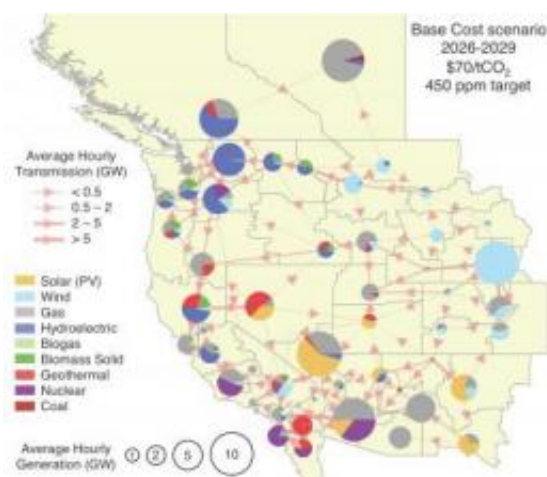


# Advanced power-grid research finds low-cost, low-carbon future in West

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One possible scenario for the electricity system in the Western US in 2026-29. Pie charts show the proportion of different types of energy sources generating power and flowing between load areas if there were a carbon tax of \$70 per ton. According to the SWITCH model, such a tax could allow the West to reach a goal of 54 percent of 1990 emissions by 2030. Credit: Daniel Kammen lab, UC Berkeley

The least expensive way for the Western U.S. to reduce greenhouse gas emissions enough to help prevent the worst consequences of global warming is to replace coal with renewable and other sources of energy that may include nuclear power, according to a new study by University of California, Berkeley, researchers.

The experts reached this conclusion using SWITCH, a highly detailed computer model of the [electric power grid](#), to study generation, transmission and storage options for the states west of the Kansas/Colorado border. The model will be an important tool for utilities and government planners.

"Decarbonization of the electric power sector is critical to achieving greenhouse gas reductions that are needed for a sustainable future," said Daniel Kammen, Distinguished Professor of Energy in UC Berkeley's Energy and Resources Group. "To meet these carbon goals, coal has to go away from the region."

One example of low-cost, low-carbon energy generation and transmission around the West by 2030.

One possible scenario for the [electricity system](#) in the Western U.S. in 2026-29. Pie charts show the proportion of different types of energy sources [generating power](#) and flowing between load areas if there were a [carbon tax](#) of \$70 per ton. According to the SWITCH model, such a tax could allow the West to reach a goal of 54% of 1990 emissions by 2030.

To achieve this level of decarbonization, policy changes are needed to cap or tax [carbon emissions](#) to provide an incentive to move toward low-carbon electricity sources, Kammen and the other study authors said.

While some previous studies have emphasized the high cost of carbon taxes or caps, the new study shows that replacing coal with more gas generation, as well as renewable sources like wind, solar and geothermal energy, would result in only a moderate increase to consumers in the cost of electric power – at most, 20 percent. They estimate a lower ratepayer cost, Kammen said, because the evolution of the electrical grid over the next 20 years – with coordinated construction of new power plants and transmission lines – would substantially reduce the actual consumer cost

of meeting carbon emission targets.

"While the carbon price required to induce these deep carbon emission reductions is high – between \$59 and \$87 per ton of CO<sub>2</sub> emitted – the cost of power is predicted to increase by at most 20 percent, because the electricity system will redesign itself around a price or cap on carbon emissions," said Kammen. "That is a modest cost considering that the future of the planet is at stake."

## **Coal hazards**

Burning coal, a non-renewable resource, produces about 20 percent of the world's greenhouse gases, but also releases harmful chemicals into the environment such as mercury, sulfur dioxide, nitrogen oxides and sulfuric acid, responsible in some areas for acid rain and respiratory illness.

California has few coal-fired power plants, but gets about 20 percent of its electricity from coal-burning plants in neighboring states. About 46 percent of the state's power comes from gas-burning plants, 11 percent from hydroelectric, 14 percent from nuclear and 11 percent from other renewables: geothermal energy, wind and solar.

The study, published in the April issue of the journal *Energy Policy*, highlights an analysis using the SWITCH electricity planning model. SWITCH, which stands for Solar, Wind, Hydro and Conventional generation and Transmission Investment, uses unprecedented detail that includes generation, transmission and storage of electricity. The model was developed by Matthias Fripp to study California's renewable energy options while he was a Ph.D. student at UC Berkeley. Kammen and his group extended the model's capabilities and used it to study Western North America.

"We use the SWITCH model to identify low-carbon supply options for the West, and to see how intermittent generation may be deployed in the future," said first author James Nelson, a UC Berkeley graduate student. "We show that it is possible to reach our goals of reducing carbon emissions using many possible mixes of power, whether natural gas, nuclear, solar, wind, biomass or geothermal."

"Models like this are eagerly anticipated by many of the agencies involved in planning," Kammen said, noting that SWITCH is a power-system model that can be fine-tuned for many different types of studies.

## **Setting targets for 2030 emissions**

Mandates called Renewable Portfolio Standards (RPS) currently dominate carbon reduction policy in the United States. These standards require that a certain fraction of electricity generation come from renewable sources. While California has a relatively high RPS target of 33 percent renewable sources by 2020, other Western states have less ambitious targets. Additional policy action throughout Western North America will be required to meet climate targets, Kammen said.

The UC Berkeley study concluded that current RPS targets are not sufficient to put electric power sector emissions on track to limit atmospheric levels of carbon to less than 450 ppm, a climate stabilization target recommended by the Intergovernmental Panel on Climate Change. That target requires carbon emissions from electricity production in industrialized countries to drop to no more than 54 percent of 1990 emissions by 2030.

However, the study finds that the right mix of renewable energy sources can meet climate goals given stronger carbon policy.

Of all 50 states, California has been the most aggressive in setting goals

for reducing carbon emissions, with a target to return to 1990 levels by 2020. The first step along the path of changing the balance of energy sources is the establishment of a [carbon](#) trading market in California, which will be up and running in September 2012, said Kammen.

Provided by University of California - Berkeley

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