MORE THAN MONEY –AN EVALUATION OF THE ECOLOGICAL, ECONOMIC, AND SOCIAL ASPECTS OF THE DECENTRAL ENERGY TRANSFORMATION

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Overview

The energy sector as a main contributor to greenhouse gas emissions needs to undergo a large and rather quick transition in order to adjust for the Paris Agreement and to limit global warming to 1.5 or at least two degrees. Moving from conventional to renewable energy generation might also shift the place of installation, especially for small-scale end-users (e.g. households). We recognize that the current regulatory set-up results in large distributional effects of costs: high income households are more likely to own properties and therefore generation technologies while low-income households co-finance the installations and the system via taxes, levies and fees, leading to an increase in their costs (Borenstein & Davis, 2016). However, there is large potential to install generation technologies at smaller capacities, but the latest development has shown that more emphasis is put on the development of large-scale renewable energy installations, i.e. onshore and offshore wind farms or open-space PV (BMWi, 2019). In an urban context, there is a limitation of space for high-capacity installations, yet high, centralized electricity demand. However, decentralized residential and small-scale technologies that combine generation and demand in one location have not been regarded as one of the main influential parts of the transition to clean energy. On the one hand, we find studies that emphasize the potential of residential and urban renewable energy technologies (Fraunhofer ISE, 2020), but also see reports, on the other, that present the downsides of the approach to rollout small-scale technology (Mathiesen et al., 2017). Considering rooftop PV, some studies show that costs for the technology, installation, and maintenance are much higher than for PV parks (Fraunhofer ISE, 2018). Arguing based on pure system costs, we see a limitation in the approach (acatech et al., 2020) and formulate the hypothesis that decentralized generation in an urban high demand area is equally important for a successful energy transition as the large-scale deployment onshore and offshore. In order to address monetary and non-monetary aspects of a large and small-scale technology deployment, we develop an alternative assessment scheme based on ecological, economic, and social criteria to qualitatively estimate the value of large-scale and small-scale renewable energy technologies. We apply this method to the German context to evaluate and identify advantages and current barriers as well as disadvantages of each approach from both a system and societal perspective.

Methods

We develop a three-dimensional assessment scheme based on ecological, economic, and social criteria to estimate the value of the deployment of large-scale or small-scale renewable energy technologies. Each of the dimensions – ecological, economic, and social – is described by a number of criteria that we derived from current studies on the profitability of each approach (acatech et al., 2020; Carbajo & Cabeza, 2019; Chilvers et al., 2018; Tobiasson & Jamasb, 2016). These criteria are separately being described in detail and evaluated in the context of deployment of large, medium, and small-scale technologies. Analyzing studies and reports, we find the following criteria driving the discussion about the place of installation:

- Ecology: climate protection, intrusion into natural biosphere, use of resources, land use
- Economy: economic efficiency/viability, technological efficiency, enforceability, regulation
- For a social assessment: acceptance, participation, social equity, health

We take architectures from both decentral and central energy system deployment and qualitatively evaluate them with regard to the named criteria by comprehensively structuring existing results from various research outcomes of studies on each of these categories. The analysis leads to an overview on all impacts, advantages and disadvantages of each of them, and allows for drawing essential conclusions for guiding policy-makers in accelerating the energy transition. In the broader sense, this assessment scheme can relate to the methodology of identifying strengths and weaknesses.

Results

In Germany, incentive mechanisms to support the deployment of generation technologies at the location of a load center have not shown the desired increase in installed capacity. Both subsidies that are in place to support the installation of for example rooftop PV suffer from their downsides that in turn lead large players to focus on large-scale projects. However, when comparing residential-scale rooftop PV to large-scale solar and wind parks, we find that the consideration of more than the pure costs of installation for the technology emphasizes the importance of improving policies to support a rollout of residential systems that are grid connected. The reason is two-fold: First, a pure cost-based approach disregards the costs for infrastructure and technology needed between generation and demand, that is, network expansion to load centers or additional substations. Second, public acceptance rises in the presence of ownership and so does the willingness to participate in the transition. In the current set-up, rights, access, and ownership of roofs, land, and technology are especially critical for residential technology and, thus, pose a challenge to the current incentive mechanism. The results for the economic assessment are most diverse: While we identify a strong support of large-scale deployment by the purely cost-related economic criteria, the regulation shows a lack of space for business models to emerge that support and increase the operation of residential technology.

Conclusions

Applying the suggested three-dimensional assessment method, we observe that aside of the pure costs of technology a deployment of residential technology has equally positive aspects as large scale wind and solar parks. In the current debate on the location of wind and solar parks and the lack of space to build these, the parallel support of residential technology allows for an additional pathway to increase aggregated installed renewable energy capacity. Ownership and access rights for small-scale residential technology have so far been one of the major barriers in the current framework: a new model where not only roof and house owners can be sharing the technology and its generation is needed to encourage and accelerate the transition in urban areas.

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