

# California's 2045 100% Renewable Electricity Dream – Can it become Reality?

*A look at the good, the bad and the ugly on the road to 100% renewable energy in California by 2045*

**It's little over two decades before the California grid needs to meet the mandate of Senate Bill 100 - the 100% Clean Energy Act of 2018** (Senate Bill 100, De León).<sup>(1)</sup> This law makes it California's policy to have 100 percent of retail electric sales to customers and all state agencies derived from renewable energy and zero-carbon resources by December 31, 2045. In a year where we have already received dire news about global land-and-sea-surface temperatures,<sup>(2)</sup> I want to be optimistic, and assess where California stands in leading us out of this mess.

As a state, and to its' immense credit, California has long pushed the envelope on technology and innovation in environmental regulation, law, and policy. This has led to much success, *for example* - California's current electric grid renewables portfolio<sup>(3)</sup> and electric vehicle (EV) boom.<sup>(4)</sup> However, there have been more than a few calamitous outcomes too, *for example* - the use of methyl tert-butyl ether (MTBE) in gasoline,<sup>(5)</sup> the failure of the California's first EV mandate,<sup>(6)</sup> and the various scrambles around the implementation of its truck, bus and car rules.<sup>(7)</sup>

**However, California's current bet on a grid powered by 100 percent renewable sources by 2045 is by far its most audacious and important to date.** Audacious in the fact that California plans on doing something that has never before been achieved, using technologies yet to be deployed (like offshore wind farms) and important in the fact that if the fifth largest economy in the world, in the richest nation in the world can't do this, who can?

## **THE GOOD....**

**So, let's start with the good news. We have the technologies to do this, and their number and application is growing.** In the 2021, the SB100 Joint Agency Report<sup>(8)</sup> prepared by the California Energy Commission (CEC), Air Resources Board (ARB), and Public Utilities Commission (CPUC) looked at how we could meet the 100 percent renewables mandate by 2045. It based its assessment and conclusion on "only commercialized technologies with publicly available cost and performance data" in other words, the stuff we have today (sort of, more on offshore wind later). The report's modeling includes solar photovoltaic, solar thermal (existing only), onshore wind, offshore wind core, geothermal, bioenergy, fuel cell (using green hydrogen), small hydro (existing only) and large hydro (existing only) generation sources and battery storage technologies in its assessment. It also briefly includes zero-carbon nuclear (existing only) technology in the first years of the model but ultimately excludes new nuclear since the "state effectively has a moratorium on new in-state nuclear power plants under the Warren-Alquist Act." As stated previously, this modeling was done without factoring in the benefit of more advanced lithium-ion batteries<sup>(9)</sup> or less costly sodium-ion batteries<sup>(10)</sup> for short term grid

storage, new technologies that have the possibility of doubling existing grid transmission capacity at half the cost of new power lines,<sup>(11)</sup> new more efficient solar panel technologies,<sup>(12)</sup> and other proposed long term grid storage technologies like compressed liquid air<sup>(13)</sup> and iron air batteries.<sup>(14)</sup> Bottom line, the tech is there and improving. The report therefore concludes that even with existing technologies, and ignoring innovation, we can achieve a 100% renewable grid in California by 2045.

**More good news** comes from a separate study by Edison International (Edison),<sup>(15)</sup> Southern California Edison's parent company. That study determined that **the 100 percent implementation of renewables would result in big cost savings for California households.** This is largely due to cutting reliance on fossil fuels for power, heat, and transportation, the deployment of solar and battery storage for homes, and electrical energy efficiency measures. Edison estimates that implementing all these measures cuts average total household energy expenses in Southern California by approximately 40 percent. Nothing to dislike there.

**Also, getting to 100 percent renewables would have significant health benefits statewide.** Today more than 28 million Californians live in areas that exceed the federal health-based standards for ozone and fine particulate matter (PM2.5). These emissions result in up to 7,000 premature deaths, thousands of illnesses and emergency room visits yearly. Additionally, half of today's natural gas power plants are in communities that rank among the 25 percent most disadvantaged in the state. Replacing fossil fuel generation and transportation emissions in these communities would reduce health impacts and equity disparities almost immediately. It would also eliminate 174 premature deaths yearly, resulting in close to \$2 billion in savings, based on USEPA's value of a statistical life (VSL) methodology.<sup>(16)</sup> A switch to renewables also eliminates greenhouse gas (GHG's) emissions and their resultant social costs. The SB100 Joint Agency Report estimates the damages avoided by going to 100 percent renewables versus a 60 percent renewables scenario at over \$3.4 billion.<sup>(8)</sup> **This totals at least a \$5 billion in savings from the implementation of 100 percent renewables** – really good news.

There are also positive job and economic impacts. For example - a 2023 CEC report<sup>(17)</sup> looked at several economic studies related to the potential build out of offshore wind. The report includes data from **the Federal American Jobs Project (AJP) which determined that an 18-gigawatt (GW) California offshore wind industry could support more than 17,500 full-time California jobs by 2045.** That is more than the present 1,700 jobs per year, assuming 17,500 jobs are created from 2036 through 2045. The report also included an assessment by the National Renewable Energy Laboratory (NREL) and Bureau of Ocean Energy Management (BOEM), that indicates positive total state gross domestic product (GDP) impacts of \$19.7 billion for construction and long-term operation of a 10 GW offshore wind industry, and \$47.6 billion for construction and long-term operation of a 16 GW offshore wind industry. These scenarios assume that the large equipment needed would be produced in California, including nacelles and turbine towers, as well as small equipment, and necessary other materials and services.

The CEC's report also includes a study by the California Polytechnic State University (CPSU) that assumed that the floating structures, towers, and turbines would be manufactured outside the United States and transported to California. That study concluded the overall economic impact to California at \$3 billion (or \$599 million per year for five years), and the creation of 15,925 full-time jobs (or 3,185 annually for five years). The bottom line in every scenario was thousands of jobs are created by renewable projects, resulting in billions of dollars being injected into the California economy – so, what's not to like there?

### **THE BAD....**

But it's not going to be all smooth sailing and we're already in a squall right at the launch ramp. For California to achieve its 2045, 100 percent renewables goal, the SB100 Joint Agency Report estimates we need to be adding an average of 5.7 GW of renewables to the grid annually.<sup>(8)</sup> That power is supposed to come from adding wind, solar generation and battery storage to the grid. **The challenge is that's almost double the historical maximum rate-of-construction that California achieved in its best year of adding renewables to the grid.** And, if the renewables addition totals for 2021<sup>(18)</sup> and 2022<sup>(19)</sup> as reported by CEC continue, we are already off course and in a deficit that will be hard and costly to build our way out of.

Unfortunately, the story only gets more complicated from there. For example, offshore wind is a generating source heavily relied on in the SB100 Joint Agency Report's modeling to meet the 100 percent renewable goal. CEC is assuming an offshore wind will generate 2 to 5 GW of grid power in 2030, and up to 25 GW of grid power by 2045.<sup>(20)</sup> However, the first federal auctions for offshore wind were only conducted for California in 2022. This means that getting actual power to the grid is many years away. This is especially true if the experience of states like Connecticut, New Jersey, New York, and Massachusetts, are repeated in California. Some of these states held auctions almost six years ago but have yet to generate significant electricity from offshore wind. Delays in those states have boiled down to permitting hurdles, significant cost over-runs, and supply chain issues. What's worse is that some developers have also abruptly canceled projects in New York, New Jersey and Massachusetts citing these cost over-runs.<sup>(21)(22)</sup> This should concern Californians, as Equinor, one of the companies who secured a lease in the 2022 federal auction, recently pulled out of its New York offshore wind contracts.<sup>(22)</sup>

However, the world has become quite a more complicated place since the halcyon days of 2018. The global pandemic, the war in Ukraine, and strained international trade relations with China have inflated costs and hampered supply chains in ways that could not have been envisaged by offshore wind developers when they bid their east coast projects. Also, it should be noted that cost issues are not isolated to the offshore power generation industry, multiple nuclear power projects are millions of dollars over budget<sup>(23)</sup> or have been canceled costs have skyrocketed in the last few years due to the same reasons.<sup>(24)</sup> Undaunted, the east coast offshore wind developers, who paid millions of dollars in fines to cancel their contracts, have all vowed to rebid their projects. So, this really does seem more like a cost realignment that a capitulation.

To get more insight into what the offshore wind industry is thinking, I spoke with Adam Stern, Executive Director of Offshore Wind California. Adam's organization is a coalition of industry partners with a shared interest in promoting policies and public support for responsible development of offshore wind power. I asked him about the timeline to get to construction and power generation and about the cost and contract issues in other states. "Offshore wind is one of the most promising technologies to help California achieve its 2045 climate goals," said Stern, "it won't be easy, but I'm very optimistic. California has learned from other states and has made a good start on coordinating the parallel work streams needed to make projects successful. We are already making great strides planning for port and transmission upgrades, workforce development, power procurement policies and supply chain issues. With additional sea space from the federal government, I'm confident that offshore wind is well positioned to start making a major contribution to California's clean energy transition beginning in the early 2030s."

A very positive note, but to me, it seems like there is a lot of work to do!

### **THE UGLY....**

Ok, so while the news about the rate at which renewables are coming online isn't great, probably **the most sobering elements of a 100 percent renewables transition in 2045, are the amounts of power needed and the costs involved.**

CARB estimated, as part of its 2022 Scoping Plan to achieve carbon neutrality,<sup>(25)</sup> that the state's power demand may increase by up to 76 percent in 2045 due to population growth and the electrification of transportation, industry, agriculture, and homes in the state. That translates to growth from an approximately 102 GW to a 180 GW grid. While building that amount of additional power is already eye watering, SB100 and other state laws also require that existing power generation sources be replaced in that timeframe. This includes retiring 41 GW of natural gas and 2.4 GW of nuclear power generation resources. After factoring in better energy efficiency, California needs to add as much as 114 GW of new renewable power generation resources by 2045. Basically, enough generation to power a whole other California!

That sounds expensive right? And it is! **Edison's "Countdown to 2045: Realizing California's Pathway to Net Zero"**<sup>(15)</sup> **estimates that "achieving this transition will take over \$370 billion of incremental transmission, distribution and utility-scale clean energy investments."** This estimate includes \$247 billion for generation and storage resources, \$75 billion to interconnect resources and to build new transmission lines, and \$50 billion in incremental investment to expand the distribution system to the scale needed in 2045. Drilling into these numbers, Edison estimates that approximately \$19 billion will be needed to pay for offshore wind generation. However, the capital costs estimated by CEC for offshore wind, even in their least expensive scenario, start at \$25 billion.<sup>(26)</sup> So, in other words, the Edison International estimates maybe too low!

Edison's numbers also don't include costs for port build-out for offshore wind (estimated at billions of dollars),<sup>(17)</sup> or for EV chargers, electric home heaters, EV trucks, EV buses, etc. These

costs will likely add up to alarming numbers, such as those published by the Clean Freight Coalition who estimated it would take almost \$1 trillion to electrify America's entire truck fleet.<sup>(27)</sup>

That's a lot of zeros and it's not quite clear where this money will come from. However, it is likely that a combination of state, federal and private investment, plus a yet-to-be-defined contribution from ratepayers,<sup>(8)</sup> will be needed to foot the bill for the generation and grid infrastructure. While this is not good news, California's investment to go 100 percent renewables will fall well short of the 1.4 percent of GDP estimated by the World Bank to be necessary to reduce greenhouse gas emissions by 70 percent without impacting economic growth.<sup>(28)</sup> This means that California can afford this, but it needs to be very careful about who pays the bill. This can't be like the roll out of light duty EVs, where California's most affluent reaped the monetary and air quality benefits of government money,<sup>(29)</sup> while also being exempted from the gas tax which pays for road upkeep.<sup>(30)</sup> This was, and is highly inequitable, to poor Californians who generally need more support to adopt new technologies and who pay more road tax, by driving older, less fuel-efficient cars. **California simply must avoid a grid clean-up that is paid for by its most vulnerable.**

## Conclusions

California can achieve a 100 percent renewable grid by 2045 that reduces overall energy costs for its residents. However, significant work needs to be done to get renewable projects like offshore wind off the ground and quickly. Also, new technologies and investments in transmission and the grid will also be necessary to achieve the 2045 goal. But perhaps most importantly, while California can afford this transition, costs need to be monitored closely to ensure they are not being borne by those already disproportionately impacted by health, equity and poverty burdens.

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