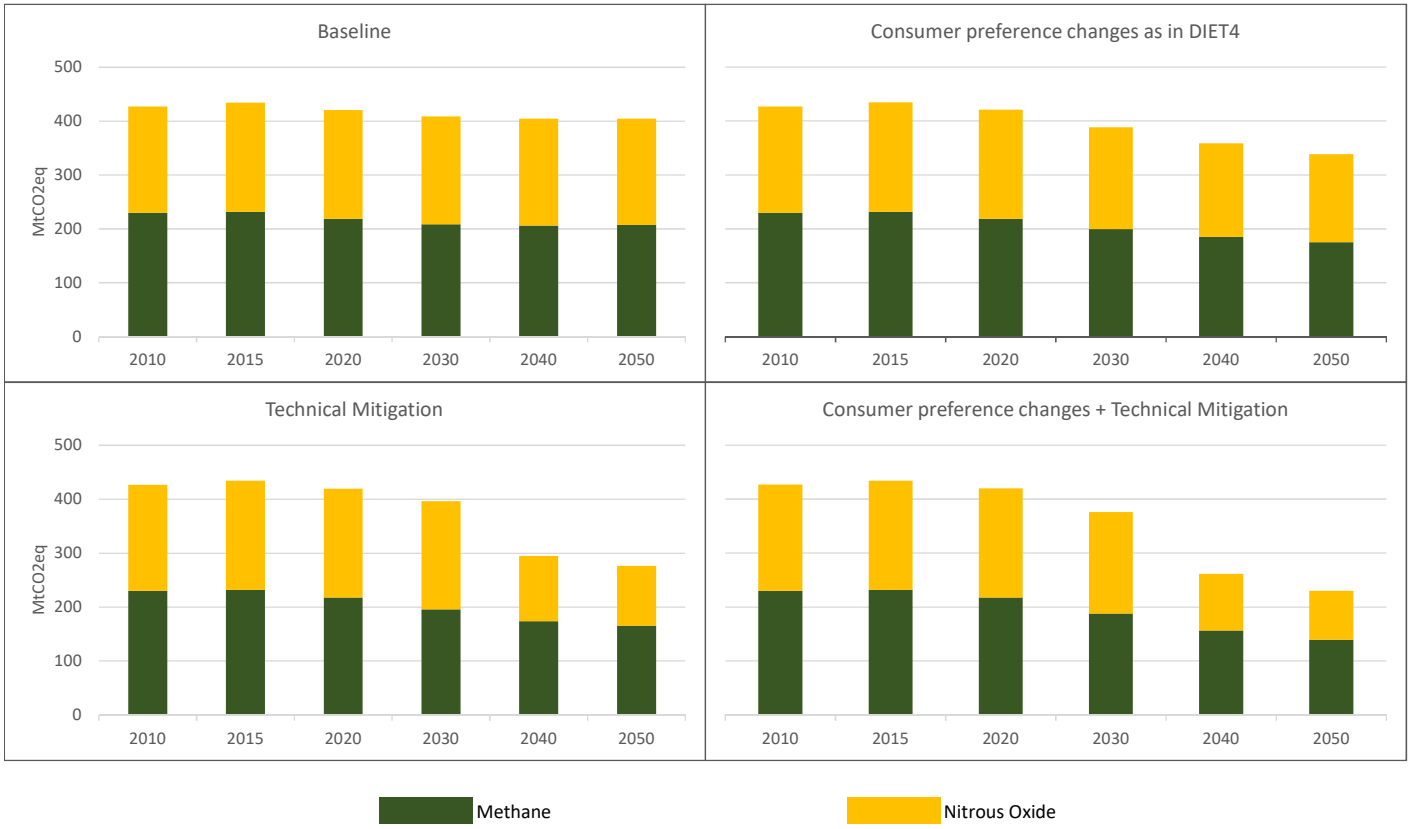


Figure 79: Reductions in non-CO2 emissions in sectors other than agriculture

2050	2005	Baseline	CIRC	COMBO	1.5 TECH	1.5 LIFE
CH4	284	97	33	33	32	29
N20	110	53	25	26	24	24
F-gases	100	59	4	5	5	5

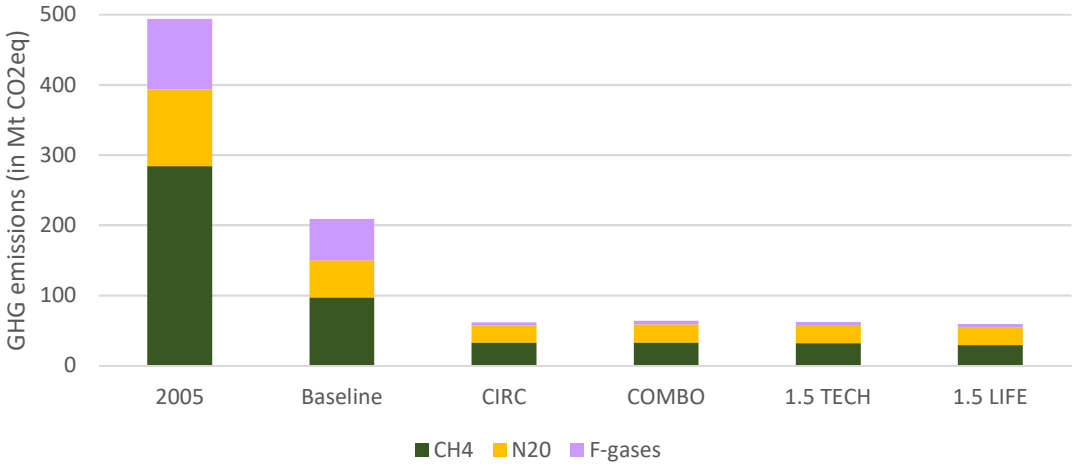


Figure 80: Additional non-CO2 emissions reduction potential in 2050 compared to baseline in the EU in sectors other than agriculture

		CH4	N20	F-Gases
Waste	Municipal solid waste	15		
	Industrial solid waste	11		
	Industrial wastewater	10		
	Domestic wastewater	6	9	
	Solid waste composting		7	
Energy	Gas distribution	3		
	Gas transmission	2		
	Transport	0	4	
	Production of crude oil	2		
	Production of natural gas	1		
	Energy use		9	
industry	Caprolactam production		3	
	Semiconductor industry			1
AC & refrigeration	Refrigeration			34
	Air conditioning (stationary & mobile)			6
Other	Direct N2O use		5	
	Aerosols			3
	Foams			3
	Fire extinguishers			1
	Other SF6			5

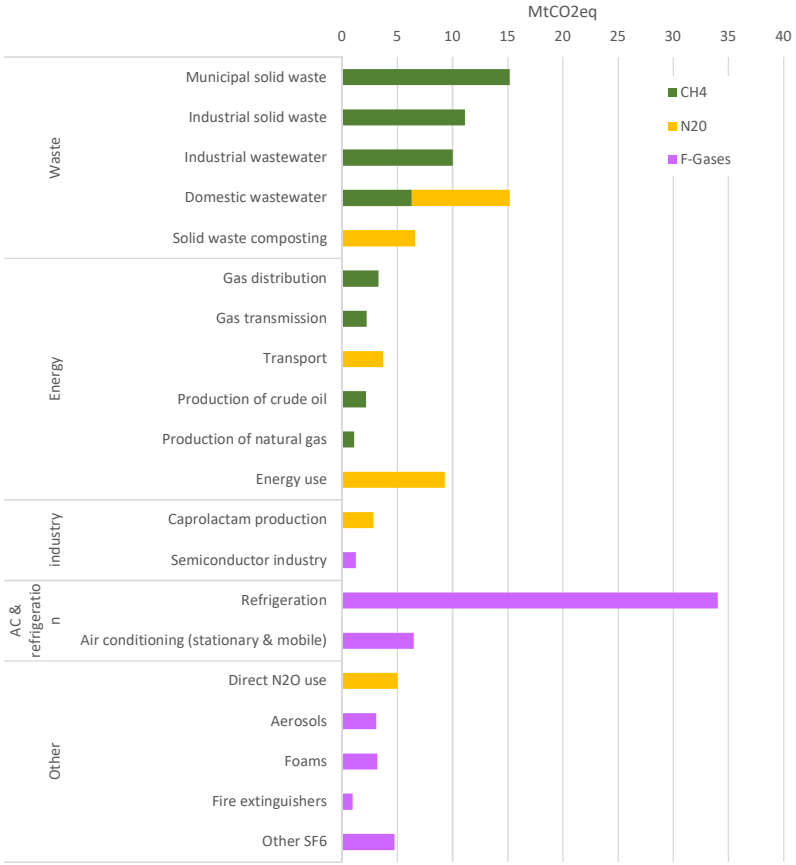


Figure 81: Land cover overview in 2015

		Mha
Artificial land	built-up areas	5.9
	Non built-up	12.1
Cropland	Cereals	60.1
	Industrial crops	12.9
	Fodder crops	8.4
	Permanent crops	5.9
	Other Crops	9.6
Forest	Broadleaved	65.1
	Coniferous	56.0
	Mixed	43.7
Shrubland	Sparse tree cover	12.2
	No tree cover	18.9
Grassland	Sparse tree/shrub cover	13.3
	No tree/shrub cover	63.1
	Spontaneous vegetation	14.2
Bare land	Bare land	14.6
Water	Water	13.2
Wetlands	Wetlands	7.3

Figure 82: Gross inland consumption of biomass and waste

	2015	2020	2025	2030	2035	2040	2045	2050
Baseline	139	169	188	190	167	169	168	169
ELEC	139	169	188	192	193	207	218	218
H2	139	167	183	189	187	208	214	220
P2X	139	168	185	190	178	215	228	240
EE	139	169	188	192	186	202	209	190
CIRC	139	169	188	192	193	213	243	233
COMBO	139	168	185	191	185	213	233	227
1.5TECH	139	168	185	192	192	231	256	252
1.5LIFE	139	168	184	191	191	231	239	207
1.5LIFE-LB	139	168	185	190	183	199	186	170

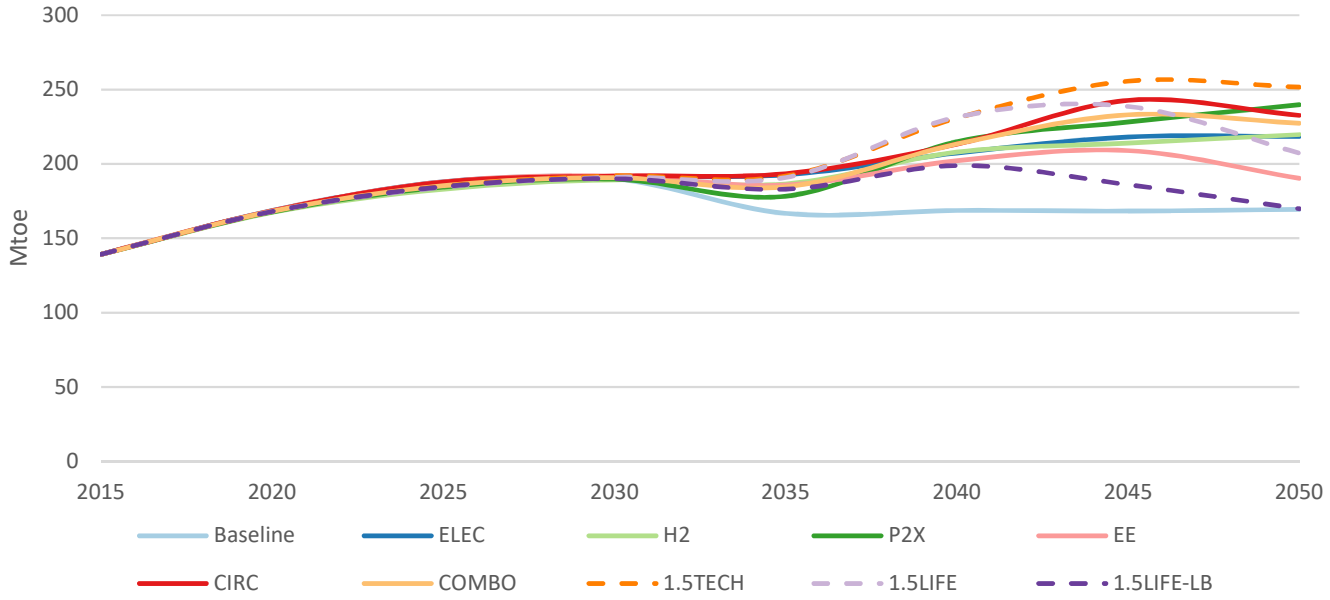


Figure 83: Use of bioenergy by sectors and by scenario in 2050

	2015	2020	Baseline	ELEC	H2	P2X	EE	CIRC	COMBO	15TECH	15LIFEa	15LIFE	15LIFE-LB
Power	49	62	89	105	106	121	79	93	115	155	120	100	126
Industry	26	33	43	47	47	52	45	52	41	35	35	35	11
Road Transport	16	21	14	25	24	24	24	31	27	18	22	22	12
Air Transport	0	0	2	13	13	5	13	15	12	14	23	23	8
Service & Agriculture	6	7	6	11	10	12	11	14	11	10	10	10	7
Residential	41	44	12	14	15	21	14	23	16	14	13	13	2
Other	1	1	3	4	5	5	5	5	5	5	6	5	4

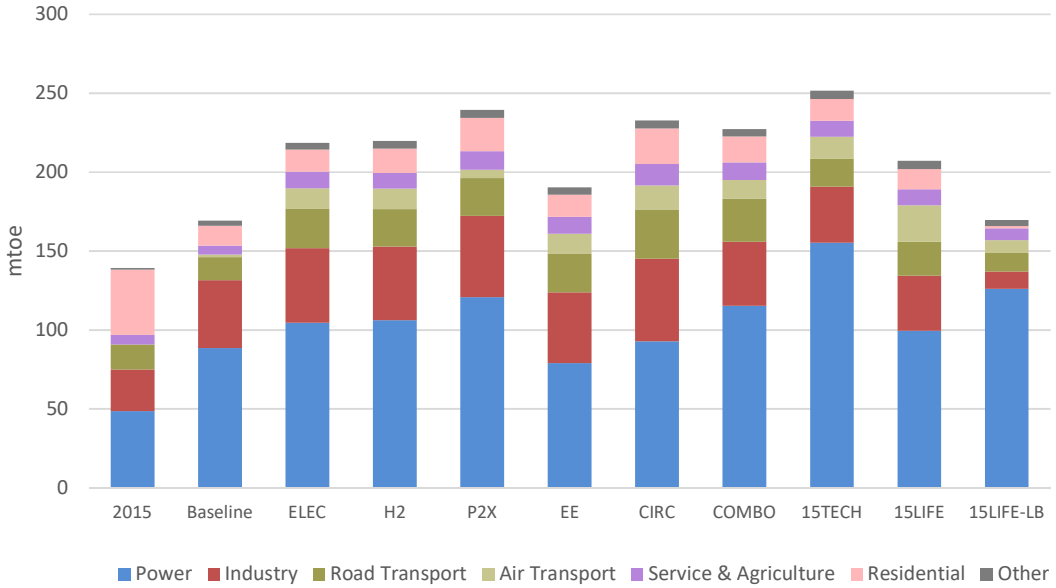


Figure 84: Break down of bioenergy feedstock in 2050

	2015	Baseline	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	15LIFEa	1.5LIFE	1.5LIFE-LB
Food crops	17	4	3	4	4	3	3	4	3	3	2	2
Lignocellulosic grass	0	18	66	72	76	45	87	79	85	79	68	31
Short rotation coppice	0	4	13	15	21	10	21	13	24	14	13	7
Agriculture residues	18	17	33	34	32	31	35	34	33	34	34	18
Forest stemwood	28	28	33	33	33	29	34	33	34	33	32	29
Forest residues	15	30	32	32	32	31	33	32	32	32	32	30
Waste	59	90	96	96	98	92	93	97	96	93	92	85
Paper and pulp residues	14	15	15	15	15	15	13	15	15	13	13	13

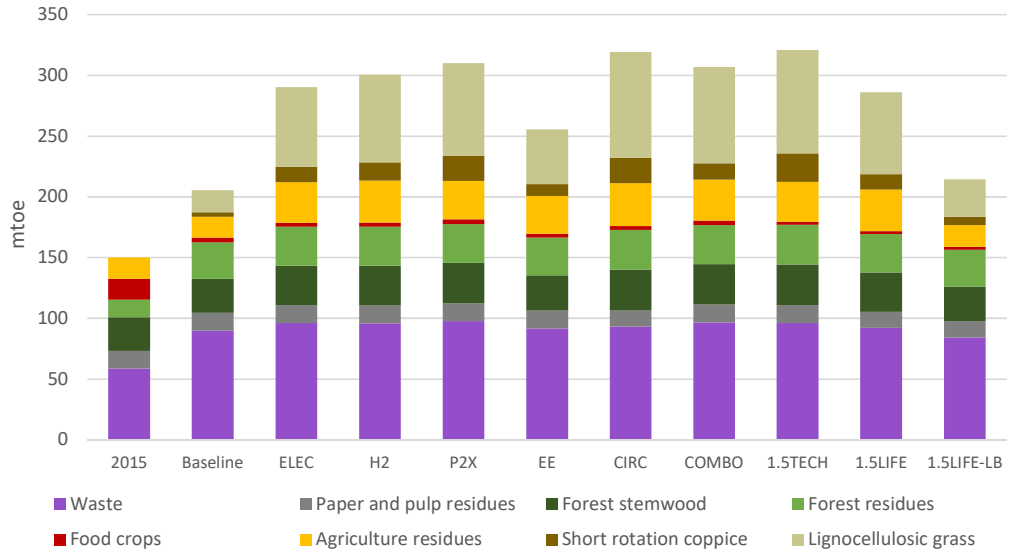


Figure 85: Use of natural land by 2050

	Baseline 2020	Baseline 2050	ELEC	H2	P2X	EE	CIRC	COMBO	15TECH	15LIFEa	15LIFE	15LIFE LB
1st generation biofuel	11	2	1	1	1	1	1	1	1	1	1	1
Energy crops	0	5	21	24	26	15	29	25	29	24	21	9
Productive agriculture land	164	162	156	154	152	158	151	153	151	131	131	134
Non-productive grassland and shrub	39	38	30	30	29	34	26	29	26	44	42	50
Forest	157	162	161	161	161	161	162	161	162	170	174	175

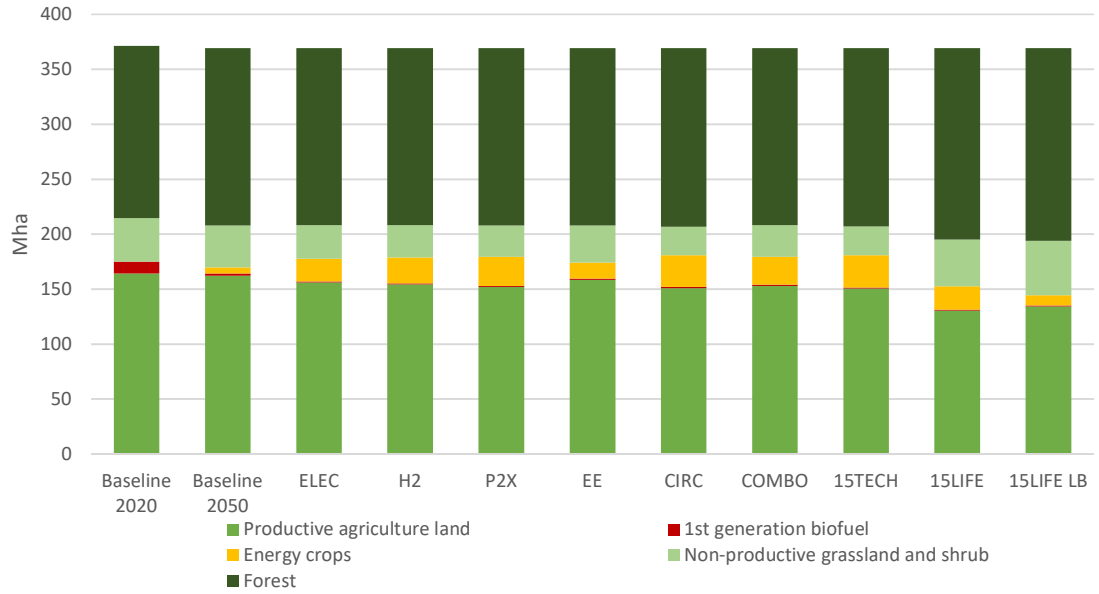


Figure 86: Potential for carbon sequestration and LULUCF sink enhancement at different carbon prices in 2050

		0	5	10	15	20	30	40	50	60	70	100	150
Forest management	-170	0	26	30	32	33	36	41	44	48	51	54	56
Afforestation	-121	0	2	6	9	11	15	19	23	25	29	32	36
Total agricultural land	32	0	5	11	15	18	21	24	28	30	32	38	44
Avoided deforestation	30	0	2	3	4	5	6	8	14	15	17	20	27
Total LULUCF	-236	0	36	51	61	68	79	94	111	120	132	147	166

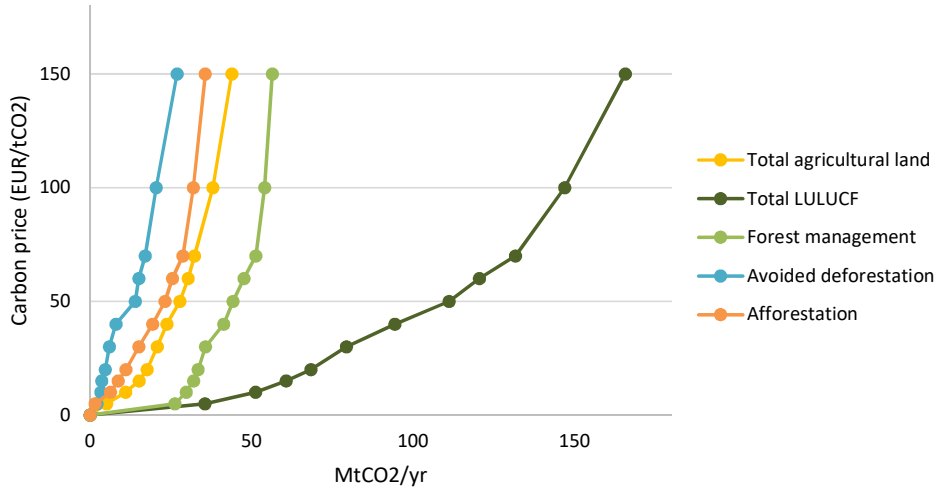


Figure 87: LULUCF emissions across the scenarios

MtCO2	Baseline	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	15LIFE	15LIFE LB
Total Forest Land	-271	-256	-257	-267	-266	-290	-264	-313	-444	-466
Forest management	-176	-166	-164	-172	-173	-190	-169	-199	-263	-279
Afforestation	-124	-122	-125	-132	-124	-130	-128	-144	-193	-198
Deforestation	29	32	32	37	30	30	33	30	12	11
Cropland	40	24	18	8	30	9	19	-19	-2	4
Grassland	-1	-1	0	0	0	0	0	-3	-4	-4
Other	25	25	25	25	25	25	25	25	25	25
Harvested Wood Products	-29	-30	-29	-29	-30	-36	-29	-29	-36	-36
Net LULUCF	-236	-238	-244	-263	-241	-292	-248	-338	-460	-477

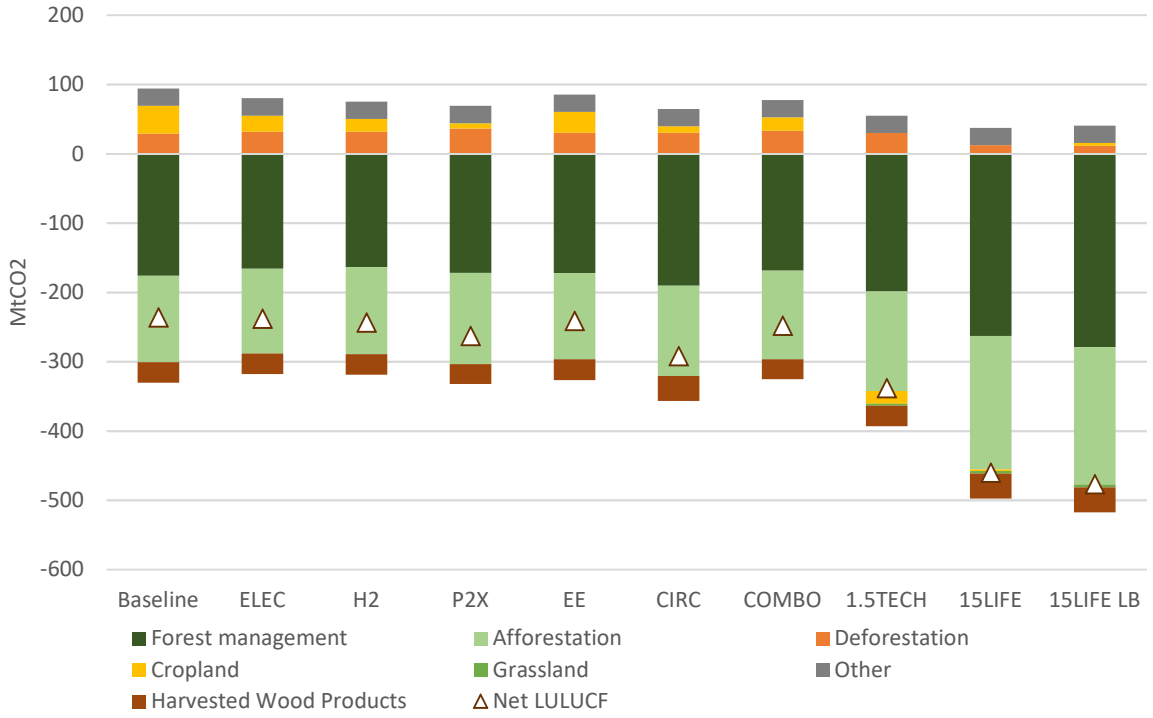


Figure 88: Cost of carbon dioxide removal technologies

	Cost (USD/tCO2)	
	Most likely	Full cost
BECCS	100–200	15-400
DACCS	100-300	25-1000
Afforestation	5-50	0-240
Enhanced weathering	50-200	15-3460
Ocean fertilization	[No author assessment due to limited potential]	0-460
Biochar	30-120	10-345
Soil carbon sequestration	0-100	-45-100

Source: Fuss, Sabine et al. (2018): "Negative emissions - Part 2: Costs, potentials and side effects", *Environmental Research Letters* , **13** 0363002. https://iopscience.iop.org/article/10.1088/1748-9326/aabf9f/meta

Figure 89: CO2 capture and storage or reuse (2050)

MtCO2	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5LIFE	1.5LIFE-LB
Fossil Fuel	60	58	71	60	47	61	120	74	77
Biomass	5	6	114	4	5	95	276	84	122
Direct Air	0	0	264	0	0	83	210	123	186
Underground Storage	-65	-63	-77	-65	-52	-67	-298	-80	-92
Synthetic Fuels	0	0	-372	0	0	-172	-227	-154	-226
Synthetic material	0	0	0	0	0	0	-80	-47	-67

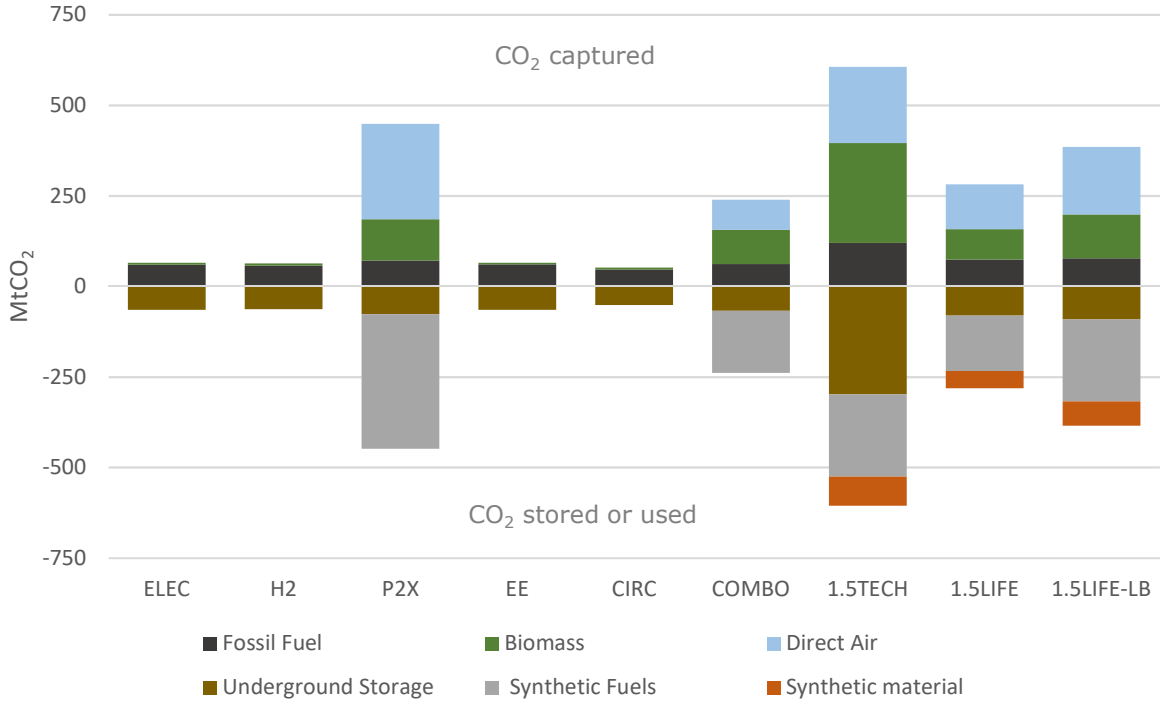
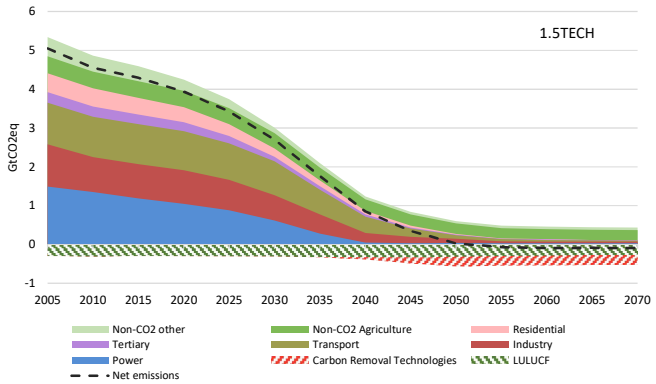


Figure 90: Two ways to reach net zero GHG emissions - reduction pathways for 1.5TECH (above) and 1.5LIFE scenario (below) with enhanced LULUCF sink

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Non-CO2 other	5.3	4.9	4.6	4.2	3.7	3.0	2.1	1.2	0.8	0.6	0.5	0.5	0.4	0.4
Non-CO2 Agriculture	4.8	4.4	4.2	4.0	3.5	2.9	2.0	1.2	0.8	0.5	0.4	0.4	0.4	0.4
Residential	4.4	4.0	3.8	3.5	3.1	2.5	1.6	0.9	0.5	0.3	0.2	0.1	0.1	0.1
Tertiary	3.9	3.6	3.3	3.1	2.8	2.3	1.5	0.8	0.4	0.3	0.1	0.1	0.1	0.1
Transport	3.7	3.3	3.1	2.9	2.6	2.1	1.4	0.7	0.4	0.2	0.1	0.1	0.1	0.1
Industry	2.6	2.2	2.1	1.9	1.7	1.3	0.8	0.3	0.2	0.1	0.1	0.1	0.1	0.1
Power	1.5	1.3	1.2	1.0	0.9	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carbon Removal Technologies	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.4	-0.5	-0.6	-0.6	-0.5	-0.5	-0.5
LULUCF	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Net emissions	5.0	4.6	4.3	3.9	3.4	2.7	1.8	0.8	0.3	0.0	-0.1	-0.1	-0.1	-0.1



	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Non-CO2 other	5.3	4.9	4.6	4.2	3.7	3.0	2.0	1.2	0.8	0.5	0.4	0.4	0.4	0.4
Non-CO2 Agriculture	4.8	4.4	4.2	4.0	3.5	2.8	1.9	1.1	0.7	0.5	0.4	0.3	0.3	0.3
Residential	4.4	4.0	3.8	3.5	3.1	2.5	1.6	0.8	0.5	0.3	0.1	0.1	0.1	0.1
Tertiary	3.9	3.6	3.3	3.1	2.8	2.3	1.4	0.8	0.4	0.2	0.1	0.1	0.1	0.1
Transport	3.7	3.3	3.1	2.9	2.6	2.1	1.4	0.7	0.4	0.2	0.1	0.1	0.1	0.1
Industry	2.6	2.2	2.1	1.9	1.7	1.3	0.7	0.3	0.2	0.1	0.1	0.1	0.1	0.1
Power	1.5	1.3	1.2	1.0	0.9	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Carbon Removal Technologies	-0.3	-0.3	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4	-0.5	-0.5	-0.5	-0.6	-0.6	-0.6
LULUCF	-0.3	-0.3	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4	-0.4	-0.5	-0.5	-0.5	-0.5	-0.5
Net emissions	5.0	4.6	4.3	3.9	3.4	2.6	1.6	0.7	0.3	0.0	-0.1	-0.2	-0.2	-0.2

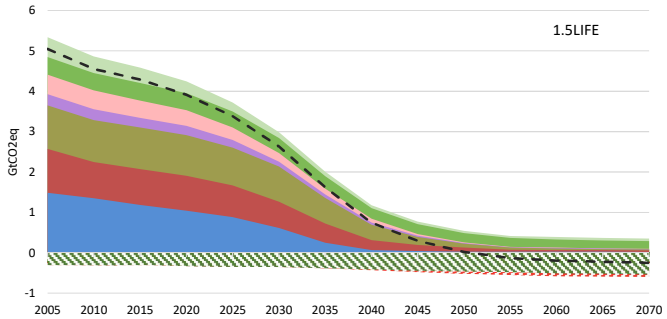


Figure 91: Sectoral emissions by 2050

	BL	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5LIFE	1.5LIFE-LB
Non-CO2 other	205.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5	55.7	55.7
Non-CO2 Agriculture	404.2	277.0	277.0	277.0	277.0	277.0	277.0	276.9	230.4	230.4
Residential	129.6	48.9	56.3	44.6	59.7	65.5	19.3	11.8	11.4	12.5
Tertiary	77.7	40.2	34.3	29.8	44.0	43.2	23.0	19.3	19.4	19.5
Transport	666.9	327.6	316.7	308.7	325.0	317.4	256.8	85.6	95.1	89.9
Industry	483.6	231.2	205.5	216.8	224.6	192.2	175.6	109.8	99.9	106.4
Power	246.3	73.7	104.9	119.3	17.4	25.2	61.9	37.5	30.4	61.8
LULUCF	-236.3	-237.9	-243.5	-263.1	-241.3	-292.1	-248.0	-316.9	-464.1	-471.7
Carbon Removal Technologies	0.0	-5.0	-5.5	-6.0	-4.4	-5.1	-6.0	-258.4	-53.4	-81.7

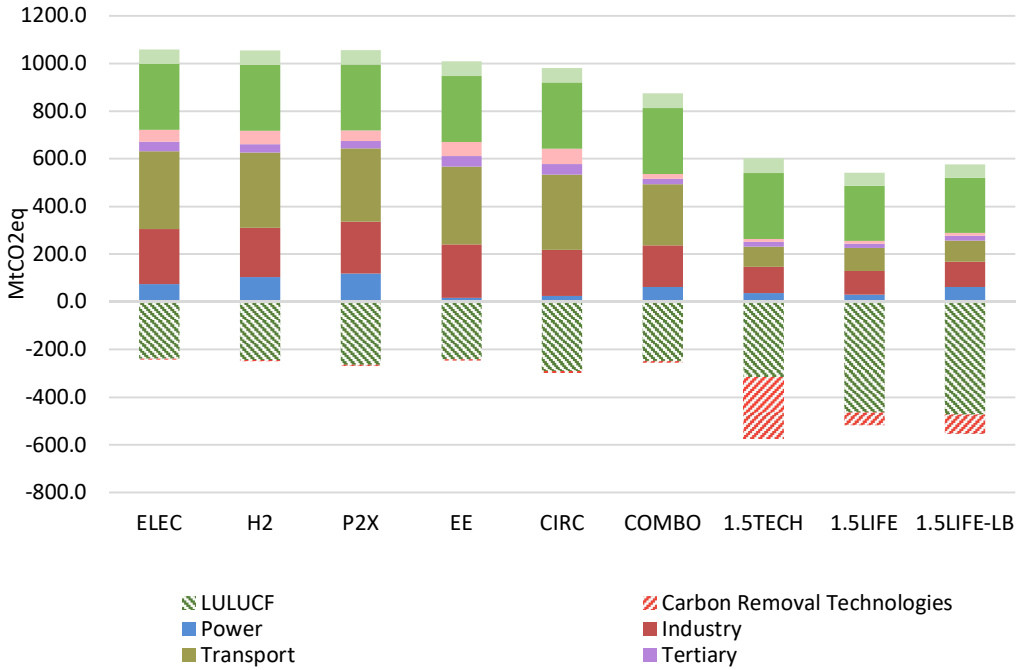


Figure 92: Real GDP and net GHG emissions 1.5 TECH (1990 = 100)

	GDP GEM-E3 1.5°C global action	GDP E3ME 1.5°C global action	Baseline GDP	Net GHG, 1.5°C TECH
1990	100.0	100.0	100.0	100.0
1991	101.1	101.1	101.1	97.8
1992	101.9	101.9	101.9	95.2
1993	101.8	101.8	101.8	93.4
1994	104.6	104.6	104.6	92.7
1995	107.4	107.4	107.4	93.4
1996	109.6	109.6	109.6	95.0
1997	112.7	112.7	112.7	93.3
1998	116.1	116.1	116.1	92.3
1999	119.6	119.6	119.6	90.2
2000	124.2	124.2	124.2	90.9
2001	126.9	126.9	126.9	91.5
2002	128.7	128.7	128.7	91.0
2003	130.3	130.3	130.3	93.1
2004	133.7	133.7	133.7	92.6
2005	136.5	136.5	136.5	92.1
2006	141.1	141.1	141.1	91.7
2007	145.4	145.4	145.4	91.6
2008	146.1	146.1	146.1	88.8
2009	139.8	139.8	139.8	81.8
2010	142.7	142.7	142.7	83.9
2011	145.1	145.1	145.1	81.3
2012	144.5	144.5	144.5	80.1
2013	144.9	144.9	144.9	78.3
2014	147.4	147.4	147.4	75.2
2015	150.8	150.8	150.8	75.9
2016	153.8	153.8	153.8	75.8
2017	155.7	155.7	155.7	73.9
2018	158.1	158.1	158.2	72.9
2019	160.6	160.7	160.7	71.9
2020	163.2	163.2	163.3	70.9
2021	165.4	165.7	165.5	69.1
2022	167.7	168.2	167.9	67.4
2023	170.1	170.7	170.2	65.7
2024	172.4	173.3	172.6	64.0
2025	174.9	175.9	175.0	62.4
2026	177.2	178.7	177.5	59.7
2027	179.5	181.5	180.0	57.1
2028	181.9	184.3	182.5	54.6
2029	184.3	187.2	185.0	52.2
2030	186.8	190.2	187.6	49.9
2031	189.6	193.7	190.6	45.8
2032	192.5	197.2	193.6	42.1
2033	195.5	200.8	196.7	38.6
2034	198.5	204.5	199.8	35.4
2035	201.5	208.2	203.0	32.5
2036	204.6	211.8	206.3	28.0
2037	207.8	215.5	209.6	24.2
2038	211.0	219.3	213.0	20.9
2039	214.3	223.1	216.4	18.0
2040	217.6	227.0	219.9	15.6
2041	220.8	230.6	223.3	13.1
2042	224.1	234.3	226.6	11.0
2043	227.4	238.1	230.1	9.3
2044	230.8	241.9	233.5	7.8
2045	234.2	245.8	237.1	6.6
2046	237.3	249.1	240.6	4.7
2047	240.6	252.4	244.3	3.4
2048	243.8	255.8	247.9	2.4
2049	247.1	259.3	251.7	1.8
2050	250.5	262.7	255.4	1.3

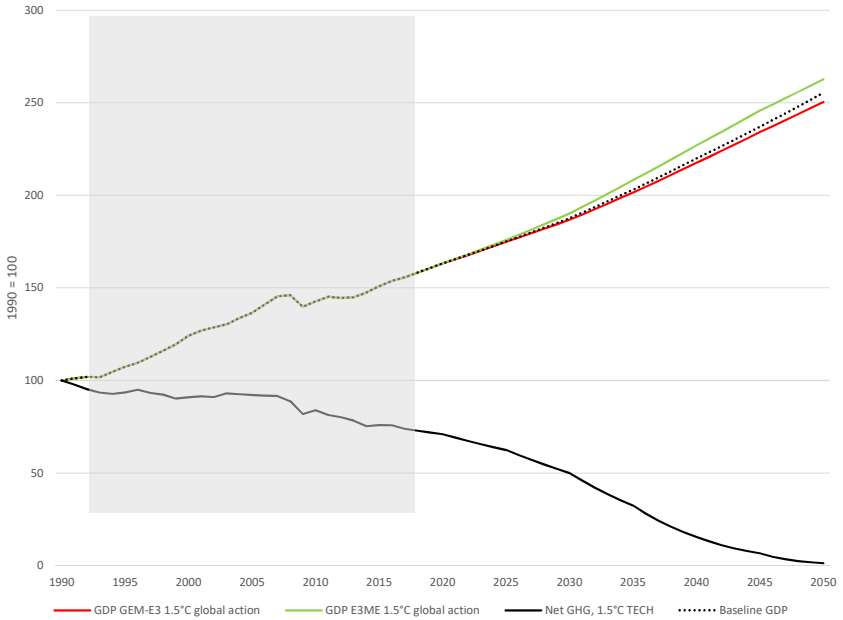


Figure 93: Real GDP (million EUR 2013) per energy consumption (Mtoe of GIC), 2015 and 2050

2015	8.0
BL	18.0
ELEC	19.5
H2	18.4
P2X	15.3
EE	22.9
CIRC	21.3
COMBO	18.2
1.5 TECH	17.5
1.5 LIFE	20.5

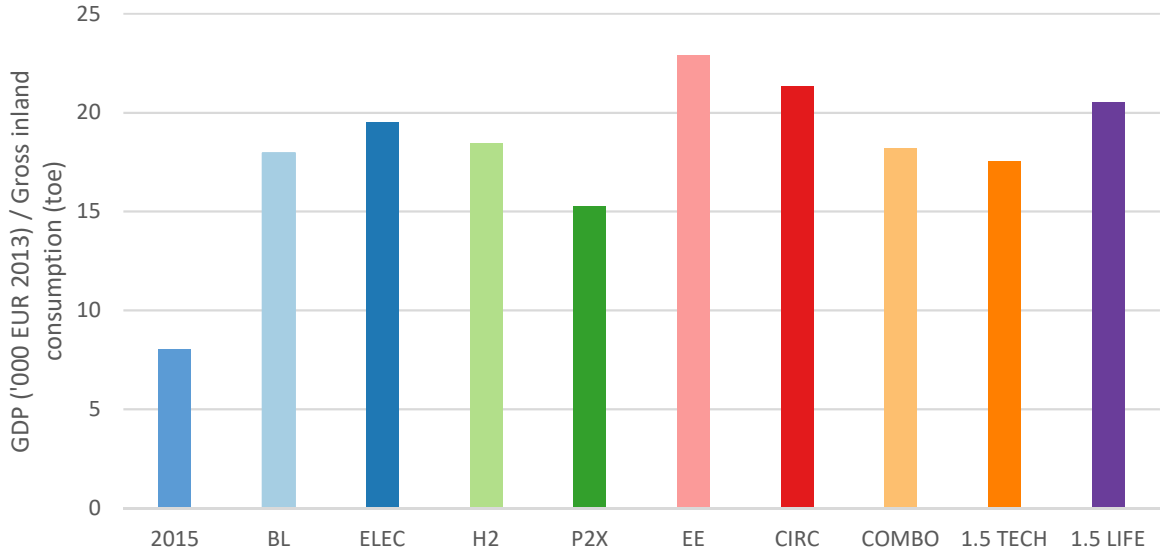


Figure 94: Additional annual investment (2031-2050) and total GHG reductions (2050) relative to Baseline

EE	CIRC	ELEC	H2	P2X	COMBO	1.5 TECH	1.5 LIFE
134.7	85.8	165.6	170.9	156.5	212.4	289.5	175.7
-1210.0	-1237.9	-1159.7	-1164.2	-1163.1	-1345.7	-1870.9	-1744.5

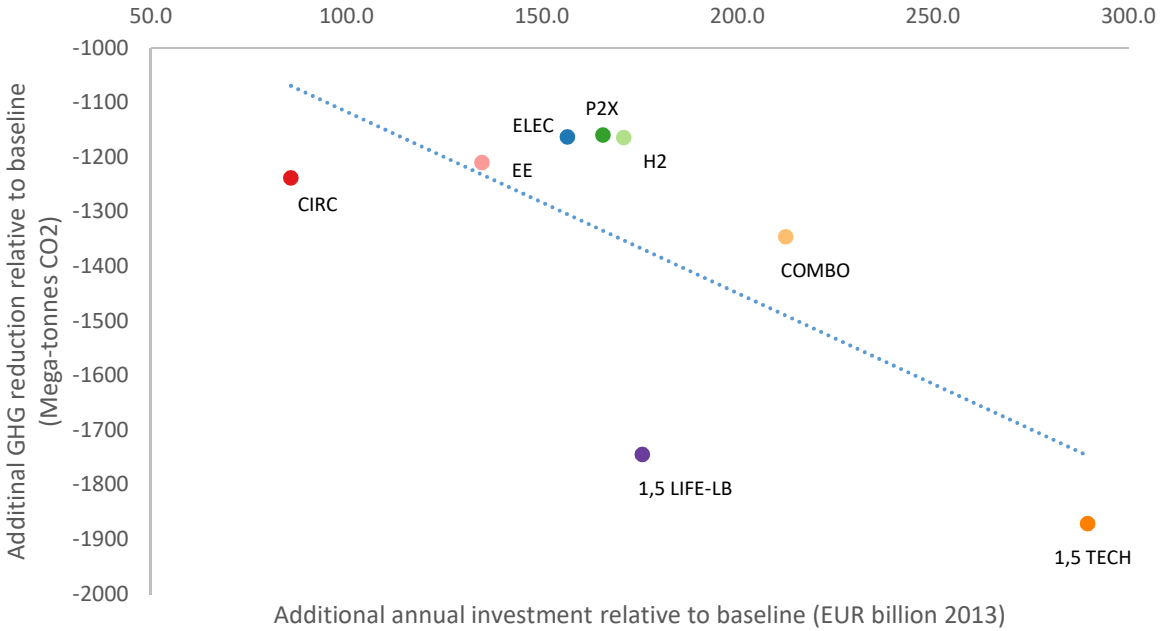


Figure 95: additional investments (including transport) compared to Baseline in % of GDP

	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
ELEC	-0.01	0.00	0.04	0.59	0.94	0.94	0.87	0.77	0.49	0.53	0.49
H2	-0.01	0.05	0.01	0.72	1.01	1.01	0.74	0.70	0.53	0.48	0.47
P2X	-0.01	0.04	0.02	0.26	1.03	1.05	0.78	0.57	0.52	0.49	0.52
EE	-0.01	0.00	0.06	0.61	0.70	0.67	0.75	0.53	0.41	0.35	0.29
CIRC	0.00	0.01	0.03	0.51	0.57	0.49	0.22	0.28	0.13	0.07	0.09
COMBO	-0.02	0.01	0.06	0.71	1.35	1.18	1.06	0.66	0.59	0.52	0.50
1.5 TECH	0.00	0.02	0.11	0.96	1.99	1.57	1.36	0.68	0.55	0.59	0.51
1.5 LIFE	-0.01	0.02	0.12	0.75	1.40	0.89	0.58	0.30	0.19	0.16	0.09

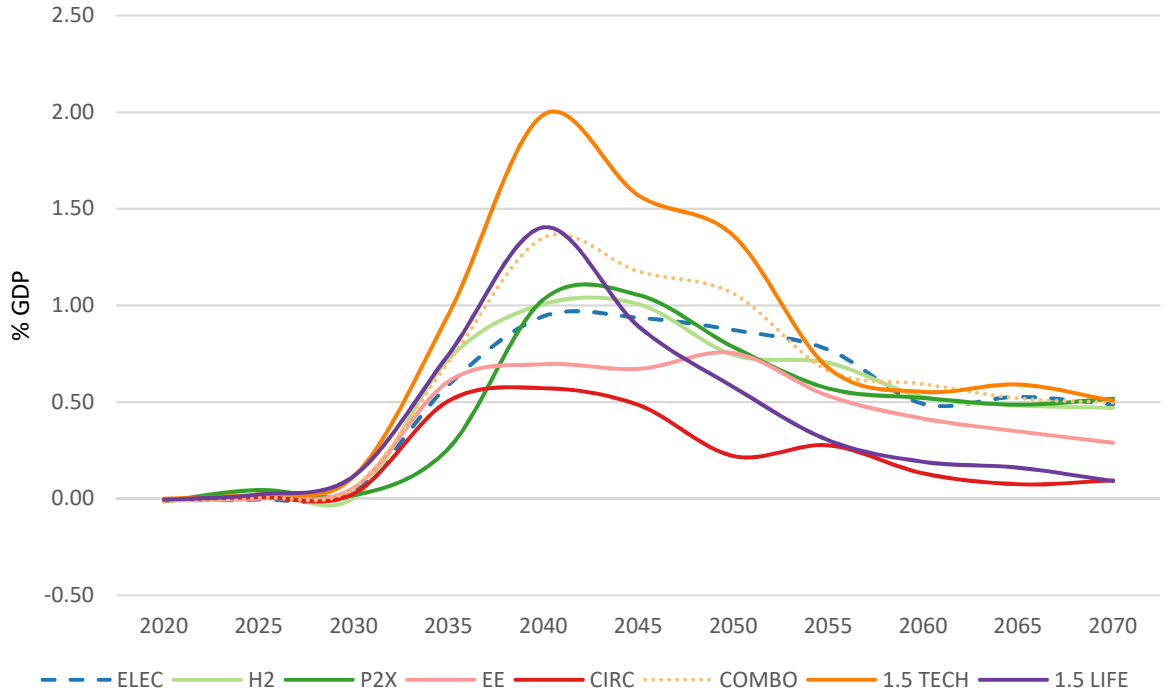


Figure 96: Minimum (-), maximum (+) and average (x) additional annual investment per sector (billion EUR 2013 compared to baseline)

Power grid	9.3	39.0	23.8
Power plants and boilers	9.6	80.8	45.8
New fuels	0.6	28.6	11.2
Industry	2.1	24.5	9.7
Residential	-1.3	35.8	16.9
Tertiary	3.3	22.3	10.0
Transport	23.9	94.0	56.6

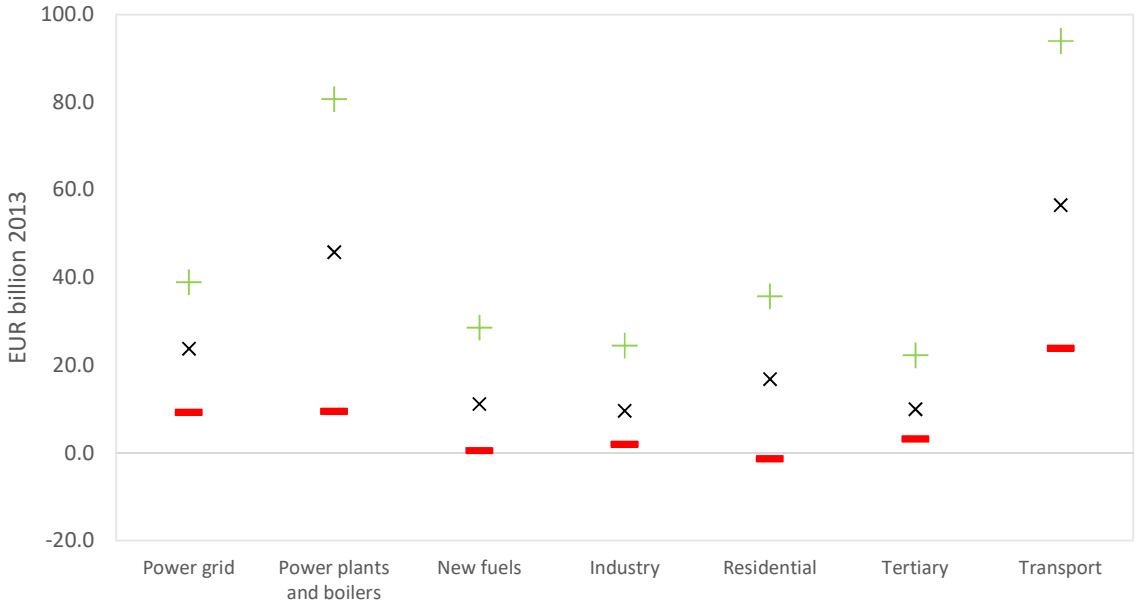


Figure 97: Total energy system costs, 2005-2070

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
BL	1282	1468	1553	1814	1990	2105	2149	2185	2219	2247	2288	2277	2313	2368
ELEC	1282	1468	1553	1813	1990	2107	2140	2237	2301	2359	2425	2437	2500	2610
H2	1282	1468	1553	1813	1992	2105	2186	2315	2381	2446	2552	2572	2622	2677
P2X	1282	1468	1553	1813	1991	2105	2160	2303	2406	2483	2575	2594	2648	2704
EE	1282	1468	1553	1815	1990	2111	2120	2216	2255	2297	2356	2380	2432	2522
CIRC	1282	1468	1553	1813	1990	2107	2124	2187	2214	2225	2267	2276	2330	2399
COMBO	1282	1468	1553	1814	1992	2109	2153	2291	2381	2453	2499	2517	2547	2590
1.5 TECH	1282	1468	1553	1815	1993	2112	2190	2435	2588	2763	2713	2675	2648	2648
1.5 LIFE	1282	1468	1553	1814	1992	2111	2164	2321	2381	2358	2354	2315	2295	2266

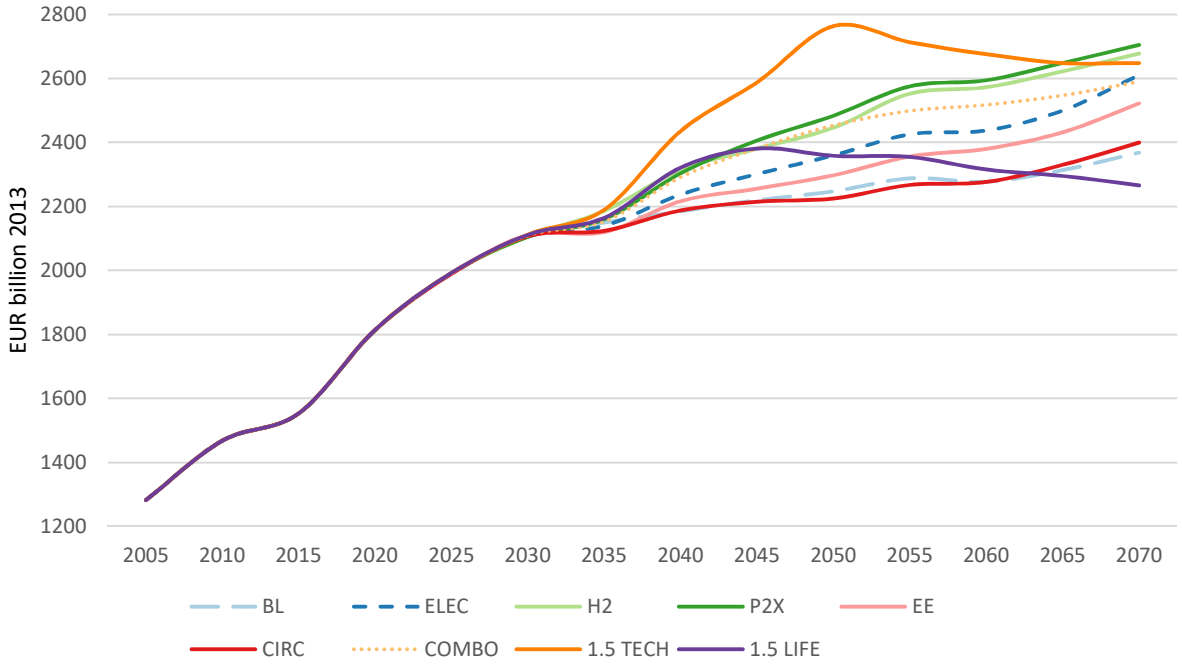


Figure 98: Total energy system costs as a percentage of GDP, 2005-2070

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
BL	10.4	11.4	11.6	12.5	12.8	12.6	12.0	11.2	10.6	10.0	9.4	8.7	8.2	7.8
ELEC	10.4	11.4	11.6	12.5	12.8	12.6	11.9	11.5	11.0	10.5	10.0	9.4	8.9	8.6
H2	10.4	11.4	11.6	12.5	12.8	12.6	12.2	11.9	11.4	10.9	10.5	9.9	9.3	8.8
P2X	10.4	11.4	11.6	12.5	12.8	12.6	12.0	11.9	11.5	11.0	10.6	10.0	9.4	8.9
EE	10.4	11.4	11.6	12.5	12.8	12.7	11.8	11.4	10.8	10.2	9.7	9.1	8.7	8.3
CIRC	10.4	11.4	11.6	12.5	12.8	12.6	11.8	11.3	10.6	9.9	9.4	8.7	8.3	7.9
COMBO	10.4	11.4	11.6	12.5	12.8	12.6	12.0	11.8	11.4	10.9	10.3	9.7	9.1	8.5
1.5 TECH	10.4	11.4	11.6	12.5	12.8	12.7	12.2	12.5	12.4	12.3	11.2	10.3	9.4	8.7
1.5 LIFE	10.4	11.4	11.6	12.5	12.8	12.7	12.0	11.9	11.4	10.5	9.7	8.9	8.2	7.5

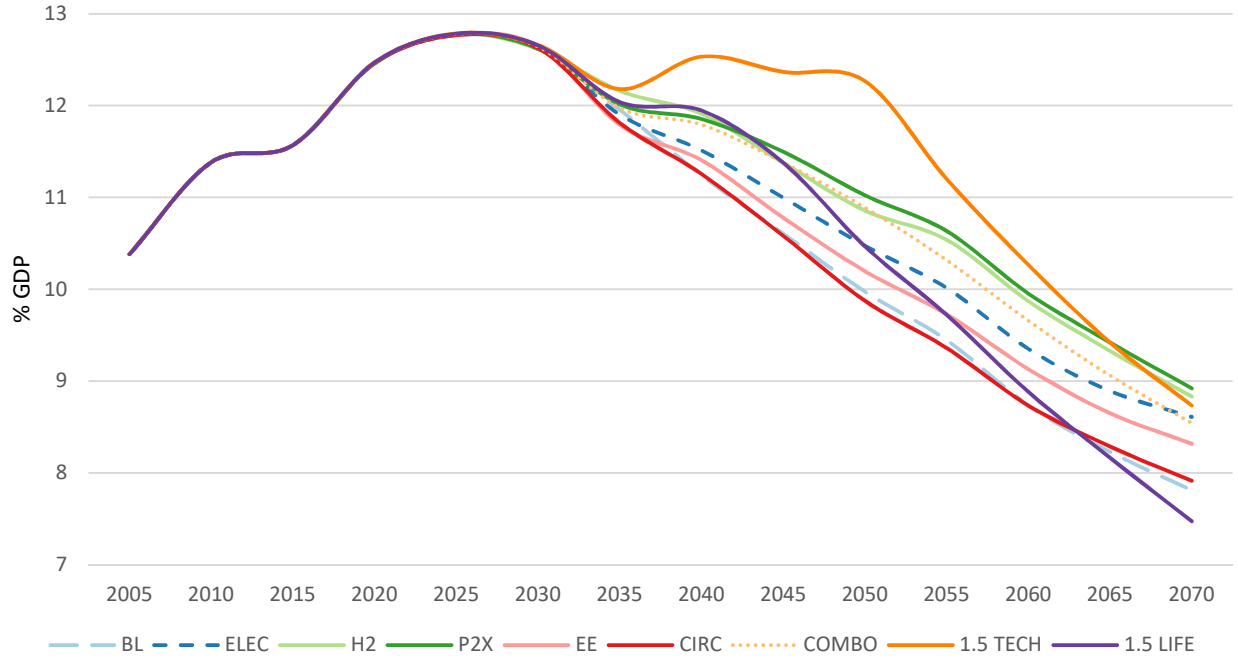


Figure 99: Projected average electricity prices for final users

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
BL	117.4	136.1	144.4	152.4	157.3	162.1	165.6	163.5	157.3	153.3	148.6	146.0	141.8	143.6
ELEC	117.4	136.1	144.4	152.4	157.2	162.0	167.6	168.7	161.9	160.1	153.2	155.5	155.1	163.7
H2	117.4	136.1	144.4	152.3	157.2	162.2	174.2	179.5	180.8	185.1	183.9	186.5	185.2	190.2
P2X	117.4	136.1	144.4	152.3	157.1	162.0	170.9	181.5	187.5	192.7	188.2	193.1	193.9	202.0
EE	117.4	136.1	144.4	152.4	157.3	162.1	169.4	168.8	160.4	158.8	156.1	158.0	161.1	176.9
CIRC	117.4	136.1	144.4	152.4	157.3	162.0	168.6	169.2	161.2	158.5	155.2	154.9	156.8	163.3
COMBO	117.4	136.1	144.4	152.4	157.4	161.9	172.7	180.6	182.0	181.6	178.8	182.4	181.0	183.0
1.5 TECH	117.4	136.1	144.4	152.4	157.4	162.2	181.6	196.5	206.5	237.3	225.7	220.3	207.8	202.2
1.5 LIFE	117.4	136.1	144.4	152.4	157.3	162.0	180.9	187.4	192.3	192.6	188.9	183.5	173.0	162.3

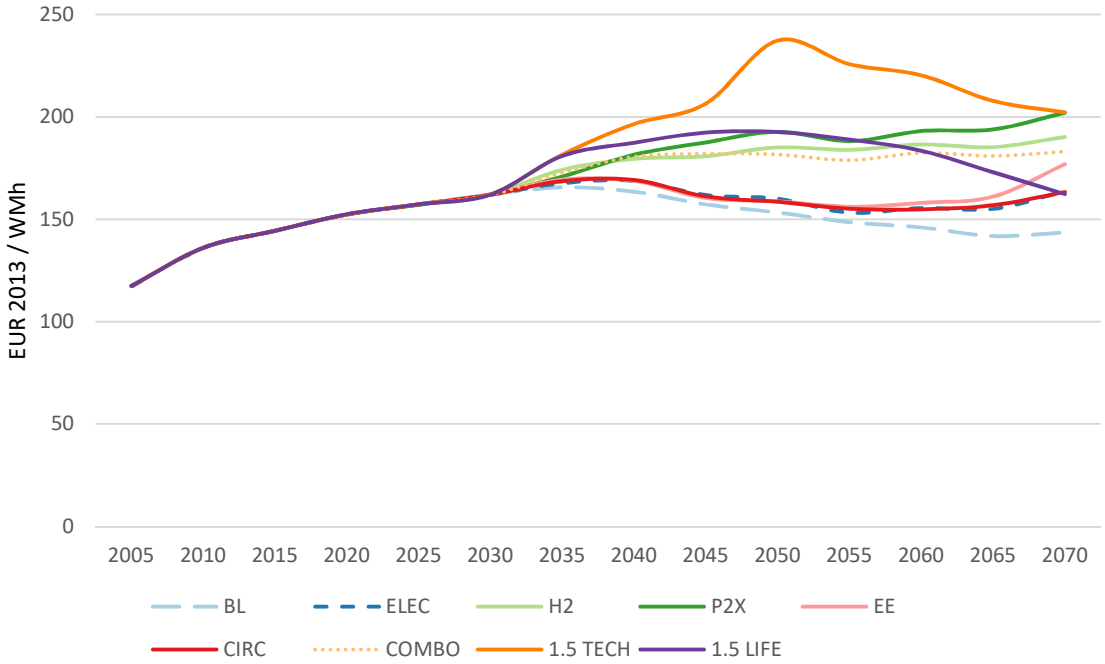


Figure 100: Composition of electricity costs in the high electrification scenario (ELEC)

	2005	2010	2015	2020	2025	2030	2035
Annual capital, fixed and O&M costs	36.4	38.9	63.9	69.2	66.6	66.2	62.3
Fuel costs	26.1	31.5	24.0	26.1	25.6	23.5	20.7
Other generation costs	2.7	2.9	6.3	9.1	9.0	7.1	9.0
Grid costs	34.7	42.8	28.6	25.7	32.5	39.2	47.3
Other costs	0.0	0.3	0.7	0.8	1.5	1.8	2.0

Annual capital, fixed and O&M costs	2040	2045	2050	2055	2060	2065	2070
Fuel costs	61.2	60.6	57.5	58.3	54.5	50.5	48.3
Other generation costs	17.4	12.5	10.8	9.2	9.0	9.3	10.2
Grid costs	6.7	4.8	4.5	4.1	6.9	10.8	17.0
Other costs	49.7	51.6	54.2	52.2	54.3	53.4	55.7
	1.9	1.7	1.9	2.1	2.1	1.6	1.6

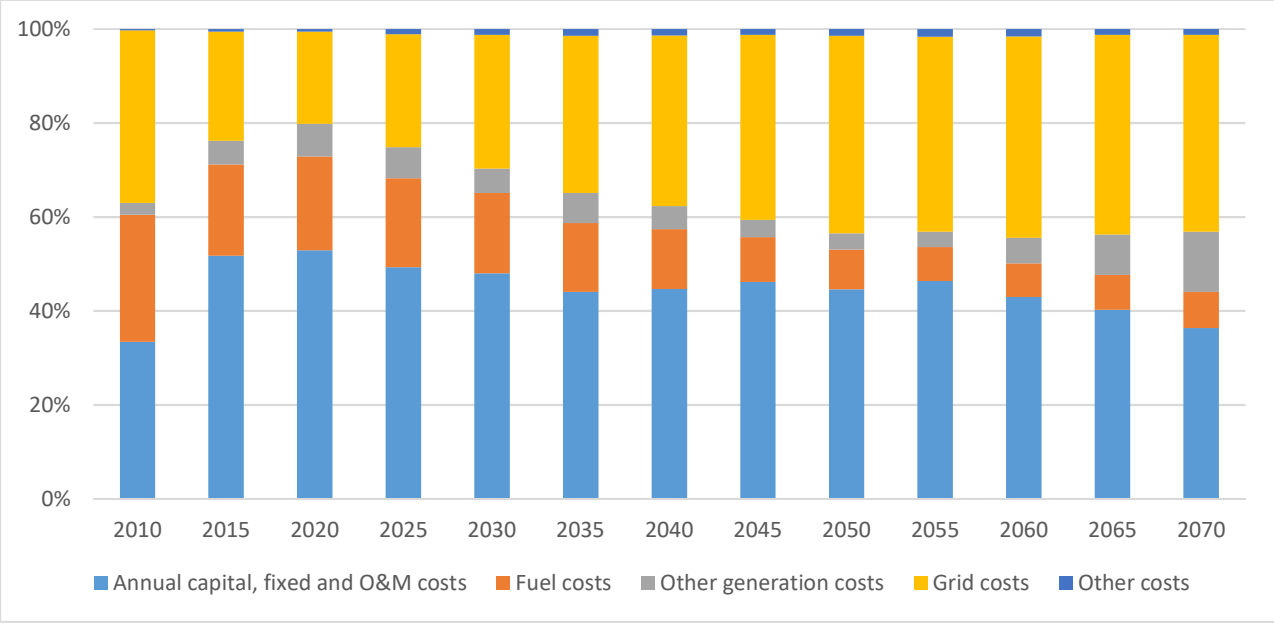


Figure 101: Energy related expenses in % of sectoral value added in industry

	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
BL	13.5	12.5	14.0	14.6	14.2	14.1	13.9	13.5	13.2	12.6	12.1	11.4	11.0
ELEC	13.5	12.5	14.0	14.6	14.3	14.1	14.1	14.1	14.0	13.4	13.0	12.3	11.9
H2	13.5	12.5	14.0	14.6	14.2	14.3	14.4	14.4	14.5	14.3	13.9	13.1	12.3
P2X	13.5	12.5	14.0	14.6	14.2	14.2	14.7	14.7	14.8	14.2	13.6	12.7	11.9
EE	13.5	12.5	14.1	14.6	14.5	14.3	14.6	14.6	14.5	14.2	13.8	13.0	12.6
CIRC	13.5	12.5	14.0	14.6	14.3	13.5	13.1	12.7	12.3	11.7	11.2	10.5	10.1
COMBO	13.5	12.5	14.0	14.6	14.3	14.3	14.9	15.1	15.2	14.4	13.7	12.7	12.0
1.5 TECH	13.5	12.5	14.1	14.6	14.3	14.7	16.0	17.3	17.2	15.7	14.8	13.3	12.4
1.5 LIFE	13.5	12.5	14.0	14.6	14.3	14.1	14.6	14.6	13.7	12.8	12.0	10.9	10.1

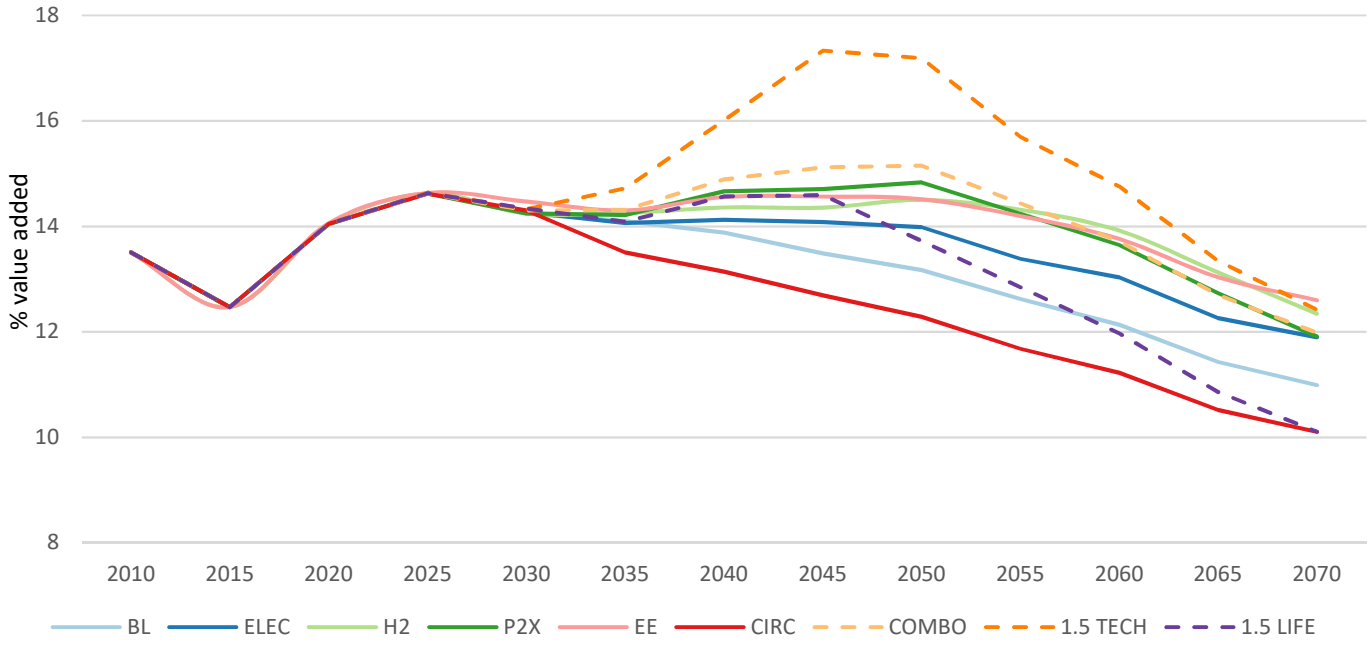


Figure 102: Energy related expenses per households in different scenarios (EUR 2013)

	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
BL	2672	2900	3169	3231	3092	3012	3059	3114	3280	3270	3362	3474
ELEC	2672	2899	3168	3231	3073	3081	3113	3237	3404	3360	3513	3755
H2	2672	2900	3171	3228	3104	3144	3192	3287	3528	3522	3630	3751
P2X	2672	2900	3171	3225	3092	3193	3271	3366	3580	3591	3718	3840
EE	2672	2907	3181	3248	3039	3063	2988	2992	3061	3066	3176	3363
CIRC	2672	2899	3168	3232	3076	3065	3028	3104	3205	3188	3320	3490
COMBO	2672	2909	3185	3253	3093	3158	3180	3237	3331	3329	3413	3522
1.5 TECH	2672	2905	3180	3251	3170	3299	3364	3648	3630	3567	3577	3638
1.5 LIFE	2672	2907	3180	3249	3153	3197	3189	3152	3189	3128	3145	3151

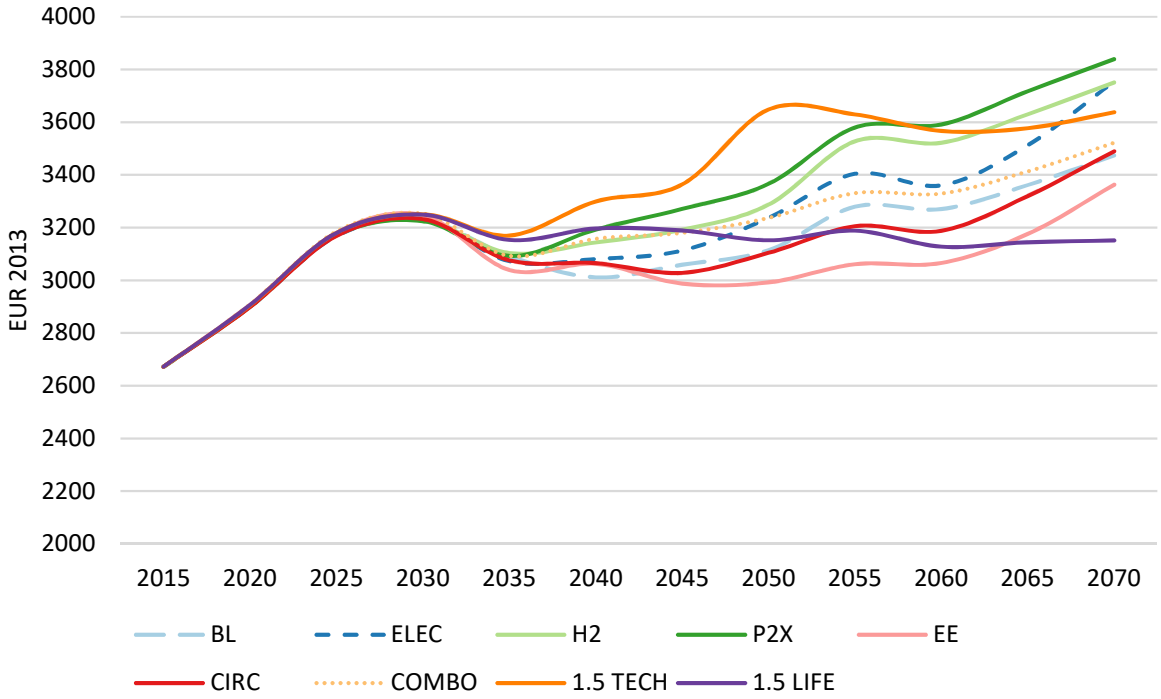


Figure 103: Energy related expenses per households in different scenarios (% of income)

	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
BL	7.3	7.4	7.6	7.3	6.6	6.0	5.7	5.4	5.3	4.9	4.6	4.4
ELEC	7.3	7.4	7.6	7.3	6.5	6.1	5.8	5.6	5.5	5.0	4.8	4.8
H2	7.3	7.4	7.7	7.3	6.6	6.2	5.9	5.7	5.7	5.2	5.0	4.8
P2X	7.3	7.4	7.7	7.3	6.6	6.3	6.0	5.8	5.7	5.3	5.1	4.9
EE	7.3	7.4	7.7	7.4	6.5	6.1	5.5	5.2	4.9	4.6	4.4	4.3
CIRC	7.3	7.4	7.6	7.3	6.5	6.1	5.6	5.3	5.1	4.7	4.6	4.5
COMBO	7.3	7.5	7.7	7.4	6.6	6.3	5.9	5.6	5.3	5.0	4.7	4.5
1.5 TECH	7.3	7.4	7.7	7.4	6.7	6.5	6.2	6.3	5.8	5.3	4.9	4.7
1.5 LIFE	7.3	7.4	7.7	7.4	6.7	6.3	5.9	5.4	5.1	4.7	4.3	4.0

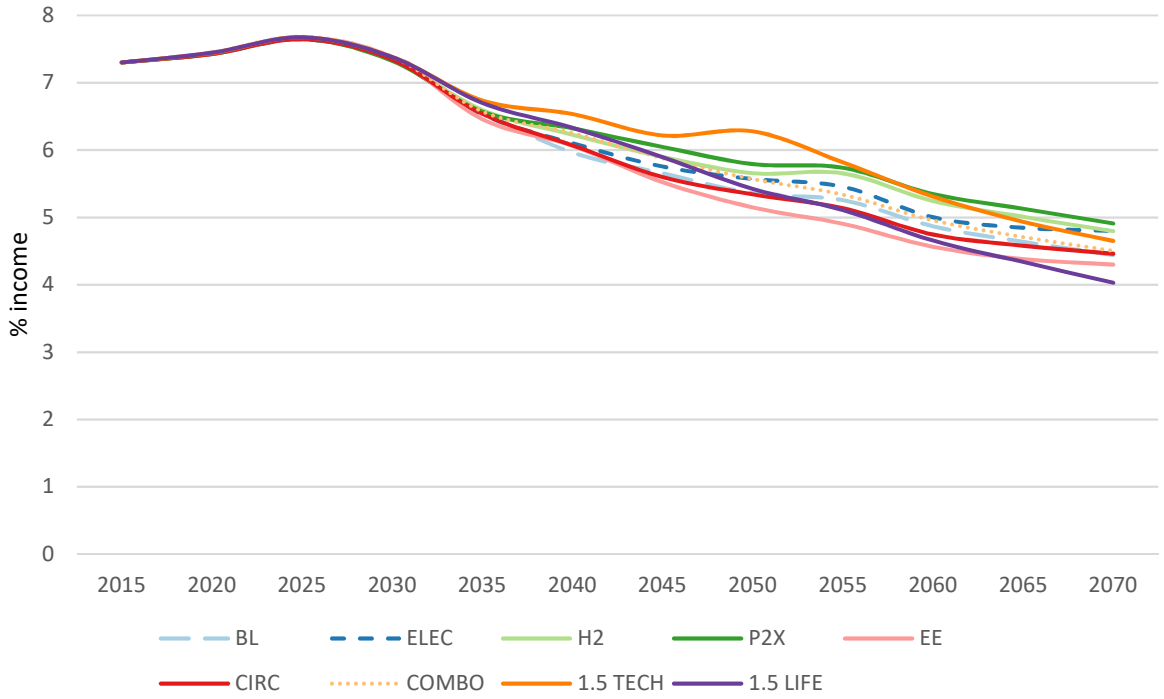


Figure 104: Net fossil fuel imports as % of GDP

	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
BL	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.4	2.3	2.1	2.0	1.9	1.8	1.7	1.6
ELEC	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.2	1.9	1.5	1.3	1.1	0.9	0.8	0.7
H2	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.2	1.9	1.5	1.3	1.1	0.9	0.8	0.7
P2X	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.3	2.0	1.6	1.3	1.1	1.0	0.8	0.7
EE	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.1	1.8	1.5	1.3	1.1	1.0	0.8	0.7
CIRC	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.1	1.8	1.4	1.2	1.0	0.9	0.8	0.7
COMBO	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.2	1.8	1.4	1.1	1.0	0.8	0.7	0.7
1.5 TECH	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.1	1.5	1.1	0.8	0.7	0.7	0.6	0.6
1.5 LIFE	1.8	2.4	2.8	2.1	2.9	2.8	2.6	2.1	1.5	1.0	0.8	0.7	0.6	0.6	0.6

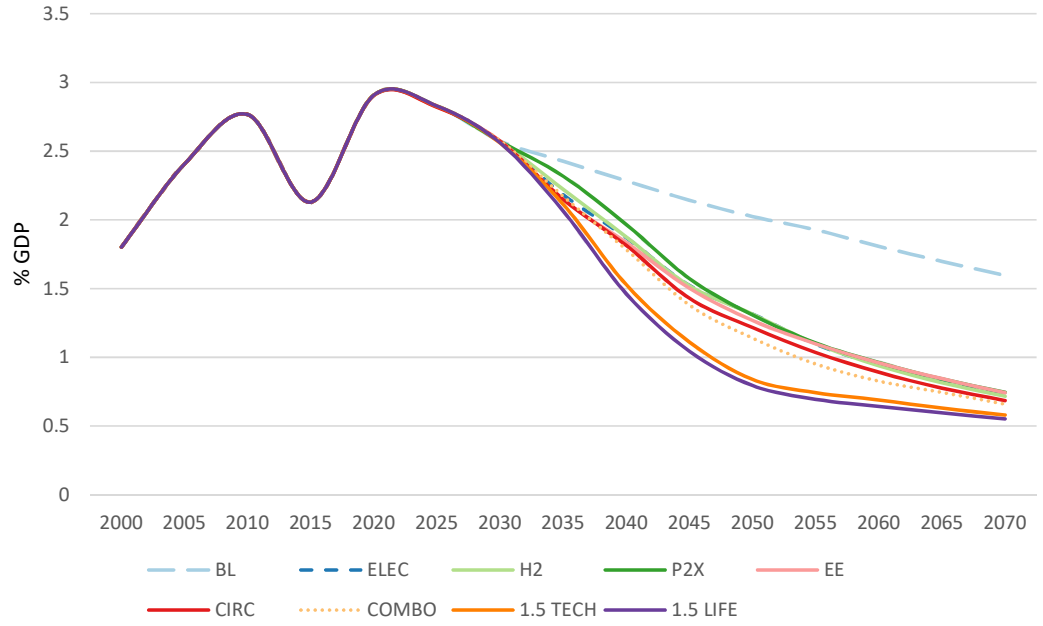


Figure 105: Cumulative savings on net imports of fossil fuels, difference from baseline in 2031-2050 (full bars) and 2051-2070 (patterned bars)

	2031-2050	2051-2070
ELEC	1699.6	4326.9
H2	1661.6	4361.0
P2X	1444.5	4268.0
EE	1814.4	4294.3
CIRC	1941.0	4621.7
COMBO	2049.4	4900.8
1.5 TECH	2816.7	5676.6
1.5 LIFE	3018.1	5883.4

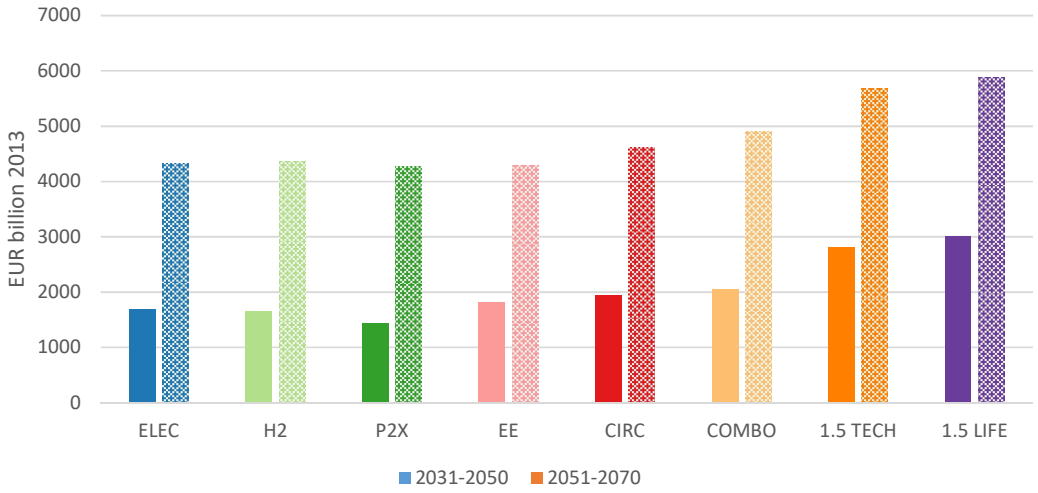


Figure 106: investment (full bars) and private consumption (patterned bars), deviation from baseline (%)

		2020	2025	2030	2035	2040	2045	2050
Investment	I - fragmented	0.9	0.5	1.3	1.1	0.9	0.8	1.4
	I - global 2C	0.9	0.4	1.1	0.9	0.7	0.5	1.1
	I - fragmented	1.1	0.6	1.3	1.1	1.0	0.4	2.3
	I - global 1.5C	0.7	0.1	0.8	0.7	0.5	0.0	1.6
Consumption	C- fragmented	0.0	0.0	-0.1	-0.2	-0.3	-0.3	-0.4
	C - global 2C	-0.4	-0.4	-0.5	-0.6	-0.7	-0.5	-0.8
	C - fragmente	-0.1	-0.1	-0.3	-0.4	-0.5	-0.5	-1.0
	C - global 1.5C	-1.4	-1.5	-1.4	-1.1	-0.9	-0.9	-1.7

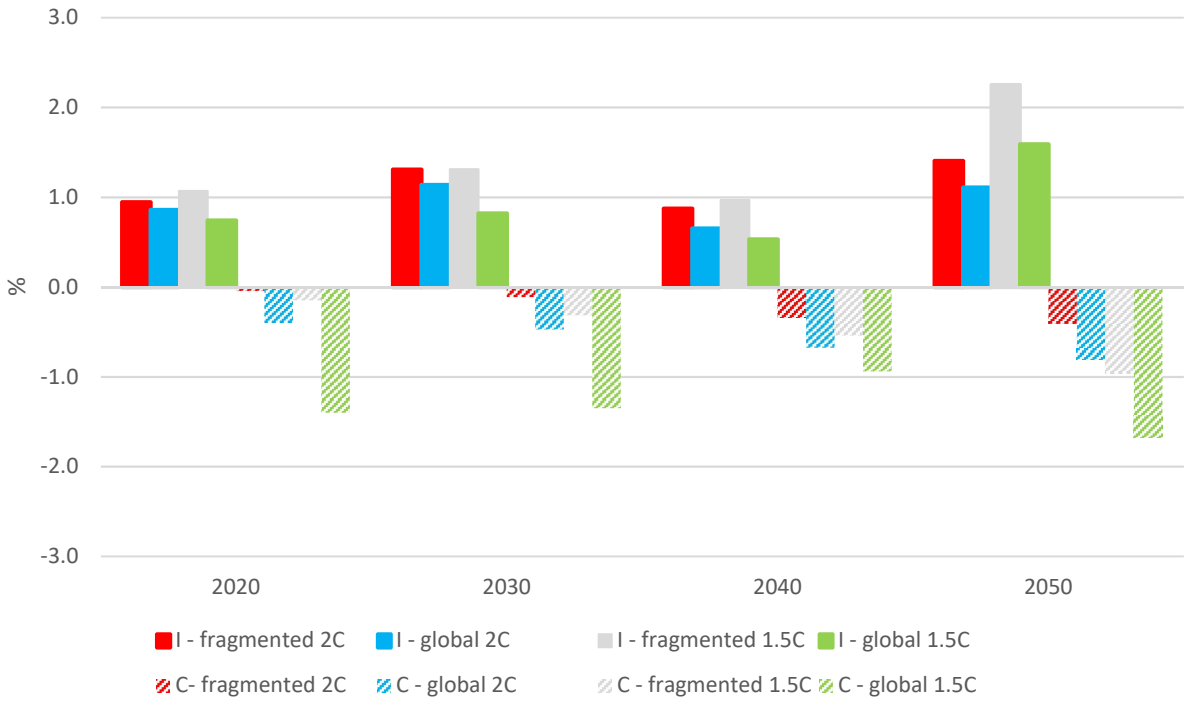


Figure 117: EU, GHG emissions on a PBA, CBA and TCBA basis

MtCO2	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
PBA	4472	4370	4353	4308	4310	4378	4351	4416	4450	4433	4441
CBA	4601	4507	4540	4532	4548	4586	4558	4633	4656	4634	4689
TCBA	4480	4383	4392	4340	4350	4376	4328	4404	4429	4417	4424

MtCO2	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PBA	4334	4232	3872	3869	3786	3735	3608	3640	3585	3563
CBA	4560	4469	4122	4113	3998	3908	3747	3774	3730	3701
TCBA	4309	4181	3810	3783	3664	3577	3426	3445	3375	3346

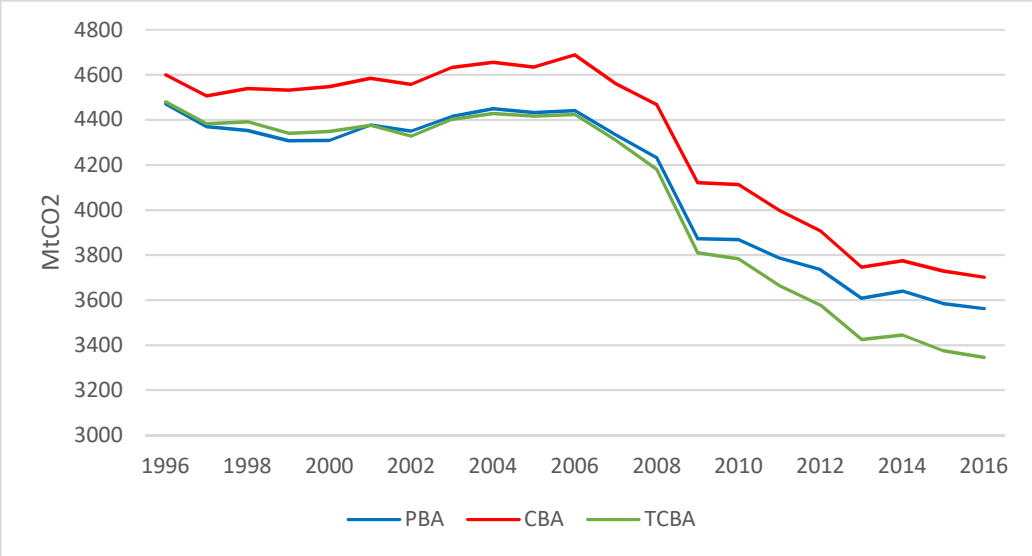


Figure 118: Reduction achieved due to EU net exports and imports, fragmented and global action (TCBA basis)

MtCO2	INDC80 Scenario	2°C Scenario	MtCO2	INDC80 Scenario	2°C Scenario
2000	40	40	2026	-245	-200
2001	-2	-2	2027	-249	-198
2002	-23	-23	2028	-251	-195
2003	-12	-12	2029	-254	-192
2004	-21	-21	2030	-256	-189
2005	-16	-16	2031	-257	-185
2006	-17	-17	2032	-258	-181
2007	-25	-25	2033	-258	-178
2008	-51	-51	2034	-259	-174
2009	-63	-63	2035	-260	-171
2010	-86	-86	2036	-260	-167
2011	-122	-122	2037	-261	-164
2012	-158	-158	2038	-262	-160
2013	-182	-182	2039	-263	-158
2014	-194	-194	2040	-264	-154
2015	-210	-208	2041	-265	-152
2016	-217	-215	2042	-266	-147
2017	-213	-210	2043	-267	-143
2018	-213	-207	2044	-268	-139
2019	-213	-204	2045	-270	-135
2020	-210	-197	2046	-272	-132
2021	-217	-199	2047	-275	-129
2022	-223	-201	2048	-278	-126
2023	-230	-202	2049	-281	-121
2024	-235	-201	2050	-284	-117
2025	-241	-201			

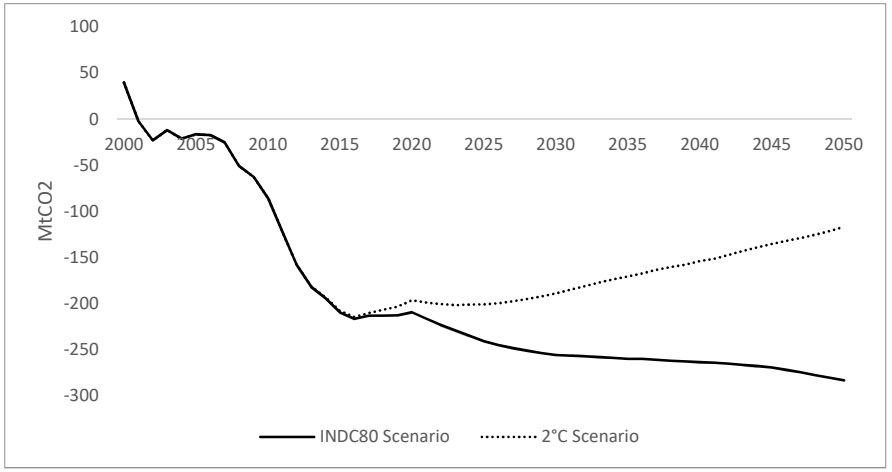


Figure 134: Differences in final energy consumption in Iron & Steel compared to Baseline in 2050 by fuel and scenario

	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5 LIFE94	1.5LIFE	LIFElowbio
Egas	0.0	0.0	6.3	0.0	0.0	3.8	1.2	1.2	1.2	1.4
Hydrogen	0.0	13.4	0.6	0.0	0.0	5.9	12.7	10.4	10.5	15.1
Electricity	3.9	-0.7	0.4	-4.5	-0.6	-2.7	-2.7	-3.7	-3.6	-2.0
Biomass	4.2	2.3	4.0	5.9	4.4	3.4	2.2	1.1	0.9	-7.2
Reduced D	1.4	0.2	1.0	4.4	7.8	3.4	4.2	9.0	9.0	10.1
Natural Ga	-2.1	-9.0	-6.2	2.5	-4.1	-8.3	-10.5	-10.5	-10.5	-10.4
Steam	0.6	0.0	0.0	-0.5	0.4	0.3	0.3	0.0	0.0	0.2
Solids	-7.4	-5.9	-5.8	-7.1	-7.4	-5.6	-7.0	-7.1	-7.1	-6.9
Fossil Base	-0.6	-0.3	-0.3	-0.5	-0.6	-0.2	-0.3	-0.4	-0.4	-0.3
Other (sola	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 135: Final energy demand in the iron & steel industry by energy carrier (excluding production of feedstocks, clean gas and hydrogen)

		Coal	Fuel oil	Other fossil	Natural gas	Ambient heat	District heating	Solar energy
3a CCS	2050	110.8	4.3	39.2	62.2	2.1	3.3	0.1
3b CleanGas	2050	28.8	2.2	15.8	9.9	1.8	3.3	0.1
3c BioCycle	2050	77.5	2.8	27.4	40.5	0.8	2.9	0.0
3d Electric	2050	31.7	2.1	19.9	39.7	3.6	2.3	0.0
4a Mix80	2050	21.5	1.8	15.5	32.3	3.4	2.2	0.0
4b Mix95	2050	6.9	0.7	9.5	2.0	3.3	2.4	0.1

		Other RES	Waste non-RES	Biomass	Electricity	Hydrogen	Egas
3a CCS	2050	0.0	3.5	16.9	121.9	0.3	0.0
3b CleanGas	2050	0.0	2.3	11.6	131.3	106.7	39.7
3c BioCycle	2050	0.0	2.3	32.2	99.3	0.2	0.0
3d Electric	2050	0.0	2.1	10.6	284.9	0.2	0.0
4a Mix80	2050	0.0	1.7	8.9	149.7	57.9	0.0
4b Mix95	2050	0.0	0.6	8.6	153.5	73.1	37.3

Figure 138: Differences in final energy consumption in Chemicals compared to Baseline in 2050 by fuel and scenario

	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5 LIFE94	1.5LIFE	LIFElowbio
Egas	0.0	0.0	3.0	0.0	0.0	1.0	0.3	0.4	0.4	0.4
Hydrogen	0.0	7.8	1.4	0.0	0.0	1.3	2.2	2.8	2.9	3.4
Electricity	12.9	-0.3	0.2	0.9	2.2	8.2	8.3	-0.5	-0.5	0.0
Biomass	-0.6	0.2	0.9	0.4	0.2	-1.5	-1.3	-1.3	-1.3	-2.4
Reduced D	-5.6	-0.6	-0.3	5.3	2.4	0.3	1.7	8.5	8.5	8.3
Natural Ga	-6.4	-6.9	-5.3	-5.1	-6.0	-8.1	-8.6	-8.5	-8.5	-8.6
Steam	1.1	-0.2	-0.1	-0.2	2.2	-0.5	-2.0	-0.7	-0.7	-0.5
Solids	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Fossil Base	-0.7	0.2	0.6	-0.9	-0.7	-0.2	-0.3	-0.3	-0.3	-0.2
Other (sola	-0.3	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.1	-0.1	-0.1

Figure 139: Final energy demand in the chemical industry by energy carrier (excluding production of feedstock hydrogen and clean gas)

		Coal	Fuel oil	Other fossil	Natural gas	Ambient heat	District heating	Solar energy
3a CCS	2050	20.4	13.3	45.8	188.8	8.9	29.3	0.3
3b CleanGas	2050	9.9	3.8	12.6	20.8	8.7	21.2	0.4
3c BioCycle	2050	7.6	4.5	18.0	60.1	3.6	21.4	0.1
3d Electric	2050	7.4	4.6	16.1	61.8	20.8	18.4	0.1
4a Mix80	2050	6.9	4.2	15.1	57.2	20.3	18.0	0.1
4b Mix95	2050	3.6	1.5	5.9	2.8	19.0	15.7	0.2

		Other RES	Waste non-B	Biomass	Electricity	Hydrogen	Egas
3a CCS	2050	0.3	10.2	112.9	208.4	0.3	0.0
3b CleanGas	2050	0.0	6.1	53.3	263.5	0.1	83.0
3c BioCycle	2050	0.0	2.1	124.5	169.4	0.1	0.0
3d Electric	2050	0.0	2.3	38.4	322.6	0.1	0.0
4a Mix80	2050	0.0	2.1	35.5	300.2	0.1	0.0
4b Mix95	2050	0.0	0.4	17.3	304.9	0.1	52.7

Figure 140: Energy Content of feedstock demand for ethylene, ammonia and methanol production by type of feedstock and scenario in 2050

	Natural gas	Naphtha	Biomass	Hydrogen
2015	82.7	481.1		
CCS	89.6	602.2		
CleanGas	17.9	120.4	0.0	485.4
Biocycle	51.8	84.3	196.8	0.0
Electric	17.9	120.4	0.0	485.4
Mix80	13.8	96.4	0.0	384.2
Mix95	0.0	0.0	0.0	480.3

Figure 142: Differences in final energy consumption in Non-Metallic Minerals compared to Baseline in 2050 by fuel and scenario

	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5 LIFE94	1.5LIFE	LIFElowbio
Egas	0.0	0.0	7.7	0.0	0.0	4.9	3.4	3.4	3.4	4.1
Hydrogen	0.0	11.6	0.2	0.0	0.0	3.0	6.8	5.3	5.4	8.9
Electricity	2.9	1.5	1.6	3.4	1.2	2.4	3.8	2.2	2.2	2.8
Biomass	3.7	1.0	2.8	2.3	4.0	2.3	1.3	0.6	0.5	-4.6
Reduced D	-1.0	-1.2	-1.0	2.7	3.9	1.3	1.3	5.5	5.5	5.0
Natural Ga	-2.7	-11.1	-9.7	-4.7	-5.8	-11.9	-13.6	-13.6	-13.6	-13.4
Steam	0.5	0.0	0.1	-0.4	0.1	-0.1	-0.2	-0.2	-0.2	-0.1
Solids	-0.8	-0.7	-0.6	-0.7	-0.9	-0.7	-0.9	-1.0	-1.0	-0.9
Fossil Base	-2.6	-1.1	-1.0	-2.7	-2.7	-1.2	-1.9	-2.1	-2.1	-1.8
Other (sola	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 143: Final energy demand in the non-metallic minerals industry by energy carrier

Non-metallic mineral products		Coal	Fuel oil	Other fossil	Natural gas	Ambient heat	District heating	Solar energy
3a CCS	2050	20.6	3.9	11.7	120.8	10.8	7.0	0.2
3b CleanGas	2050	12.1	2.2	5.2	27.0	10.3	6.5	0.3
3c BioCycle	2050	5.5	1.2	2.6	27.6	5.3	5.9	0.1
3d Electric	2050	13.3	2.4	6.9	81.2	15.9	4.4	0.1
4a Mix80	2050	12.4	2.3	6.4	76.6	15.6	4.3	0.1
4b Mix95	2050	5.4	1.1	2.6	5.1	15.6	4.6	0.1

		Other RES	Waste non-RES	Biomass	Electricity	Hydrogen	Egas
3a CCS	2050	0.1	7.8	60.0	83.3	0.2	0.0
3b CleanGas	2050	0.1	6.6	55.6	52.4	0.1	107.8
3c BioCycle	2050	0.0	3.5	164.8	46.7	0.0	0.0
3d Electric	2050	0.1	4.8	54.3	115.8	0.2	0.0
4a Mix80	2050	0.1	4.5	47.5	100.6	0.2	0.0
4b Mix95	2050	0.1	1.6	36.3	110.1	0.1	96.0

Figure 145: Differences in final energy consumption in Pulp & Paper compared to Baseline in 2050 by fuel and scenario

	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5 LIFE94	1.5LIFE	LIFElowbio
Egas	0.0	0.0	1.7	0.0	0.0	1.2	1.0	1.2	1.2	1.3
Hydrogen	0.0	2.5	0.6	0.0	0.0	1.0	2.0	2.0	2.0	3.0
Electricity	4.3	0.9	0.8	2.5	0.4	2.5	2.7	-0.8	-0.8	0.3
Biomass	-2.6	-1.1	-1.0	-3.6	-2.1	-3.2	-4.2	-4.3	-4.3	-7.1
Reduced Demand	0.3	0.1	0.6	3.0	4.2	2.9	3.5	7.0	7.0	7.3
Natural Gas (incl. coal gas)	-1.3	-2.0	-2.3	0.3	-1.0	-2.8	-3.2	-3.2	-3.2	-3.1
Steam	-0.7	-0.4	-0.4	-2.2	-1.4	-1.7	-1.9	-2.0	-2.0	-1.9
Solids	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	-0.1	0.0
Fossil Based Liquids	-0.1	0.0	0.0	0.0	-0.1	0.1	0.1	0.1	0.1	0.2
Other (solar, geothernal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 146: Final energy demand in pulp & paper by energy carrier

Paper and printing		Coal	Fuel oil	Other fossil	Natural gas	Ambient heat	District heating	Solar energy
3a CCS	2050	13.7	11.8	1.6	44.2	28.8	19.4	0.2
3b CleanGas	2050	12.8	11.1	1.5	9.9	27.9	18.4	0.3
3c BioCycle	2050	8.4	7.9	1.1	26.6	17.4	17.7	0.1
3d Electric	2050	9.5	8.9	1.2	32.2	31.9	14.7	0.1
4a Mix80	2050	8.2	7.1	1.0	27.9	29.5	14.0	0.1
4b Mix95	2050	2.4	3.9	0.4	1.6	30.6	14.3	0.2

Paper and printing		Other RES	Waste non-RES	Biomass	Electricity	Hydrogen	Egas
3a CCS	2050	0.1	14.2	72.2	93.6	0.0	0.0
3b CleanGas	2050	0.1	13.5	69.2	88.6	0.0	39.8
3c BioCycle	2050	0.1	7.8	104.8	76.9	0.0	0.0
3d Electric	2050	0.1	9.3	49.8	141.0	0.0	0.0
4a Mix80	2050	0.1	7.9	45.1	128.6	0.0	0.0
4b Mix95	2050	0.0	3.0	49.2	134.3	0.0	31.2

Figure 148: Differences in final energy consumption in Non-Ferrous compared to Baseline in 2050 by fuel and scenario

	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5 LIFE94	1.5LIFE	LIFElowbio
Egas	0.0	0.0	0.8	0.0	0.0	0.6	0.4	0.4	0.4	0.5
Hydrogen	0.0	1.4	0.2	0.0	0.0	0.5	0.9	1.1	1.1	1.4
Electricity	0.5	0.0	0.0	-0.3	0.1	-0.3	-0.2	-0.5	-0.5	-0.3
Biomass	0.3	0.1	0.2	0.4	0.7	0.2	0.1	0.3	0.3	-0.2
Reduced Demand	-0.4	0.1	0.1	0.2	-0.5	0.3	0.3	0.1	0.1	0.0
Natural Gas (incl. coal gas)	-0.7	-1.5	-1.3	-0.5	-0.6	-1.6	-1.8	-1.8	-1.8	-1.8
Steam	0.4	0.0	0.0	0.3	0.4	0.4	0.3	0.4	0.4	0.4
Solids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fossil Based Liquids	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
Other (solar, geothernal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 149: Final energy demand in the non-ferrous industry by energy carrier

Non-ferrous metals		Coal	Fuel oil	Other fossil	Natural gas	Ambient heat	District heating	Solar energy
3a CCS	2050	1.8	0.8	0.8	16.1	2.4	2.1	0.0
3b CleanGas	2050	1.6	0.7	0.7	3.7	2.2	1.9	0.1
3c BioCycle	2050	1.1	0.6	0.6	11.1	0.8	1.8	0.0
3d Electric	2050	1.1	0.6	0.8	13.2	3.1	1.2	0.0
4a Mix80	2050	1.2	0.6	0.8	13.0	3.1	1.2	0.0
4b Mix95	2050	0.5	0.3	0.4	0.7	3.0	1.2	0.0

		Other RES	Waste non-RES	Biomass	Electricity	Hydrogen	Egas
3a CCS	2050	0.0	1.1	9.4	62.1	0.0	0.0
3b CleanGas	2050	0.0	1.0	8.4	61.6	0.0	14.7
3c BioCycle	2050	0.0	0.5	18.9	60.0	0.0	0.0
3d Electric	2050	0.0	0.5	4.0	71.1	0.0	0.0
4a Mix80	2050	0.0	0.5	3.9	70.6	0.0	0.0
4b Mix95	2050	0.0	0.1	4.2	70.9	0.0	13.4

Figure 151: Differences in final energy consumption in Refineries compared to Baseline in 2050 by fuel and scenario

	ELEC	H2	P2X	EE	CIRC	COMBO	1.5TECH	1.5 LIFE94	1.5LIFE	LIFElowbio
Egas	0.0	0.0	0.3	0.0	0.0	0.1	0.1	0.2	0.1	0.1
Hydrogen	0.0	1.5	1.6	0.0	0.0	1.3	1.6	1.6	1.5	1.4
Electricity	18.9	-0.3	-0.2	-0.4	8.6	0.3	1.1	0.2	-0.1	0.8
Biomass	-0.4	0.3	0.3	0.4	-0.3	0.2	0.2	0.2	0.2	0.0
Reduced Demand	-6.0	13.1	12.5	12.0	4.8	12.1	14.5	15.7	15.9	14.9
Natural Gas (incl. coal gas)	-4.5	-3.7	-4.2	-3.7	-4.7	-5.1	-5.5	-5.6	-5.5	-5.5
Steam	2.5	-0.6	-0.3	2.5	2.4	2.5	1.9	1.7	1.7	1.9
Solids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fossil Based Liquids	-10.4	-10.2	-10.0	-10.8	-10.7	-11.4	-14.0	-14.0	-13.8	-13.5
Other (solar, geothernal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 152: Final energy demand in the refining industry by energy carrier

		Coal	Fuel oil	Other fossil	Natural gas	Ambient heat	District heating	Solar energy
3a CCS	2050	0.5	7.8	86.7	49.5	2.2	6.1	0.0
3b CleanGas	2050	0.5	6.5	81.3	14.1	2.1	6.0	0.0
3c BioCycle	2050	0.3	5.6	78.6	28.2	0.9	6.1	0.0
3d Electric	2050	0.3	7.6	85.2	46.7	2.9	5.7	0.0
4a Mix80	2050	0.3	7.6	85.2	46.7	2.9	5.7	0.0
4b Mix95	2050	0.1	3.0	44.6	1.9	2.2	3.7	0.0

		Other RES	Waste non-RES	Biomass	Electricity	Hydrogen	Egas
3a CCS	2050	0.1	0.6	12.9	33.7	0.1	0.0
3b CleanGas	2050	0.1	0.6	9.4	20.4	0.1	56.3
3c BioCycle	2050	0.1	0.3	59.5	17.9	0.0	0.0
3d Electric	2050	0.1	0.3	9.1	40.3	0.1	0.0
4a Mix80	2050	0.1	0.3	9.1	40.3	0.1	0.0
4b Mix95	2050	0.0	0.0	4.2	19.3	0.0	37.0

Figure 159: CO2 Feedstock used for the production of Synthetic Fuels (in MtCO2)

	2030	2035	2040	2045	2050	2055	2060	2065	2070
COMBO	0.0	8.0	87.0	149.7	172.0	192.8	192.3	188.3	188.3
P2X	0.0	13.2	127.6	260.4	371.5	408.6	438.9	450.2	474.7
1.5TECH	0.0	23.4	90.5	179.2	226.1	224.1	225.1	227.1	229.9
1.5LIFE	0.0	23.1	82.5	139.3	152.2	159.3	161.8	165.2	169.6

Annex 7.7 GHG Pathways towards 2050 (GtCO2eq)
MtCO2eq

Baseline

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.1	381.8	316.7	275.1	215.3	205.1	205.0	205.0	205.5
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	412.8	409.0	406.3	404.2	404.1	404.2
Residential	484.2	466.9	422.8	387.4	309.6	213.5	173.7	157.6	151.6	129.6
Tertiary	271.6	267.9	245.7	231.0	184.5	122.0	98.7	89.3	85.1	77.7
Transport	1079.8	1036.6	1029.8	999.2	941.4	868.9	785.3	725.8	683.8	666.9
Industry	1083.6	901.0	888.1	867.7	777.8	658.9	595.0	543.8	509.2	483.6
Power	1490.4	1347.3	1183.2	1047.4	879.1	620.8	517.3	387.2	296.4	246.3
LULUCF	-293.4	-314.8	-296.5	-266.2	-260.0	-252.1	-242.5	-229.1	-232.2	-236.3
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net emissions	5046.6	4551.1	4289.1	4004.4	3520.3	2856.2	2539.0	2283.8	2103.1	1977.5

ELEC

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.0	213.7	118.0	98.3	75.5	60.5
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	412.8	409.0	339.1	322.5	285.9	277.0
Residential	484.2	466.9	422.8	387.6	309.4	213.0	170.0	149.4	110.5	48.9
Tertiary	271.6	267.9	245.7	230.9	184.7	122.2	94.2	76.2	56.0	40.2
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.3	648.0	492.5	376.7	327.6
Industry	1083.6	901.0	887.8	869.5	782.4	660.3	506.2	384.7	298.5	231.2
Power	1490.4	1347.3	1183.2	1046.3	881.9	614.5	381.6	194.9	89.9	73.7
LULUCF	-293.4	-314.9	-296.7	-266.3	-259.0	-252.2	-249.7	-248.5	-241.5	-237.9
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-4.7	-5.0
Net emissions	5046.6	4551.1	4288.7	4005.4	3529.5	2848.8	2007.5	1469.4	1046.9	816.2

H2

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.0	213.7	118.0	98.3	75.5	60.5
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	412.8	409.0	339.1	322.5	285.9	277.0
Residential	484.2	466.9	422.8	389.1	307.4	213.3	169.5	145.7	110.6	56.3
Tertiary	271.6	267.9	245.7	231.1	180.8	120.9	94.9	77.6	56.8	34.3
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.4	641.6	485.5	365.4	316.7
Industry	1083.6	901.0	887.8	869.8	782.9	661.7	550.3	409.4	294.2	205.5
Power	1490.4	1347.3	1183.2	1045.1	889.2	609.3	414.8	219.1	117.9	104.9
LULUCF	-293.4	-314.8	-296.2	-265.6	-262.2	-262.1	-259.7	-257.4	-251.0	-243.5
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-1.0	-5.1	-5.5
Net emissions	5046.6	4551.1	4289.2	4006.9	3528.2	2834.2	2068.2	1499.7	1050.0	806.1

P2X

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.0	213.7	118.0	98.3	75.5	60.5
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	412.8	409.0	339.1	322.5	285.9	277.0
Residential	484.2	466.9	422.8	389.0	307.4	212.5	166.3	109.3	77.4	44.6
Tertiary	271.6	267.9	245.7	231.2	180.8	120.0	93.4	63.5	44.3	29.8
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.4	736.2	611.1	437.1	308.7
Industry	1083.6	901.0	887.9	870.8	783.2	662.2	564.2	418.5	303.2	216.8
Power	1490.4	1347.3	1183.2	1045.4	893.5	619.3	375.7	202.6	129.9	119.3
LULUCF	-293.4	-314.8	-295.8	-265.0	-262.0	-262.9	-268.7	-272.1	-266.6	-263.1
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.7	-4.9	-6.0
Net emissions	5046.6	4551.2	4289.8	4008.8	3532.8	2842.1	2124.2	1553.1	1081.8	787.7

EE

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.0	213.7	118.0	98.3	75.5	60.5
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	412.8	409.0	339.1	322.5	285.9	277.0
Residential	484.2	466.9	422.8	388.9	311.5	213.0	166.7	143.0	111.7	59.7
Tertiary	271.6	267.9	245.7	231.3	183.7	121.4	94.6	78.9	60.6	44.0
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.4	650.3	494.0	376.5	325.0
Industry	1083.6	901.0	887.7	868.1	781.9	661.0	495.9	387.3	309.7	224.6
Power	1490.4	1347.3	1183.2	1044.2	878.5	628.2	337.5	160.0	54.7	17.4
LULUCF	-293.4	-314.5	-296.2	-265.9	-256.6	-249.2	-243.8	-239.2	-240.5	-241.3
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-4.4	-4.4
Net emissions	5046.6	4551.4	4289.1	4003.9	3529.1	2865.4	1958.4	1444.3	1029.5	762.6

CIRC

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.0	213.7	118.0	98.3	75.5	60.5
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	412.8	409.0	339.1	322.5	285.9	277.0
Residential	484.2	466.9	422.8	387.4	309.1	212.9	170.5	146.8	105.6	65.5
Tertiary	271.6	267.9	245.7	230.8	182.1	121.3	95.8	78.6	55.5	43.2
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.4	657.8	501.4	377.2	317.4
Industry	1083.6	901.0	887.9	869.0	779.8	659.5	479.1	350.8	250.1	192.2
Power	1490.4	1347.3	1183.2	1045.0	881.8	620.4	346.7	168.4	58.7	25.2
LULUCF	-293.4	-314.6	-296.5	-267.6	-259.5	-243.4	-259.0	-274.6	-283.8	-292.1
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	-5.1	-5.1
Net emissions	5046.6	4551.4	4289.1	4002.0	3523.4	2861.7	1948.1	1391.4	919.6	683.8

COMBO

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.0	213.7	118.0	98.3	75.5	60.5
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	412.8	409.0	339.1	322.5	285.9	277.0
Residential	484.2	466.9	422.8	389.1	311.3	212.4	158.4	100.3	57.1	19.3
Tertiary	271.6	267.9	245.7	231.2	184.4	121.0	91.0	61.0	37.9	23.0
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.4	650.3	486.2	325.7	256.8
Industry	1083.6	901.0	887.6	869.6	783.6	661.8	535.2	395.7	270.7	175.6
Power	1490.4	1347.3	1183.2	1043.8	882.0	622.6	377.6	192.6	105.3	61.9
LULUCF	-293.4	-314.8	-294.7	-264.9	-263.6	-262.5	-268.3	-271.8	-259.1	-248.0
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	-5.6	-6.0
Net emissions	5046.6	4551.2	4290.5	4006.2	3527.7	2846.4	2001.4	1384.2	893.3	620.1

1.5TECH

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.0	213.7	117.3	78.9	69.6	60.5
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	412.8	409.0	331.0	295.1	285.7	276.9
Residential	484.2	466.9	422.8	388.5	310.4	211.5	148.5	92.6	42.8	11.8
Tertiary	271.6	267.9	245.7	231.0	183.9	120.3	87.5	57.9	32.2	19.3
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.3	636.0	415.0	211.3	85.6
Industry	1083.6	901.0	888.2	869.3	784.9	656.3	491.3	249.8	162.2	109.8
Power	1490.4	1347.3	1183.2	1043.9	880.4	612.4	279.1	47.5	33.7	37.5
LULUCF	-293.4	-314.5	-294.3	-306.7	-310.4	-311.7	-326.8	-336.3	-327.1	-316.9
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	-1.6	-51.5	-162.5	-258.4
Net emissions	5046.6	4551.5	4291.5	3963.4	3479.3	2779.7	1762.2	849.2	348.0	26.0

1.5LIFE

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.2	212.0	113.9	74.7	66.7	55.7
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	401.9	388.2	304.2	261.2	245.2	230.4
Residential	484.2	466.9	422.8	388.8	310.6	212.1	148.8	91.4	41.8	11.4
Tertiary	271.6	267.9	245.7	230.8	183.7	120.4	87.8	58.2	32.3	19.4
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.4	629.0	381.0	198.9	95.1
Industry	1083.6	901.0	887.8	869.2	783.4	652.2	470.1	244.6	150.6	99.9
Power	1490.4	1347.3	1183.2	1043.3	881.0	613.8	255.6	66.7	41.7	30.4
LULUCF	-293.4	-314.6	-294.7	-330.2	-341.1	-350.8	-384.7	-415.7	-438.2	-464.1
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	-1.9	-17.1	-41.2	-53.4
Total	5046.6	4551.4	4290.8	3939.3	3436.9	2716.4	1622.9	744.9	298.0	24.8

1.5LIFE-LB

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Non-CO2 other	490.2	419.2	381.8	317.1	276.2	212.0	113.9	74.7	66.7	55.7
Non-CO2 Agriculture	440.2	427.2	434.3	421.1	401.9	388.2	304.2	261.2	245.2	230.4
Residential	484.2	466.9	422.8	388.5	310.2	211.1	150.6	91.9	44.2	12.5
Tertiary	271.6	267.9	245.7	230.9	183.9	120.5	88.7	58.5	33.0	19.5
Transport	1079.8	1036.6	1029.8	999.2	941.3	868.3	639.8	385.1	202.7	89.9
Industry	1083.6	901.0	888.9	868.5	780.7	651.0	471.8	258.2	160.1	106.4
Power	1490.4	1347.3	1183.2	1042.9	879.9	608.5	257.1	94.6	93.7	61.8
LULUCF	-293.4	-314.6	-294.8	-329.1	-340.0	-349.7	-371.9	-396.3	-433.0	-471.7
Carbon Removal Technologies	0.0	0.0	0.0	0.0	0.0	0.0	-1.7	-24.0	-59.7	-81.7
Net emissions	5046.6	4551.4	4291.7	3939.2	3434.1	2709.9	1652.6	803.8	353.0	22.7

Figure 2: Fuel mix in Gross Inland Consumption

		solids	non-energy fossil liquids	natural gas	e-liquids	e-gas	nuclear	renewables
	2016	15%	6%	30%	23%	0%	0%	13%	13%
	2030	10%	9%	25%	20%	0%	0%	12%	25%
2050	Baseline	2%	11%	20%	19%	0%	0%	12%	36%
	Average of "well below 2°C" scenarios (-80% emissions)	0%	11%	10%	8%	1%	2%	15%	53%
	Intermediary level of ambition	0%	11%	8%	4%	2%	4%	16%	55%
	Average of "1.5°C" scenarios (net zero emissions)	0%	9%	4%	3%	3%	4%	17%	61%