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An overview of land-use requirements for solar PV and wind power

Olga Turkovska¹, Katharina Gruber¹, Michael Klingler^{1,2}, Claude Klöckl¹, Luis Ramirez Camargo^{1,3}, Peter Regner¹, Sebastian Wehrle¹, and Johannes Schmidt¹

¹Institute for Sustainable Economic Development, University of Natural and Life Science Vienna, Vienna, Austria

(olga.turkovska@boku.ac.at)

²Department of Geography, University of Innsbruck, Innsbruck, Austria

³Vehicle and Energy Research Group (EVERGI), Mobility, Logistics and Auto-motive Technology Research Centre (MOBI), Department of Electrical Engineering and Energy Technology, Vrije Universiteit Brussel, Brussels, Belgium

From a superficial reading of the literature on land-use requirements for renewable energy systems, one may conclude that the community has a very clear understanding of how much land is necessary to deploy renewable energy generation technologies. In particular for solar PV and wind power (VRES), the technologies with the highest growth potentials in the coming decades, abundant literature is available. However, a systematic overview is lacking, in particular, concerning approaches used for estimating the requirements, underlying factors that affect the results, and the regional differences.

There is no standard metric that is applied for estimating the land area necessary to accommodate a certain amount of renewable energy capacity. Several different metrics are used for this purpose, including land-use efficiency, land-use intensity, power density, and land occupation, to name a few. E.g., land-use efficiency in one paper can refer to the land area needed to install a certain capacity for energy generation, whereas another paper considers land-use efficiency as the area needed to generate a certain amount of electricity. Therefore, estimates of land-use requirements quantified with the same metrics vary greatly.

The variability of the land-use requirements is also rooted in the underlying assumptions regarding the area, power-related component, and time of the chosen metrics. However, a systematized review of all aforementioned assumptions on land-use by renewable energies is absent.

Land-use requirements are often derived from the existing VRES facilities. Hence, their values are influenced by such location-specific factors as climatic conditions, orography, land ownership, among others. As land-use requirements are often integrated into the research that estimates potentials for the future deployment of renewable energy, the influence of those factors is implicitly integrated as well. Hence, the potentials for one region may be estimated by applying the data from another region. Although the application of region-specific land-use requirements could reduce the introduced inconsistencies, known land-use requirements are in its vast majority estimated for the US. Therefore, a compilation that in particular gathers literature on land-use of renewable energies in underrepresented world regions is of high importance.

