

PATHS TO A CLIMATE-NEUTRAL ENERGY SYSTEM

The German energy transformation in its social context

Appendix to the study

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1 Appendix

Link to the study: www.ise.fraunhofer.de/climate-neutral-energy-system.pdf
 More figures and data of the study can be found at www.energy-charts.de.

1.1 Energy values of main scenarios

Table 1 – Electricity consumption in TWh

		Orig. elec. demand	Transport	Industry	Heat-pump	Power-to-Heat	Power-to-Hydrogen	Power-to-Methane	Power-to-Liquid	Others
2030	Reference	398	38	85	55	22	5	4	5	71
	Persistence	398	28	140	48	0	11	7	12	76
	Non-acceptance	398	42	77	45	24	3	4	6	57
	Sufficiency	338	24	78	33	8	5	2	2	56
	Reference100	398	38	114	59	23	9	2	5	73
	Sufficiency2035	338	28	128	83	46	13	8	21	96
2040	Reference	398	95	143	143	51	35	11	30	128
	Persistence	398	68	201	90	0	98	102	37	137
	Non-acceptance	398	95	111	127	61	25	14	25	116
	Sufficiency	278	71	123	123	26	16	7	18	87
	Reference100	398	95	161	159	45	99	13	24	123
	Sufficiency2035	278	57	168	180	55	163	46	48	135
2050	Reference	398	122	197	198	78	181	60	45	168
	Persistence	398	86	243	96	0	198	200	59	184
	Non-acceptance	398	100	189	155	95	121	33	48	144
	Sufficiency	218	88	188	171	55	118	47	49	134
	Reference100	398	128	198	181	87	240	67	55	188
	Sufficiency2035	218	53	202	174	55	167	105	60	145

Table 2 – Energy demand per sector in TWh

		Electricity	Heat	Transport	Industry	Total
2030	Reference	398	774	695	487	2353
	Persistence	398	773	722	480	2371
	Non-acceptance	398	767	685	499	2349
	Sufficiency	338	811	580	482	2211
	Reference100	398	769	692	476	2334
	Sufficiency2035	338	795	443	436	2012
2040	Reference	398	683	549	445	2074
	Persistence	398	814	639	422	2273
	Non-acceptance	398	672	539	448	2057
	Sufficiency	278	705	412	418	1813
	Reference100	398	676	509	412	1995
	Sufficiency2035	278	660	290	378	1606
2050	Reference	398	632	474	395	1899
	Persistence	398	805	635	379	2216
	Non-acceptance	398	704	476	392	1970
	Sufficiency	218	609	324	372	1523
	Reference100	398	609	449	380	1836
	Sufficiency2035	218	543	267	342	1370

Table 3 – Energy demand in transport (incl. air transport and national shipping) in TWh

		Hydrogen	Methane	Liquids	Electricity
2030	Reference	5	1	650	38
	Persistence	6	2	686	28
	Non-acceptance	2	4	638	42
	Sufficiency	4	2	550	24
	Reference100	8	4	642	38
	Sufficiency2035	29	2	384	28
2040	Reference	28	2	425	95
	Persistence	35	1	535	68
	Non-acceptance	45	3	396	95
	Sufficiency	14	2	326	71
	Reference100	101	2	311	95
	Sufficiency2035	107	2	124	57
2050	Reference	135	0	217	122
	Persistence	44	0	505	86
	Non-acceptance	174	0	202	100
	Sufficiency	77	0	159	88
	Reference100	174	0	147	128
	Sufficiency2035	105	0	109	53

Table 4 – Energy consumption in industry in TWh

		Coal	Liquids	Methane	Electricity	Biomass	Hydrogen	Environm. Heat
2030	Reference	87	8	250	72	58	8	4
	Persistence	87	8	169	136	57	18	4
	Non-acceptance	87	8	299	34	59	8	4
	Sufficiency	87	8	295	38	44	8	3
	Reference100	64	8	215	106	58	20	4
	Sufficiency2035	15	8	125	121	66	97	5
2040	Reference	56	0	137	145	85	14	8
	Persistence	56	0	39	234	46	35	12
	Non-acceptance	56	0	199	99	70	15	8
	Sufficiency	56	0	180	117	45	14	6
	Reference100	17	0	85	185	60	57	9
	Sufficiency2035	0	0	0	196	54	117	10
2050	Reference	35	0	6	228	33	80	13
	Persistence	35	0	2	279	3	42	18
	Non-acceptance	35	0	35	222	28	58	12
	Sufficiency	36	0	24	213	41	47	10
	Reference100	0	0	1	227	33	106	13
	Sufficiency2035	0	0	12	236	12	69	13

Table 5 – Consumption per energy carrier for space heat and domestic hot water supply in TWh

		Liquids	District heat	Methane	Electricity	Biomass	Hydrogen	Environm. Heat
2030	Reference	88	141	386	46	41	0	71
	Persistence	88	108	424	27	59	0	66
	Non-acceptance	88	146	371	44	46	0	73
	Sufficiency	93	147	454	22	46	0	49
	Reference100	87	147	355	55	42	0	83
	Sufficiency2035	82	97	265	93	41	96	120
2040	Reference	1	188	187	115	17	13	162
	Persistence	0	98	359	45	49	161	102
	Non-acceptance	0	194	174	98	21	33	153
	Sufficiency	0	211	261	79	23	3	127
	Reference100	0	168	148	124	17	38	180
	Sufficiency2035	0	110	72	154	16	86	221
2050	Reference	4	192	31	148	1	49	207
	Persistence	0	116	288	45	30	204	122
	Non-acceptance	0	207	27	115	1	204	151
	Sufficiency	1	218	51	117	3	40	179
	Reference100	1	189	24	136	1	58	200
	Sufficiency2035	3	173	33	116	1	18	199

Distribution grid (expansion PV)	Specific Installation Cost	€/kW _{PV}	140	140	140	140	140	140	140
	Life time	a	40	40	40	40	40	40	40
	M/O cost	% Sp. Inst. Cost	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Elektrolysis (MIX PEM/AEL/HTEL)	Specific Installation Cost	€/kW _{el}	738	676	613	584	554	525	495
	Life time	a	26	26	25	26	28	29	30
	M/O cost	% Sp. Inst. Cost	3.5	3.4	3.3	3.5	3.6	3.8	3.9
	Efficiency	%	64.5	64.8	65.1	66.4	67.6	68.9	70.2
Stationary battery	Specific Installation Cost	€/kWh _{el}	400	275	150	138	125	113	100
	Life time	a	10	10	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Efficiency	%	85.8	86.5	87.2	87.8	88.5	89.2	90.0
Hydrogen storage & compressor	Specific Installation Cost	€/kW _{H2}	163	163	163	163	163	163	163
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Efficiency	%	95.0	95.0	95.0	95.0	95.0	95.0	95.0
Methanation (incl. electrolysis and capture of CO₂ from the air)	Specific Installation Cost	€/kW _{el}	1914	1494	1074	1040	1006	1000	995
	Life time	a	21	23	24	26	27	29	30
	M/O cost	% Sp. Inst. Cost	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	Efficiency Elyse	%	57.1	59.3	61.5	61.5	61.5	61.5	61.5
	Efficiency Sabatier	%	74.3	74.3	74.3	74.3	74.3	74.3	74.3
Natural gas steam reforming	Specific Installation Cost	€/kW _{Gas}	995	995	995	995	995	995	995
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Efficiency	%	69.4	69.4	69.4	69.4	69.4	69.4	69.4
Power-to-Methanol-to-Gasoline (incl. capture of CO₂ from the air)	Specific Installation Cost	€/kW _{el}	1814	1394	974	940	906	900	895
	Life time	a	21	23	24	26	27	29	30
	M/O cost	% Sp. Inst. Cost	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	Efficiency	%	43.3	44.9	46.6	46.6	46.6	46.6	46.6

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	Efficiency el.	%	36.0	36.0	36.0	36.0	36.0	36.0	36.0
	Efficiency th.	%	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Hydrogen fuel cell for electricity and heat in individual buildings <100 kW_{el} LT	Specific Installation Cost	€/kW _{el}	8285	3903	2072	1455	1308	1289	1289
	Life time	a	15	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	3.6	3.4	3.3	3.3	3.3	3.3	3.3
	Efficiency el.	%	62.9	63.4	63.9	64.4	64.9	65.4	65.9
	Efficiency th.	%	27.9	28.1	28.3	28.5	28.7	28.9	29.1
Methane fuel cell LT	Specific Installation Cost	€/kW _{el}	9113	4293	2280	1600	1438	1418	1418
	Life time	a	15	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	3.6	3.4	3.3	3.3	3.3	3.3	3.3
	Efficiency el.	%	53.5	53.9	54.3	54.8	55.2	55.6	56.0
	Efficiency th.	%	33.0	33.0	34.0	34.0	34.0	34.0	34.0
Electrical heat pump (heat source: soil) HT	Specific Installation Cost	€/kW _{th}	1822	1732	1642	1550	1458	1368	1278
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	1.3	1.1	1.0	1.0	1.0	1.0	1.0
Electrical heat pump (heat source: outside air) HT	Specific Installation Cost	€/kW _{th}	990	943	897	847	798	751	704
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Hybrid heat pump (el. heat pump and gas boiler, outside air) HT	Specific Installation Cost	€/kW _{th}	1097	1049	1003	954	904	858	811
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Hydrogen fuel cell for electricity and heat in individual buildings < 100 kW_{el} HT	Specific Installation Cost	€/kW _{el}	8285	3903	2072	1455	1308	1289	1289
	Life time	a	10	10	10	10	10	10	10
	M/O cost	% Sp. Inst. Cost	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Efficiency el.	%	55.1	56.9	58.7	60.5	62.3	64.1	65.9
	Efficiency th.	%	39.9	38.1	36.3	34.5	32.7	30.9	29.1
Methane fuel cell HT	Specific Installation Cost	€/kW _{el}	7826	3724	2071	1543	1429	1418	1418
	Life time	a	17	20	20	20	20	20	10
	M/O cost	% Sp. Inst. Cost	3.5	3.4	3.3	3.3	3.3	3.3	3.0
	Efficiency el.	%	46.8	48.4	49.9	51.4	52.9	54.5	56.0
	Efficiency th.	%	39.0	38.2	37.3	36.5	35.7	34.8	34.0
Solar thermal (roof-mounted installations) LT/HT	Specific Installation Cost	€/m ²	550	475	400	375	350	330	310
	Life time	a	25	25	25	25	25	25	25

Table 10 – Biomass converters

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
Woody biomass to methane (gasification with subsequent synthesis)	Specific Installation Cost	€/kW _{th}	2561	2198	1955	1808	1732	1704	1700
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Efficiency	%	55.0	55.0	55.0	55.0	55.0	55.0	55.0
Woody biomass to hydrogen (gasification with subsequent synthesis)	Specific Installation Cost	€/kW _{th}	1874	1609	1431	1323	1267	1247	1244
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Efficiency	%	61.0	61.0	61.0	61.0	61.0	61.0	61.0
Woody biomass to liquid fuels (gasification with subsequent synthesis)	Specific Installation Cost	€/kW _{th}	2835	2434	2164	2001	1917	1886	1882
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Efficiency	%	46.0	46.0	46.0	46.0	46.0	46.0	46.0
Biodiesel plant (rape to biodiesel)	Specific Installation Cost	€/kW _{th}	150	150	150	150	150	150	150
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Efficiency (field to fuel)	%	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Biogas plant (raw biogas – without CHP unit)*	Specific Installation Cost	€/kW _{Biogas}	965	852	776	731	707	698	697
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Biogas treatment (CO₂ capture -> bio natural gas)	Specific Installation Cost	€/kWh _{Gas}	538.5	412.7	328.4	277.3	251.1	241.4	240.0
	Life time	a	25	25	25	25	25	25	25
	M/O cost	% Sp. Inst. Cost	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Efficiency	%	88.0	88.0	88.0	88.0	88.0	88.0	88.0
CHP unit < 0.5 MW (direct electricity generation from biogas)	Specific Installation Cost	€/kW _{el}	556	541	528	517	509	503	500
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Efficiency	%	25.0	25.0	25.0	25.0	25.0	25.0	25.0

* Usually, the used amounts of energy are already given as „biogas“. Therefore no efficiency.

Table 11 – Drivetrain concepts for transport – passenger cars

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
Liquid fuels ICE (passenger cars)	Specific Installation Cost	€/vehicle	23561	24309	24999	25622	26167	26610	26880
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	1.6	1.6	1.6	1.6	1.6	1.6	1.6
	Efficiency*	%	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Gas ICE (passenger cars)	Specific Installation Cost	€/vehicle	25041	25468	25912	26377	26864	27383	27952
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	1.4	1.4	1.4	1.4	1.4	1.4	1.4
	Efficiency*	%	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Hydrogen fuel cell (passenger cars)	Specific Installation Cost	€/vehicle	55000	43500	33226	30720	29440	28160	26880
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	1.1	1.1	1.1	1.1	1.2	1.2	1.2
	Efficiency*	%	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Plug-in hybrid hydrogen fuel cell / battery (passenger cars)	Specific Installation Cost	€/vehicle	49375	42760	35000	33130	31260	30462	29665
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	1.1	1.1	1.1	1.1	1.2	1.2	1.2
	Efficiency*	%	56.0	56.0	56.0	56.0	56.0	56.0	56.0
	Share of battery	%	40	40	40	40	40	40	40
	Battery capacity	kWh	12.5	20	20	20	20	20	20
Plug-in hybrid ICE liquid fuel / battery (passenger cars)	Specific Installation Cost	€/vehicle	31832	31651	30350	30198	30046	30499	30952
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Efficiency*	%	27.4	27.8	27.8	27.8	27.8	27.8	27.8
	Share of battery	%	40.0	40.0	40.0	40.0	40.0	40.0	40.0
	Battery capacity	kWh	12.5	20	20	20	20	20	20
Plug-in hybrid ICE gas / battery (passenger cars)	Specific Installation Cost	€/vehicle	34129	33982	32690	32527	32364	32808	33252
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Efficiency*	%	24.3	25.6	25.6	25.6	25.6	25.6	25.6
	Share of battery	-	40	40	40	40	40	40	40

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	Battery capacity	kWh	14	20	20	20	20	20	20
	Battery efficiency*	%	74.1	74.1	74.1	74.1	74.1	74.1	74.1
Battery electric (passenger cars)	Specific Installation Cost	€/vehicle	33000	28812	24624	24358	24092	23827	23561
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Efficiency*	%	68.0	68.0	68.0	68.0	68.0	68.0	68.0
	Share of battery	-	100	100	100	100	100	100	100
	Battery capacity	kWh	50	66.65	66.65	66.65	66.65	66.65	66.65
	Battery efficiency*	%	74.1	74.1	74.1	74.1	74.1	74.1	74.1

*Efficiency: Conversion of the used energy carrier to the traction energy (kinetic energy necessary for the movement of vehicles).

Table 12 – Drivetrain concepts for transport – trucks

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
Liquid fuels ICE (trucks)	Specific Installation Cost	€/vehicle	99772	102543	105315	108086	110858	113629	116401
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	18.0	17.5	17.1	16.6	16.2	15.8	15.5
	Efficiency*	%	37.3	37.3	37.3	37.3	37.3	37.3	37.3
Gas ICE (trucks)	Specific Installation Cost	€/vehicle	107771	109476	111301	113260	115367	117652	120183
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	16.7	16.4	16.2	15.9	15.6	15.3	15.0
	Efficiency*	%	30.1	30.1	30.1	30.1	30.1	30.1	30.1
Hydrogen fuel cell (trucks)	Specific Installation Cost	€/vehicle	151574	122291	116497	117600	120177	122939	125710
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	10.1	12.5	13.1	13.0	12.7	12.4	12.2
	Efficiency*	%	56	56	56	56	56	56	56
Plug-in hybrid hydrogen fuel cell / battery (trucks)	Specific Installation Cost	€/vehicle	165674	132399	124847	126262	127677	129994	132310
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	9.2	11.5	12.2	12.1	12.0	11.8	11.5
	Efficiency*	%	56.0	56.0	56.0	56.0	56.0	56.0	56.0
	Share of battery	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Battery capacity	kWh	50	50	50	50	50	50	50
Plug-in hybrid ICE liquid fuel / battery (trucks)	Specific Installation Cost	€/vehicle	124728	121279	119580	119395	120463	122492	125123
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	14.4	14.8	15.0	15.1	14.9	14.7	14.4
	Efficiency*	%	37.3	37.3	37.3	37.3	37.3	37.3	37.3
	Share of battery	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Battery capacity	kWh	50	50	50	50	50	50	50
Plug-in hybrid ICE gas / battery (trucks)	Specific Installation Cost	€/vehicle	133788	130476	128831	128645	129684	131682	134301
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	13.4	13.8	14.0	14.0	13.9	13.7	13.4
	Efficiency*	%	30.1	30.1	30.1	30.1	30.1	30.1	30.1
	Share of battery	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Battery capacity	kWh	50	50	50	50	50	50	50

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	Battery efficiency*	%	74.1	74.1	74.1	74.1	74.1	74.1	74.1
Battery electric (trucks)	Specific Installation Cost	€/vehicle	204067	165765	136400	134700	133000	131200	129400
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp. Inst. Cost	14.0	14.0	15.0	16.0	16.0	16.0	16.0
	Efficiency*	%	74.0	74.0	74.0	74.0	74.0	74.0	74.0
	Share of battery	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Battery capacity	kWh	200	200	200	200	200	200	200
	Battery efficiency*	%	74.0	74.0	74.0	74.0	74.0	74.0	74.0

* Efficiency: Conversion of the used energy carrier to motion energy of the vehicle.

Table 13 – Charging infrastructure (passenger cars and trucks)

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
Charging infrastructure slow (purely) battery electric vehicles * passenger cars	Specific Installation Cost	€/charging station	1283	1126	1005	1005	1005	1005	1005
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Charging infrastructure fast (purely) battery electric vehicles * passenger cars	Specific Installation Cost	€/charging station	629102	527507	448894	448894	448894	448894	448894
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Charging infrastructure fuel cell vehicles * passenger cars	Specific Installation Cost	€/charging station	224305 1	200099 1	178789 4	178836 0	178836 0	178836 0	178836 0
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Charging infrastructure CNG vehicles * passenger cars	Specific Installation Cost	€/charging station	429350	429350	429350	429350	429350	429350	429350
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Charging infrastructure slow (purely) battery electric vehicles * trucks	Specific Installation Cost	€/charging station	0	93459	0	145190 5	0	0	0
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Charging infrastructure fast (purely) battery electric vehicles * trucks	Specific Installation Cost	€/charging station	0	0	0	0	0	0	0
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Charging infrastructure fuel cell vehicles * trucks	Specific Installation Cost	€/charging station	224305 1	200099 1	178789 4	178789 4	178789 4	178789 4	178789 4
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Charging infrastructure CNG vehicles * trucks	Specific Installation Cost	€/charging station	170886 0	158448 3	146915 9	146915 9	146915 9	146915 9	146915 9
	Life time	a	30	30	30	30	30	30	30
	M/O cost	% Sp. Inst. Cost	0.5	0.5	0.5	0.5	0.5	0.5	0.5

*Assumption for charging infrastructure: no additional cost for hybrid drivetrain concepts.

Coal boiler industry HT	Specific Installation Cost	€/kW _{th}	251	243	236	228	221	214	206
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Efficiency	%	85.0	85.0	85.0	85.0	85.0	85.0	85.0

Table 16 – Energy prices in €/MWh

	2020	2025	2030	2035	2040	2045	2050
Natural gas	23	23	23	23	23	23	23
Oil/Fuel	51	51	51	51	51	51	51
Hard coal	13	13	13	13	13	13	13
Lignite	2	2	2	2	2	2	2
Electricity by NPP	30	30	30	30	30	30	30
Solar process heat	89	82	75	69	63	58	54
Biomass (wood/straw)	30	30	30	30	30	30	30
Biomass growing	50	50	50	50	50	50	50
Wet biomass	1	1	1	1	1	1	1
Hydrogen import	275	242	213	187	164	145	127
Methane import	423	373	328	289	254	224	197
Fuel import	498	441	390	346	306	271	240