A COMPREHENSIVE ANALYSIS OF AUSTRIA'S TRANSFORMATION TOWARDS 100% RENWABLE ELECTRICTY BY 2030

Claudia Kettner, Austrian Institute of Economic Research (WIFO), +43 1 798 26 01 406, claudia.kettner@wifo.at
Michael Böheim, Austrian Institute of Economic Research (WIFO), +43 1 798 26 01 227, michael.boeheim@wifo.at
Mark Sommer, Austrian Institute of Economic Research (WIFO), +43 1 798 26 01 226, mark.sommer@wifo.at
Udo Bachhiesl, Graz University of Technology, +43 316 873 7903, bachhiesl@tugraz.at
Robert Gaugl, Graz University of Technology, +43 316 873 7904, robert.gaugl@tugraz.at
Lia Gruber, Graz University of Technology, +43 316 873 7909, lia.gruber@tugraz.at
Thomas Florian Klatzer, Graz University of Technology, +43 316 873 7908, thomas.klatzer@tugraz.at
Sonja Wogrin, Graz University of Technology, +43 316 873 7900, wogrin@tugraz.at
Kurt Kratena, Centre of Economic Scenario Analysis and Research (CESAR), kurt.kratena@cesarecon.at

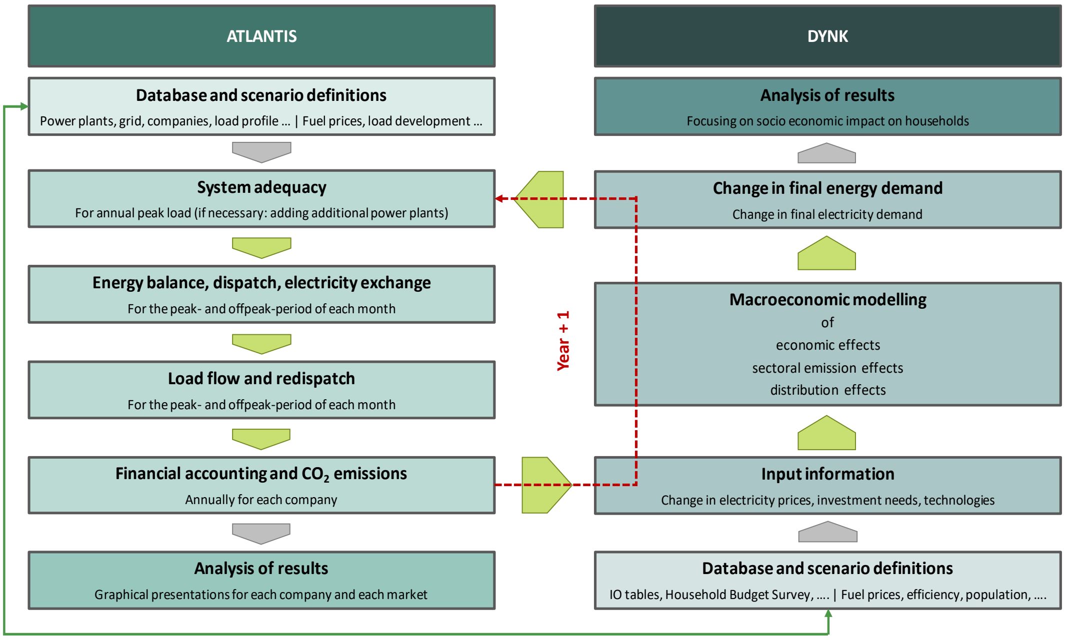
Overview

To mitigate the climate crisis ambitious emission reductions and respectively rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings) as well as industrial systems that are unprecedented in terms of scale are required. In the wide portfolio of mitigation options renewable energy sources will play a key role in delivering the aspired emission reductions, together with efficiency improvements and changes in lifestyles. The Austrian government has stipulated a goal of 100% renewable electricity (RES-E) supply in Austria by 2030. As of 2020, RES-E held a share of 78% in total electricity generation in Austria. Bridging the gap to the 100% target over the next years will nevertheless require fundamental changes in the Austrian electricity system entailing considerable investment. The economic and social impacts of these investments will be far-reaching and might vary substantially depending on which technology mix will ultimately be implemented. In this paper we provide comprehensive analyses of the economic incidence and social impacts of a transition to a 100% RES-E system in Austria by 2030.

Methods

To model the transformation towards 100% renewable electricity generation in Austria, the models DYNK (Kirchner et al. 2019) and ATLANTIS (Stigler et al. 2016) are linked.
The econometric model DYNK (Dynamic New Keynesian) will be applied for the macroeconomic simulations. As a hybrid between a classic Input-Output model and a computational general equilibrium model it accounts for institutional rigidities (e.g. liquidity constrains by consumers, wage bargaining, imperfect competition). DYNK integrates a detailed consumption and income distribution block for private households, developments in energy economics and demand system theory. The production module has been elaborated concerning interfuel substitution and the link to physical energy flows. A labour market module and the public sector are included as well. DYNK also comprises specific modules of energy demand for both industry sectors and private households, which, i.a., includes explicit demand for mobility and vehicles. Further modules considering household income and investments are available.
The techno-economic model ATLANTIS of the Continental European electricity sector is used to analyse changes in the electricity system. The database of the model contains all necessary elements of the physical and economic systems. On the physical side, the model includes the transmission network at various voltage levels, existing power plants and power plant projects of various types, as well as a geographically referenced energy consumption divided up over nodes. The economic side includes over 100 electricity companies for which an annual profit and loss account as well as balance record is calculated. Electricity trading is covered by two models: The zonal price market model, which implements implicit Europe-wide market coupling between countries based on net transfer capacities (NTC) and the redispatch model which uses a DC-optimised power flow (DC-OPF) algorithm.
For the linking, both models have been adapted and expanded. In DYNK, the energy sector has been disaggregated into electricity generation & supply, gas supply and heat & steam generation and supply. In order to transfer the switch between technologies simulated in ATLANTIS to DYNK, moreover the electricity sector is split up into different generation technologies. For this purpose, specific technology and cost data for the different generation technologies (investment, costs of operation, fuel, emissions, labour and investment related) as well as the electricity output price from the ATLANTIS model results are used. Figure 1 sketches the exchange of data between the two models. DYNK will provide changes in final energy demand of electricity to ATLANTIS. ATLANTIS will model which technology mix is used to meet the demand, and calculate investment needs and changes in the electricity price. Together with the changes in the technology mix, these parameters will be fed back into the macroeconomic model. This process is repeated until convergence is achieved.

Figure 1. Flow chart of the simulations with the combined model system



Results

Four policy scenarios will be analysed to depict the broad range of potential effects associated with the transformation. The scenarios hence depict a range of different futures but share one key assumption, i.e. that the share of 100% RES-E in Austria is achieved in 2030. With respect to the demand side, one pathway assumes a conservative development of energy efficiency while the other assumes ambitious energy efficiency improvements. With respect to the supply side, one pathway depicts the additional RES-E capacity as envisaged by the Austrian Renewable Expansion Act, while the other aims at illustrating a cost optimal RES-E mix. Combining the demand and supply side yields a matrix of four scenarios to be simulated. The scenarios for Austria are integrated in a consistent scenario of the development of the European electricity system and were specified in close co-operation with relevant stakeholders. The model simulations are currently work in progress. By the time of the IAEE conference, they will deliver insights in terms of the emission impact as well as regarding the macroeconomic and distributional effects of the RES-E scenarios. The model analysis will show how vulnerable different household types are in the context of the changing economic environment, in terms of e.g. decreasing consumption or reduced employment opportunities. In addition, the aggregate economic effects (i.e. changes in GDP, value added, and employment) as well as changes in energy flows and GHG emissions until 2030 will be reported. Moreover, the additional investments for the resulting power plant park and the necessary electricity grid expansions are calculated as well as the changes in electricity price and the energy generation per power plant type. Furthermore, we conduct sensitivity analysis by altering the most important parameters (as energy prices).

Conclusions

We will derive policy recommendations for designing the transformation towards a 100% renewables target for the Austrian electricity system based on the model analysis and a literature review. Emphasis will be put on the social dimension of the transition, i.e. on how low-income households will be affected by the transformation and how potential regressive effects can be mitigated.

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References

Kirchner M. et al. (2019). CO_2 taxes, equity and the double dividend – Macroeconomic model simulations for Austria, *Energy Policy* 126, 295–314.

Stigler H. et al. (2016). ATLANTIS: techno-economic model of the European electricity sector. *Central European Journal of Operations Research* 24(4), 965–988