Lessons from Modeling 100% Renewable Scenarios Using GENeSYS-MOD

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Executive summary

1. Motivations underlying the research and a short account of the research performed

The main aim of models has never been to provide numbers, but insights (Huntington, Weyant, and Sweeney 1982) – still challenges prevail for modelers to use the best configuration of their models to actually provide helpful insights. This becomes even more complicated due to increasing complexity of the energy system transition through the potential and need for sector coupling as well as rising international connections. When the first scenarios with 100% renewable energy supply were published, back in the 2000 years, they were generally considered as "out-of-the-box" thinking, if not completely utopic. By the end of 2019, however, there are now numerous studies, which elaborate 100% renewable energy scenarios using different models. This paper showcases specific characteristics and challenges for energy system modelling of 100% renewable scenarios. The findings are based on various applications and modifications of the framework Global Energy System Model (GENeSYS-MOD) examining different regional characteristics for high renewable configurations in the world, China, India, South-Africa, Mexico, Europe, Germany, and Colombia. GENeSYS-MOD is based on the well-established Open Source Energy Modelling System (OSeMOSYS), an open-source software for long-term energy system analyses. The paper elaborates on our experiences of the last years of choosing the best, yet still computable, configuration of GENeSYS-MOD (section 2) with respect to spatial (section 3) and temporal resolution (section 4) as well as sufficient detailed description of the energy system transition effects (section 5) and result interpretation (section 6). The aim of this

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paper is therefore twofold, to better understand and interpret existing models as well as to improve future modeling exercises.

2. Main conclusions and policy implications of the work

This paper underlines the importance of a fast renewable application to slow down global warming and to prevent a climate catastrophe. This transition, at the same time, goes along with the possibility of creating millions of new jobs and providing electricity access to many regions in the world. Relying on the existing mathematical models to calculate such optimal configurations of more sustainable pathways and technology choices, however, goes along with several model(er)'s biases, elaborated in more detail in the paper. Being aware of these model(er)'s biases can help to improve future modeling work allowing for a better interpretation of the still helpful insights that energy system models can provide. Even though many uncertainties of the future energy system prevail and regional challenges differ a lot; still some general no regret options can be identified from our experiences: i) Reduce energy demand through the enhancement of behavioral changes as well as technological improvements such as efficiency gains; ii) Investment in renewables enables the energy system transition and provides numerous job opportunities for people around the globe; iii) Avoid additional investments in fossil fuel infrastructure (i.a. mines, oil riggs, harbor terminals, gas pipelines) which might otherwise create lock-in effects as well as potential sunk investments – by 2020, no new infrastructure should be constructed which is not compatible with a zero carbon society; and iv) Weaken the fossil fuel regime and support alternative actors to ease a faster transition to more sustainable energy forms.

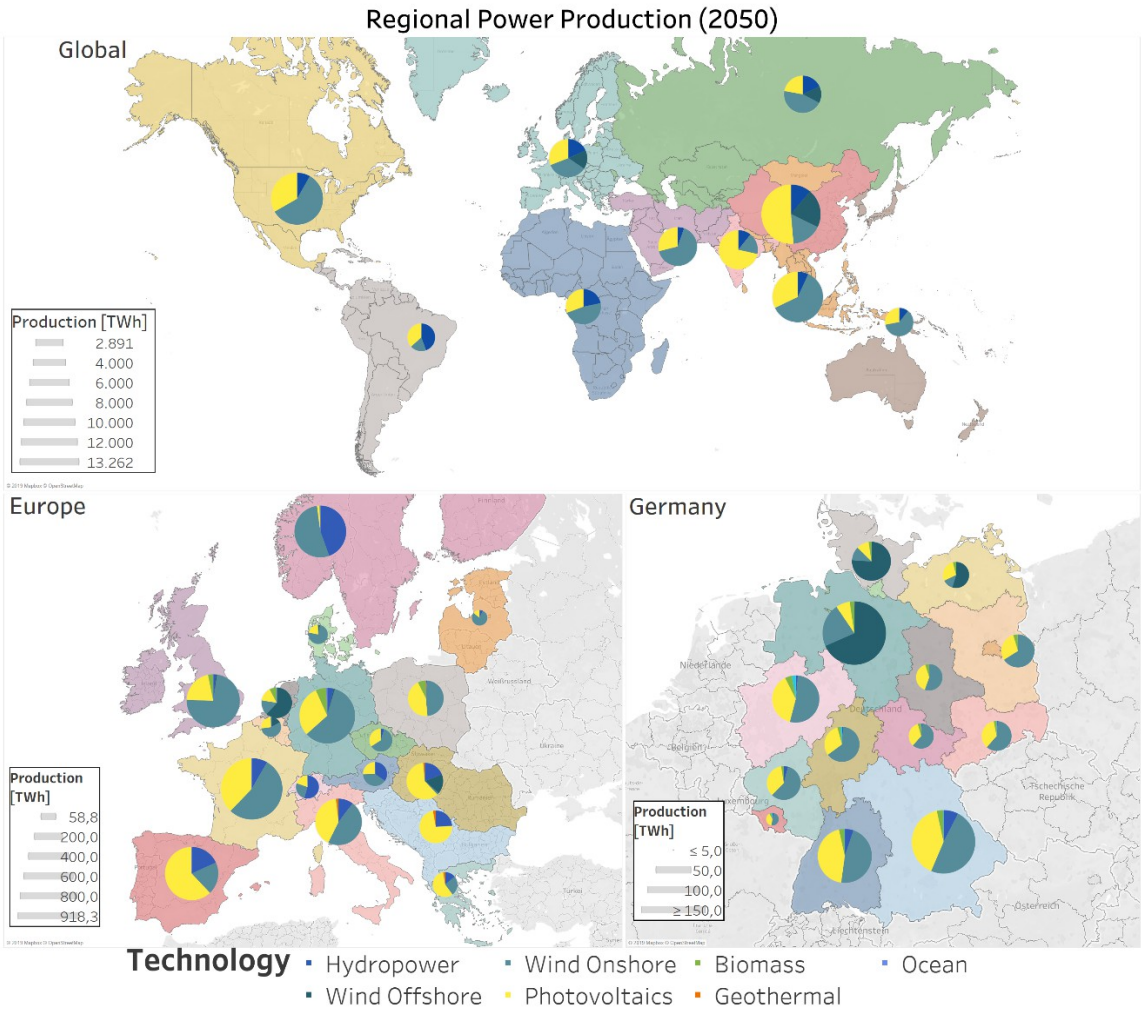

Figure : Scaling down 100% Renewable scenarios - for the World, Europe and Germany.
Source: Own illustration based on several own previous works.