

Toward the Hidden Cost of China's 2060 Carbon Neutrality: Potential Biodiversity Impacts of Terrestrial Wind and Solar Energy Expansion

Zhijie Zhou, Yixin Fang and Binbin V. Li

ABSTRACT:

As China strives for its ambitious “2060 Carbon Neutrality” objective, the rapid growth of wind and solar energy holds the promise of mitigating climate change while fostering economic development and cleaner air. The increase in utility-scale infrastructure for renewable energy, such as solar and wind farms, is essential in climate change mitigation efforts and the transition towards a low-carbon economy. The term “utility-scale” distinguishes those large-scale renewable energy projects, e.g., solar farms, wind farms, concentrated solar plants, etc., from the smaller-scale or distributed energy generation systems, such as rooftop solar panels or small wind turbines installed on individual homes or businesses sites. The rapid development of utility-scale wind and solar energy facilities can pose significant land use conflicts and threaten biodiversity conservation, and may become barriers to biological corridors, drivers of habitat fragmentation, etc. Therefore, it is crucial to assess the potential conflicts between renewable energy development and biodiversity and identify effective strategies to prioritize biodiversity factors to minimize ecological disruption from photovoltaic and wind power installations. Based on the distribution model of wind and solar plants and Area-of-Habitat (AOH) refined species ranges, we conducted a spatial-explicit analysis of the potential area of conflict between the high-suitability sites for large-scale terrestrial wind and solar energy deployment in China and the terrestrial biodiversity indicators including species richness, endangered and endemic species richness, rarity-weighted richness, and trait-based Rao's quadratic index for functional diversity. We also analyzed the current areas of potential conflict of the existing or planned renewable energy facilities. Our analysis revealed that although only a minimal ratio of the sites ideal for wind and solar energy projects also contain habitats vital for various species, including those at risk of extinction, the overlap of projected renewable energy expansion with areas prioritized for biodiversity protection could potentially affect important and endemic species habitats, stressing the need for strategic site selection and the implementation of conservation measures. Our study sheds light on the intricate balance between renewable energy development and biodiversity conservation, providing actionable insights for sustainable planning toward a harmonious coexistence of renewable energy expansion and the protection of critical ecosystems and species.

KEYWORDS: *renewable energy; conservation priority; species diversity; functional diversity; spatial modeling*

Zhijie Zhou, Ph.D. Student, Department of Geography and GIS, University of Illinois Urbana-Champaign, Urbana, IL, USA

Yixin Fang, Research Associate, The Environmental Research Center, Duke Kunshan University, Suzhou, Jiangsu, China

Binbin V. Li, Associate Professor, Environmental Research Centre, Duke Kunshan University, Kunshan, Jiangsu 215316, China; Nicholas School of the Environment, Duke University, Durham, NC, USA.