

PATHS TO A CLIMATE-NEUTRAL ENERGY SYSTEM

The German Energy Transition
in its Social Context

Appendix

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Link to 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-pumpe	Power-to-Heat	Power-to-H2	Power-to-Methan	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
	Inacceptance	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
	Inacceptance	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
	Inacceptance	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
	Inacceptance	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
	Inacceptance	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
	Inacceptance	398	704	476	392	1970
	Sufficiency	218	609	324	372	1523
	Reference100	398	704	476	392	1970
	Sufficiency2035	218	609	324	372	1523

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

		H2	Methan	Liquids	Electricity
2030	Reference	5	1	650	38
	Persistence	6	2	686	28
	Inacceptance	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
	Inacceptance	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
	Inacceptance	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	Methan	Electricity	Biomass	H2	Environm. Heat
2030	Reference	87	8	250	72	58	8	4
	Persistence	87	8	169	136	57	18	4
	Inacceptance	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
	Inacceptance	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
	Inacceptance	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 Verbrauch aufgeteilt nach Energieträgern im Sektor RaumHeat in TWh

		Liquids	FernHeat	Methan	Electricity	Biomass	H2	Environm. Heat
2030	Reference	88.0	141	386	46	41	0	71
	Persistence	87.8	108	424	27	59	0	66
	Inacceptance	87.8	146	371	44	46	0	73
	Sufficiency	93.0	147	454	22	46	0	49
	Reference100	87	587	78	42	0	117	87
	Sufficiency2035	82	385	121	41	96	151	82
2040	Reference	0.6	188	187	115	17	13	162
	Persistence	0.2	98	359	45	49	161	102
	Inacceptance	0.2	194	174	98	21	33	153
	Sufficiency	0.5	211	261	79	23	3	127
	Reference100	0	299	180	17	38	255	0
	Sufficiency2035	0	133	207	16	86	280	0
2050	Reference	3.5	192	31	148	1	49	207
	Persistence	0.2	116	288	45	30	204	122
	Inacceptance	0.2	207	27	115	1	204	151
	Sufficiency	1.4	218	51	117	3	40	179
	Reference100	1	122	239	1	58	303	1
	Sufficiency2035	3	108	195	1	18	297	3

	Cost								
	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
Verteilnetz (PV-Ausbau)	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
Elektrolyse (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
Stationäre Batterien	Specific Installation Cost	€/kW _{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
H2speicher & -verdichter	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
Methanisierung (inkl. Elektrolyse und CO2-Abtrennung aus der Luft)	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
Erdgas-Dampf-Reformierung	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 (inkl. CO2-Abtrennung aus der Luft)	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

Table 9 - Heizungstechnologien - Einzelgebäude

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
Ölkessel	Specific Installation Cost	€/kW _{th}	136	136	136	136	136	136	136
	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 NT	%	94.0	94.0	94.0	94.0	94.0	94.0	94.0
	Efficiency HT	%	89.0	89.0	89.0	89.0	89.0	89.0	89.0
Gaskessel	Specific Installation Cost	€/kW _{th}	97	97	97	97	97	97	97
	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 NT	%	98.0	98.0	98.0	98.0	98.0	98.0	98.0
	Efficiency HT	%	93.0	93.0	93.0	93.0	93.0	93.0	93.0
Biomasskessel/Holzessel	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	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	Efficiency NT	%	93.0	93.0	93.0	93.0	93.0	93.0	93.0
	Efficiency HT	%	88.0	88.0	88.0	88.0	88.0	88.0	88.0
GasHeat Pump HT/NT	Specific Installation Cost	€/kW _{th}	1100	1100	1100	1000	1000	900	900
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	5.0	5.0	5.0	5.0	4.0	4.0	4.0
Elektrische Heat Pump (Heatquelle: Erdreich) NT	Specific Installation Cost	€/kW _{th}	1656	1574	1493	1409	1325	1244	1162
	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
Elektrische Heat Pump (Heatquelle: Außenluft) NT	Specific Installation Cost	€/kW _{th}	900	857	815	770	725	683	640
	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
Hybride Heat Pump (el. WP und Gaskessel, Außenluft) NT	Specific Installation Cost	€/kW _{th}	997	954	912	867	822	780	737
	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
BHKW Einzelgebäude <100 kW_{el} NT/HT	Specific Installation Cost	€/kW _{el}	1614	1534	1480	1448	1431	1425	1424

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	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
	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
H₂-Brennstoffzelle für Electricity&Heat im Einzelgebäude <100 kW_{el} NT	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
CH₄-Brennstoffzelle NT	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
Elektrische Heat Pump (Heatquelle: Erdreich) 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
Elektrische Heat Pump (Heatquelle: Außenluft) 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
Hybride Heat Pump (el. WP und Gaskessel, Außenluft) 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
H₂-Brennstoffzelle für Electricity&Heat im Einzelgebäude <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
CH₄-Brennstoffzelle 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
Solarthermiekollektoren	Specific	€/m ²	550	475	400	375	350	330	310

(Aufdachanlagen) NT/HT	Installation Cost								
	Life time	a	25	25	25	25	25	25	25
	M/O cost	% Sp. Inst. Cost	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Heatspeicher (Wasser) - in Einzelgebäuden	Specific Installation Cost	€/l	1	1	1	1	1	1	1
	Life time	a	20	20	20	20	20	20	20
	M/O cost	% Sp. Inst. Cost	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Gebäudesanierung EnEV2015 -25% (Bezeichnung: "vollsaniert")	Specific Installation Cost	€/m ²	102	102	102	102	102	102	102
	Life time	a	50	50	50	50	50	50	50
	M/O cost	% Sp. Inst. Cost	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Gebäudesanierung "Passivhaus" (Bezeichnung: "vollsaniert+")	Specific Installation Cost	€/m ²	180	180	180	180	180	180	180
	Life time	a	50	50	50	50	50	50	50
	M/O cost	% Sp. Inst. Cost	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Absenkung der Vorlauftemperatur in Wohngebäuden (z.B. durch Fußbodenheizung)	Specific Installation Cost	€/m ²	60	60	60	60	60	60	60
	Life time	a	50	50	50	50	50	50	50
	M/O cost	% Sp. Inst. Cost	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Table 10 - Biomass-Wandler

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
Holz- und holzartige Biomass zu CH₄ (Vergasung mit anschl. Synthetisierung)	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
Holz- und holzartige Biomass zu H₂ (Vergasung mit anschl. Synthetisierung)	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
Holz- und holzartige Biomass zu Liquidsn Kraftstoffen (Vergasung	Specific Installation Cost	€/kW _{th}	2835	2434	2164	2001	1917	1886	1882

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mit anschl. Synthetisierung)	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
Biodieselanlage (Raps zu 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 (Feld zu Fuel)	%	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Biogasanlage (Rohstoff Biogas - ohne BHKW)*	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 Aufbereitung (CO₂-Abscheidung -> Bio-Erdgas)	Specific Installation Cost	€/kW _{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
BHKW < 0.5 MW (Biogas-DirektverElectricityung)	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

* Die verf. Energiemengen werden i.d.R. bereits als "Biogas" ausgewiesen, deshalb kein Efficiency.

Table 11 - Antriebskonzepte Transport – PKW

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
PKW ICE- Flüssigtreibstoff	Specific Installation Cost	€/PKW	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
PKW ICE Gas	Specific Installation Cost	€/PKW	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
PKW H2- Brennstoffzelle	Specific Installation Cost	€/PKW	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
PKW Hybrid H2- Brennstoffzelle / Batterie	Specific Installation Cost	€/PKW	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
	Anteil Batterie Fahrleistung	%	40	40	40	40	40	40	40
	Batteriekapazität	kWh	12.5	20	20	20	20	20	20
	Efficiency Batterie*	%	74.1	74.1	74.1	74.1	74.1	74.1	74.1
PKW Hybrid ICE Flüssigtreibstoff / Batterie	Specific Installation Cost	€/PKW	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
	Anteil Batterie Fahrleistung	%	40.0	40.0	40.0	40.0	40.0	40.0	40.0
	Batteriekapazität	kWh	12.5	20	20	20	20	20	20
	Efficiency Batterie*	%	74.1	74.1	74.1	74.1	74.1	74.1	74.1
PKW Hybrid ICE Gas / Batterie	Specific Installation Cost	€/PKW	34129	33982	32690	32527	32364	32808	33252
	Life time	a	15	15	15	15	15	15	15

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	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
	Anteil Batterie Fahrleistung	-	40	40	40	40	40	40	40
	Batteriekapazität	kWh	14	20	20	20	20	20	20
	Efficiency Batterie*	%	74.1	74.1	74.1	74.1	74.1	74.1	74.1
PKW Batterie-Elektromotor	Specific Installation Cost	€/PKW	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
	Anteil Batterie Fahrleistung	-	100	100	100	100	100	100	100
	Batteriekapazität	kWh	50	66.65	66.65	66.65	66.65	66.65	66.65
	Efficiency Batterie*	%	74.1	74.1	74.1	74.1	74.1	74.1	74.1

*Efficiency: Umrechnung von verwendetem Energieträger in Bewegungsenergie des Fahrzeuges

Table 12 – Antriebskonzepte Transport – LKW

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
LKW ICE- Flüssigtreibstoff	Specific Installation Cost	€/LKW	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
LKW ICE Gas	Specific Installation Cost	€/LKW	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
LKW H₂- Brennstoffzelle	Specific Installation Cost	€/LKW	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
LKW Hybrid H₂- Brennstoffzelle / Batterie	Specific Installation Cost	€/LKW	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
	Anteil Batterie Fahrleistung	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Batteriekapazität	kWh	50	50	50	50	50	50	50
LKW Hybrid ICE Flüssigtreibstoff / Batterie	Specific Installation Cost	€/LKW	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
	Anteil Batterie Fahrleistung	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Batteriekapazität	kWh	50	50	50	50	50	50	50
LKW Hybrid ICE Gas/Batterie	Specific Installation Cost	€/LKW	133788	130476	128831	128645	129684	131682	134301
	Life time	a	15	15	15	15	15	15	15
	M/O cost	% Sp.	13.4	13.8	14.0	14.0	13.9	13.7	13.4

		Inst. Cost							
	Efficiency*	%	30.1	30.1	30.1	30.1	30.1	30.1	30.1
	Anteil Batterie Fahrleistung	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Batteriekapazität	kWh	50	50	50	50	50	50	50
	Efficiency Batterie*	%	74.1	74.1	74.1	74.1	74.1	74.1	74.1
LKW Batterie-Elektromotor	Specific Installation Cost	€/LKW	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
	Anteil Batterie Fahrleistung	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Batteriekapazität	kWh	200	200	200	200	200	200	200
	Efficiency Batterie*	%	74.0	74.0	74.0	74.0	74.0	74.0	74.0

*Efficiency: Umrechnung von verwendetem Energieträger zu Bewegungsenergie des Fahrzeuges.

Table 13 – Ladeinfrastruktur PKW & LKW

Technology	Parameter	Value	2020	2025	2030	2035	2040	2045	2050
Ladeinfrastruktur langsam (reine) Batteriefahrzeuge * PKW	Specific Installation Cost	€/Ladesäule	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
Ladeinfrastruktur schnell (reine) Batteriefahrzeuge * PKW	Specific Installation Cost	€/Ladesäule	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
Ladeinfrastruktur Brennstoffzellen Fahrzeuge * PKW	Specific Installation Cost	€/Ladesäule	224305	200099	178789	178836	178836	178836	178836
	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
Ladeinfrastruktur CNG Fahrzeuge * PKW	Specific Installation Cost	€/Ladesäule	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
Ladeinfrastruktur langsam (reine) Batteriefahrzeuge * LKW	Specific Installation Cost	€/Ladesäule	0	93459	0	145190	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
Ladeinfrastruktur schnell (reine)	Specific Installation Cost	€/Ladesäule	0	0	0	0	0	0	0

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Batteriefahrzeuge * LKW	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
Ladeinfrastruktur Brennstoffzellen Fahrzeuge * LKW	Specific Installation Cost	€/Ladesäule	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
Ladeinfrastruktur CNG Fahrzeuge* LKW	Specific Installation Cost	€/Ladesäule	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

*Annahme Ladeinfrastruktur: keine Mehrkosten für hybride Konzepte

Table 16 – Energiepreise in €/MWh

	2020	2025	2030	2035	2040	2045	2050
Erdgas	23	23	23	23	23	23	23
Öl/Treibstoff	51	51	51	51	51	51	51
SteinCoal	13	13	13	13	13	13	13
BraunCoal	2	2	2	2	2	2	2
Electricity aus AKW	30	30	30	30	30	30	30
Solare ProzessHeat	89	82	75	69	63	58	54
Biomass (Holz/Stroh)	30	30	30	30	30	30	30
Biomass Anbau	50	50	50	50	50	50	50
Biomass (feucht)	1	1	1	1	1	1	1
H₂-Import	275	242	213	187	164	145	127
CH₄-Import	423	373	328	289	254	224	197
Fuel-Import	498	441	390	346	306	271	240