

RENEWABLE DEPLOYMENT

Model for a fairer distribution

Typically, the allocation of renewable power sources is determined by a desire to maximise output and reduce generation costs, to satisfy the preferences of a small number of stakeholders. A new model broadens this perspective by considering societal equity and acceptability with the aim to improve the siting process.

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We have a choice when locating wind and solar power sites: we can pick the sunniest or windiest region, where they would produce the most electricity, or we can take a wider perspective and ask where would they do the most good for the energy system and society? Maximising output is what an investor would do to increase revenue. However, this could lead to a clustering of installations in a small number of locations. When optimising the location of power installations, many studies focus on the levelled cost of generation ; external costs are sometimes incorporated into these models^{1,2}. Writing in *Nature Energy*³, Martin Drechsler from the Helmholtz Centre for Environmental Research and colleagues across Germany have taken a more holistic approach to determining how to locate wind and solar photovoltaic (PV) power plant sites by building a model that includes social acceptability and network costs. They conclude that the cost of allocating PV and wind resources across Germany in a manner that is considered fairer by the public increases the cost of generation by a mere 2%.

Drechsler and colleagues' work is specific to Germany, but many of the principles apply anywhere with uneven distribution of population and renewable resources. Broadly speaking, Germany has a windy and less densely populated north, and a sunny, highly populated, prosperous and politically influential south. The default allocation for renewables

using conventional least cost approaches would therefore locate many of the less attractive wind turbines in the north and modest amounts of more amenable PV installations in the south. This is exactly what the researchers' optimisation algorithm does initially. Their novel contribution is to then introduce the results of two choice experiments to their model. The first asks how much people are willing to pay to avoid living near wind or PV installations (the answer: around €60 per year per km for wind turbines and roughly half as much for PV). In the second, they asked the public what they consider to be fair when it comes to distributing wind and PV geographically.

The willingness to pay for renewables to be placed further away affects local decisions. Drechsler and colleague's model suggests that the benefits of placing renewables close to settlements outweigh the willingness of citizens to pay for moving them further away. The researchers thus conclude that installations should be placed as close to settlements as legally possible.

The second choice experiment informs the national distribution of renewables. The public perception is that a larger share of PV in the south, with fewer wind farms in the north would be a fairer solution. When this redistribution is applied to the model, the cost of electricity increases, but only very slightly (less than 2% from 3.82 to 3.89ct/kWh). The difference is small because in the future the cost of PV is projected to be barely higher than that of wind, if the expected cost reductions of between 60 and 70% on current levels are realised⁴.

Drechsler and colleagues then add a final element to the model that further emphasises the value of better distribution of resources by considering network costs. When these costs are included, the distribution of resources becomes further diversified north to south and between wind and PV.

These results are consistent with a broader realisation that whole system efficiency is quite different from efficiency at the component level⁵. It may be true that the maximum amount of energy can be extracted at the windiest or sunniest location and that these locations subsequently produce the lowest cost electricity (in that location). However, if we are interested in the efficiency of the wider system we have to take a more holistic approach, as adopted by Drechsler and colleagues. Diversity in generator types and in their location brings with it a wide range of benefits. Like fund managers who manage the risk of their portfolios by deliberately diversifying their investments, so do energy systems become more resilient the less they rely on one type of generator or one region.

In practice the allocation of renewable assets is less a question of optimal allocation and more dependent on local planning, political decisions and policy choices.

Current market structures, which reward output above all else, still struggle with this concept and Drechsler and co-workers' results are a welcome reminder of the discrepancies between a narrow framing of cost optimal allocation and what is in the wider system interest.

Of course we need to be careful with choice experiments of a very hypothetical nature. The expressed preferences can differ quite considerably from those revealed in real life and attitudes towards wind turbines have been found to change over time and after installation. Similarly, a local planning authority may take a dim view of what the general public considers fair, when local amenities are at stake.

It is one thing to re-optimize allocation based on willingness to pay, and quite another to compensate citizens. Arguably, one solution could be to give regions with high shares of renewables access to lower cost electricity and conversely charge those with lower deployment more to reflect the willingness to pay for not having renewables nearby and the cost of networks to bring the electricity to them. Ironically, transmission lines are themselves unattractive and carry their own willingness to pay to have them placed further away. If the

imbalance of renewable deployment resulted in different regional electricity prices (lower in the windy north, higher in the south) an incentive would be created to reinforce networks and to rethink the siting of further renewables. Such regional prices are politically unattractive to the south of Germany and therefore unlikely to happen (even if it was 'fair').

Furthermore, should we broaden this discussion beyond national boundaries? Germany in particular already relies heavily on neighbouring countries when balancing its renewable generation with demand. Drechsler and colleagues' approach could help us to understand if we should go further in how we think about distributing resources across Europe and internationally. Sunnier and windier regions could provide lower cost electricity, if we are willing to invest in the networks. A main obstacle is political will, and that depends on mutual trust between different regions. Taking a whole systems view can inform this political debate and ensure we appreciate the value as well as social costs.

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References

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