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

InNOSys

Evaluation of Energy Scenarios through Focus Groups and Discrete-Choice Experiment

InNOSys – Integrated Sustainability Assessment and Optimzation of Energy Systems

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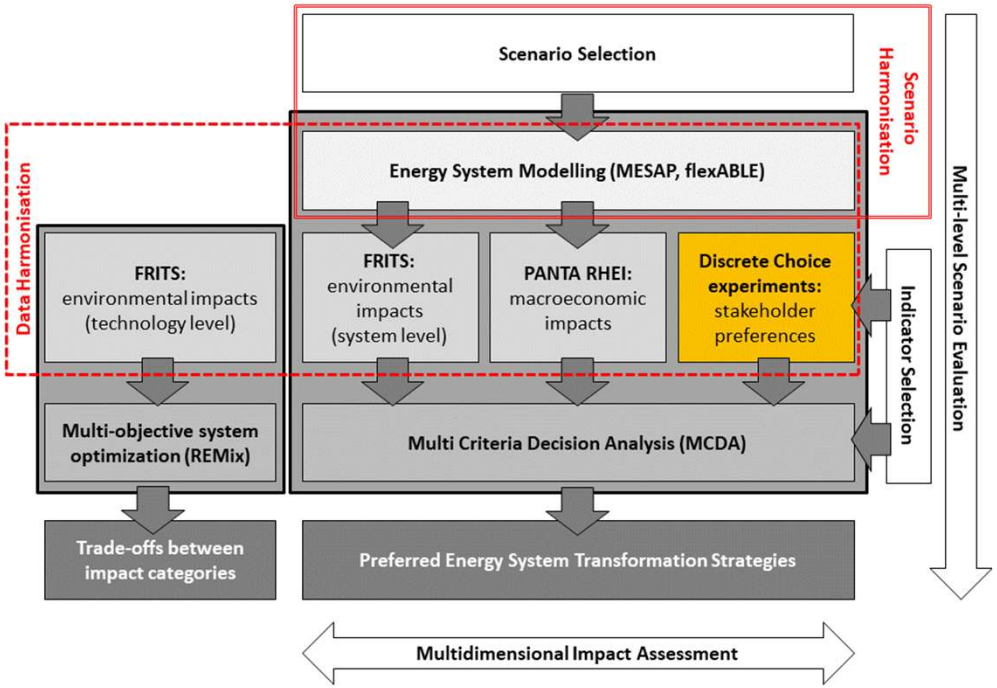
Project structure and workflow



STEP 5:

Evaluation of scenarios through focus groups and discrete choice experiments

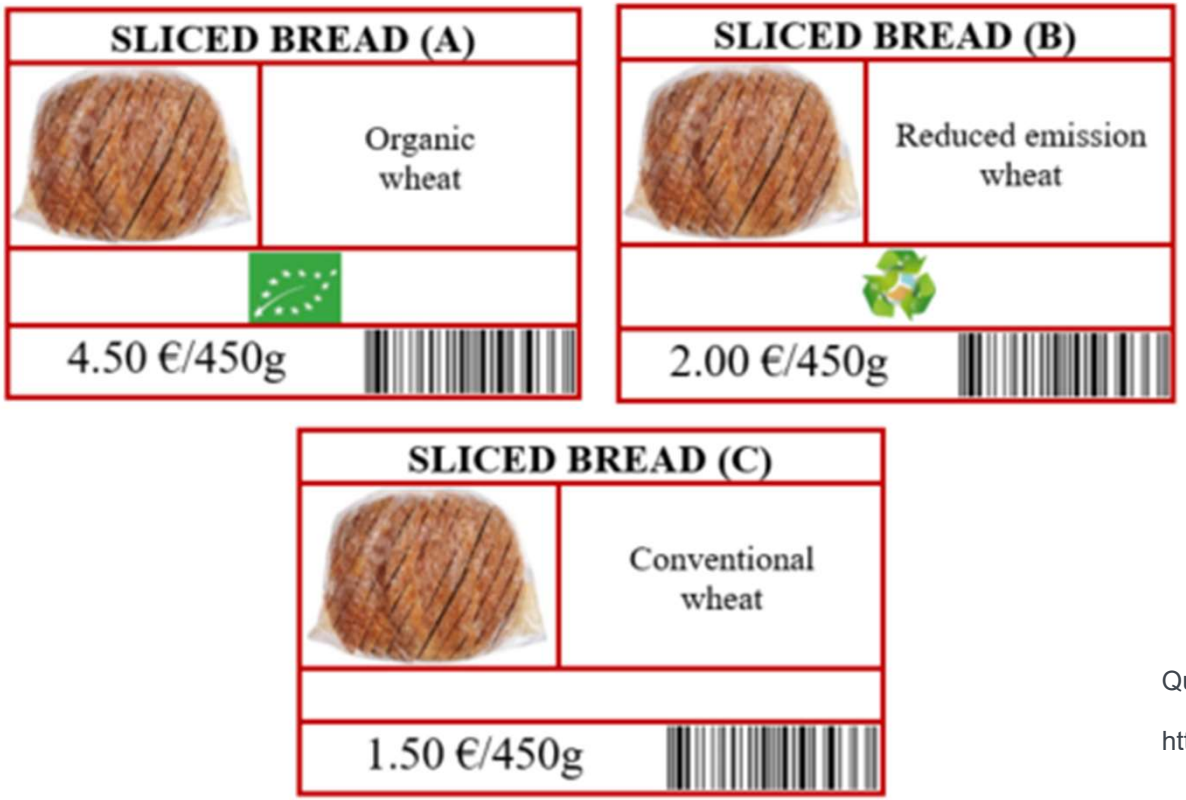
Discrete-Choice Experiment

Method:

- Discrete-Choice Experiments (DCE) are widely used in market and consumer research to evaluate the importance of specific product attributes for consumers purchase decision.
- Several products with differing attributes (brand, price, ...) are shown to the respondents, which have to choose the product they would buy.
- DCE have proven to be more reliable than direct questions regarding the importance of specific attributes for consumer choice. (Louviere et al. 2000, Hainmüller et al. 2015)
- DCE have been applied in energy related research to analyze e.g.
  - investments in energy technologies (Bergmann et al. 2006)
  - nuclear waste storage (Krütli et al. 2012)
  - wind power developers perspective on the effect of support policies (Präßler 2014)
  - ...

Discrete-Choice Experiment

A very simple example:

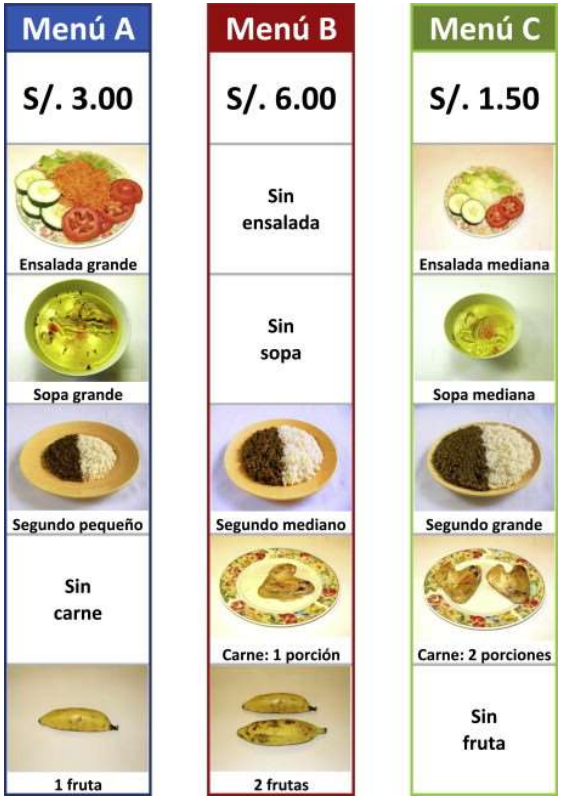


Quellle:

https://www.nutri2cycle.eu/

Discrete-Choice Experiment

A less simple example:



Quellle:

Buttorff et al. 2015

Discrete-Choice Experiment

	Policy A	Policy B	CURRENT policy
Landscape	 strong increment of bushes reduction of meadows and crops	 light decrement of bushes light increment of meadows and crops	 light increment of bushes meadows and crops are maintained
Bearded vulture	 7 pairs	 15 pairs	 11 pairs
Forest fires	 **6** forest fires per year	 **2** forest fires per year	 **4** forest fires per year
Product quality linked to territory	 **2** quality products available sheep cheese and lamb meat	 **6** quality products available sheep cheese, lamb meat, pasture pork meat, olive oil, pasture beef and organic lamb	 **4** quality products available sheep cheese, lamb meat, pasture pork meat and olive oil
Annual cost	 15 €	 75 €	 45 €
CHOICE	◯ A	◯ B	◯ C

Quelle:

Bernués et al. 2014

Discrete-Choice Experiment

Challenges:

- Complete Energy Scenarios are complex if-then statements defined by various assumptions and parameters
  - It is very time-consuming to understand and evaluate energy scenarios
- Specific energy technologies have many connotations and are in complex interaction with the energy system, society, and the environment
  - Direct ranking of preferred technologies might be biased and not reflect the respondents preference structures regarding the technologies impacts
- Life cycle assessment of technologies (per/kWh)

Paired Technologies

Auf einen Blick: Eigenschaften einer exemplarischen Windkraftanlage

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

Geld und Wirtschaft	
Die hier dargestellten Daten beziehen sich auf eine typische 2 MW Windkraftanlage, welche im Binnenland aufgestellt ist und eine Lebensdauer von 20 Jahren hat.	
Installierte Leistung in D:	*50.291 MW (2017)*
Erzeugungskosten:	9,7 Cent pro kWh Strom 345% · -55% · -72%
Beschäftigung durch Neuinstallation:	0, 0000141 Beschäftigte pro kWh -87% · 28% · 103%
Beschäftigung durch Betrieb und Wartung:	0, 00000037 Beschäftigte pro kWh -39% · 39% · 42%
Sicherheit	
Importe:	-Importunabhängig -Wertschöpfung kann zum Teil auch außerhalb Deutschlands liegen, z. B. wenn Anlagenteile importiert werden.
Systemanforderungen:	Keine gesicherte Leistung bei Windflauten; fluktuierende Einspeisung
Versorgungssicherheit:	7 von insgesamt 15 Punkten (Experteneinschätzung) -32% · 26%
Mensch und Umwelt	
Wirkungen auf den Klimawandel:	verursacht 5 g CO_2-Äquivalente pro kWh Strom 134% · -89%
Mineralischer und fossiler Ressourcenverbrauch:	bedarf 1,7 mg Antimon-Äquivalent (geologische Knappheit) pro kWh Strom 342% · -68% · -94%
Flächennutzung und Bodenqualität:	verursacht einen Verlust von 58 g organischer Substanz im Boden pro kWh Strom 549% · -81% · -99% Anmerkung: Flächen außerhalb des Fundaments können weiterhin landwirtschaftlich genutzt werden. Üblich ist ein Abstand von mind. 500 m zu Wohngebieten.
Einfluss auf menschliche Gesundheit:	verursacht 0,00037 CTUh pro kWh Strom (Humantoxizitätspotential) 135% · -93% · -98% Anmerkung: Nicht einbegriffen sind mögliche Lärmbelästigung und Schattenwurf in der unmittelbaren Umgebung
Weitere Aspekte	

→ Optischer Eingriff in die Landschaft durch hochragende Rotoren
→ Windpotenzial und Standortfindung: Identifikation und optimale Ausnutzung geeigneter Standorte
→ Windenergie steht oft in Konkurrenz zu Naturschutzinteressen

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%*

Paar A | *Paar B*

Choice of technologies

- Key Technologies with major impact on the energy system
- Covering Electricity and Heat

- Windpower
- Photovoltaics
- Geothermal plant
- Gas power plant
- Heat pump
- Power-to-gas
- Battery storage

Presenting paired-choices

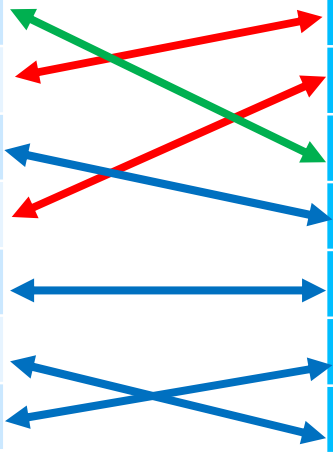
Beaking down complex information

- To convey a feeling that technologies are not single solutions, we presented 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 and access to the online experiment, and met in 6 focus groups.

Ranking of Technologies

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

Ranking calculated via discrete choice experiment		
1. Rank	1,41129032	Heat pump
2. Rank	0,66532258	Wind turb.
3. Rank	0,17741935	Geotherm.
4. Rank	-0,15053763	Photovoltaics
5. Rank	-0,74193548	Power-to-gas
6. Rank	-0,75806452	Natural gas
7. Rank	-0,88306452	Li - battery



Direct technology ranking from questionnaire		
1. Rank	5,92741935	Wind turb.
2. Rank	4,73387097	Photovoltaics
3. Rank	4,59677419	Heat pump
4. Rank	3,46774194	Geotherm.
5. Rank	3,33870968	Power-to-gas
6. Rank	3,03225806	Li - battery
7. Rank	2,90322581	Natural gas

→ 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.

Data Analysis

- 1.488 pairwise choices have been analyzed
- To account for unobserved heterogeneity and nested data a respective multinomial logit model has been applied (mixlogit, Hole 2007)
- Indicators have been normalized to enable direct comparison of coefficients within analyzed groups
- The utility U of a chosen alternative *j* for individual *n* on occasion *t* is given by:

$$U_{njt} = \beta'_n x_{njt} + \varepsilon_{njt}$$

Results

Table 1: Results Discrete-Choice Experiment

Group	**All**		**Students**		**Working**		**Retired**	
	β	$P > \|z\|$	β	$P > \|z\|$	β	$P > \|z\|$	β	$P > \|z\|$
Mean								
Costs	.0138	*.037*	.0209	*.213*	.0117	*.171*	.0835	*.037*
Security	.0229	*.000*	.0478	*.004*	.0177	*.010*	.0748	*.016*
Employment	.0137	*.006*	.0024	*.863*	.0111	*.097*	.0076	*.736*
Climate	.0581	*.000*	.0921	*.001*	.0530	*.000*	.0874	*.016*
Health	.0252	*.006*	.0363	*.073*	.0196	*.093*	.1021	*.054*
Landuse	.0189	*.000*	.0143	*.062*	.0176	*.000*	.0404	*.021*
Ressources	.0299	*.000*	.0298	*.199*	.0347	*.000*	-.0109	*.720*
SD								
Climate	.0322	*.000*	.0282	*.136*	.0275	*.000*	.1170	*.004*
Health	.0407	*.000*	.0146	*.291*	.0403	*.000*	.1174	*.003*
Landuse	.0141	*.000*	.0169	*.120*	.0144	*.003*	.0575	*.006*
Ressources	.0320	*.000*	.0522	*.005*	.0339	*.002*	.1107	*.001*
n	2,976		528		1,608		480	
$P > x^2$	.0000		.0036		.0000		.0000	

Why focus groups

- Focus groups help to gain deeper insight in the reasoning for their perception on sustainability than questionnaires. Benefit: Mutual understanding about terms can be checked – optimal for complex topics
- Participants get the information to read at home, in the group they get time to ask questions to really get on a sufficient level of knowledge to voice a robust opinion.
- Focus groups follow group dynamics – that has to be monitored by the moderation, but can be used.
- Listening to the reasoning behind given answers to questions give insight into underlying attitudes and crucial aspects about the energy transition.

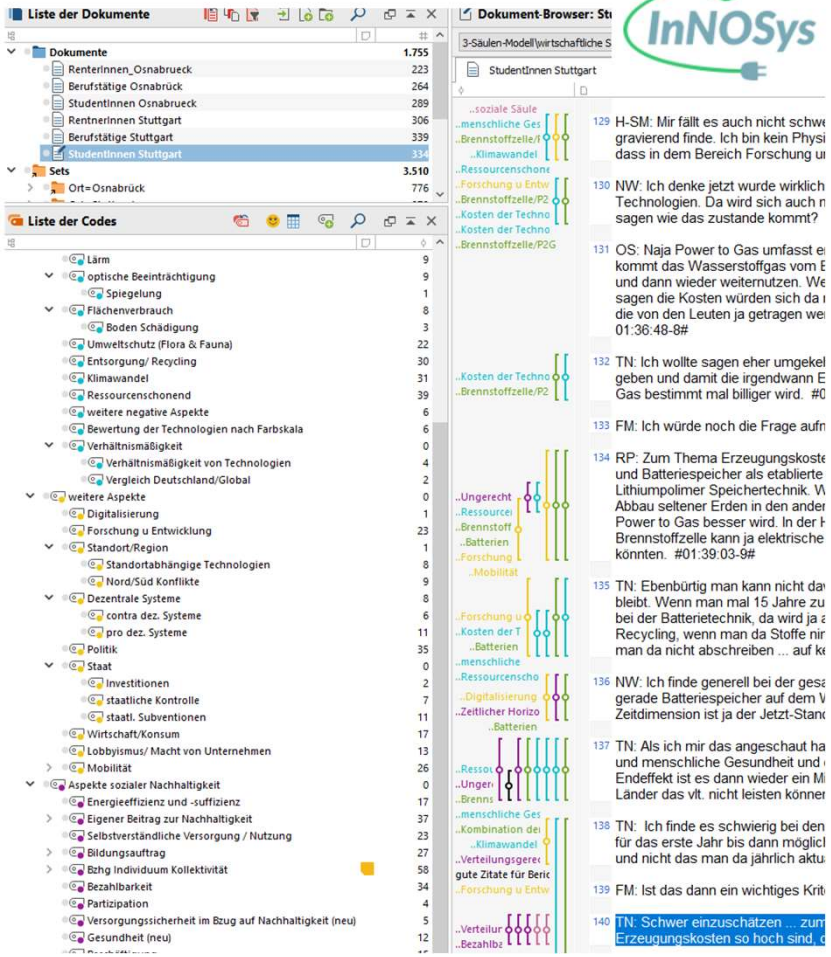
Qalitative analysis of focus groups
with Max QDA

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 reliability) mark the transcripts independently, then discus changes and adjustments to code base and unify code mapping.

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

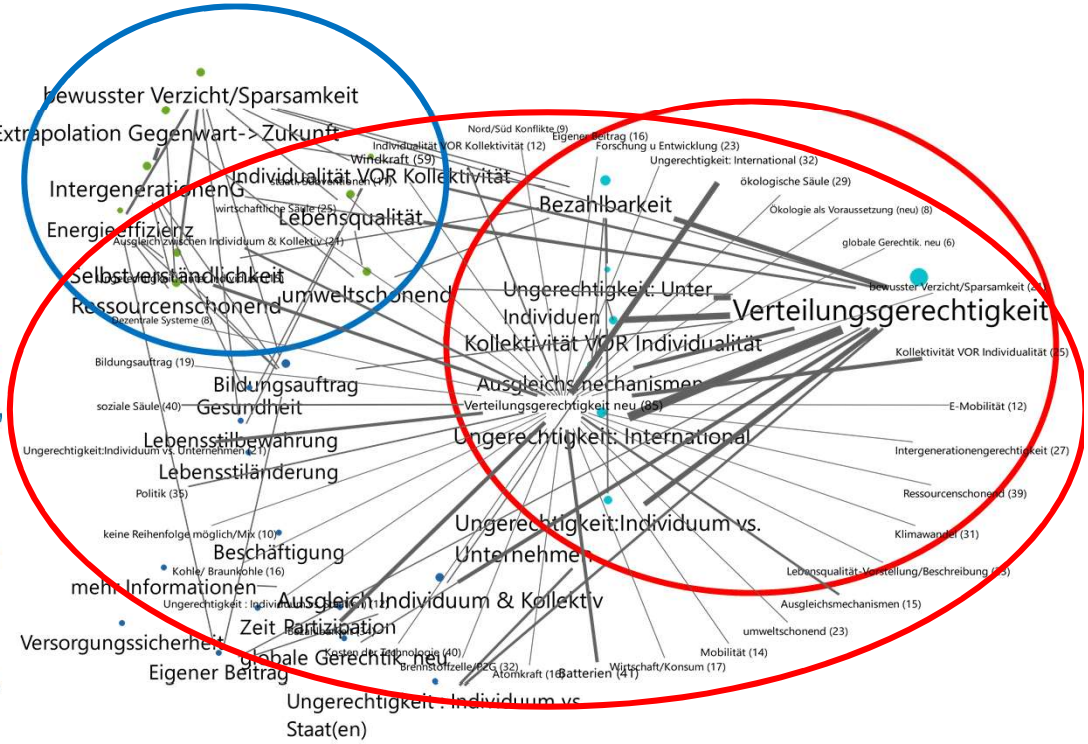


Qalitative analysis of focus groups

Main 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)

Qalitative analysis of focus groups

Comparison subsamples

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	Saving environment	20	Saving environment	16	Quality of life	16
4	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	Justice between generations	11	Employment	10
8	Mindfullness about energy	10	Quality of life	10	Education	10
9	Justice between generations	8	Mindfullness about energy	7	Equilibrating mechanisms	8

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

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

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

Qalitative analysis of focus groups

Important dimensions of social sustainability

Many arguments presented in the focus groups circle around distributional and intergenerational-justice as well as definitions of quality of life. It is necessary to fill these gaps in the database via more in-depth social science. We still need more information on the cleavages between:

- individualism & collectivism
- Attitudes towards lifestyle preservation & adaptation to new lifestyles in the climate chance

„Letztlich ist davon auch die gesamte Menschheit betroffen und nicht einzelne Leute, die ihren Job verlieren oder Probleme mit der Gesundheit haben sondern es geht ja darum uns alle zu retten“

#01:38:32-0

„Also da hört es für mich bei der Nachhaltigkeit dann irgendwann auf, wenn ich wieder alles andere mitfinanzieren muss.“

#01:42:17-0

Qalitative analysis of focus groups

Quotes from our participants

„Reicht vielleicht die ausreichende Lebensqualität, wo jeder sagt: »Okay, damit kann ich gut leben« vielleicht auch aus, um zu sagen, dass die nächsten 20 Generationen auf dieser Erde noch ein schönes Leben haben und nicht Dürresommer durchstehen müssen, wo es gefühlt monatelang 35°C sind und Ernten nicht mehr existieren.“

#01:10:55-6

„Ich kann auch nicht gutheißen, wenn mir jemand von außen suggeriert wie ich zu leben habe, wenn mir jemand etwas aufdrücken möchte, was überhaupt nicht zu meinem Lebensstil passt.“

#01:18:12-0

„Die Frage nach der Bedürftigkeit finde ich ganz gut. Man kann diese auch anders interpretieren. Unsere Bedürftigkeit müsste sein unsere Erde zu erhalten und kein Bedürfnis nach schneller, weiter, größer. Das muss in den Fokus gerückt werden.“

#01:15:04-0

„Das ist doch dann ein großer Rückschritt, wenn ich das Teil, das ich habe teilen soll. Man kann sparen aber ich muss mir nicht unbedingt das Auto mit 6 Leuten teilen z.B.“

#01:16:53-8

Summary:

- DCE are suited to rank the importance of different attributes for consumer choice
  - Respondents ranked climate change as most important for the sustainability of future energy systems
  - In contrast to the overall sample system costs and employment effects did not show significant effects on the choice of preferred technology pairs among students
  - Retired persons seem to attribute far more importance to health effects, security of supply and system costs than other groups.
- Distributive justice was the most discussed topic in all of the focus groups.
  - This topic was only captured with the indicator regional disparity by the numeric models. Thus, a crucial factor influencing the public acceptance of transformation pathways is a blind spot for current ESMs and economic models.

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Thank you!

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