



Spatial distributive justice for onshore wind power and utility-scale solar PV deployment – Optimizations for the case of Germany

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Renewable energies (RES) infrastructure may imply local benefits and burdens. Local benefits might be, e.g., energy autonomy or trade tax income. Local burdens may be reflected, e.g., in house price losses or local opposition by citizens. From a justice perspective, this leads to our overarching research question: What would a just spatial distribution of local burdens and benefits of RES infrastructure look like and how could distributive spatial justice be achieved? With respect to the first part of the question (what would be a just distribution of benefits and burdens?), different answers may exist depending on one's understanding of distributive justice. With regard to the second part of the question (how to achieve a just distribution of benefits and burdens?), there are basically two possible approaches. Firstly, the distribution of local benefits can be addressed. By modifying the institutional framework and/or the spatial infrastructure deployment the spatial distribution of benefits can be adjusted to achieve a distribution of benefits and burdens being considered as just. Secondly, the distribution of local burdens can be targeted and affected in order to achieve a distribution of benefits and burdens considered as just. That is the focus of this paper. We assume local burdens being solely influenced by infrastructure deployment and local benefits being spatially equivalent to the burdens, thus not requiring separate consideration.

To examine our overarching research question, we use a numerical optimization model. We apply the model to the future spatial deployment of onshore wind power and utility scale solar photovoltaics (PV) in Germany in a fully renewable system. We optimize the deployment for given energy production targets with respect to a cost-effectiveness criterion and with respect to various alternative spatial distributive justice understandings. These relate to the equality principle, ability principle, and benefit-principle. By doing so, we shed light on three sub-questions: (1) Can spatial distributive justice of the RES deployment be improved and if so, to what extent? Our results show that, due to regional RES potential limitations, perfect justice cannot be achieved for any of the assumed concepts of justice. But our results also show that the current infrastructure allocation can be assessed as relatively unjust with regard to all assumed concepts of justice, and considerable improvements in justice would be possible by redistributing deployment in space. (2) What relevance do different normative assumptions have for the spatial distributional justice of the RES deployment? Our results reveal that the justice assessment of an allocation depends largely on the understanding of justice that is assumed. In addition, our optimizations

demonstrate that it is easier to establish distributive justice between larger and fewer regions than between smaller and more regions. (3) To what extent are there trade-offs between pursuing spatial distributive justice and cost-effectiveness? We find that optimizing the RES deployment by levelized costs of electricity (LCOE) is comparatively unfavorable with respect to the assumed justice concepts. In turn, optimizing the spatial allocation of RES deployment by the assumed justice concepts increases LCOE by 1%-14%, compared to the cost-optimal allocation.