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Driving factors of the growth of US wind power generation - A decomposition of historical on-shore wind power generation data

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US Wind power generation has grown significantly over the last decades, driven by more and larger turbines being installed. However, less is known about how other factors affect the expansion of wind power. In this study, we use historical wind power generation time series, data on installed wind turbines and wind speed time series from the ERA5 data set to quantify driving factors of the growth of US wind power generation. By use of index-decomposition techniques and a regression analysis, we show how different factors affect the output of wind power generation in the US. These include changes in the number of installed turbines, average swept area, park efficiency, location choice, and hub height. Based on this, we discuss potential consequences for the future expansion of wind energy. As expected, the total rotor swept area is responsible for the largest part of the increase in generated power, due to a larger number of installed turbines and larger rotor sizes in particular. Unexpectedly, turbine efficiency slightly declined in the last decades. Wind speeds available to wind turbines have slightly increased. This is a result of larger hub heights, but also of new wind turbines being installed at windier locations.