MODELLING RENEWABLE ENERGY ISLANDS

AND THE BENEFITS FOR ENERGY PLANNING

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The photo on the cover page shows the German island Föhr – taken by the author born there – as seen from the ferry on a visit half way through the PhD research.

SUMMARY

This PhD thesis, titled 'Modelling Renewable Energy Islands', investigates the role of islands and their models in sustainable energy planning. Resulting from the Paris Agreement, the fight against climate change can be addressed through the uptake of renewable energy sources in a sustainable way by including environmental, social and economic aspects. In order to align this with the decentralisation of the energy supply, islands are to be investigated accordingly as part of global or national energy planning under consideration of their potentials and limitations. While this can be approached through models, exploring island settings and demonstration potentials, further understanding and inclusion of local island energy system aspects are needed. The PhD thesis addresses this under the two-folded perspective of using islands for energy planning as well as islands actively contributing to it. The resulting research questions are addressed throughout the thesis accordingly:

What role can modelling renewable energy islands have in sustainable energy planning?

1. How can modelling *of* islands be used to evaluate renewable energy technologies?
2. Why and how should modelling *on* islands be improved by considering and comparing local conditions?
3. How can contextual and institutional alignment elaborate modelling *from* islands?

In order to answer the research questions, a framework of concepts, theories and methods is defined to guide the following analysis and present the related PhD publications. Thereby, the PhD research is put into conceptual perspectives regarding energy on islands, presenting their potentially significant role in sustainable energy planning. Before the theory of modelling is discussed, two theoretical frameworks are presented to illustrate this role, leading to the methodological framework of the publications made during the PhD research and the analysis of the PhD thesis. In order to answer the research questions, the application of energy system analysis and case studies are further presented, whereby the influence of the modelling tool EnergyPLAN and the case study islands of Samsø, Orkney and Madeira are introduced.

The sub-research questions build on top of one another and are answered in three main sections discussing the different perspectives by emphasising the modelling *of* islands, modelling *on* islands, and the perspectives gained through modelling *from* islands. The sections conclude that modelling in sustainable energy planning should be done *with* islands. These perspectives are supported by the PhD publications, which highlight the role of islands in evaluating renewable energy technology by providing suitable test settings, while also underlining the need for improvements. This is

addressed through the inclusion of local perspectives and the consideration and comparison of local conditions on islands. The further alignment with local contexts and institutions, as well as the knowledge to be gained from islands, concludes the various roles of islands and modelling in energy planning.

On reflection, islands present a variety of contributions, which – combined – benefit not only energy planners but also islanders. This is underlined by the discussion of islands in transition theory by assisting innovation at the niche level, contributing to the regime and landscape levels if supported and aligned properly. Furthermore, multi-level governance highlights the potentials from hybrid vertical and horizontal coordination across geographical and governance levels.

In conclusion, modelling renewable energy islands contributes to the understanding and development of sustainable energy planning. This is achieved through coordination and collaboration with islands, acknowledging their quantitative and qualitative inputs, the recognition of island mode and innovation potentials, and the consideration of the limitations. The resulting understanding of islands as lighthouses – despite or due to being on the edge – supports not only energy planners and islanders but also, in turn, the energy transition and the Paris Agreement.