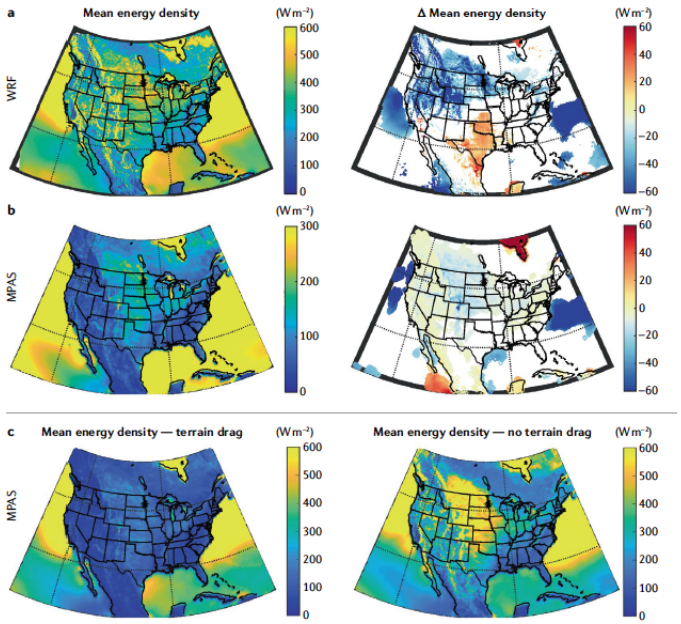
Climate change & wind power

U.S. Department of Energy | Office of Science
HYPERFACETS
A Framework for Improving Analysis and Modeling of Earth System and Intersectoral Dynamics at Regional Scales



Contemporary & projected wind resources.
a| Mean annual energy density at ~100m a.g.l. for 1980-2005 (left) and the difference between 2075-2099 and 1980-2005 (right) from WRF at 12 km nested in MPI-ESM-LR. **b|** as in a, but at ~60m derived using MPAS simulations at 25 km resolution. Only grid cells where differences are significant at α =0.05 are shown.
Illustration of a key uncertainty – terrain drag:
c| Energy density computed with MPAS for 2008 with (left) and without (right) terrain drag.

Pryor S.C., Barthelmie R.J., Bukovsky M.S., Leung L.R. and Sakaguchi K. (2020): Climate change impacts on wind power generation. *Nature Reviews: Earth and Environment* doi: 10.1038/s43017-020-0101-7

Scientific Achievement

Wind energy is both a climate change mitigation option and a climate sensitive energy resource. This solicited review comprehensively documents the state of the science regarding climate change impacts on wind power generation, documents key trends in the wind energy industry, and articulates key challenges and opportunities for geoscience research to address key research needs for this critical renewable energy industry.

Significance and Impact

We show expansion of wind turbine installed capacity from 433 GW in 2011 to 5000 GW in 2050 leads to 154 Gigatons of avoided CO_2 emissions equivalent to 5 times annual anthropogenic CO_2 emissions. Downscaling of current generation climate projections indicate only a modest impact on wind resources in high resource areas of the USA and Europe.

Research Details

This is a comprehensive state-of-knowledge assessment of the reciprocal relationship between wind energy and climate change. A roadmap for future research is provided.