ANALYSING THE IMPACTS OF AN EXTERNAL POWER SUPPLIER IN A RENEWABLE ENERGY COMMUNITY

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Motivation

In 2019, the European Commission adopted a comprehensive package of measures to pursue the transformation of the European energy supply system considering both the Paris Agreement of 2015 as well as the decarbonization (or defossilization) of the European economic system by 2050. [1] Based on that, the Austrian government adopted the Renewable Energy Expansion Act (REEA) in 2021 with the goal declared therein to convert Austria's electricity supply to 100% electricity (on balance) from renewable energy sources by 2030 [2]. The REEA significantly expanded the options of joint usage of power plants by several parties in the same building and made the model of establishing energy communities legally possible. This new model basically created the option for associations of people to produce, store, consume and sell energy across property boundaries. In this legal basis, the implementation of a spatially limited renewable energy community (REC) is made possible. [3] This article analyses in detail the financial and ecological effects of taking an external power supplier in a spatially limited REC in Austria into account, in which only renewable electricity is exchanged. [4,5]

Methodological approach

A new techno-economic analysis tool that was being developed enables the simulation and analysis of different REC constellations and scenarios. Within that analytical tool, a basic distinction is made between "consumer", "prosumer" and "power supplier", each of which has different characteristics. Consumers are typical consumers (e.g., households, businesses), while prosumers can additionally have both an electricity production system (e.g., PV), and a battery storage system. A power supplier, on the other hand, only feeds electrical energy into the REC with their production systems (e.g., PV, wind, biogas, small hydropower). Key input parameters include both, technical aspects (e.g., demand and production profiles [6], storage capacity) as well as economic aspects (e.g., discount rate, inflation, electricity prices) supplemented by a CO_2 emission factor of electricity production to estimate the ecological effects. A dynamic distribution model determines which member receives how much electricity from the REC at each point in time during a year. Based on this, a profitability analysis of the REC is carried out using the net present value (NPV) method considering a period of 25 years. The NPV_m of a member m in a REC is defined as follows

$$NPV_m = I + \sum_{i=1}^{n} \frac{(E_i - A_i)}{(1+d)^i}$$

with investments I, annual revenues E and expenses A, a discount rate d, a point in time i (in years) and the duration n (in years). The revenues also include all indirect revenues in the form of auxiliary power consumption (e.g., for prosumers) as well as a distribution of the profit generated by the REC among its members. Furthermore, the effects of the technical wear and tear of the PV systems and the storage systems are considered by means of a simple approximate calculation.

Results

The REC under consideration comprises a total of 30 members distributed among 22 households, six businesses (three general commerces, two shops/hairdressers and one bakery) and two prosumers (one general commerce and another bakery). As mentioned above, these members have different

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synthesized profiles for both demand and production assigned, the choice of which has a significant effect on the simulation results. The consideration of an external power supplier with an annual production of 30.000 kWh proves to be beneficial to the REC but also to the power supplier [7]. On that basis, Figure 1 depicts the effects if such an external power supplier would switch from a fluctuating production plant (E1) to a constant band production plant (E0) assuming the same initial investment. All households and all prosumers in this REC under consideration would not only financially benefit, but would also reduce their CO_2 emissions as well as increase their level of autarky (not depicted). A sensitivity analysis in Figure 2 highlights the impacts of variations in selected key parameters (e.g., discount rate, electricity prices, feed-in renumerations, production capacity) on the financial result of the REC. Furthermore, the REC renumeration causes financial redistribution effects within the REC.

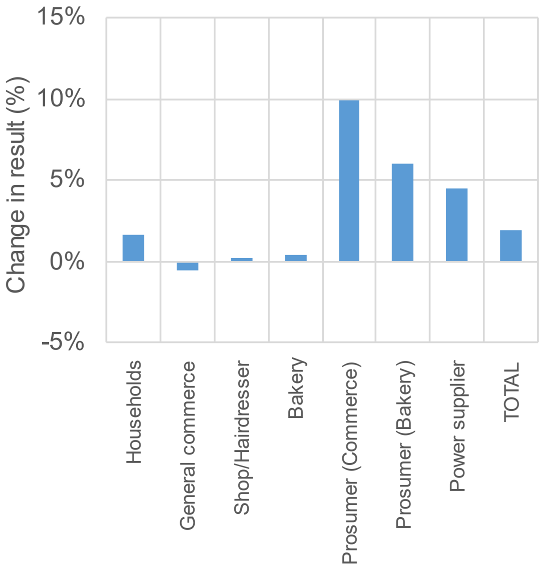

Figure 1: Financial effects with an external power supplier switching its load profile from fluctuating production E1 to constant band production E0 (own illustration)

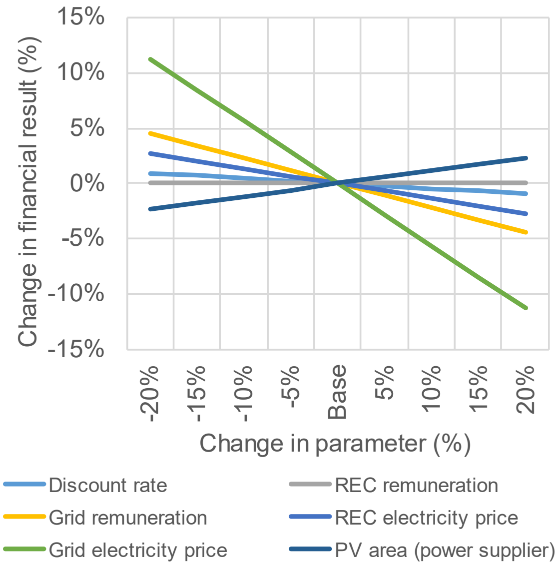

Figure 2: Sensitivity analysis for selected key parameters with respect to the financial result of the REC with an external power supplier having a fluctuating load profile E1 (own illustration)

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