Study Committee C3

POWER SYSTEM ENVIRONMENTAL PERFORMANCE

Paper 11101

Regional sustainability assessment of energy systems: integrating stakeholder perspectives and conditions on a regional scale

[1]Benjamin Kraus, [1]Johannes Gaiser, [1]Witold-Roger Poganietz, [2]Britta Buchholz

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Motivation

- A fundamental transition of the energy system with impacts on society and economy is necessary to reach climate goals
- The transition leads to a more decentralized energy system with diverse impacts for different regions

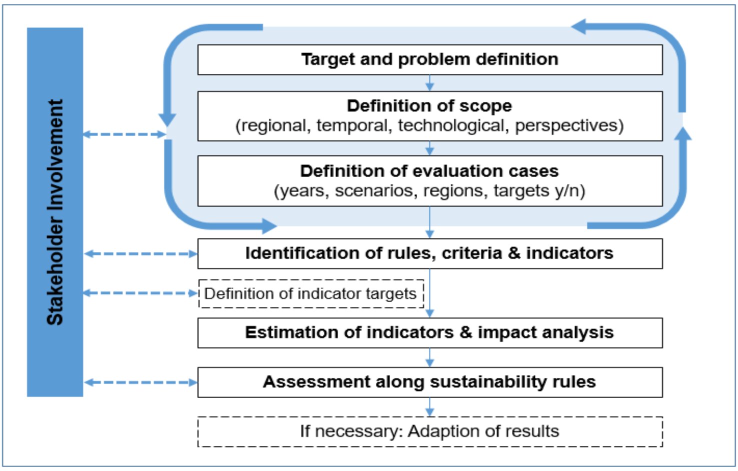
→ Avoiding regionally non-sustainable pathways; identifying local characteristics; increasing local acceptability

Method/Approach

- Holistic and prospective sustainability assessment using the Integrative Concept of Sustainability (ICoS) adapted to the regional context
- Following the claims of the Brundtland Commission ICoS integrates anthropocentrism with inter- and intragenerational justice on a global scale
- ICoS differs between three sustainability goals, with each contextualized by five rules:

Goals		
1. Securing human existence	**2. Maintaining society's productive potential**	**3. Preserving society's options for development and action**
Rules		
1.1 Protection of human health	2.1 Sustainable use of renewable resources	3.1 Equal access for all people to information, education, occupation
1.2 Ensuring satisfaction of basic needs	2.2 Sustainable use of non-renewable resources	3.2 Participation in societal decision-making processes
1.3 Autonomous subsistence based on own income	2.3 Sustainable use of the environment as a sink	3.3 Conservation of cultural heritage and cultural diversity
1.4 Just distribution of chances for using natural resources	2.4 Avoiding technical risks with potentially catastrophic impacts	3.4 Conservation of the cultural function of nature
1.5 Reduction of extreme income or wealth inequalities	2.5 Sustainable development of human-made, human and knowledge capital	3.5 Conservation of social re-sources (tolerance, solidarity, etc.)

- Conducting a regional sustainability assessment:



The authors gratefully acknowledge funding by the German Federal Ministry of Education and Research (BMBF) within the Kopernikus Project ENSURE 'New ENergy grid StructURes for the German Energiewende'.

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Object of investigation

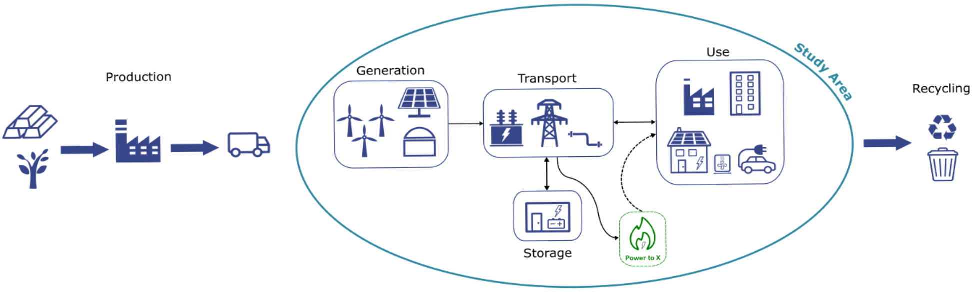
Assessment of the energy system in the district of Steinburg using four regional energy scenarios for 2050:

a) Scenario A ‘Reference scenario’ assumes a greenhouse gas emission reduction target of ca. 85 % by 2050 compared to 1990

b) Scenario B ‘Ambitious climate protection’ aims to keep an increase in average global temperatures compared to the pre-industrial era to well below 2°C, in line with the Paris Climate Agreement. This will result in net-zero emissions by 2050 at the latest

c) Scenario C ‘Europe’ assumes climate neutrality by 2050 through integration into the European transition. Electricity is primarily provided at optimal locations across Europe

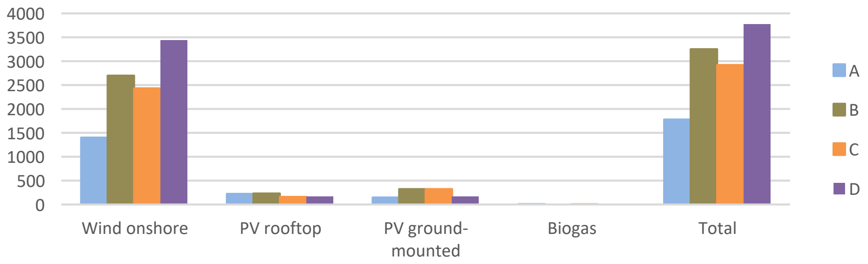
d) Scenario D ‘Decentralized’ suggests climate neutrality until 2050 by a more load-related energy provision. Sites for generating electricity are as close as possible to the (domestic) consumers



Experimental setup

- Input data from scenario calculation, for example:

Electricity generation in Steinburg 2050



- Stakeholder involvement in three workshops with representatives from local public administration, non-governmental organizations and companies
- Identification of 18 criteria represented by one indicator each to assess regional sustainability
- Differentiation between local and global impacts, since the region is involved in supra-regional processes and cannot be investigated in isolation
- Indicator calculation using Life Cycle Assessment (LCA), Input-Output Tables (IOT) and other methods

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(Preliminary) results & discussion

The indicator-results were translated into scores ranging from '0' for the worst performing scenario to '1' for the best performing. This means, that the scores can only be interpreted line by line because the values of two different indicators cannot be compared.

The results show, that no scenario dominates all the other ones. Overall assessment depends on regional preferences:

a) Scenario A 'Reference scenario' scores worst for 10 of 18 indicators. It has disadvantages in terms of global impacts and regional ones that are not immediately perceptible for residents. On the other hand, there are low direct impacts through local infrastructures

b) Scenario B 'Ambitious climate protection' performs well or very well for most indicators. The most relevant challenge is the increasing land use competition

c) Scenario C 'Europe' shows a slightly worse result compared to Scenario B for most indicators. It has disadvantages in direct land use

d) Scenario D 'Decentralized' performs often either best or worst. The decentralized design increases the land use competition as well as locally relevant impacts, like landscape, noise and light. On the other hand, some locally relevant aspects such as value added and participation score better than in the other scenarios.

	Indicator	Scores			
		A	B	C	D
1	**Particulate matter** *[kg PM2.5]*	0,00	0,89	0,95	1,00
2	**Noise & light emissions** *[number of windturbines; noisy vehicle kilometres]*	1,00	0,79	0,46	0,00
3	**Greenhouse gas emissions** *[t CO_2 eq.]*	0,00	1,00	0,84	0,87
4	**Land use** *[ha direct land use]*	0,95	0,17	0,00	1,00
5	**Resource consumption** *[kg Sb eq.]*	0,50	1,00	0,65	0,00
6	**Cumulative fossil energy expenditure** *[MJ eq.]*	0,00	1,00	0,81	0,95
7	**Eutrophication** *[kg PO eq.]*	0,00	0,90	0,79	1,00
8	**Acidification** *[kg SO_2 eq.]*	0,00	1,00	0,51	0,37
9	**Employment effects** *[full-time equivalents]*	0,00	1,00	0,55	0,11
10	**Regional value added** *[€ Gross value added]*	0,00	0,84	0,61	1,00
11	**Energy poverty** *[€]*	0,35	1,00	0,52	0,00
12	**Energy import dependency** *[% import ratio]*	0,47	0,91	1,00	0,00
13	**Conflict of use with food production** *[ha land use for energy crops]*	0,04	0,31	0,00	1,00
14	**Final energy consumption of private households** *[kWh / person]*	0,00	1,00	0,19	0,19
15	**Procedural participation** *[qualitative]*	0,00	1,00	0,50	1,00
16	**Financial participation** *[semiquantitative]*	0,00	0,95	0,73	1,00
17	**Landscape** *[ha indirect land use]*	1,00	0,31	0,44	0,00
18	**Human rights** *[semiquantitative]*	0,5	0,5	0,5	0,5

Conclusion & next steps

- Regional sustainability assessment can provide a well-founded basis for decision-making for regional actors. But the actors scope of action must be considered
- The method can be used on different regions and case studies if data availability is sufficient
- Stakeholder involvement offers valuable insights in regional characteristics and supports the identification of relevant criteria
- Differing between local and global impacts provides a more comprehensive picture preventing in neglecting important aspects, e.g. the embeddedness of the region in national and global developments
- A comprehensive assessment demands the recognition of local preferences, which will be done in the next step

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