Are wind turbines actually green



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: "In order to power a city the size of NYC you"d need 57,000 acres; and who knows the astronomical amount of land you would need to power the entire US."

: "The carbon footprint on wind [energy] is significant."

How green is wind power? It's not a simple question. Of course the wind blows without carbon emissions, but catching it isn't easy. Building and erecting wind turbines requires hundreds of tons of materials -- steel, concrete, fiberglass, copper, and more exotic stuff like neodymium and dysprosium used in permanent magnets.

All of it has a carbon footprint. Making steel requires the combustion of metallurgical coal in blast furnaces. Mining metals and rare earths is energy intensive. And the manufacture of concrete emits lots of carbon dioxide.

In the case of wind and solar power, those emissions are nearly all front-loaded. That contrasts with fossil-fueled electric power plants, where emissions occur continuouisly as coal and natural gas are combusted.

It"s a big distinction. But how significant? Analyst Deepa Venkateswaran at Bernstein Research looked into it.

Citing data from the likes of National Renewable Energy Laboratory, Vestas, Siemens Gamesa Renewable Energy, and Bernstein estimates, Venkateswaran determined that the biggest contributors to the carbon footprint of wind turbines are steel, aluminum and the epoxy resins that hold pieces together -- with the steel tower making up 30% of the carbon impact, the concrete foundation 17% and the carbon fiber and fiberglass blades 12%.

Good news: amortizing the carbon cost over the decades-long lifespan of the equipment, Bernstein determined that wind power has a carbon footprint 99% less than coal-fired power plants, 98% less than natural gas, and a surprise 75% less than solar.

More specifically, they figure that wind turbines average just 11 grams of CO2 emission per kilowatthour of electricity generated. That compares with 44 g/kwh for solar, 450 g for natural gas, and a whopping 1,000 g for coal.

But beating them all is the original large-scale zero-carbon power source, nuclear power, at 9 g/kwh.

Thanks to technology, these stats aren"t static. Offshore wind turbines are becoming enormous, with General



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Electric's GE Haliade X featuring blades 360 feet long and generating 14 megawatts. The carbon footprint of such monsters could get as low as 6 g/kwh.

And they could be trending lower, thanks to the advent of so-called green steel.Swedish companies Hybrit and H2 Green Steel are investing billions to make millions of tons a year of green steel. Instead of burning metallurgical coal to fire a traditional blast furnace to reduce iron ore into pig iron, they will use green hydrogen electrolyzed via renewable power.

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