Cost-competitive Reduction of Carbon Emissions of Up to 80% from the U.S. Electric Sector by 2030

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Carbon dioxide emissions from electricity generation are a major cause of anthropogenic climate change. The deployment of wind and solar power reduces these emissions, but is subject to the variability of the weather. In the present study, we calculate the cost-optimized configuration of variable electric power generators using high spatial (13-km) and temporal (60-minute) resolution weather data over the contiguous U.S.. Our results show that carbon dioxide emissions from the U.S. electricity sector can be reduced by up to 80% compared with 1990 levels, without an increase in cost. The reductions are possible with current technologies and without electric storage. Wind and solar power increase their share of electricity production as the system grows to encompass large-scale weather patterns. The largest reduction in carbon emissions is achieved by moving away from a regionally divided electricity sector to a national system enabled by high-voltage direct-current transmission.

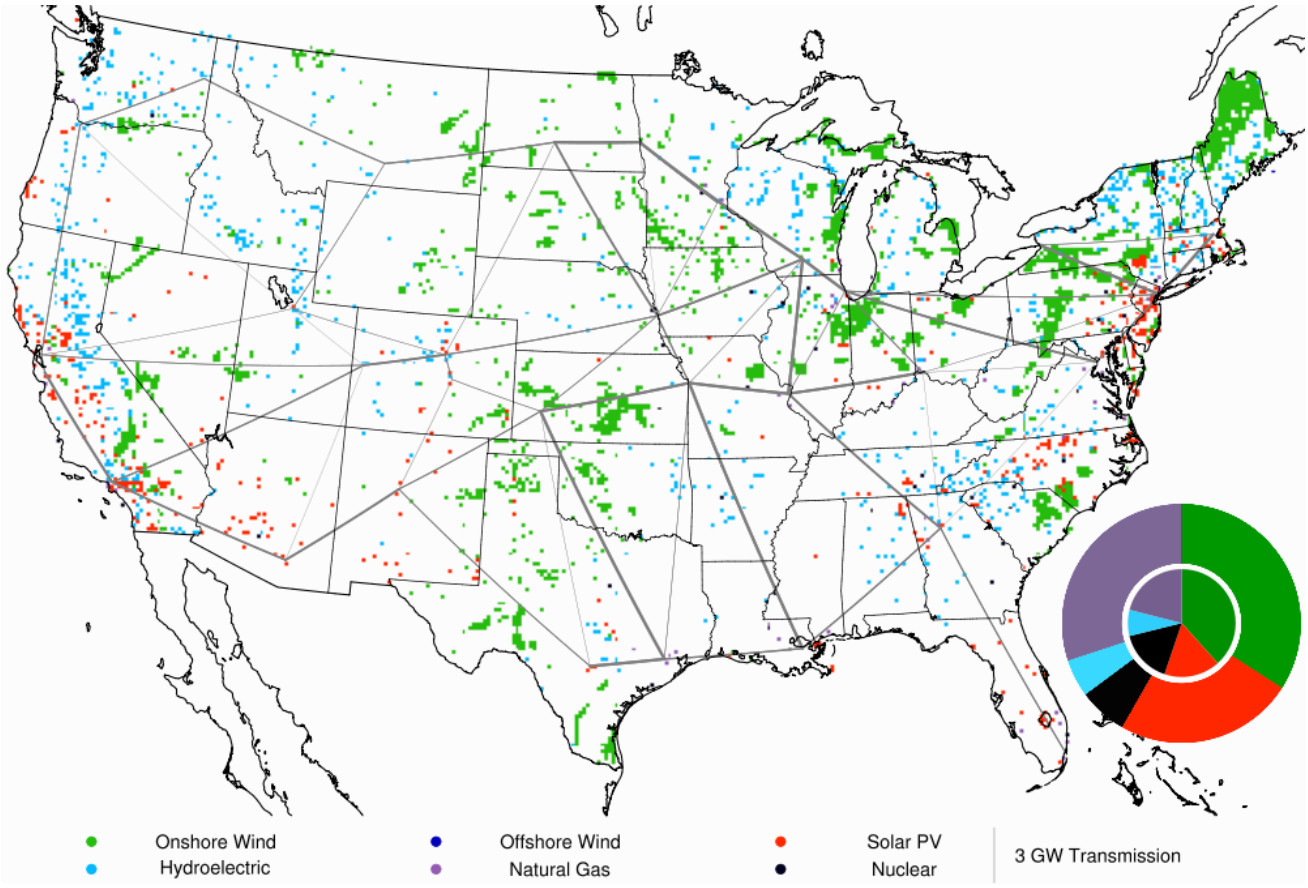

Figure 1. A cost-optimized single electric power system for the contiguous U.S.. The colors indicate that a model grid cell has a technology sited within it. The gray lines show the HVDC transmission network. The outer pie chart on the right represents the installed capacity by technology, while the inner pie chart shows the electric demand met by each technology. Electricity is shared across the entire U.S. along HVDC transmission lines connected to 32 nodes.