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Chances and limits of multi-objective optimization when siting renewable energies considering the ‚Sustainable Development Goals' (SDGs)

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Motivation

In the process of **securing land for renewable energies** areas have been excluded through consistent negative planning (e.g. buffers to settlements, excluding landscape protection areas). However, this also led to discussions about the remaining areas and **whether energy and climate policy goals can be achieved** in the future. In the case of onshore wind turbines (WT) in particular, **trade-offs** with nature conservation, forest protection and emission control, for example, have not only led to long procedural times, but also to a sharp decline in the construction of new WT and the replacement of WT of previous generations, both of which are necessary from a climate protection and energy security point of view.

- The aim of the PhD project is to explore a solution model that supports decision makers and stakeholders in a **multi-criteria planning approach** to identify **sufficient areas** for the energy transition, which currently fail due to a ‚wicked problem' - i.e. the **negotiation and balancing of sustainability trade-offs** - in the course of predominantly negative planning.
- For this purpose, **ecological, economic and social effects** are to be considered in the search for locations for wind energy and ground-mounted photovoltaics (referring to the SDGs), thus also allowing for potential welfare effects.
- In particular, the project discusses how **a multi-criteria (sustainability) planning** approach can better support **‚positive planning'**, i.e. if the achievement of concrete, regionalized and cumulative development targets for renewable energies is just as ‚fair' as excluding planning criteria.

Approach

Cumulative dissertation (2021-2023):

- Can area-wide positive planning approaches allow for a swifter target orientation in developing wind energy? **(Fig.1 – No. 1)**
- Can MCDA serve ex post to indicate winners and losers in sustainability dilemmas? A case study of marine spatial planning in Germany **(Fig.2 – No. 2)**
- Is there room for two? - A multi-criteria scenario framework to model the energy-species-land nexus footprint for regional renewable energy planning **(Fig.3 – No. 3)**
- Gridlock in compromise, or is multi target optimization in planning renewable energies possible? A stakeholder case study using scenario-MCDA (in preparation) **(No. 4)**

1

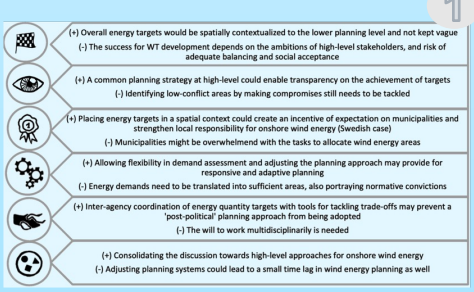
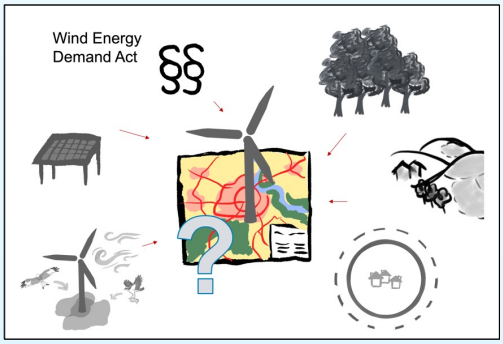


Fig.1: Can area-wide positive planning approaches allow for a swifter target orientation in developing wind energy?

- Chances and limits of positive planning approaches (case study of onshore wind energy planning in Sweden, and offshore wind energy in the German Exclusive Economic Zone (EEZ))
- Positive planning refers to a target-oriented adaptation, when regionalized development targets are addressed as 'fairly' as restrictive specifications, the steering impetus evolves by met targets



Multi-Criteria Decision Making (MCDA)

Ex ante MCDA
- ❖ Support for decision-making, generating information and transparency using (inter- and transdisciplinary) multiple criteria, aggregation and criteria ranking techniques

Ex post MCDA
- ❖ Tracing back decision making, understanding dynamics, learning for future planning using (inter- and transdisciplinary) multiple criteria, aggregation and criteria ranking techniques

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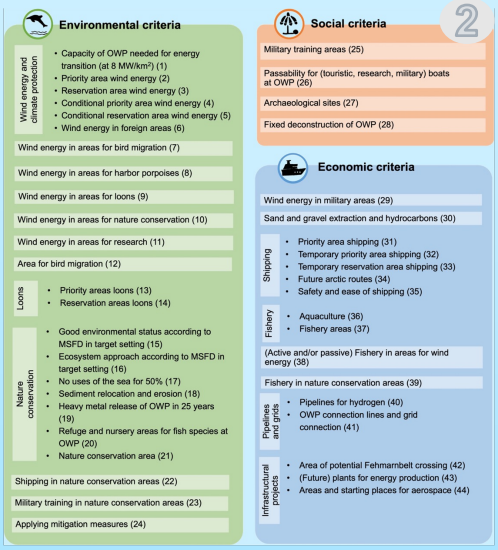

Fig.2: Can MCDA serve ex post to indicate winners and losers in sustainability dilemmas? A case study of marine spatial planning in Germany*

- Sustainability criteria shifted in weights in the spur of moment during planning stages, with nature conservation goals apparently being deferred in the process
- Ex post MCDA might allow for reviewing the potential policy dynamics of planning processes, learning for future processes

*OWP = Offshore Wind Parks

Conclusions (preliminary)

- Frequent planning approaches may not give equal weight to climate protection and renewable energy concerns at lower planning levels (‚negative planning') (No. 1)
- Planning might also be understood as executing official decision-making, meaning that a transparent planning process that is open to change may become increasingly important for democratic planning decisions (No. 2)
- Multi-criteria scenarios allow quantification of objectives/criteria and transparent negotiation (democratic planning mandate) (No. 2, 3)
- Multi-objective optimization involves combining scenarios and adjusting levers, i.e criteria, to minimize impacts on protected areas from all sides (No. 3)

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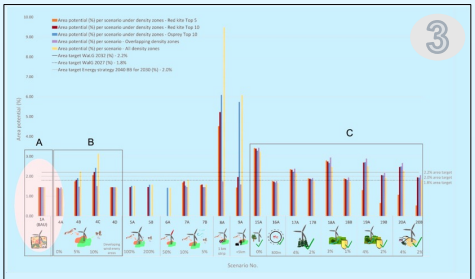

Fig.3: Is there room for two? - A multi-criteria scenario framework to model the energy-species-land nexus footprint for regional renewable energy planning

- Where should wind energy be sited; which land uses/objectives/criteria should be prioritized, or set back?
- Is wind energy needed in forests to meet the wind energy spatial targets of the Wind Energy Demand Act, for example?
- What would be the 'least intrusive' approach to wind energy development?

Next steps: Gridlock in compromise?

4

Is an added value of multi-criteria planning tools recognized in practice?

Are there boundaries between siloed institutions, i.e. is multi-objective optimization possible?

Contact

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References

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2. Weber, J.; Köppel, J. Can MCDA Serve Ex-Post to Indicate 'Winners and Losers' in Sustainability Dilemmas? A Case Study of Marine Spatial Planning in Germany. *Energies* 2022, *15*, 7654. https://doi.org/10.3390/en15207654
3. Weber, J., Steinkamp, T., Reichenbach, M., 2023. Competing for space? - A multi-criteria scenario framework to model the energy-biodiversity-land nexus for regional renewable energy planning on a German case: Preprint. https://www.researchsquare.com/article/rs-2599221/v1