

# When wind and solar power don't add up

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In April, Gov. Jerry Brown made headlines by signing into law an ambitious mandate that requires California to obtain one-third of its electricity from renewable energy sources like sunlight and wind by 2020. Twenty-nine states and the District of Columbia now have renewable electricity mandates. President Obama and several members of Congress have supported one at the federal level. Polls routinely show strong support among voters for renewable energy projects — as long as they don't cost too much.

But there's the rub: while energy sources like sunlight and wind are free and naturally replenished, converting them into large quantities of electricity requires vast amounts of natural resources — most notably, land. Even a cursory look at these costs exposes the deep contradictions in the renewable energy movement.

Consider California's new mandate. The state's peak electricity demand is about 52,000 megawatts. Meeting the one-third target will require (if you oversimplify a bit) about 17,000 megawatts of renewable energy capacity. Let's assume that California will get half of that capacity from solar and half from wind. Most of its large-scale solar electricity production will presumably come from projects such as the \$2 billion Ivanpah solar plant, which is now under construction in the Mojave Desert in southern California. When completed, Ivanpah, which aims to provide 370 megawatts of solar generation capacity, will cover 3,600 acres — about five and a half square miles.

The math is simple: to have 8,500 megawatts of solar capacity, California would need at least 23 projects the size of Ivanpah, covering about 129 square miles, an area more than five times as large as Manhattan. While there's plenty of land in the Mojave, projects as big as Ivanpah raise environmental concerns. In April, the federal Bureau of Land Management ordered a halt to construction on part of the facility out of concern for the desert tortoise, which is protected under the Endangered Species Act.

Wind energy projects require even more land. The Roscoe wind farm in Texas, which has a capacity of 781.5 megawatts, covers about 154 square miles. Again, the math is straightforward: to have 8,500 megawatts of wind generation capacity, California would likely need to set aside an area equivalent to more than 70 Manhattans. Apart from the impact on the environment itself, few if any people could live on the land because of the noise (and the infrasound, which is inaudible to most humans but potentially harmful) produced by the turbines.

Industrial solar and wind projects also require long swaths of land for power lines. Last year, despite opposition from environmental groups, San Diego Gas & Electric started construction on the 117-mile Sunrise Powerlink, which will carry electricity from solar, wind and geothermal projects located in Imperial County to customers in and around San Diego. In January, environmental groups filed a federal lawsuit to prevent the \$1.9 billion line from cutting through a nearby national forest.

Not all environmentalists ignore renewable energy's land requirements. The Nature Conservancy has coined the term “energy sprawl” to describe it. Unfortunately, energy sprawl is only one of the ways that renewable energy makes heavy demands on natural resources.

Consider the massive quantities of steel required for wind projects. The production and transportation of steel are both expensive and energy-intensive, and installing a single wind turbine requires about 200 tons of it.

Many turbines have capacities of 3 or 4 megawatts, so you can assume that each megawatt of wind capacity requires roughly 50 tons of steel. By contrast, a typical natural gas turbine can produce nearly 43 megawatts while weighing only 9 tons. Thus, each megawatt of capacity requires less than a quarter of a ton of steel.

Obviously these are ballpark figures, but however you crunch the numbers, the takeaway is the same: the amount of steel needed to generate a given amount of electricity from a wind turbine is greater by several orders of magnitude.

Such profligate use of resources is the antithesis of the environmental ideal. Nearly four decades ago, the economist E. F. Schumacher distilled the essence of environmental protection down to three words: “Small is beautiful.” In the rush to do something — anything — to deal with the intractable problem of greenhouse gas emissions, environmental groups and policy makers have determined that renewable energy is the answer. But in doing so they've tossed Schumacher's dictum into the ditch.

All energy and power systems exact a toll. If we are to take Schumacher's phrase to heart while also reducing the rate of growth of greenhouse gas emissions, we must exploit the low-carbon energy sources — natural gas and, yes, nuclear — that have smaller footprints.