

University of Stuttgart

Germany ZIRIUS - Center for Interdisciplinary Risk and Innovation Studies









Supported by:



Adding the Social Perspective to Live Cycle Analysis (LCA) of Energy Transition Scenarios

> Oliver Scheel M. A.

Federal Ministry for Economic Affairs and Energy on the basis of a decision by the German Bundestag

InNOSys - LCA-Analysts and Social-Scientists The Problem

 LCA (life cycle analysis) data includes +43.000 variables on ecological effects from technologies used in the transition to green energy production. Economic science offers hundreds of variables assessing the financial outcome of green energy production technologies.

 \rightarrow Data on social impact for sustainable development is scarce and often not compatible for inclusive analysis.

- Our steps in Project InNOSys
 - a) Tracing which future & technologies Citizens prefer.
 - b) Fill gaps in the sustainability concept with qualitative data on Quality of life, justice between generations and justice of distribution of benefits of energy change

	WND ur TS(2)	Good	battery, LFP-C	0,0667 kgCC2-Eg
LCD 1.0.8 2016 midpoint - climate change, GWP 100a LCD 1.0.8 2016 midpoint - climate change, GWP 100a	WNDur TS(2)	Bad	used Li-ion battery	0.0058 kgC02-Eg
	WND ur TS(2)	Good	battery, LFP-C	0.0008 molH+-Eq
LCD 1.0.8 2016 midpoint - ecosystem quality, freshwater and terrestrial acidification				
ECD 1.0.8 2016 midpoint - ecosystem quality, freshwater and terrestrial acidification	WND or TS(2)	Bad	used Li-ion battery	4E-05 molH+-Eq
LCD 1.0.8 2016 midpoint - ecosystem quality, freshwater ecotosicity	WIND ur TS(2)	Good	battery, LFP-C	1,5146 CTUh.m3.yr
LCD 1.0.8 2016 midpoint - ecosystem quality, freshwater ecotoxicity	WIND or TS(2)	Bad	used Li-ion battery	0,068 CTUh.m3.yr
LCD 1.0.8 2016 midpoint - ecosystem quality, freshwater eutrophication	WIND ur TS(2)	Good	battery, LFP-C	SE-05 kgP-Eq
LCD 1.0.8 2016 midpoint - ecosystem quality, freshv ater eutrophication	MND ur TS(2)	Bad	used Li-ion battery	3E-06 kgP-Eq
LCD 1.0.8 2016 midpoint - ecosystem guality, ionising radiation	MIND ur TS(2)	Good	battery, LFP-C	3E-08 molN-Eq
LCD 1.0.8 2016 midpoint - ecosystem quality, ionising radiation	WND ur TS(2)	Bad	used Li-ion battery	2E-09 molN-Eg
LCD 1.0.8 2016 midpoint - ecosystem guality, marine eutrophication	MND ur TS(2)	Good	battery, LFP-C	7E-05 kgN-Eg
LCD 1.0.8 2016 midpoint - ecosystem quality, marine eutrophication	WIND ur TS(2)	Bad	used Li-ion battery	6E-06 kgN-Eq
LCD 1.0.8 2016 midpoint - ecosystem guality, terrestrial eutrophication	WIND ur TS(2)	Good	battery, LFP-C	0,002 molN-Eq
LCD 1.0.8 2016 midpoint - ecosystem quality, terrestrial eutrophication	WIND ur TS(2)	Bad	used Li-ion battery	6E-05 molN-Eq
	WNDur TS(2)	Good		2E-08 CTUh
LCD 1.0.8 2016 midpoint - human health, carcinogenic effects			battery, LFP-C	
LCD 10.8 2016 midpoint - human health, caroinogenic effects	WND ur T5(2)	Bad	used Li-ion battery	4E-10 CTUh
LCD 1.0.8 2016 midpoint - human health, ionising radiation	WIND ur TS(2)	Good	battery, LFP-C	0,0101 kgU235-Eq
LCD 1.0.8 2016 midpoint - human health, ionising radiation	WIND ur TS(2)	Bad	used Li-ion battery	0.0007 kgU235-Eq
LCD 1.0.8 2016 midpoint - human health, non-carcinogenic effects	WIND ur TS(2)	Good	battery, LFP-C	6E-08 CTUh
LCD 1.0.8 2016 midpoint - human health, non-carcinogenic effects	WND ur TS(2)	Bad	used Li-ion battery	2E-09 CTUh
LCD 1.0.8 2016 midpoint - human health, ozone layer depletion	WIND or TS(2)	Good	battery, LFP-C	3E-07 kgCFC-11-Eq
LCD 1.0.8 2016 midpoint - human health, ozone layer depletion	WIND or TS(2)	Bad	used Li-ion battery	SE-10 kgCFC-11-Eg
LCD 1.0.8 2016 midpoint - human health, photochemical ozone creation	WIND ur TS(2)	Good	battery, LFP-C	0,0002 kg ethylene-Eq
LCD 10.8 2016 midpoint - human health, photochemical ozone creation	WIND or TS(2)	Bad	used Li-ion battery	2E-05 kg ethylene-Eq
LCD 10.02016 midpoint - numan health, respiratory effects, inorganics	WIND or TS(2)		battery, LFP-C	6E-05 kg PM2.5-Eq
CCD 10.0 2010 midpoint - numan nearth, respiratory effects, inorganics		Good	Darlery, LFP-C	
LCD 10.8 2016 midpoint - human health, respiratory effects, inorganics	WIND or TS(2)	Bad	used Li-ion battery	6E-06 kg PM2.5-Eq
LCD 1.0.8 2016 midpoint - resources, land use	WIND or TS(2)	Good	battery, LFP-C	0,102 kg Soll Organic Carbo
LCD 1.0.8 2016 midpoint - resources, land use	WIND or TS(2)	Bad	used Li-ion battery	0,007 kg Soil Organic Carbo
LCD 1.0.8 2016 midpoint - resources, mineral, fossils and renew ables	WIND ur TS(2)	Good	battery, LFP-C	2E-05 kg Sb-Eq
LCD 1.0.8 2016 midpoint - resources, mineral, fossils and renew ables	WIND ur TS(2)	Bad	used Li-ion battery	SE-07 kg Sb-Eq
LCD 1.0.8 2016 midpoint - climate change, GWP 100a	PV-Dao TS(4)	Good	battery, LFP-C	0.0667 kgCC2-Eg
LCD 1.0.8 2016 midpoint - climate change, GWP 100a	PV-Dac TS(4)	Bad	used Li-ion battery	0,0058 kgCO2-Eq
LCD 10.8 2016 midpoint - ecosystem quality, freshwater and terrestrial acidification	PV-Dac TS(4)	Good	battery, LFP-C	0,0008 molH+-Eq
LCD 10.8 2016 midpoint - ecosystem guality, freshwater and terrestrial acidification	PV-Dac TS(4)	Bad	used Li-ion battery	4E-05 molH+-Eq
	PV-Dac 15(4)			
LCD 1.0.8 2016 midpoint - ecosystem quality, freshv ater ecotoxicity	PV-Dao TS(4)	Good	battery, LFP-C	1,5146 CTUh.m3.yr
LCD 1.0.8 2016 midpoint - ecosystem quality, freshwater ecotoxicity	PV-Dac TS(4)	Bad	used Li-ion battery	0,068 CTUh.m3.yr
LCD 1.0.8 2016 midpoint - ecosystem quality, freshwater eutrophication	PV-Dac TS(4)	Good	battery, LFP-C	SE-05 kgP-Eq
LCD 1.0.8 2016 midpoint - ecosystem quality, freshv ater eutrophication	PV-Bac T5(4)	Bad	used Li-ion battery	3E-06 kgP-Eq
LCD 1.0.8 2016 midpoint - ecosystem quality, ionising radiation	PV-Dac TS(4)	Good	battery, LFP-C	3E-08 molN-Eq
LCD 1.0.8 2016 midpoint - ecosystem quality, ionising radiation	PV-Dac TS(4)	Bad	used Li-ion battery	2E-09 molN-Eq
	PV-Dac TS(4)	Good	battery, LFP-C	7E-05 kgN-Eg
LCD 10.8 2016 midpoint - ecosystem quality, marine eutrophication	PV-Dao T5(4)			
LCD 1.0.8 2016 midpoint - ecosystem quality, marine eutrophication	PV-Dac TS(4)	Bad	used Li-ion battery	6E-06 kgN-Eq
LCD 10.8 2016 midpoint - ecosystem quality, marine eutrophication LCD 10.8 2016 midpoint - ecosystem quality, terrestrial eutrophication	PV-Dac TS(4) PV-Dac TS(4)	Bad Good	used Li-ion battery battery, LFP-C	6E-06 kgN-Eq 0,002 molN-Eq
LCD 10.8 2016 midpoint - ecosystem quality, marine eutrophication LCD 10.8 2016 midpoint - ecosystem quality, terrestrial eutrophication LCD 10.8 2016 midpoint - ecosystem quality, terrestrial eutrophication	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad	used Li-ion battery battery, LFP-C used Li-ion battery	6E-06 kgN-Eq 0,002 molN-Eq 6E-05 molN-Eq
LCD 10.8 2016 midpoint - ecosystem quality, marine eutrophication LCD 10.8 2016 midpoint - ecosystem quality, terrestrial eutrophication LCD 10.8 2016 midpoint - ecosystem quality, terrestrial eutrophication LCD 10.8 2016 midpoint - tuman health, casicologenic effects	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	6E-06 kgN-Eq 0.002 molN-Eq 6E-05 molN-Eq 2E-08 CTUh
LCD 10.8 2016 midpoint - eccosystem quality, trenestrial europhication LCD 10.8 2016 midpoint - eccosystem quality, terrestrial europhication LCD 10.8 2016 midpoint - eccosystem quality, terrestrial europhication LCD 10.8 2016 midpoint - human health, cacinogenic effects LCD 10.8 2016 midpoint - human health, cacinogenic effects	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery	6E-06 kgN-Eq 0,002 molN-Eq 6E-05 molN-Eq 2E-08 CTUh 4E-10 CTUh
LCD 10.8.2016 midpoint - ecceptione quality, matche eutrophication LCD 10.8.2016 midpoint - ecceptione quality, meterial eutrophication LCD 10.8.2016 midpoint - ecceptione quality, trienstial eutrophication LCD 10.8.2016 midpoint - human healt, cacinopario effects LCD 10.8.2016 midpoint - human healt, cacinopario effects LCD 10.8.2016 midpoint - human healt, cacinopario effects	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	6E-06 kgN-Eq 0.002 molN-Eq 6E-05 molN-Eq 2E-08 CTUh 4E-10 CTUh 0.0101 kgU235-Eq
LCD 10.8.20% midpoint - ecosystem quality, marine eutrophication LCD 10.8.20% midpoint - ecosystem quality, tenerstial eutrophication LCD 10.8.20% midpoint - ecosystem quality, tenerstial eutrophication LCD 10.8.20% midpoint - human health, cascinogenic effects LCD 10.8.20% midpoint - human health, censing radiation LCD 10.8.20% midpoint - human health, censing radiation LCD 10.8.20% midpoint - human health, censing radiation	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Bad Good Bad Good Bad	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery	6E-06 kgN-Eq 0.002 molN-Eq 6E-05 molN-Eq 2E-08 CTUh 4E-10 CTUh 0.0101 kgU235-Eq 0.0007 kgU235-Eq
LCD 10.8.2016 midpoint - ecceptione quality, matche eutrophication LCD 10.8.2016 midpoint - ecceptione quality, meterial eutrophication LCD 10.8.2016 midpoint - ecceptione quality, trienstial eutrophication LCD 10.8.2016 midpoint - human healt, cacinopario effects LCD 10.8.2016 midpoint - human healt, cacinopario effects LCD 10.8.2016 midpoint - human healt, cacinopario effects	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	6E-06 kgN-Eq 0.002 molN-Eq 6E-05 molN-Eq 2E-06 CTUh 4E-10 CTUh 0.0101 kgU235-Eq 0.0007 kgU235-Eq 6E-06 CTUh
LCD 10.8.20% midpoint - ecosystem quality, marine eutrophication LCD 10.8.20% midpoint - ecosystem quality, tenerstial eutrophication LCD 10.8.20% midpoint - ecosystem quality, tenerstial eutrophication LCD 10.8.20% midpoint - human health, cascinogenic effects LCD 10.8.20% midpoint - human health, censing radiation LCD 10.8.20% midpoint - human health, censing radiation LCD 10.8.20% midpoint - human health, censing radiation	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Bad Good Bad Good Bad	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery	6E-06 kgN-Eq 0.002 molN-Eq 6E-05 molN-Eq 2E-08 CTUh 4E-10 CTUh 0.0101 kgU235-Eq 0.0007 kgU235-Eq
LCD10.820% micpoint - ecosystem quality, marite eutrophosinion LCD10.820% micpoint - ecosystem quality, teentral eutrophosition LCD10.820% micpoint - ecosystem quality, teentral eutrophosition LCD10.820% micpoint - human health, cachogonic effects LCD10.820% micpoint - human health, iconsign caldwiden LCD10.820% micpoint - human health, iconsign caldwiden LCD10.820% micpoint - human health, iconsign caldwiden	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	6E-06 kgN-Eq 0.002 molN-Eq 6E-05 molN-Eq 2E-06 CTUh 4E-10 CTUh 0.0101 kgU235-Eq 0.0007 kgU235-Eq 6E-06 CTUh
LCD10.2016 midjoir - ecospre quality, maine aurophosision LCD10.2016 midjoir - ecospre quality, treamail aurophosion LCD10.2018 midjoir - ecospre quality, treamail aurophosion LCD10.2018 midjoir - ecospre quality, treamail aurophosion LCD10.2018 midjoir - human haath, users gradient LCD10.2018 midjoir - human haath, users gradient	PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good	used Lirion battery battery, LFP-C used Lirion battery battery, LFP-C used Lirion battery battery, LFP-C used Lirion battery battery, LFP-C used Lirion battery battery, LFP-C	6E-06 kg/N-Eq 0.002 molN-Eq 6E-05 molN-Eq 72E-06 CTUh 4E-10 CTUh 0.0101 kg/U235-Eq 6E-08 CTUh 2E-03 CTUh 2E-03 CTUh 3E-07 kg/CPC-11-Eq
LCD10.2016 micjorr - ecospre quality, marine autophication LCD10.3016 micjorr - ecospre quality, terestrail autophication LCD10.3016 micjorr - ecospre quality, terestrail autophication LCD10.3016 micjorr - humo hash compense effects LCD10.3016 micjorr - humo hash come sciencegence effects	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	66-06 kgN-Eq 0.002 molN-Eq 66-05 molN-Eq 22-08 CTUh 46-10 CTUh 0.0101 kgU235-Eq 0.0007 kgU235-Eq 0.0007 kgU235-Eq 26-08 CTUh 22-09 CTUh 35-07 kgCFC-11-Eq 35-10 kgCFC-11-Eq
LCD10.2016 micjorr - ecosystem quality, marine autorghication LCD10.2016 micjorr - ecosystem quality, internati autorghication LCD10.2016 micjorr - ecosystem quality, internati autorghication LCD10.2016 micjorr - team provide autorghication LCD10.2016 micjorr - team health, concerptor affects LCD10.2016 micjorr - team health, concer upon depletion LCD10.2016 micjorr - team health, concer loy of depletion LCD10.2016 micjorr - team health, concer loy of depletion	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	EE-06 kgN-Eq 0.002 molN-Eq EE-05 molN-Eq 2E-08 CTUh 4E-10 CTUh 40-10 CTUh 0.0011 kgU235-Eq EE-08 CTUh 2E-09 CTUh 3E-07 kgCPC-11-Eq 3E-01 kgCPC-11-Eq 0.0002 kgeVene-Eq
LCD10.2016 micjoint - ecosystem quality, maine autophication LCD10.2018 2016 micjoint - ecosystem quality, internial autophication LCD10.2018 2016 micjoint - Nume hash, concregative effects LCD10.2016 micjoint - Num hash, concre elempt effects LCD10.2016 micjoint - Num hash, concre elempt effects LCD10.2017 micjoint - Num hash, concre elempt effection LCD10.2017 micjoint - Num hash, concre elempt effection LCD10.2017 micjoint - Num hash, concre elempt effection	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad	used Li-ion battery battery, LFP-C used Li-ion battery	EE-06 kgN-Eq 0.002 m0N-Eq EE-05 m0N-Eq 2E-08 CTUh 4E-00 CTUh 0.0001 kgU235-Eq 0.0007 kgU235-Eq 2E-09 CTUh 2E-09 CTUh 3E-07 kgCFC-11-Eq 3E-07 kgCFC-11-Eq 0.0002 kg ethylene=Eq 2E-05 kgUhlene=Eq
LCD10.2016 micjorr - ecosystem quality, marine autophication LCD10.2016 micjorr - ecosystem quality, terestrail autophication LCD10.2016 micjorr - ecosystem quality, terestrail autophication LCD10.2017 micjorr - human hards, consequence differs LCD10.2017 micjorr - human hards, correspondent differs LCD10.2017 micjorr - human hards, correspondent LCD10.2017 micjorr - human hards, correspondent done constant LCD10.2017 micjorr - human hards, correspondent done constant LCD10.2017 micjorr - human hards, correspondent done constant	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	EE-06 kg/N-Eq 0.002 m/N-Eq EE-05 m/N-Eq 2E-08 CTUh 4E-10 CTUh 0.0001 kg/L235-Eq 0.0007 kg/L235-Eq 0.0007 kg/L235-Eq 2E-09 CTUh 2E-09 CTUh 3E-07 kg/CC-11-Eq 0.0002 kg/atv/km=Eq 2E-05 kg/kv/km=Eq 2E-05 kg/kv/s=5-Eq
LCD10.2016 midjoir - eospite quality, marine autophosision LCD10.2016 midjoir - eospite quality, tremsnik autophosion LCD10.2018 midjoir - eospite quality, tremsnik autophosion LCD10.2018 midjoir - eospite quality, tremsnik autophosion LCD10.2018 midjoir - hum health, sciencigar adaron LCD10.2018 midjoir - hum health, sciencigar adaron LCD10.2018 midjoir - hum health, sciencig adaron LCD10.2018 midjoir - hum health, sciencig adaron LCD10.2018 midjoir - hum health, science acrospecie affects LCD10.2018 midjoir - hum health, science acrospecie affects LCD10.2018 midjoir - hum health, science layor depletion LCD10.2018 midjoir - hum health, science layor depletion LCD10.2019 midjoir - hum health, science layor depletion LCD10.2018 midjoir - hum health, science layor depletion layor depletion LCD10.2018 midjoir - hum health, science layor depletion layor depletion LCD10.2018 midjoir - hum health, science layor depletion layor depletion LCD10.2018 midjoir - hum health, science layor depletion layor depletio	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad	used Li-ion battery battery, LFP-C used Li-ion battery	EE-06 kgN+Eq 0.002 mN+Eq EE-05 mN+Eq 2E-08 CTUh 4E-00 CTUh 0.007 kgU235-Eq 0.0007 kgU235-Eq 2E-03 CTUh 2E-03 CTUh 3E-07 kgCFC-11-Eq 3E-07 kgCFC-11-Eq 0.0002 kgethylene-Eq 2E-05 kgPM25-Eq EE-06 kgPM25-Eq
LCD10.2016 midjoirr - ecosorem quality, maine autophication LCD10.2016 midjoirr - teopatre quality, internal autophication LCD10.2016 midjoirr - Internal health, accrogance effects LCD10.2016 midjoirr - Internal health, accrogance enderson LCD10.2016 midjoirr - Internal health, accrogance enderson LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	6E:06 igNEq 0.002 mol/HEq 6E:05 mol/HEq 2E:08 CTUA 0.001 igU23FEq 0.001 igU23FEq 0.002 igU23FEq 5E:08 CTUA 2E:08 CTUA 2E:08 CTUA 2E:08 CTUA 2E:08 CTUA 2E:08 CTUA 2E:07 ligC7C-THEq 5E:07 ligC7C-THEq 5E:05 ligsthylem=Eq 2E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 6E:05 ligsthylem=Eq <
LCD10.2016 midjoir - eospite quality, marine autophosision LCD10.2016 midjoir - eospite quality, tremsnik autophosion LCD10.2018 midjoir - eospite quality, tremsnik autophosion LCD10.2018 midjoir - eospite quality, tremsnik autophosion LCD10.2018 midjoir - hum health, sciencigar adaron LCD10.2018 midjoir - hum health, sciencigar adaron LCD10.2018 midjoir - hum health, sciencig adaron LCD10.2018 midjoir - hum health, sciencig adaron LCD10.2018 midjoir - hum health, science acrospecie affects LCD10.2018 midjoir - hum health, science acrospecie affects LCD10.2018 midjoir - hum health, science layor depletion LCD10.2018 midjoir - hum health, science layor depletion LCD10.2019 midjoir - hum health, science layor depletion LCD10.2018 midjoir - hum health, science layor depletion layor depletion LCD10.2018 midjoir - hum health, science layor depletion layor depletion LCD10.2018 midjoir - hum health, science layor depletion layor depletion LCD10.2018 midjoir - hum health, science layor depletion layor depletio	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad	used Li-ion battery battery, LFP-C used Li-ion battery	EE-06 kgN+Eq 0.002 mN+Eq EE-05 mN+Eq 2E-08 CTUh 4E-00 CTUh 0.007 kgU235-Eq 0.0007 kgU235-Eq 2E-03 CTUh 2E-03 CTUh 3E-07 kgCFC-11-Eq 3E-07 kgCFC-11-Eq 0.0002 kgethylene-Eq 2E-05 kgPM25-Eq EE-06 kgPM25-Eq
LCD10.2016 midjoirr - ecosorem quality, maine autophication LCD10.2016 midjoirr - teopatre quality, internal autophication LCD10.2016 midjoirr - Internal health, accrogance effects LCD10.2016 midjoirr - Internal health, accrogance enderson LCD10.2016 midjoirr - Internal health, accrogance enderson LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y activity, and y accompany LCD10.2016 midjoirr - Interna health, acceptation y	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good	used Li-ion battery battery, LFP-C used Li-ion battery battery, LFP-C	6E:06 igNEq 0.002 mol/HEq 6E:05 mol/HEq 2E:08 CTUA 0.001 igU23FEq 0.001 igU23FEq 0.002 igU23FEq 5E:08 CTUA 2E:08 CTUA 2E:08 CTUA 2E:08 CTUA 2E:08 CTUA 2E:08 CTUA 2E:07 ligC7C-THEq 5E:07 ligC7C-THEq 5E:05 ligsthylem=Eq 2E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 5E:05 ligsthylem=Eq 6E:05 ligsthylem=Eq <
LCD10.2016 midjoire - eospare quality, maine aurophesision LCD10.2016 and the software - eospare quality, internation aurophesision LCD10.2016 and the software - terminal marks the software and LCD10.2016 midjoire - terminal have, concentration and the LCD10.2016 midjoire - terminal have, concent layor depletion LCD10.2016 midjoire - termina have, terminal have, concentration LCD10.2016 midjoire - terminal have, terminal have, concentration LCD10.2016 midjoire - terminal have, terminal have, terminal have, terminal LCD10.2016 midjoire - terminal have, term	PV-Dac TS(4) PV-Dac TS(4)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good	usedLi-ion-battery bartery, LFP-C usedLi-ion-battery bartery, LFP-C usedLi-ion-battery bartery, LFP-C usedLi-ion-battery bartery, LFP-C usedLi-ion-battery bartery, LFP-C usedLi-ion-battery bartery, LFP-C usedLi-ion-battery bartery, LFP-C	EE-06 igN-Eq 0.002 moN-Eq EE-05 moN-Eq EE-05 moN-Eq EE-05 CTUA 0.0007 igU235-Eq EE-08 CTUA 0.0007 igU235-Eq EE-08 CTUA SE-010
LCD10.2016 midjoir - ecosore quality, maine exorghication LCD10.2016 midjoir - ecosore quality, internal exorghication LCD10.2016 midjoir - human health, accordigation effects LCD10.2016 midjoir - human health, according and explore existence LCD10.2016 midjoir - human health, according and effects. Incogneds LCD10.2016 midjoir - human health, according and effects. Incogneds LCD10.2016 midjoir - human health, according and existence existence LCD10.2016 midjoir - human health, according and according	PV-Dac 15(4) PV-Dac 15(4) PV	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Bad Bad Bad Bad Bad Bad Bad	usedLinohatery barren, LFP-C usedLinohatery barren, LFP-C	EE-06 igN-Eq 0.002 mNH-Eq EE-05 mNH-Eq EE-05 mNH-Eq EE-05 mNH-Eq EE-05 CTUA 0.0007 igU235-Eq EE-08 CTUA EE-08 CTUA EE-08 CTUA EE-08 CTUA EE-08 igNPE-5-Eq EE-08 igPNE-5-Eq EE-08 igSH-Eq 0.0007 igSdC igsdE-Eq 0.0007 igSdC igsdE-Eq EE-08 igSH-Eq EE-08 igSH-Eq E
LCD10.2016 midjorr - ecosyste quality, marine autophosision LCD10.2016 midjorr - ecosyste quality, treamail autophosision LCD10.2016 midjorr - ecosyste quality, treamail autophosision LCD10.2016 midjorr - home half, science quality and the LCD10.2016 midjorr - human half, science layer depletion LCD10.2016 midjorr - human half, science layer depletion LCD1	PV-Dae 15(4) PV-Dae 15(4) PV	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good	usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C	EE-06 isyN-Eq 0.002 mol/N-Eq EE-05 isge/hysen-Eq EE
LCD10.2016 midjoir - ecostem quality, maine autophication LCD10.2018 at 70% midjoir - Rossima quality, internial autophication LCD10.2018 at 70% midjoir - Numh halth, cachrogenia effects LCD10.2018 dt 70% midjoir - Numh halth, cachrolemical dations LCD10.2018 dt 70% midjoir - Numh halth, cachrolemical dations LCD10.2018 midjoir - Human Halth, cachrolemical dations	PV-Dac 15(4) PV-Dac 15(5) PV-Dac 15(5) PV	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad	usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C	EE-06 igh-Eq 0,002 mol/H-Eq EE-05 mol/H-Eq EE-05 mol/H-Eq EE-05 mol/H-Eq EE-05 mol/H-Eq EE-05 mol/H-Eq EE-05 mol/H-Eq D000 ight255-Eq 0.0007 ight255-Eq 0.00007 ight255-Eq 0.000007 ight255-Eq 0.00000000000000000000000000000000000
LCD10.2016 midjorr - ecosyste quality, marine autophication LCD10.2016 midjorr - ecosyste quality, setterabl autophication LCD10.2016 midjorr - ecosyste quality, setterabl autophication LCD10.2016 midjorr - tomaticable according to the setterable LCD10.2016 midjorr - ecosysterable, the totable according to the setterable LCD10.2016 midjorr - ecosysterable, the totable according to the setterable LCD10.2016 midjorr - ecosysterable, the totable according to the setterable according t	PV-Dae 15(4) PV-Dae 15(4) PV	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad	usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C	EE-06 isgN-Eq 0.002 moNH-Eq 8E-05 moNH-Eq 8E-05 moNH-Eq 4E-05 CTUA 4E-07 CTUA 0.0007 isgU235-Eq 0.0007 isgU235-Eq 0.0007 isgU235-Eq 0.0007 isgU235-Eq 0.0007 isgU235-Eq 0.0007 isgU235-Eq 0.0000 isgU72-Tr4Eq 0.0000 isgU72-Tr4Eq 0.0000 isg052-Eq 0.0000 isg052-Eq 0.0000 isg152-Eq
LCC10.2016 midjoir - ecosyste quality, maine autophication LCC10.2018 and the end of the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end LCC10.2018 and the end of the end of the end of the end of the end LCC10.2018 and the end of the end LCC10.2018 and the end of the end of the end of the end of the end LCC10.2018 and the end of the end LCC10.2018 and the end of the end	PV-Dae 15(4) PV-Dae 15(4) PV-Frei 15(5) PV-Frei 15(5)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad	usedLinonbattery barrey, LFP-C usedLinonbattery barrey, LFP-C	$\begin{array}{c} {\rm EC-06}\;{\rm isp}{\rm N-E_{0}}\\ {\rm OU20}\;{\rm cm}{\rm N-N-E_{0}}\\ {\rm Cd}{\rm Cd}\;{\rm cm}{\rm OL}{\rm N-E_{0}}\\ {\rm Cd}{\rm Cd}\;{\rm cm}{\rm OL}{\rm N-E_{0}}\\ {\rm Cd}{\rm Cd}\;{\rm cm}{\rm OL}{\rm N-E_{0}}\\ {\rm Cd}{\rm Cd}\;{\rm Cd}\;{\rm N-E_{0}}\\ {\rm Cd}{\rm Cd}\;{\rm Cd}\;{\rm Sd}\;{\rm Cd}{\rm Cd}{\rm Sd}\;{\rm Sd}\\ {\rm Cd}{\rm Cd}\;{\rm Cd}\;{\rm Sd}\;{\rm Cd}{\rm Sd}\;{\rm Sd}\\ {\rm Cd}{\rm Cd}\;{\rm Cd}\;{\rm Sd}\;{\rm Cd}{\rm Sd}\;{\rm Cd}{\rm Sd}\\ {\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Sd}\;{\rm Cd}\;{\rm Cd}\;{\rm Sd}\\ {\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Sd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Sd}\\ {\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\\ {\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\;{\rm Cd}\\ {\rm Cd}\;{\rm Cd}\\ {\rm Cd}\;{\rm Cd$
LCC10.2016 midjan - ecostem quality, maine autophication LCC10.2018 2016 midjan - ecostem quality, internal autophication LCC10.2018 2016 midjan - Numh halfh, cachrogenia effects LCC10.2018 2016 midjan - Numh halfh, cachrose acrospense effects LCC10.2018 2016 midjan - Numh halfh, cachrose acrospense effects LCC10.2018 2016 midjan - Numh halfh, cachrose acrospense effects LCC10.2018 2016 midjan - Numh halfh, pictochemical dozene creation LCC10.2018 2016 midjan - resource, land use LCC10.2018	PV-Dae 15(4) PV-Dae 15(4) PV-Dae 51(4) PV-Dae 15(4) PV-Dae 15(4) PV-Frei 15(5) PV-Frei 15(5)	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good	usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C	64-06 ipi+fca 0002 melh+fca 164-06 cm1+fca 44-00 cm1 00071 ipi235-fca 44-00 cm3 00071 ipi235-fca 46-00 cm3 00071 ipi235-fca 46-00 cm3 164-00
LCC10.2016 midjorr - ecosystem quality, marine autorphisation LCC10.2016 action factor - ecosystem quality, treatmini autorphisation LCC10.2018 action factor - ecosystem quality, treatmini autorphisation LCC10.2018 action factor - towards and action factor - towards action LCC10.2018 action factor - human haath, action grad adon LCC10.2018 action factor - human haath, action layor depletion LCC10.2018 action factor - human haath, action layor depletion LCC10.2018 action factor - human haath, action layor depletion LCC10.2018 action factor - human haath, actional layor depletion LCC10.2018 action - depletion - Actional layor depletion LCC10.2018 action - human haath, actional	PV-Dar 1540 PV-Dar 1550 PV-Fer 1550 PV-Fer 1550 PV-Fer 1550 PV-Fer 1550	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Bad Bad Good Bad Bad Bad Good Bad Bad Bad Good Bad Bad Good Bad Bad Good Bad Bad Good Bad Bad Bad Bad Bad Bad Bad Bad Bad Ba	usedLinonbattery barrey, LPP-C usedLinonbattery barrey, LPP-C	62-06 ip/62_6 0002 mal/62_1 0002 mal/62_1 0002 mal/62_1 0007 ip/02564 0007 i
LCC10.020% mbg/or - cospere quality, maine aurophasision LCC10.020% mbg/or - tessing aurophasision LCC10.020%	PV-Dar 15(4) PV-Dar 15(4) PV-Da	Bad Good Good Bad Good Bad Good Bad Good Bad Good Bad Good Good Good Good Bad Good Good Good Good Good Good Good Go	usedLinonbatten barten, LFP-C usedLinonbatten barten, LFP-C	$\begin{array}{c} 6.co. \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$
LCC10.2016 midjorr - ecosystem quality, marine autorphisation LCC10.2016 action factor - ecosystem quality, treatmini autorphisation LCC10.2018 action factor - ecosystem quality, treatmini autorphisation LCC10.2018 action factor - towards and action factor - towards action LCC10.2018 action factor - human haath, action grad adon LCC10.2018 action factor - human haath, action layor depletion LCC10.2018 action factor - human haath, action layor depletion LCC10.2018 action factor - human haath, action layor depletion LCC10.2018 action factor - human haath, actional layor depletion LCC10.2018 action - depletion - Actional layor depletion LCC10.2018 action - human haath, actional	PV-Dar 1540 PV-Dar 1550 PV-Fer 1550 PV-Fer 1550 PV-Fer 1550 PV-Fer 1550	Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Good Bad Bad Bad Good Bad Bad Bad Good Bad Bad Bad Good Bad Bad Bad Good Bad Bad Good Bad Bad Good Bad Bad Good Bad Bad Bad Bad Bad Bad Bad Bad Bad Ba	usedLinonbattery barrey, LPP-C usedLinonbattery barrey, LPP-C	62-06 ip/62_6 0002 mal/62_1 0002 mal/62_1 0002 mal/62_1 0007 ip/02564 0007 i
LCD10.2016 midjorr - costem quality, maine autophication LCD10.2016 midjorr - humo hash, increased and the set LCD10.2016 midjorr - humo hash, conception effects LCD10.2016 midjorr - humo hash, hore-science gene effects LCD10.2016 midjorr - resource, land use LCD10.2016 midjorr -	PV-Dar 15(4) PV-Dar 15(5) PV-Fre 15(5) PV-Fr	Bad Good Bad Bad Good Bad Bad Bad Bad Bad Bad Bad Bad Bad Ba	usedLinonbattery bartery, LFP-C usedLinonbattery bartery, LFP-C	EC-06 bjek-Eq 0.005 bjek-Eq 0.006
LCC10.020% mbg/or - cospere quality, marine autophosism LCC10.020% mbg/or - cospere quality, terestrial antiphosism LCC10.020% mbg/or - cospere quality, terestrial antiphosism LCC10.020% mbg/or - cospere quality, terestrial antiphosism LCC10.020% mbg/or - hum-hash, costing usadion LCC10.020% mbg/or - hum-hash, costing usadione costion LCC10.020% mbg/or - hum-hash, costing usadioption LCC10.020% mbg/or - costing usadioption LCC10.020% mbg/or - costing usadioption LCC10.020% mbg/or - costing usadioption, hardva are domental actification LCC10.020% mbg/or - costing usadioption, hardva are domental actification LCC10.	PV-Dar 15(4) PV-Dar 15(5) PV-Fre 15(5) PV-Fr	Bad Good Bad Bad Bad Bad Bad Bad Good Bad Bad Bad Bad Bad Bad Bad Bad Bad Ba	usedLinonbatteny barteny, LPP-C usedLinonbatteny barteny, LPP-C	62-06 ip/62-6 0002 mil/62-6 62-07 CUA 62-07 CUA 62-
LCC10.2015 mdgorr - costre quality, maine according to attra- CC10.2015 according to the costre quality in the set of the set LCC10.2015 according to the set of the set of the set of the set LCC10.2015 according to the set of the set of the set of the set LCC10.2015 according to the set of the set of the set of the set LCC10.2015 according to the set of th	PV-Dar 15(4) PV-Dar 15(5) PV-Fie 15(5) PV-Fi	Bad Good	ured Lino having barroy, LFP-C ured Lino having barroy, LFP-C	62-06 ipik-54 0000 million for the first second se
LCC10.2015 mdgorr - ecosyste quality, marine autophosision LCC10.2016 2015 mdgorr - ecosyste quality, treatrial autophosision LCC10.2016 2015 mdgorr - ecosyste quality, treatrial autophosision LCC10.2016 2015 mdgorr - hum health, corrispication LCC10.2016 2015 mdgorr - hum health, corrispicat	PV-Dar 15(4) PV-Dar 15(4) PV-Fre 15(5) PV-Fre 15(5) PV-Fr	Bad Good	ured Linohamp barroy, LPP-C ured Linohamp barroy, LPP-C	64-06 ipHe54 0002 meMP54 64:05 meMP54 04:07 meMP54 0007 ipU23-54 0007 ipU33-54 0007 ipU33-
LCC10.20% micro-ecosystem quality, mainer exception profile solve CC10.20% active active resource quality, international methods and LCC10.20% active active resource quality active active active LCC10.20% active resource quality active active active LCC10.20% active resource quality active active active LCC10.20% active resource quality active active active LCC10.20% active resource quality active active LCC10.20% active resource quality, leady active LCC10.20% acti	PV-Dar 15(4) PV-Dar 15(5) PV-Fer 15(5) PV-Fe	Bad Good	ured Livo hamp barroy, UP-C ured Livo hamp barroy, UP-C	$\begin{array}{c} 6-6 & 0 \\ 0.00 \\ c = 0.01 $
LCC10.2015 mdgorr - ecosyste quality, marine autophosision LCC10.2016 2015 mdgorr - ecosyste quality, treatrial autophosision LCC10.2016 2015 mdgorr - ecosyste quality, treatrial autophosision LCC10.2016 2015 mdgorr - hum health, corrispication LCC10.2016 2015 mdgorr - hum health, corrispicat	PV-Dar 15(4) PV-Dar 15(4) PV-Fre 15(5) PV-Fre 15(5) PV-Fr	Bad Good	ured Linohamp barroy, LPP-C ured Linohamp barroy, LPP-C	64-06 ipHe54 0002 meMP54 64:05 meMP54 04:07 meMP54 0007 ipU23-54 0007 ipU33-54 0007 ipU33-

University of Stuttgart

11.02.2021

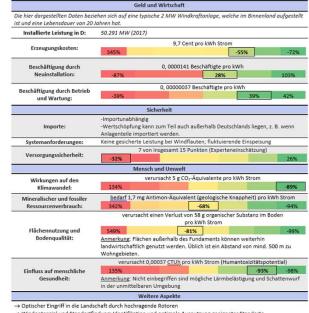
Informing the Citizens From LCA data to usable knowledge

We took the LCA-data for 7 power (& heat) technologies: wind turbine, photovoltaics (on field / on roof), natural gas, geothermal energy, Power-to-gas, Lithium- battery, heat pump. We translated an normalized it to 8 scales: Costs, employment (installation / maintenance) security of supply, contribution to climate change, usage of resources, land use, damage to ecosystems and damage to human health.

We expressed the numbers on a red to green (related to sustainability) scale with their change if implemented in percentage in comparison to the others.

Auf einen Blick: Eigenschaften einer exemplarischen Windkraftanlag

Die Skalen geben an, um wiewiel Prozent die Effekte der Technologie jeweils vom Mittelwert aller betrachteten Technologien abweichen. Laut Experten können sich diese Effekte stark sostiw (grün), wenig (gelb) oder stark negativ (rot) auf die Nachhaltigkeit auswirken.



→ Windpotenzial und Standortfrindung: Identifikation und optimale Ausnutzung geeigneter Standorte
→ Windpotenzie steht oft in Konkurrenz zu Naturschutzinteressen

Presenting paired-choices breaking down complex information

- To convey a feeling hat the technologies are not single solutions, we presented always paired-technologies as combined systems.
- To facilitate the decision and present more choices per respondent (n=12), the combined systems were presented as paired-choice experiment with the question to mark the more sustainable system.
- We conducted the experiment with 124 citizens, 60 only got the information and access to the online experiment, 64 got the information, met in 6 focus groups and then access to the online experiment.
- Among these 3 age groups were sampled: students, working people, seniors.
 University of Stuttgart

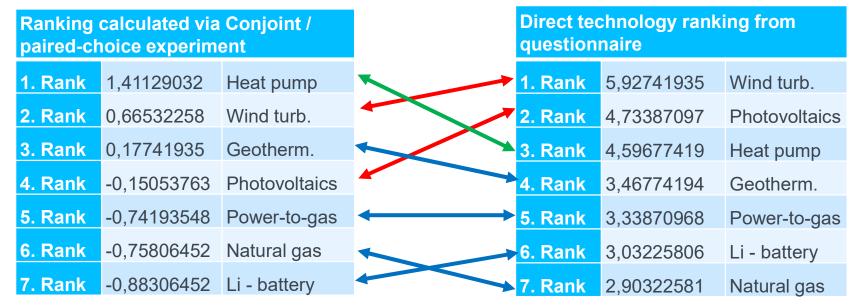
Welches der beiden Paare wäre aus Ihrer Sicht eine insgesamt nachhaltigere Stromversorgung in Deutschland?

Die Prozentzahlen stellen die Abweichungen vom jeweiligen Durchschnitt aller anderen betrachteten Paare dar. Werte sind entweder schlechter (rot/orange) oder besser (gelb/grün) als der Durchschnitt.)

	A: Windkraftanlage + PV-Anlage	B: Gaskraftwerk + Geothermiekraftwerk
Beschäftigung – Installation & Neubau	-7%	-7%
Beschäftigung – Betrieb & Wartung	-24%	+35%
Gestehungskosten	-35%	-21%
Versorgungssicherheit	-19%	+40%
Effekte auf menschliche Gesundheit	-55%	+11%
Wirkung auf den Klimawandel	-84%	+274%
Flächenverbrauch	-91%	-62%
Ressourcenverbrauch	-25%	-81%

Ranking of Technologies

paired-choice experiment (left) vs. direct ranking (right)



→ well-known technologies tend to be favoured beyond the appreciation of their properties in the direct ranking, paired-choice with small energy systems mask single technologies and show attitudes without publicity bias.

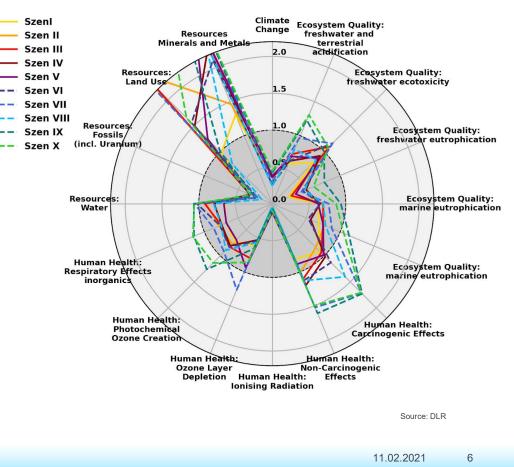
Conjoint Analysis of paired-choices

with mixed logit model

The conjoint analysis then enables us to assess the attitude towards the properties behind every technology.

Overall climate impact is the most important factor followed by resource depletion, health issues and security of supply for assessing sustainability to any energy scenario.

The coefficients now can be reincluded as social sustainability perception into the - soon to be published - results of our LCA collegues.



University of Stuttgart

Table 1: Results Discrete-Choice Experiment			
Factor	β coefficient	significance	
costs	0.0138	0.037	
Security of supply	0.0229	0.004	Climate Change Kesources Minerals and Metals Change terrestrial
Employment	0.0137	0.006	2.0 activitication Ecosystem Quality: and Use
Climate impact	0.0581	< 0.000	
Human health impact	0.0252	0.006	m) Ecosystem Quality: freshvater eutrophication
Land use	0.0189	< 0.000	
Consumption of resources	0.0299	< 0.000	0.0 Ecosystem Quality: marine eutrophication
		Human Hea Respiratory E inorganic	ffects Ecosystem Quality:

Human Health: Photochemical Ozone Creation

Human Health: Carcinogenic Effects

Human Health: Ozone Layer Depletion Human Health: Ionising Radiation

Qualitative analysis of focus groups using Max QDA

Transferring audio records into transcripts 922 statements in total, about 153 per focus group

A code tree for all different arguments with regards to content / topics discussed / opinions found is created.

3 different social scientists (intercoder realiability) mark the transcripts independently, then discus changes and adjustments to code base and unify code mapping.

Crosschecking of mapping three times. 1.755 coded positions in total, 86 different codes

University of Stuttgart

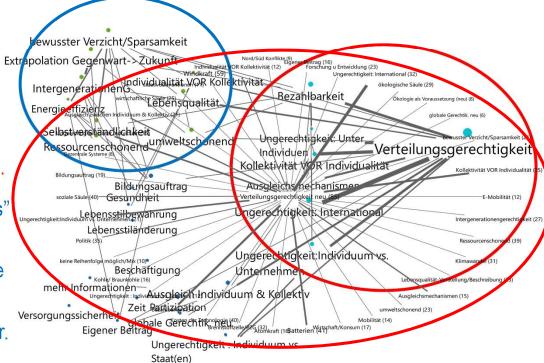
Liste der Dokumente 📔 4 🙀 🔁 🔓 🔎	G×X	🗹 Dokument-Browser: Studentinnen Stuttgart
0	3-Säulen-Modell/wirtschaftliche Säule	
Dokumente	1.755	
Renterinnen_Osnabrueck	223	📄 StudentInnen Stuttgart 🗙 📄 RentnerInnen Stuttgart 🗙
Berufstätige Osnabrück	264	(
Studentinnen Osnabrueck	289	soziale Säule
Rentnerinnen Stuttgart	306	menschliche Ges 129 H-SM: Mir fällt es auch nicht sch
Berufstätige Stuttgart	339	Brennstoffzelle/i ooo gravierend finde. Ich bin kein Ph
🖲 🛃 Studentinnen Stuttgart	334	"Klimawandel
Sets	3.510	Ressourcenschone
> 📭 Ort=Osnabrück	776	"Forschung u Entw [130 NW: Ich denke jetzt wurde wirkli
		.Brennstoffzelle/P2
Liste der Codes 👘 😨 🔎	₫ ¥ X	Kosten der Techno
D	0 ^	Brennstoffzelle/P2G 131 OS: Naja Power to Gas umfass
🖉 💽 Lārm	9	kommt das Wasserstoffgas von
Optische Beeinträchtigung	9	und dann wieder weiternutzen.
Co Spiegelung	1	sagen die Kosten würden sich d
V 🔍 🔄 Flächenverbrauch	8	die von den Leuten ja getragen v
👓 💽 Boden Schädigung	3	01:36:48-8#
🔍 🔄 Umweltschutz (Flora & Fauna)	22	
Entsorgung/ Recycling	30	132 TN: Ich wollte sagen eher umge
🖉 💽 Klimawandel	31	Kosten der Techno 🔷 geben und damit die irgendwan
Ressourcenschonend	39	.Brennstoffzelle/P2 Gas bestimmt mal billiger wird.
Image: Second	6	
• Comparison of the second	6	133 FM: Ich würde noch die Frage a
 Verhältnismäßigkeit 	0	
Verhältnismäßigkeit von Technologien	4	134 RP: Zum Thema Erzeugungsko
Vergleich Deutschland/Global	2	und Batteriespeicher als etablie
V III weitere Aspekte	0	Ungerecht
. C Digitalisierung	1	Ressource LLOOO Abbau seltener Erden in den an
e Forschung u Entwicklung	23	Brennstoff Power to Gas besser wird. In de
✓ ■ Standort/Region	1	.Batterien Brennstoffzelle kann ja elektrisc
Standortabhängige Technologien	8	"Forschung L LLL könnten. #01:39:03-9#
Nord/Süd Konflikte	9	Mobilitat
V @ Dezentrale Systeme	8	135 TN: Ebenbürtig man kann nicht
Contra dez. Systeme	6	bleibt. Wenn man mal 15 Jahre
© pro dez. Systeme	11	
Politik	35	Kosten der T oo Batterien de T oo Batterien au da nicht abschreiben au
✓ IC Staat	0	menschliche
• • • • • • • • • • • • • • • • • • •	2	Ressourcenscho [[] 136 NW: Ich finde generell bei der ge
staatliche Kontrolle	7	Digitalisierung 000
Co staati. Subventionen	11	Zeitlicher Horizo
	17	"Batterien
© Wirtschaft/Konsum		[[[[137 TN: Als ich mir das angeschaut
Cobbyismus/ Macht von Unternehmen	13	und menschliche Gesundheit u
> • • • • • • • • • • • • • • • • • • •	26	Endeffekt ist es dann wieder ein
 Aspekte sozialer Nachhaltigkeit 	0	Brenns Lander das vit. nicht leisten kön
Energieeffizienz und -suffizienz	17	menschliche Ges
> Igener Beitrag zur Nachhaltigkeit	37	.Kombination der
Selbstverständliche Versorgung / Nutzung	23	Klimawandel of für das erste Jahr bis dann möc
> 🤍 🚱 Bildungsauftrag	27	.Verteilungsgerer und nicht das man da jährlich a
> @	58	gute Zitate für Beric
C Bezahlbarkeit	34	"Forschung u Entw 139 FM: Ist das dann ein wichtiges H
Partizipation	4	
Contraction of the second seco	5	"Verteilur USS 140 TN: Schwer einzuschätzen z
📲 💽 Gesundheit (neu)	12	"Bezahlba LILLI Erzeugungskosten so hoch sind
	15	

Qualitative analysis of focus groups

Code clusters

"Distributional justice" is the most talked about topic in the focus groups. It is strongly connected to arguments circling around ecology, injustice among individuals, injustice between individuals and corporations and costs.

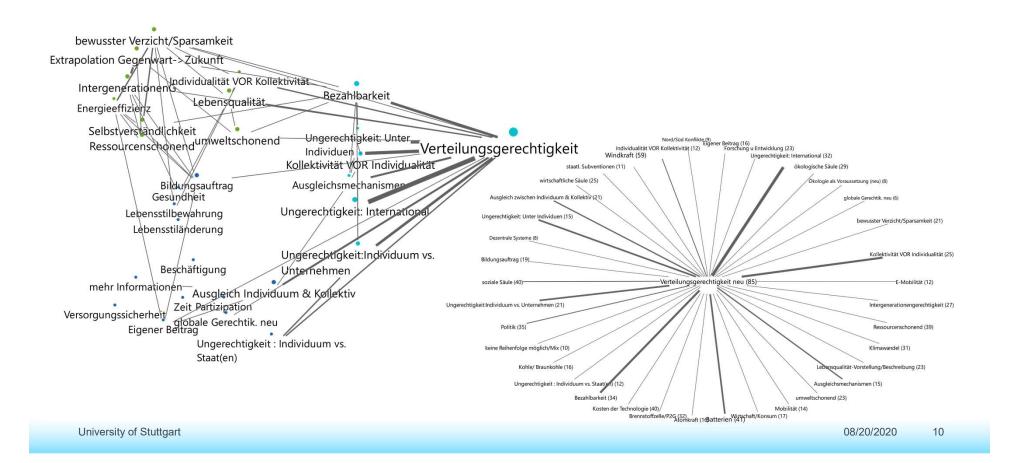
The topic "justice between generations" is another argument cluster, mostly among retired participants. The debate between collectivist and individualist perspective is connected to this cluster.



(Lines show at least three connected statements, the more, the thicker)

11.02.2021

9



Qualitative analysis of focus groups

subsample comparison

Rank		Retired	n	Working	n	Studying	n
1		Distributional justice	23	Distributional justice	32	Distributional justice	30
2		Individuum vs. collective	23	Future perspective	19	Individuum vs. collective	22
3	des	Saving environment	20	Saving environment	16	Quality of life	16
4	မီ ပိ	Own contribution	14	(Energy) costs	14	(Energy) costs	14
5		Education	14	Individuum vs. collective	13	Own contribution	12
6		Quality of life	13	Own contribution	11	Saving environment	11
7		Future perspective	11	Inter-generation justice	11	Employment	10

Overall many similarities.

Students focus more on costs and employment due to lack of security.

Middle aged participants often focus on options for future development among the scenarios.

Seniors tend to favour educational programs on energy saving & climate awareness.



University of Stuttgart ZIRIUS - Center for Interdisciplinary Risk and Innovation Studies

Thank you!



Oliver Scheel, M. A.

e-mail oliver.scheel@zirius.uni-stuttgart.de phone +49 (0) 711 685- 83931 www.zirius.uni-stuttgart.de/ research team / co-authors:

Dr. Wolfgang Hauser (ZIRIUS) Dr. Ricarda Scheele (ZIRIUS)

University of Stuttgart ZIRIUS - Center for Interdisciplinary Risk and Innovation Studies Seidenstraße 26, 70174 Stuttgart, Germany