Is California going the way of Germany when it comes to energy?

Wind turbines in Furstenwalde, in eastern Germany. Wind power accounts for 160,000 jobs in Germany but the country's integration of renewable energy sources has been less than smooth. (PATRICK PLEUL / AFP/Getty Images)

By **Rob Nikolewski**

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One place possesses the fourth-largest economy in the world. Another is home to the fifth-largest.

Both places have instituted ambitious energy and climate goals.

But one — Germany — is struggling to meet those targets and its citizens pay some of the highest electricity prices in the industrialized world. Is the German experience a cautionary tale for the other place — California?

It's a question increasingly on the minds of some energy experts in the Golden State.

"There are a lot of parallels," said James Bushnell, economics professor at the University of California at Davis. "Both have been leaders and both have experienced a period of energy cost increases that are starting to create some worries of a pending backlash. I think that backlash has hit a little more in Germany."

Yes, California is not a country unto itself but its gross state product in 2017 was $2.747 trillion. If the Golden State were a nation, it would have surpassed the United Kingdom in economic terms last year for the world's No. 5 spot.

Germany, at $3.685 trillion, is No. 4.

Germany takes the leap

Keen to drastically reduce greenhouse gas emissions and transform its energy sector, German leaders adopted a vast program called *Energiewende* eight years ago and the country prides itself on setting the pace for change in the European Union.

In the U.S., California sees itself in the same light — leading the nation in a raft of metrics, such as the number of rooftop solar

installations, and mandates, like the establishment of the country's most aggressive Renewable Portfolio Standard.

But Germany has suffered a series of setbacks on its path to become cleaner and greener.

It set a long-term goal to generate 80 percent of all its electricity from renewable sources by 2050. In the interim, Germany planned to slash CO2 emissions by 40 percent by 2020, compared to 1990 levels.

But earlier this year, officials admitted the country will not hit the 2020 goal, saying it would reach 32 percent at best.

Greenhouse gas emissions in Germany have not decreased for the last nine years and emissions from the transportation sector have not fallen since 1990. In fact, the United States has reduced carbon emissions more than Germany, in both real and nominal terms.

"We in Germany have to admit that we have to get it right again," Chancellor Angela Merkel said at a climate meeting in June.

It hasn't come from lack of effort or money.

About 25 billion euros ($28.4 billion U.S.) in subsidies go to the renewable sector in Germany. The country is expected to spend more than 500 billion euros ($580 billion) by 2025 to overhaul its energy system, according to Bloomberg News.

As a result, renewable energy sources now account for 36 percent of the power in Germany.

In contrast to California, where the solar industry has boomed, wind power has taken off in Germany. It accounts for 160,000 jobs. That's about eight times more employees than in the country's coal industry.

Accommodating a long-term conversion to renewable energy has required a rapid expansion of Germany's power grid.

Wind farms in Germany produce plenty of power but they are largely located in the northern part of the country. But German factories are concentrated in the south. About 5,000 miles of transmission lines are being laid, paid for by German utility customers.

In addition, wind energy production is so robust that windy conditions can sometimes deliver more energy than the grid can handle, overloading power lines.

In August, Germany's economics minister said grid expansion plans were "catastrophically behind schedule."

But perhaps the biggest stumbling block relates to nuclear power.

After the 2011 disaster at the Fukushima nuclear plant in Japan following a tsunami, Merkel's coalition government decided to shut down all nuclear power in Germany by 2022.

At the time of the decision, there were 17 nuclear plants operating in Germany. Seven remain. While nuclear power has more than its share of critics, it produces electricity free of greenhouse gases.

In an ironic twist, phasing out nuclear power triggered the construction of new facilities using coal, one of the most polluting fossil fuels.

Renewable sources such as wind and solar have problems with "intermittency." That is, solar production drops when the sun goes down and wind power wanes when breezes don't blow. In order to fill in the gaps, grid managers turn to "baseload" generation from other, more traditional, sources.

In Germany's case, lignite, or "brown coal," is plentiful. More than one-third of the country's supply of energy last year came from coal — 23 percent from lignite and 14 percent from black coal.

"Prices for natural gas have increased in the last (few) years, making it less competitive compared to coal," said Michael Pahle of Germany's Potsdam Institute for Climate Impact Research in an email.

Bushnell, who is working with Pahle on a study comparing California with Germany, said, "There's a pretty clear uptick in fossil fuel and coal production that you can trace to the nuclear phaseout. I would wager that's probably one of the biggest reasons why they will miss their climate targets."

Rising costs

The growing pains have led to higher prices, largely shouldered by residential power customers.

Between 2015 and 2017, Germany inched ahead of Denmark for the highest electricity prices for household customers (35 cents per kilowatt-hour, in U.S. currency), according to the statistical office of the European Union.

“In Germany, commercial industrial rates have not gone up much,” said Severin Borenstein, professor of business administration and public policy at the Haas School of Business at UC Berkeley.

“And for good reason. It’s easy for companies to move across boundaries within the (European Union) so that if you raise commercial industrial rates very much, you would just get a bunch of leakage as companies moved to other parts of the EU ... So they’ve ratcheted up residential rates.”

Despite paying higher energy bills, Germans still seem to support the country’s renewable energy strategy. A survey conducted in 2017 showed 88 percent of voters backed *Energiewende.*.

“People are in general very concerned about the environment and think this is a good way of protecting it,” Pahle said.

Will the experience in Germany follow its way to California?

Not so fast, said Borenstein.

“I think California has pursued a much smarter environmental policy,” he said. “Germany is not going to, on its own, change world greenhouse gas emissions. It’s a matter of creating the technologies. But in many ways, when you look at what Germany is doing, they aren’t pursuing the technologies in the same way” as California.

Differences in California

For one thing, coal is a essentially non-factor in California. It accounts for only 0.15 percent of in-state generation, which comes from a single coal facility, and the state’s energy commission expects the percentage to drop to “almost zero by the end of 2025.”

California does import 4.13 percent from coal sources in other states but that is expected to dwindle to zero by 2026.

Borenstein also said the state is “grappling much more directly with how you balance the grid with intermittent renewables.”

While Germany’s grid wrestles with handling abundant amounts of wind generation, California’s operators deal with excess solar production.

So much solar is produced at peak periods that wholesale energy prices can drop to zero or into negative territory. That puts strain on the grid, and the California Independent System Operator (the organization which oversees the operation of about 80 percent of the state's electric power system) often has to send the excess solar to neighboring states like Arizona or curtail it altogether.

The solution is to find a way to save the energy and dispatch it later, such as when the sun sets. One possible answer is battery storage.

The California Public Utilities Commission has ordered power companies to find storage options — such as a lithium-ion facility in Escondido recently built by San Diego Gas & Electric. But the sector is still in its early stages and while storage costs are going down, they are still more expensive than traditional energy sources such as natural gas.

According to the most recent numbers compiled by the California Energy Commission, natural gas accounts for the largest portion of in-state generation — 43.40 percent. Renewables are growing, up to 29.65 percent.

Nuclear power accounts for 8.69 percent of in-state generation — all from California’s last remaining nuclear plant, Diablo Canyon. But Diablo Canyon is scheduled to shut down in 2025.

Michael Shellenberger, president of the Berkeley-based research and pro-nuclear group Environmental Progress, said California will struggle — just as Germany has — without nuclear power.

“If you shut down nuclear plants, your emissions are either not going to decline or they’re not going to decline nearly as quickly as they would if you kept nuclear plants open,” Shellenberger said.

Greenhouse gas emissions from California’s electric power sector increased in 2012, the same year the San Onofre Nuclear Generating Station closed and in-state natural gas generation spiked to meet energy demand. Those effects have flattened out in recent years, however.

Nuclear power may not emit greenhouse gases but the industry has a vast number of critics, especially in California. Opponents cite the potential danger of radiological exposure, the federal government's failure to come up with a location to put the spent fuel stored at the 99 reactor sites across the country and numerous cost overruns to construct new nuclear power plants.

Shellenberger says without nuclear power, California won't reach its climate goals.

"It's never going to happen," he said. "It's just public relations, just a veil to mask the replacement of nuclear with natural gas ... And the people that end up paying for it, of course, are the ratepayers."

Integration

Borenstein said making up for the loss of nuclear will depend largely on how effectively California can integrate renewables into the grid.

"We all know now that wind and solar power, on a per kilowatt-hour basis, can be produced pretty cheaply," Borenstein sad. "The problem is, if you can't store it, it doesn't end up (being used) at the right time."

Other storage options include "pumped hydro" facilities in which hydro-electric facilities, using turbines, pump water from one reservoir up to another and then release it. The ensuing rush of water generates electricity when the grid needs it.

The San Diego County Water Authority wants to develop an energy storage facility at the San Vicente Reservoir.

"Some environmentalists aren't wild about" pumped hydro, Borenstein said. "It may not be an ideal solution but my view is there is no ideal solution. We have to be grappling with reality, not a perfect outcome and deal with the reality that we're not going to get there at all if the only solutions we propose are very expensive ones."

Californians pay an average of 15.23 cents per kilowatt-hour for electricity, according to the U.S. Energy Information Administration. While that's decidedly less expensive than the 35 cents per kilowatt-hour in Germany, California's electricity price is about 50 percent higher than the average state in the U.S.

Will California electricity customers end up paying rates similar to those in Germany?

"I am worried about where California's rates are going," said Bushnell of UC Davis, "but I don't really see it following the German trajectory."

Bushnell's larger concern? That the state's drive to eliminate all sources of carbon from the electric industry is galloping ahead of efforts to slash carbon in other sectors, such as transportation (by promoting electric vehicles) and converting home heating from natural gas to electricity.

The retail price of electricity that California customers pay is climbing as the state adds to its ambitious renewable energy policies.

The state's Renewable Portfolio Standard requires utilities to obtain 50 percent of the state's overall energy mix from renewable sources like solar and wind power by 2030.

On top of that, Gov. Jerry Brown in September signed Senate Bill 100 into law that calls on the state to derive 100 percent of its retail from clean-energy sources by 2045.

SB 100 calls for 60 percent of the state's total power to come from renewable sources such as utility-scale solar and wind by 2030. The remaining 40 percent of the mix, to be achieved by 15 years after that, can come from other zero-carbon sources, such as large hydroelectric dams. (Nuclear also counts toward the 100 percent goal but Diablo Canyon is scheduled to shut down in 2025.)

Bushnell worries that as the state gets closer to 100 percent, electricity costs will rise to a point where consumers will be driven away from electric power just as the state's efforts to electrify the transportation and heating sectors are taking off.

"We're trying to squeeze every ounce of carbon out of the electric sector, no matter what the cost," Bushnell said. "Somewhere between 60 and 100 percent, I think we're going to hit a big cost spike and then we'll have to think about how we buy renewables."

Bushnell, who detailed his concerns in a recent blog post, wondered if reaching a politically popular 100 percent clean goal that could theoretically triple the costs is as worthy as reaching, say, 80 or 90 percent and keeping costs manageable while ensuring electrification efforts in other sectors.

“I think we’re crossing the threshold where the money spent on electricity is giving us decreased returns,” Bushnell said.

Energy and climate experts talk about the “waterbed effect,” in which carbon is pushed down in one area, only to pop up in another.

Dan Jacobson, state director of Environment California and a staunch advocate of SB 100, acknowledges the issues facing Germany but does not see a direct connection that applies to California.

“The stuff we’re talking about isn’t easy and that shouldn’t deter us from doing the work,” Jacobson said. “What it should encourage is a think tank-like process where we can all learn from each other’s mistakes and move forward ... To use a football analogy, if Tom Brady had thrown an interception, you wouldn’t take him out of the game.”

Pahle said Germany’s climate policy “is at a certain impasse” and has reached the point where “it is not about getting (renewables) into the system anymore; it is about using them efficiently.”

Bushnell said it may be too early to tell where the paths for Germany and California overlap and diverge.

“Europe seems more expensive in a lot of ways that are not necessarily going to be issues for California,” Bushnell said. “But I think a common theme is that both (places) are trying to go where electric systems have not gone before.”

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