

The energy community and the grid*

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1 Overview

Community-based solutions are a private approach to correct various market failures and ease energy transition. In the energy sector, compared to decentralized investments from individual consumers into renewable energy sources, energy communities can leverage additional renewable production capacities, closer to the place of consumption, and in areas where it is complicated otherwise. Think, for instance, on the rooftop of an apartment building shared by multiple households. More generally, the idea is that citizens, firms and organizations, located in the same neighborhood form a community and invest collectively in renewable production units like wind or solar and storage facilities. And, the energy that the community produces locally can be shared and collectively self-consumed by the members. The idea is that the community sells the energy self-consumed at a discounted price compared to commercial retailers, bringing benefits to the members and, under conditions, to the energy system as a whole. Local exchanges inside the community take place on the public grid and, to facilitate energy sharing, an appropriate regulatory framework for collective self-consumption should be designed. This paper addresses these two questions: the community's efficiency and the appropriate regulatory framework for power exchanges.

2 Methods

We provide an economic model of the integration of renewable energy communities in an energy system composed of consumers, energy producers and retailers and a regulated grid network connecting together all the agents. The community invests in production and storage and sells the energy to its members and the surplus to the market. Our model discusses the conditions for a community to be feasible and compares these conditions with those for welfare maximization to identify the circumstances under which the two coincide. Our model also analyzes

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the internal organization of the community to identify the prices prevailing for the exchanges taking place within the community.

3 Results

Our analysis provides the following takeaways. First, we highlight when renewable energy communities are welfare-improving. The critical conditions to be respected relate to a minimum amount of self-consumption inside the community. As the energy produced by the community is consumed at the place of production, it is a cheaper solution than transporting it from a traditional retailer to consumers and this can be beneficial for the energy system as a whole. Second, we show that, if consumers pay the true cost of the centrally produced electricity (that is the retail market is competitive and a carbon tax equal to the value of the emissions it produces is implemented and grid tariffs reflect costs), only renewable energy communities that increase welfare are feasible. Importantly, this result is independent of how the electricity is priced and shared inside the community. Hence, in this context, decentralized, community-based solutions can be a suitable approach to boost the deployment of renewable energy sources. In addition, we also show that there is a subset of welfare-improving grid tariffs that have a non-negative impact on non-members of the community, henceforth limiting distributional issues that could *in fine* impair the social acceptability of renewable energy communities. Third, we show that irrespective of how the energy surplus is shared among the community, various entry tickets into the energy community and prices paid for the self-consumed electricity can lead to the creation of the first best community and renewable capacity level. In other words, the community's efficiency is independent of its internal organization.

4 Conclusions

For the political world, our key conclusion is that, yes, renewable energy communities can be beneficial for the energy system. This community-based solution can boost investments in renewable energy sources and help tackle climate change. However, without adequately designed competition and environmental policies leading to the 'right' price of energy, we might see the emergence of welfare-decreasing renewable energy communities. Stand-alone policies promoting only renewable energy communities are unlikely to lead to a successful energy transition.

In the energy regulatory arena, it is essential to remember that one of the key advantages of renewable energy communities is their ability to boost the renewable investments and their public acceptance. Up to now, large renewable investments have mostly benefited profit-seeking firms and created external negative effects for the local communities in the vicinity of the installations in the form of noise or visual pollution. Smaller-size investments done by individual citizens have enjoyed generous support paid by the public finance system or cross-subsidies financed by non-prosumers via preferential metering systems and relatively low fixed connection charges. Large take-up rates have led to lower public acceptance and tensions around the expansion of renewables. Community-based solutions can circumvent these problems. They can lead to large-scale investment in renewables and share the benefits among the local community, solving the above-mentioned problems.