Electronic Supplementary Information for 'A matter of meters: state of the art in life cycle assessment of enhanced geothermal system' by Menberg et al.

Table SI1: Reservoir and technical parameters for the evaluated EGS plants in St.Gallen and Basel. Projected values assumed for the planned projects respectively, not necessarily equal to the actually encountered site conditions. Deviating parameters for plant design with co-generation in brackets. Parameters not explicitly listed here were adopted from Frick *et al*. (2010).[1]

Parameter	St.Gallen	Basel
Number of geothermal wells	2	2
Well depth [m]	4450	5000
Technical life time [years]	30	30
Geothermal flow rate [m^3/s]	0.05	0.08
Load hours	7000 (6529)	7000 (6529)
Thermal load hours	0 (3600)	0 (2250)
Conversion efficiency	0.104	0.132
Power capacity [kW_{el}]	4500	3000
Heat capacity [MW_{th}]	0 (18)	0 (20)
Fluid temperature at production [°C]	145	190
Fluid temperature at reinjection [°C]	70	70
Energy consumption for drilling [kWh_{el}/m]	787[a]	1157[b]
Annual net energy production [GWh_{el}/a]	24.4 (22.7)	14.0 (13.0)
Annual heat production [TJ_{th}/a]	234	162
Life time energy production [GWh_{el}]	732	419
Life time heat production [TJ_{th}]	7020	4860

[a] Sonderegger[2]; [b] Häring[3], Kaiser and Fäs[4]

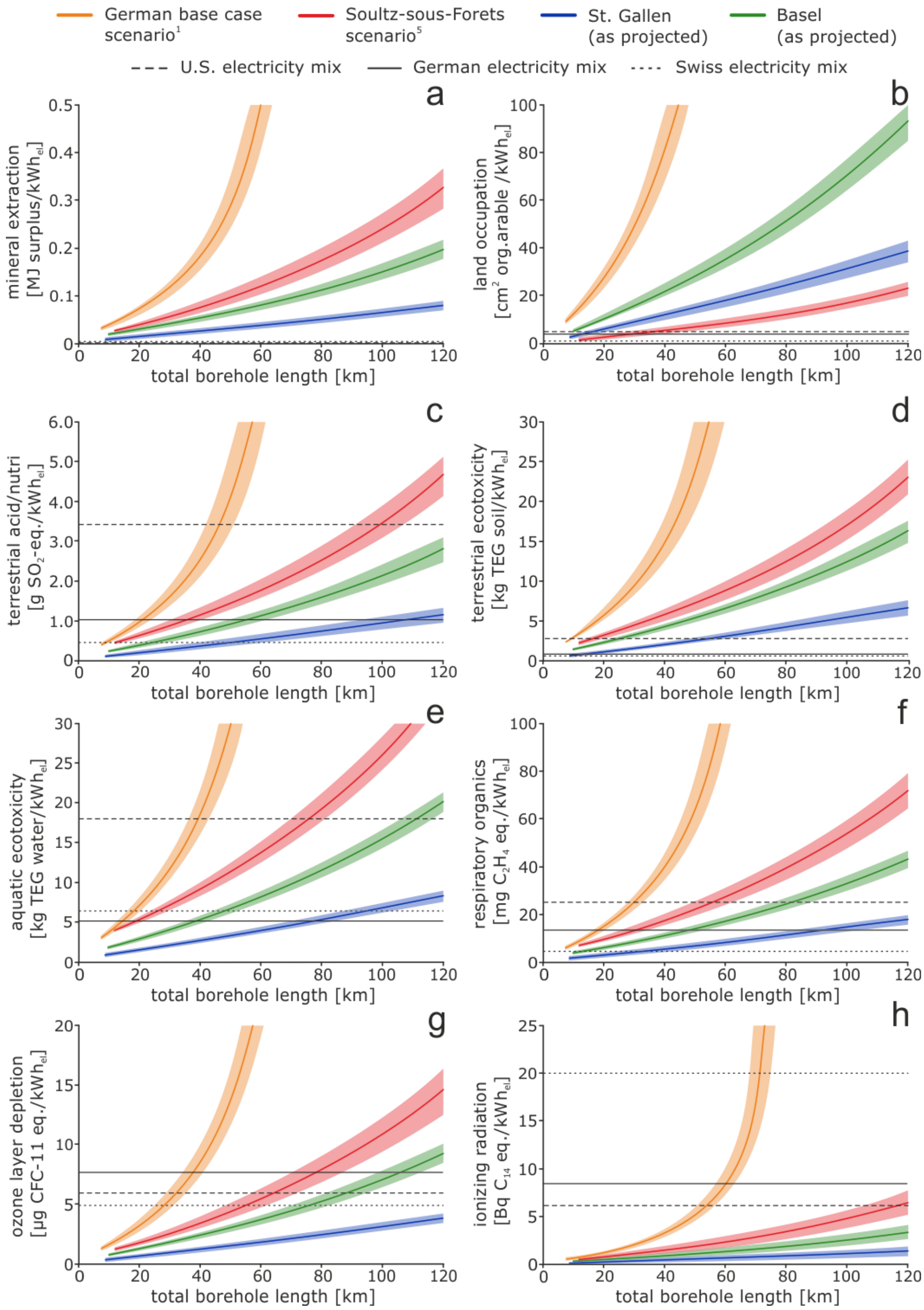

Figure SI1: Life time environmental impacts due to a) mineral extraction, b) land occupation, c) terrestrial acidification and nutrification, d) terrestrial ecotoxicity, e) aquatic ecotoxicity, f) respiratory organics, g) ozone layer depletion, h) ionizing radiation, i) respiratory inorganics, j) human toxicity as non-carcinogens and k) carcinogens per produced kWh electricity for four EGS plants as a function of overall borehole depth (number wells multiplied by well depth). The German base case is identical to scenario A1 in Frick *et al.* and Soultz-sous-Forêts is identical with scenario case 6 in Lacirignola and Blanc.[1,5] Data for the emissions caused by electricity mixes are taken from Ecoinvent 2.2.[10] The band accounts for the standard deviation of LCI uncertainty.

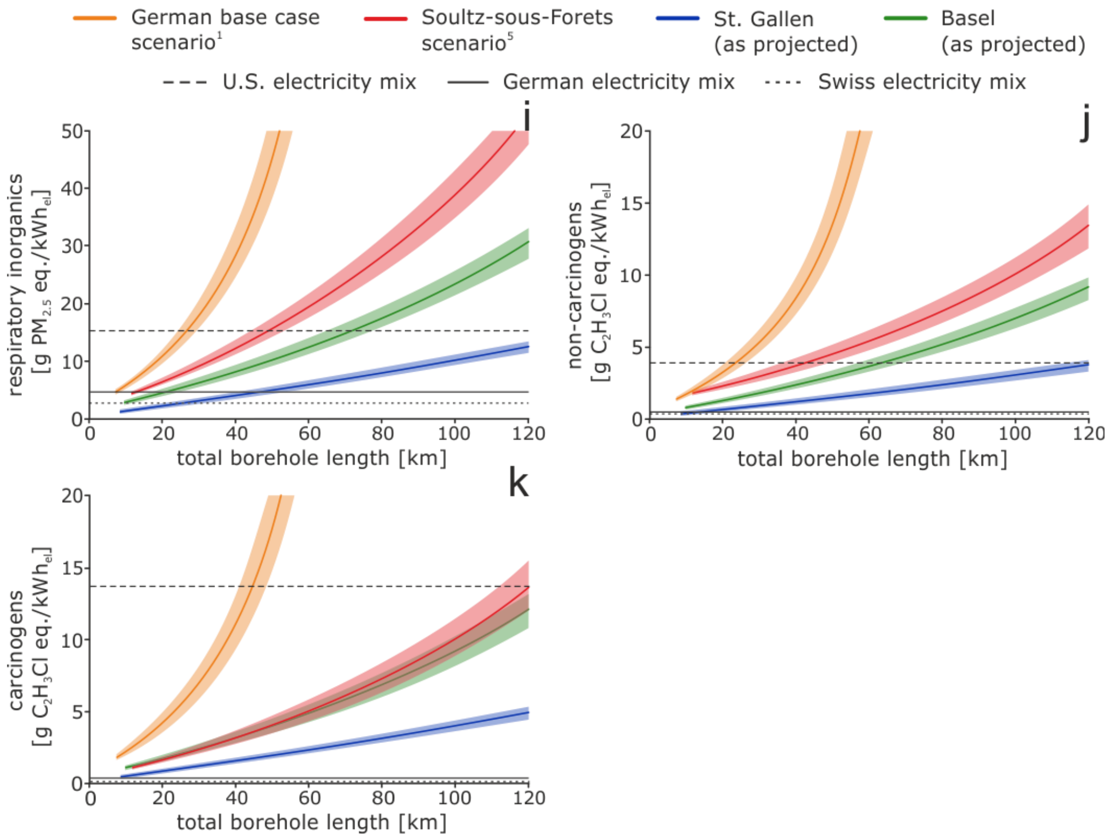

Figure SI1 continued: Life time environmental impacts due to a) mineral extraction, b) land occupation, c) terrestrial acidification and nutrification, d) terrestrial ecotoxicity, e) aquatic ecotoxicity, f) respiratory organics, g) ozone layer depletion, h) ionizing radiation, i) respiratory inorganics, j) human toxicity as non-carcinogens and k) carcinogens per produced kWh electricity for four EGS plants as a function of overall borehole depth (number wells multiplied by well depth). The German base case is identical to scenario A1 in Frick *et al.* and Soultz-sous-Forêts is identical with scenario case 6 in Lacirignola and Blanc.[1,5] Data for the emissions caused by electricity mixes are taken from Ecoinvent 2.2.[6] The band accounts for the standard deviation of LCI uncertainty.

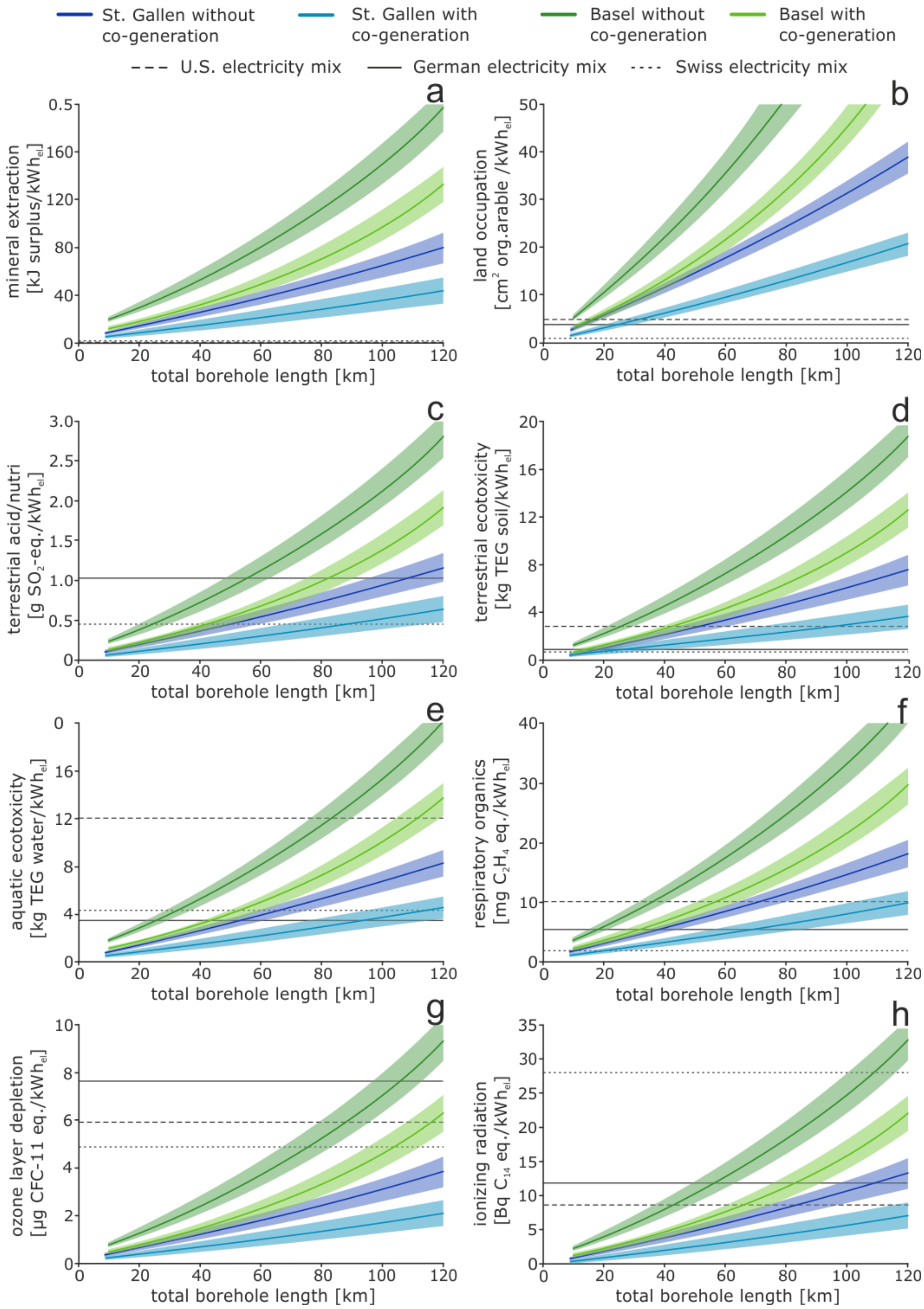

Figure SI2: Life time environmental impacts due to a) mineral extraction, b) land occupation, c) terrestrial acidification and nutrification, d) terrestrial ecotoxicity, e) aquatic ecotoxicity, f) respiratory organics, g) ozone layer depletion, h) ionizing radiation, i) respiratory inorganics, j) human toxicity as non-carcinogens and k) carcinogens per produced kWh electricity for the projected EGS plant in St. Gallen and Basel with and without co-generation of heat. The band accounts for the standard deviation of LCI uncertainty. Data for the emissions caused by electricity mixes are taken from Ecoinvent 2.2.[6]

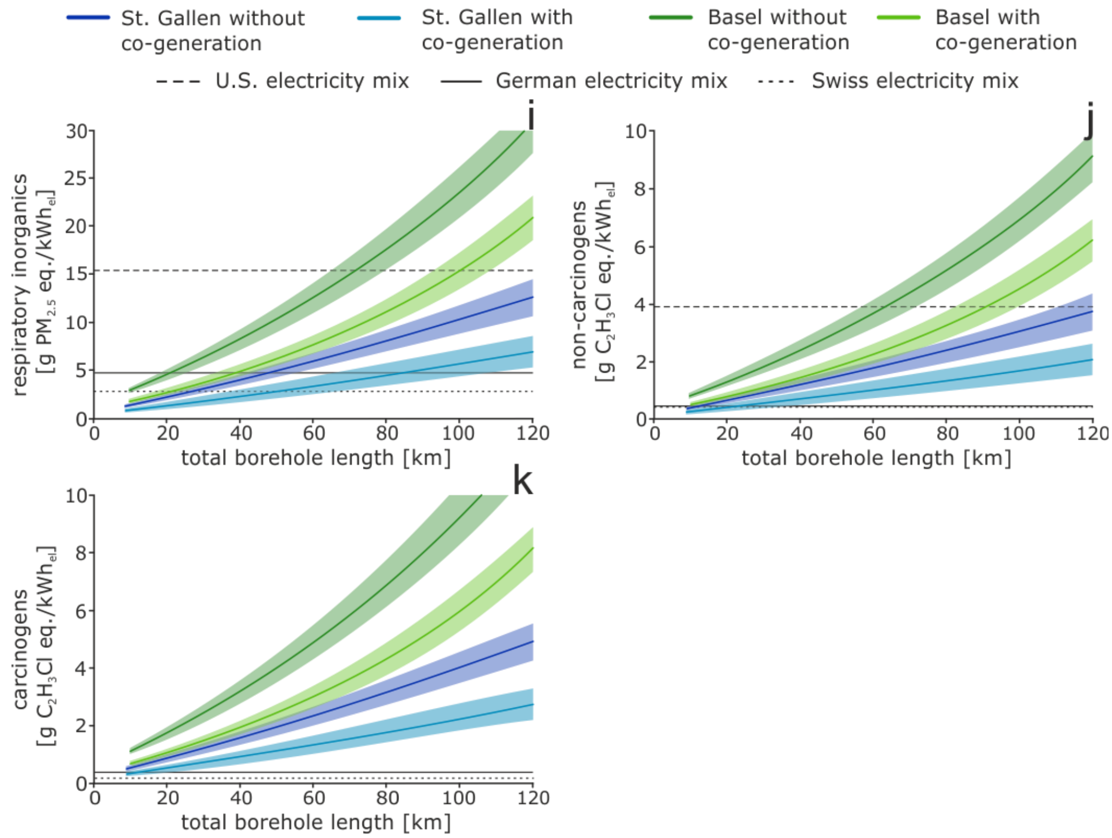

Figure SI2: Life time environmental impacts due to a) mineral extraction, b) land occupation, c) terrestrial acidification and nutrification, d) terrestrial ecotoxicity, e) aquatic ecotoxicity, f) respiratory organics, g) ozone layer depletion, h) ionizing radiation, i) respiratory inorganics, j) human toxicity as non-carcinogens and k) carcinogens per produced kWh electricity for the projected EGS plant in St. Gallen and Basel with and without co-generation of heat. The band accounts for the standard deviation of LCI uncertainty. Data for the emissions caused by electricity mixes are taken from Ecoinvent 2.2.[6]

Table SI2: Reservoir and technical parameter for the future scenarios for EGS power plants taking into account four different perspectives for future geothermal drilling. Reservoir and power plant parameters were adopted from the future 2030 scenario in Limberger *et al.* (2014).[7] The energy consumption for the specific drilling technologies was calculated based on the disintegration energy, assuming the amount of auxiliary energy to be equal to rotary drilling, and normalized considering the specific penetration rates in relation to rotary drilling using actual drilling data.[2,8] The numbers given in brackets refer to the magnitude of the worst and best case scenario for the corresponding parameters and outputs.

Parameter	Electric rotary drilling (min, max)	Hydrothermal spallation drilling (min, max)	Flame Jet thermal spallation drilling (min, max)	Electro pulse drilling (min, max)
Number of geothermal wells	3			
Well depth [m]	7000			
Technical life time [years]	30			
Geothermal flow rate [m³/h]	360 (300, 420)			
Load hours	8000			
Conversion efficiency	0.14 (0.11, 0.17)			
Gross power output [kW_{el}]	7280 (2933, 14280)			
Fluid temperature at production [°C]	200 (150, 250)			
Fluid temperature at reinjection [°C]	70			
Disintegration energy [kWh_{el}/m][a]	275	20	527	10.0
Auxiliary energy [kWh_{el}/m]	564	564	564	564
Penetration rate [m/h]	5.7[b]	15.8[a]	15.8[a]	10.0[a]
Additional emissions [gCO_2-eq./m]	0	791[c]	1888[d]	0
Energy consumption for drilling [kWh_{el}/m]	972 (787, 1157)	225 (180,270)	732 (585, 878)	334 (267, 401)
Annual net energy production [GWh_{el}/a]	54.4 (20.2, 109.7)			
Life time net energy production [GWh_{el}]	1631.0 (606.5, 3292.2)			
Total drilling energy [GWh_{el}]	21.5 (17.6, 25.4)	5.8 (4.8, 6.7)	16.4 (13.4, 19.5)	8.1 (6.7, 9.5)
Life time total energy production [GWh_{el}]	1609.5 (581.1, 3274.6)	1625.2 (599.8, 3287.4)	1614.6 (587.0, 3278.8)	1622.9 (599.8, 3285.5)

[a] Ndeda *et al.*[9]; [b] Sonderegger[2] ,Tester *et al.*[8]; [c] direct emission due to combustion of ethanol from Stathopoulos *et al.*[10] and indirect emissions from Ecoinvent 2.2[6]; [d] direct emission due to combustion of petrol from Rinaldi[11] and indirect emissions Ecoinvent 2.2.[6]

Table SI3: Additional information on the individual studies used to compile Figure 7 for each impact factor and each technology.

Energy generation technology	**Reference**	**Values (range)**	**Count of estimates**	**Comments**
Greenhouse gas emissions		*[gCO2-eq. /kWh]*		
EGS (electric drilling)	Menberg et al. (20XX), EES	5.8 – 12.8	2	with current drilling technology
	Treyer et al. (2015)[12]	7.5 – 45.6	3	Switzerland, different capacities
EGS co-generation	Menberg *et al.* (20XX), EES	3.8 – 7.8	2	with current drilling technology
Coal-fired power generation	Ecoinvent database 2.2[6]	1030 - 1190	6	different geographical references
	US LCI database[13]	1080 - 1260	2	different types of coal
	UNEP report 2015[14]	146 – 900	6	different technologies
	Hertwich *et al.* (2015)[15]	201 – 933	6	different technologies
	Martin-Gamboa *et al.* (2015)[16]	1083	1	hard coal, Spain
	SRREN Report (2012)[17]	1000	1	average of global review
	Whitaker *et al.* (2012)[18]	1001	164	median of different technologies
	Rule *et al.* (2009)[19]	325.7	1	New Zealand
	Hondo (2005)[20]	975.2	1	Japanese average
	Sullivan *et al.* (2010)[21]	1243	1	GREET model, US average
	Amponsah *et al.* (2014)[22]	888	3	global average

	Atilgan & Azapagic (2014)[23]	1126	8	average in Turkey
	Varun *et al.* (2009)[24]	975.3	1	Indian average
	Agrawal *et al.* (2014)[25]	1127	1	Indian case study
	Turconi *et al.* (2014)[26]	965 – 997	5	case studies Ireland
	Garcia *et al.* (2014)[27]	988 – 1021	2	case studies Portugal
	Santoyo-Castelazo *et al*. (2011)[28]	1094	1	Mexican average
Natural gas	Ecoinvent database 2.2[6]	483 – 690	6	different geographical references
	US LCI database[29]	720	1	US average
	UNEP report 2015[14]	187 – 516	4	different technologies
	Hertwich *et al.* (2015)[15]	247 – 527	2	different technologies
	Martin-Gamboa *et al.* (2015)[16]	507	1	Spain
	SRREN Report (2012)[17]	480	1	average of global review
	Heath *et al*. (2014)[30]	488	9	median for shale gas
	O'Donoughue *et al.* (2014[31])	450 – 670	69	median for different conventional natural gas technologies
	Rule *et al.* (2009)[19]	194	1	New Zealand
	Hondo (2005)[20]	519 – 608	2	different technologies, Japan
	Sullivan *et al.* (2010)[21]	487	1	GREET model, US average
	Amponsah *et al.* (2014)[22]	500	3	average
	Kannan *et al*. (2005)[32]	474	1	average for Singapore
	Atilgan & Azapagic (2014)[23]	499	187	average in Turkey
	Varun et al. (2009)[24]	607.6	1	Indian average
	Agrawal *et al.* (2014)[25]	584	1	Indian case study
	Turconi *et al.* (2014)[26]	349 – 450	20	case studies Ireland
	Garcia *et al*. (2014)[27]	423 – 588	3	case studies Portugal
	Santoyo-Castelazo *et al.* (2011)[28]	468	1	Mexican average
Oil combustion	Ecoinvent database 2.2[6]	606 – 1129	6	different geographical references
	US LCI database[29]	935	1	residual fuel oil
	SRREN Report (2012)[17]	850	1	average of global review
	Hondo (2005)[20]	742	1	Japanese average
	Amponsah *et al.* (2014)[22]	750	3	global average
	Varun *et al.* (2009)[24]	742.1	1	Indian average
	Turconi *et al.* (2014)[26]	839 – 1475	5	case studies Ireland
	Garcia *et al.* (2014)[27]	912	1	case studies Portugal
	Santoyo-Castelazo *et al*. (2011)[28]	964	1	Mexican average
Nuclear power	Ecoinvent database 2.2[6]	5.3 – 13.2	6	different geographical references
	US LCI database[29]	11.5	1	US average
	SRREN Report (2012)[17]	20	1	average of global review
	Warner & Heath (2012)[33]	12	99	light water reactors
	Hondo (2005)[20]	24.2	1	Japanese average
	Sullivan *et al.* (2010)[21]	16.55	1	GREET model, US average
	Amponsah *et al.* (2014)[22]	24	3	global average
	Dones *et al.* (2003)[34]	5 – 11.5	2	average for Switzerland
	Varun *et al*. (2009)[24]	24.2	1	Indian average
	Santoyo-Castelazo *et al.* (2011)[28]	12	1	Mexican average
Lignite coal	Ecoinvent database 2.2[6]	1059 - 1407	6	different geographical references
	US LCI database[29]	1190	1	coal fired steam generation
	Amponsah *et al.* (2014)[22]	1050	3	global average
	Atilgan & Azapagic (2014)[23]	1062	16	average in Turkey
Diesel combustion	Ecoinvent database 2.2[6]	732	1	Switzerland

	US LCI database[29]	1130	1	US average
	Santoyo-Castelazo *et al.* (2011)[28]	866	1	Mexican average
Conventional geothermal	Martin-Gamboa *et al.* (2015)[16]	5.8	1	diesel-driven drilling
	SRREN Report (2012)[17]	50	1	average of global review
	Rule *et al.* (2009)[19]	5.6	1	high temperature binary cycle
	Pehnt (2006)[35]	41.0	1	hot dry rock
	Hondo (2005)[20]	15	1	double flash, Japan
	Karlsdottir *et al.* (2010)[36]	35	1	double flash, Iceland
	Sullivan *et al.* (2010)[21]	5.7 – 103	2	different technologies
	Amponsah *et al.* (2014)[22]	11 – 78	4	average
	Bertani & Thain (2002)[37]	4 – 470	85	different technologies
	Santoyo-Castelazo *et al.* (2011)[28]	131	1	Mexican average
	Bravi & Basosi (2013)[38]	380 – 1045	4	single flash, steam, Tuscany
Hydropower	Ecoinvent database 2.2[6]	4.1 – 1099	7	different geographical references; run-of-river, reservoir plants and pumped storage
	UNEP report 2015[14]	10.0 – 137	4	reservoir power plants
	Hertwich *et al.* (2015)[15]	5.6 – 78.8	2	reservoir power plants
	SRREN Report (2012)[17]	4.0 – 14.0	2	average of global review
	Rule *et al.* (2009)[19]	4.6	1	reservoir, New Zealand
	Pehnt (2006)[35]	10 - 13	2	different plant sizes, Germany
	Hondo (2005)[20]	15	1	run-of-river, Japan
	Sullivan *et al.* (2010)[21]	1.7 -8.1	3	different technologies
	Amponsah *et al.* (2014)[22]	2 – 74.9	11	different technologies
	Varun *et al.* (2012)[24]	11.3 – 74.9	145	run-of-river, dam, India
	Garcia *et al.* (2014)[27]	4 – 17	3	case studies Portugal
	Santoyo-Castelazo *et al.* (2011)[28]	12	1	Mexican average
Wind power	Ecoinvent database 2.2[6]	11.2 – 112	4	different geographical references; offshore and onshore
	UNEP report 2015[14]	8.0 – 11.0	6	offshore and onshore
	Hertwich *et al.* (2015)[15]	8.4 – 11.4	3	offshore and onshore
	SRREN Report (2012)[17]	8.0 – 20.0	2	average of global review
	Dolan & Heath (2012)[39]	11.0	126	average, offshore and onshore
	Padey *et al.* (2012)[40]	4.5 – 76.7	17	different wind conditions
	Rule *et al.* (2009)[19]	3.0	1	onshore, New Zealand
	Pehnt (2006)[35]	9.0 – 11.0	2	onshore, offshore, Germany
	Hondo (2005)[20]	29.5	1	onshore wind park, Japan
	Sullivan *et al.* (2010)[21]	2.6 – 21.3	3	different technologies
	Amponsah *et al.* (2014)[22]	4.6 – 123.7	19	onshore and offshore
	Celik *et al.* (2007)[41]	20.5	6	micro-wind plants, Turkey
	Garcia *et al.* (2014)[27]	23	1	case studies Portugal
	Santoyo-Castelazo *et al.* (2011)[28]	18	1	Mexican average
	Reimers *et al.* (2014)[42]	13.2 – 22.2	6	onshore and offshore, Germany
Solar power	Ecoinvent database 2.2[6]	47.4 – 86.6	6	different geographical references; photo-voltaic (PV)
	UNEP report 2015[14]	14.0 – 56.0	9	CSP, different types of PV
	Hertwich *et al.* (2015)[15]	16.1 – 57.5	8	CSP, different types of PV
	SRREN Report (2012)[17]	23 – 55	2	average of global review, CSP and PV
	Burkhardt *et al.* (2012)[43]	26 – 38	36	median for tower and through CSP
	Hsu *et al.* (2012)[44]	45.0	42	median for crystalline-silicon PV
	Kim *et al.* (2012)[45]	14 – 27	7	different thin-film PV types

	Pehnt (2006)[35]	14 – 104	2	PV, solar thermal, Germany
	Hondo (2005)[20]	53.4	1	polycrystalline silicon PV, Japan
	Sullivan *et al.* (2010)[21]	8.4 – 142	3	different technologies
	Amponsah *et al.* (2014)[22]	9.4 – 300	19	different PV technologies
	Garcia *et al*. (2014)[27]	51	1	case studies Portugal
Tidal and wave power	SRREN Report (2012)[17]	8 – 23	2	average of global review
	Rule *et al.* (2009)[19]	1.8	1	New Zealand
	Amponsah *et al.* (2014)[22]	10 – 50	4	different plant types
	Parker *et al.* (2007)[46]	22.8	1	wave energy converter
	Douglas *et al.* (2008)[47]	15.0	1	tidal current turbine
Biogas	Ecoinvent database 2.2[6]	241 – 387	3	different geographical references; co-generation
	SRREN Report (2012)[17]	144	1	average of global review
	Sullivan *et al.* (2010)[21]	115	1	US average
	Garcia *et al.* (2014)[27]	239	1	case studies Portugal
	Fuchsz & Kohlheb (2014)[48]	260 – 413	2	different plant types, Germany
Biomass	Ecoinvent database 2.2[6]	25 – 1110	8	different types of biomass
	US LCI database[29]	45.8	1	US average
	SRREN Report (2012)[17]	45	1	average of global review
	Pehnt (2006)[35]	27 – 86	7	different types of biomass
	Gerin *et al.* (2008)[49]	31 – 104	9	different crops in Belgium
	Amponsah *et al.* (2014)[22]	14.4 – 650	14	different types of biomass
	Shafie *et al*. (2014)[50]	845 – 1086	3	different crops, Malaysia
	Ramjeawon (2008)[51]	35.6	1	case study Mauritius
	Kami Delivand et al. (2012)[52]	193	1	case study Thailand
	Liu et al. (2010)[53]	664	1	case study China
	Sebastián et al. (2011)[54]	1066 - 1074	2	case studies Spain
	Garcia et al. (2014)[27]	33 – 56	2	case studies Portugal
Waste incineration	Ecoinvent database 2.2[6]	147 – 1800	2	different types of waste
Non-renewable energy demand		*[MJ/kWh]*		
EGS (electric drilling)	Menberg *et al.* (20XX), EES	0.09 – 0.19	2	with current drilling technology
EGS co-generation	Menberg *et al.* (20XX), EES	0.06 – 0.12	2	with current drilling technology
Coal-fired power generation	Ecoinvent database 2.2[6]	11.4 – 13.5	6	different geographical locations
	US LCI database[29]	13.4 – 16.3	2	different types of coal
	UNEP report 2015[14]	8.5 – 14.4	6	different technologies
	Martin-Gamboa *et al.* (2015)[16]	12.1	1	hard coal, Spain
	Garcia *et al.* (2014)[27]	11.0 – 11.5	2	case studies Portugal
Natural gas	Ecoinvent database 2.2[6]	8.2 – 11.9	6	different geographical locations
	US LCI database[29]	11.4	1	US average
	UNEP report 2015[14]	8.2 – 9.8	2	different technologies
	Martin-Gamboa *et al.* (2015)[16]	8.7	1	case study Spain
	Kannan *et al.* (2005)[32]	7.8	1	case study Singapore
	Garcia *et al.* (2014)[27]	6.5 – 9.4	3	case studies Portugal
Oil combustion	Ecoinvent database 2.2[6]	8.6 – 15.9	6	different geographical locations
	US LCI database[29]	12.6	1	US, residual fuel oil
	Garcia *et al.* (2014)[27]	13.2	1	case study Portugal
Nuclear power	Ecoinvent database 2.2[6]	0.07 – 0.16	6	different geographical locations
	US LCI database[29]	0.15	1	US average
	Lenzen (2008)[55]	0.1 – 0.3	24	LWR and HWR reactors, Germany
Lignite coal	Ecoinvent database 2.2[6]	7.8 – 19.9	6	different geographical locations

	US LCI database[29]	20.5	1	US average
Diesel combustion	Ecoinvent database 2.2[6]	9.92	1	Switzerland
	US LCI database[29]	14.65	1	US average
Conventional geothermal	UNEP report 2015[14]	0.2	1	binary systems
	Martin-Gamboa *et al.* (2015)[16]	0.05	1	case study Spain
	Hirschberg et al. (2015)[56]	0.09 – 0.54	3	Switzerland
	Rule *et al*. (2009)[19]	0.09	1	binary plant, New Zealand
	Pehnt (2006)[35]	0.54	1	Germany, hot dry rock
Hydropower	Ecoinvent database 2.2[6]	0.04 – 12.8	7	different geographical references; run-of-river, reservoir plants and pumped storage
	UNEP report 2015[14]	0.1 – 2.0	2	different reservoir types
	Rule *et al.* (2009)[19]	0.06	1	reservoir, New Zealand
	Pehnt (2006)[35]	0.1 – 0.14	2	different plant sizes, Germany
	Garcia *et al*. (2014)[27]	0.04 – 0.05	3	case studies Portugal
Wind power	Ecoinvent database 2.2[6]	0.14 – 0.22	4	different geographical references; offshore and onshore
	UNEP report 2015[14]	0.2 – 0.3	3	offshore and onshore
	Rule *et al.* (2009)[19]	0.07	1	onshore, New Zealand
	Pehnt (2006)[35]	0.11 – 0.12	2	onshore, offshore, Germany
	Celik *et al.* (2007)[41]	0.45	6	micro-wind plants, Turkey
	Garcia *et al.* (2014)[27]	0.04	1	case studies Portugal
Solar power (PV only)	Ecoinvent database 2.2[6]	0.6 – 1.1	6	different geographical references; photo-voltaic (PV)
	UNEP report 2015[14]	0.2 – 0.9	6	different types of PV
	Pehnt (2006)[35]	0.14 – 1.5	2	PV, solar thermal, Germany
	Garcia *et al.* (2014)[27]	0.65	1	case studies Portugal
Tidal and wave power	Rule *et al.* (2009)[19]	0.04	1	New Zealand
	Douglas *et al.* (2008)[47]	0.21	1	tidal current turbine
	Parker *et al.* (2007)[46]	0.29	1	wave energy converter
Biogas	Ecoinvent database 2.2[6]	0.66 – 1.34	3	different geographical references; co-generation
	Pehnt (2006)[35]	0.09	1	Germany
	Garcia *et al.* (2014)[27]	1.31	1	case studies Portugal
Biomass	Ecoinvent database 2.2[6]	0.18 – 0.7	8	different types of biomass
	US LCI database[29]	0.03	1	US average
	Pehnt (2006)[35]	0.28 – 0.46	7	different types of biomass
	Garcia *et al.* (2014)[27]	0.37 – 0.6	2	case studies Portugal
Waste incineration	Ecoinvent database 2.2[6]	1.17 – 1.60	2	different types of waste
	Garcia et al. (2014)[27]	1.71	1	case study Portugal
Acidification potential		*[gSO$_2$-equivalent/kWh]*		
EGS (electric drilling)	Menberg *et al.* (20XX), EES	0.03 – 0.07	2	with current drilling technology
EGS co-generation	Menberg *et al.* (20XX), EES	0.02 – 0.04	2	with current drilling technology
Coal-fired power generation	Ecoinvent database 2.2[6]	6.01 – 6.28	3	different geographical locations
	US LCI database[29]	8.6 – 37.8	2	different types of coal
	Hertwich *et al.* (2015)[15]	0.72 – 1.61	6	different technologies
	Martin-Gamboa *et al.* (2015)[16]	11.6	1	hard coal, Spain
	Atilgan & Azapagic (2014)[23]	6.00	8	average in Turkey
	Garcia et al. (2014)[27]	2.84 – 8.72	2	case studies Portugal
Natural gas	Ecoinvent database 2.2[6]	0.28 – 6.0	6	different geographical locations

	US LCI database[29]	6.4	1	US average
	Hertwich *et al.* (2015)[15]	3.78 – 4.68	2	different technologies
	Martin-Gamboa *et al.* (2015)[16]	0.28	1	case study, Spain
	Atilgan & Azapagic (2014)[23]	0.80	8	average in Turkey
	Garcia et al. (2014)[27]	0.35 – 0.74	3	case studies Portugal
Oil combustion	Ecoinvent database 2.2[6]	8.26 – 10.5	6	different geographical locations
	US LCI database[29]	3.44	1	US, residual fuel oil
	Garcia et al. (2014)[27]	19.0	1	case study Portugal
Nuclear power	Ecoinvent database 2.2[6]	0.04 – 0.08	6	different geographical locations
	US LCI database[29]	0.27	1	US average
Lignite coal	Ecoinvent database 2.2[6]	1.12 – 6.85	5	different geographical locations
	US LCI database[29]	12.3	1	US average
	Atilgan & Azapagic (2014)[23]	11.0	16	average in Turkey
Diesel combustion	Ecoinvent database 2.2[6]	1.66	1	Switzerland
	US LCI database[29]	2.66	1	US average
Conventional geothermal	Martin-Gamboa *et al.* (2015)[16]	0.01	1	case study Spain
	Hirschberg *et al.* (2015)[56]	0.1 – 0.03	3	Switzerland
	Pehnt (2006)[35]	0.19	1	hot dry rock, Germany
	Bravi & Basosi (2013)[38]	0.1 – 44.8	4	single flash, steam, Tuscany
Hydropower	Ecoinvent database 2.2[6]	0.01 – 6.94	7	different geographical references; run-of-river, reservoir plants and pumped storage
	Hertwich *et al.* (2015)[15]	0.03 – 0.44	2	different technologies
	Pehnt (2006)[35]	0.04 – 0.06	2	different plant sizes, Germany
	Garcia *et al*. (2014)[27]	0.02 – 0.03	3	case studies Portugal
Wind power	Ecoinvent database 2.2[6]	0.05 – 0.07	4	different geographical references; offshore and onshore
	Hertwich *et al.* (2015)[15]	0.04 – 0.09	3	different technologies
	Pehnt (2006)[35]	0.05 – 0.06	2	onshore, offshore, Germany
	Garcia *et al.* (2014)[27]	0.11	1	case study Portugal
Solar power (PV only)	Ecoinvent database 2.2[6]	0.21 – 3.77	6	different geographical references; photo-voltaic (PV)
	Hertwich *et al.* (2015)[15]	0.04 – 0.09	3	CSP, different types of PV
	Pehnt (2006)[35]	0.09 – 0.53	2	PV, solar thermal, Germany
	Garcia et al. (2014)[27]	0.25	1	case study Portugal
Biogas	Ecoinvent database 2.2[6]	0.78 – 7.25	3	different geographical references; co-generation
	Pehnt (2006)[35]	3.81	1	Germany
	Garcia *et al.* (2014)[27]	0.72	1	case study Portugal
Biomass	Ecoinvent database 2.2[6]	0.26 – 2.80	8	different types of biomass
	US LCI database[29]	0.77	1	US average
	Pehnt (2006)[35]	0.24 – 1.31	7	different types of biomass
	Garcia *et al.* (2014)[27]	0.65 – 1.40	2	case studies Portugal
	Ramjeawon (2008)[51]	0.36	1	case study Mauritius
Waste incineration	Ecoinvent database 2.2[6]	1.23 – 1.40	2	different types of waste
	Garcia *et al.* (2014)[27]	1.28	1	case study Portugal
Eutrophication potential		*[mgPO_4^{3-}-equivalent/kWh]*		
EGS (electric drilling)	Menberg *et al.* (20XX), EES	1.9 – 3.5	2	with current drilling technology
EGS co-generation	Menberg *et al.* (20XX), EES	1.4 – 2.6	2	with current drilling technology
Coal-fired power generation	Ecoinvent database 2.2[6]	249 – 831	6	different geographical locations

	Hertwich *et al.* (2015)[15]	427 – 687	6	different technologies
	Martin-Gamboa *et al.* (2015)[16]	2110	1	hard coal, Spain
	Atilgan & Azapagic (2014)[23]	2300	8	average in Turkey
	Garcia et al. (2014)[27]	2300 - 2480	2	case studies Portugal
Natural gas	Ecoinvent database 2.2[6]	0.53 – 11.6	6	different geographical locations
	Hertwich *et al.* (2015)[15]	5.40 – 10.1	2	different technologies
	Martin-Gamboa *et al.* (2015)[16]	70.0	1	case study, Spain
	Atilgan & Azapagic (2014)[23]	100	8	average in Turkey
	Garcia et al. (2014)[27]	4.0 – 150	3	case studies Portugal
Oil combustion	Ecoinvent database 2.2[6]	17.0 – 31.5	6	different geographical locations
	Garcia et al. (2014)[27]	57.0	1	case study Portugal
Nuclear power	Ecoinvent database 2.2[6]	2.60 – 5.90	6	different geographical locations
Lignite coal	Ecoinvent database 2.2[6]	1800 – 4620	6	different geographical locations
	Atilgan & Azapagic (2014)[23]	11900	16	average in Turkey
Diesel combustion	Ecoinvent database 2.2[6]	22.8	1	Switzerland
Conventional geothermal	Martin-Gamboa *et al.* (2015)[16]	42.0	1	case study Spain
	Hirschberg *et al.* (2015)[56]	4.68 – 27.6	3	Switzerland
	Pehnt (2006)[35]	24.8	1	hot dry rock, Germany
Hydropower	Ecoinvent database 2.2[6]	0.85 – 157	6	different geographical references; run-of-river, reservoir plants and pumped storage
	Hertwich *et al.* (2015)[15]	0.03 – 3.82	2	different technologies
	Pehnt (2006)[35]	5.0 – 6.0	2	different plant sizes, Germany
	Garcia *et al*. (2014)[27]	1.0 – 6.0	3	case studies Portugal
Wind power	Ecoinvent database 2.2[6]	7.21 – 11.5	4	different geographical references; offshore and onshore
	Hertwich *et al.* (2015)[15]	5.86 – 8.62	3	different technologies
	Pehnt (2006)[35]	2.7 – 4.0	2	onshore, offshore, Germany
	Garcia *et al.* (2014)[27]	60.0	1	case study Portugal
Solar power (PV only)	Ecoinvent database 2.2[6]	39.8 – 72.7	6	different geographical references; photo-voltaic (PV)
	Hertwich *et al.* (2015)[15]	4.07 – 44.5	3	CSP, different types of PV
	Pehnt (2006)[35]	10.0 – 44.0	2	PV, solar thermal, Germany
	Garcia et al. (2014)[27]	160	1	case study Portugal
Biogas	Ecoinvent database 2.2[6]	11.3 – 14.6	3	different geographical references; co-generation
	Pehnt (2006)	609	1	Germany
	Garcia *et al.* (2014)[27]	130	1	case study Portugal
Biomass	Ecoinvent database 2.2[6]	5.64 – 47.5	8	different types of biomass
	Pehnt (2006)[35]	38.0 – 196	7	different types of biomass
	Garcia *et al.* (2014)[27]	230 – 440	2	case studies Portugal
	Ramjeawon (2008)[51]	442	1	case study Mauritius
Waste incineration	Ecoinvent database 2.2[6]	159 - 176	2	different types of waste
	Garcia *et al.* (2014)[27]	1190	1	case study Portugal

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