PRESIDENT'S MESSAGE

By Al Tucker

What happens when the sun doesn't shine and the wind doesn't blow?

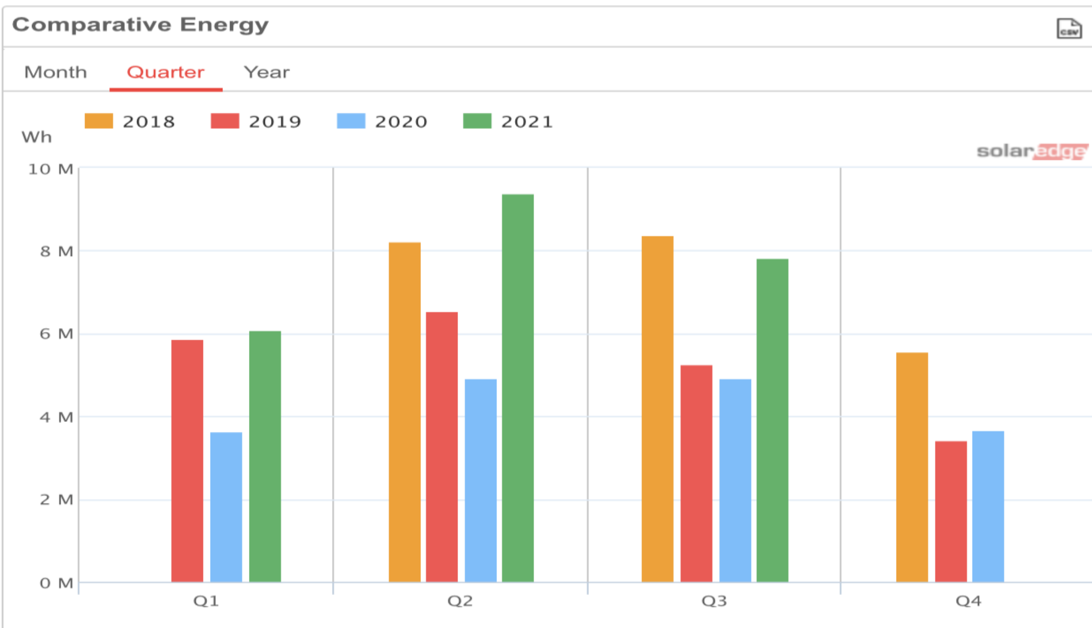
This question didn't appear important to me until my personal experience with my solar system intersected with my professional knowledge of electrical systems and caused me to ask that broad question above. I began to realize that the magnitude of the technical, social, and economic issues that the transition from fossil fuels to 100% noncarbon sources of energy is not well understood in the public sphere. The science behind the need to eliminate greenhouse gas emissions is well understood, but the public remains perplexed by the seemingly large number of interrelated technological, social, and economic choices that must be made to achieve this goal. Leadership at the Federal level is needed to set the priorities for the public to support the way forward. The effects of global warming are accelerating faster than previously thought. Therefore, time is of the essence if we wish to mitigate its adverse effects.

At our last Board of Trustees meeting in June, I presented my experience with my relatively new solar photovoltaic system. Subsequently, I have recorded a video of this presentation for others who were interested in my experience. I have attached the link[1] to the presentation below.

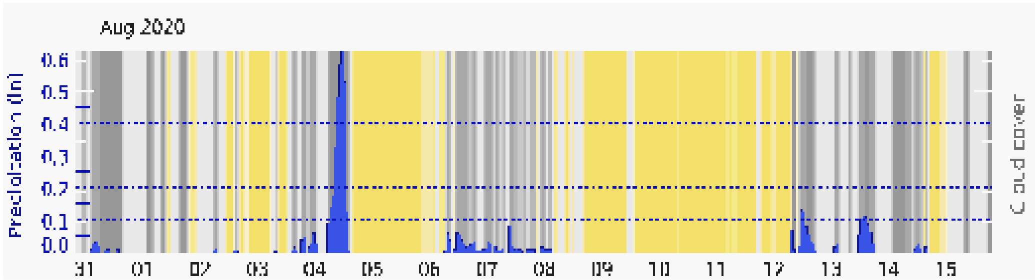
The impetus for this study arose because I thought my system was failing. I was shocked by the magnitude of variability of its solar production. As shown in the figure below, for more than two years, the system produced significantly less electricity than its design, as much as 40% less. But, almost miraculously this year, the system seems to have recovered and has produced more electricity so far this year than all last year in total.

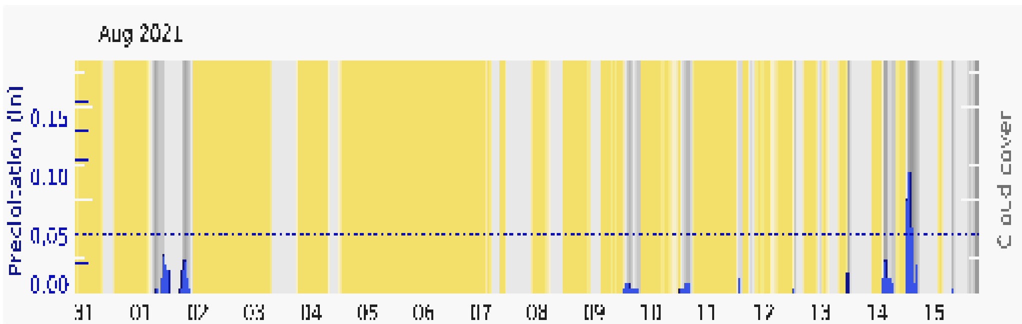
To find the answer, I looked at the weather records, cloud cover statistics as well as the day-to-day variability. And what I found was that my system experiences extreme variability on a daily, monthly, and annual basis. Currently, the smoke from wildfires also seems to impact production. The figures on the next page compare two typical time periods of this year with last, and we can see the cloud cover dominated in August of 2020 (the gray areas).

Returning to my broader question, the variability of renewable noncarbon sources along with converting fossil-fueled machines to electricity reveals a host of technical, social, and economic implications.



1 https://vimeo.com/574091773/b27e1ab71e





The alternating current (AC) grid as we know it today is essential to our daily lives and will remain so for millennia. The average person simply does not have enough real estate to own a personal renewable energy system. They must rely on the grid for electrical energy. Unfortunately, the technology of the grid designed in 1880 by Nikola Tesla was not envisioned to carry variable, geographically dispersed generation. The electricity grid is only an electrical energy carrier, much like an oil pipeline. But it has a major difference - once an electron is generated it must be used or stored nearly instantaneously. The grid, however, cannot be stopped or restarted instantaneously. Electricity generation must always be in balance with the demand from consumers. That is its major drawback. Fossil-fueled power generators take days to start and are slow to respond to changes. In the past, our daily energy usage was predictable based on our daily habits and weather forecasts. While the current grid can respond to slowly changing hourly fluctuations, the minute-to-minute fluctuations caused by renewable sources require generators or storage systems to respond rapidly. Fortunately, new battery technology can handle these rapid fluctuations, but it remains inadequate for storing enough energy to supply energy deficits that exceed more than a few hours.

Some will argue that, if we have more geographically dispersed solar and wind installations, the renewable energy deficits will even out. Can we depend on the wind as an alternate source? Currently in the U.K., the wind provides only 7% of the country's energy makeup—a steep drop from the 25% it generated on average across 2020[2]. This result begs a further question. What is the effect of global warming on wind patterns and solar radiation? The observations currently indicate that the jet stream and the westerlies are shifting to poles, having a larger effect in the northern hemisphere. Future major changes to cloud cover remain a critical unknown for siting solar generation. Hence, the siting of present renewable systems may require changes in future decades.

Further compounding the problem, the electrification of transportation vehicles will require a doubling of electricity generation by 2050. This in turn will require a significant upgrade to the transmission and distribution networks to carry the additional energy. The social impact of new, dispersed renewable sources cannot be easily quantified. New transmission corridors from far-flung wind and solar sites to major metropolitan areas will have to be constructed. In urban areas, major distribution lines and transformer systems will need to be upgraded and expanded. The current NIMBY protests over solar and wind turbine sites will be minor in comparison to those against these other major disruptors.

From an economic viewpoint, the cost of these upgrades will necessarily be borne by the consumer. Current estimates place this number to be approximately 5 trillion dollars. (Compare this to the contentious debate in Congress over the current infrastructure costs.) The ongoing costs of generation and maintenance are not included. In a real-life experiment, Germany has attempted to convert to renewable electricity generation. The "Energy Transition" has resulted in 3-5 times the cost of electricity there compared to the US. This cost includes a surcharge to subsidize the

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[2] Fortune.com, "The U.K. went all-in on wind power. Here's what happens when it stops blowing", https://fortune.com/2021/09/16/the-u-k-went-all-in-on-wind-power-never-imaging-it-would-one-day-stop-blowing/

insertion of renewables. In turn, this approach led to an over-investment in wind and solar generation while it ignored the capability of the grid to distribute it. However, only a relatively small reduction in CO_2 has resulted in the past two decades. Similar impacts to the grid are occurring in New South Wales, Australia where the abundance of sunshine produces more electricity than the grid can handle. Here, the grid operators are considering switching off the solar arrays of homeowners. Obviously, individual homeowners are not happy with this idea. In both cases, renewable energy is sacrificed to maintain the stability of the grid.

Unfortunately, building more renewable energy generators will not solve the climate crisis if this energy cannot be distributed to consumers. Without policy guidance from the federal government and a commitment to technology development, utility companies will continue to use the 1880's technology which severely hinders, if not blocks, the pathway to renewable energy. What the grid of the future will be requires a technical consensus for its operation. Massive changes to regulations dictated by the Federal Energy Regulatory Commission, the myriad of state public service commissions, regional transmission operators, and the utilities themselves will have to address technology choices, operational strategies, safety regulations, and more.

Perhaps the biggest challenge is human behavior. Saving resources through energy efficiency has led to the paradox of consuming more energy. People unconsciously think they are saving but tend to use their LED lights more or they drive their more fuel-efficient vehicles further because the costs are less. Hence, the paradox, increasing energy efficiency leads to more energy consumption. Changing consumers' behavior requires making them aware of the choice. One of the best ways is to raise the costs. However, German experience has shown us that unless a holistic approach from generation to consumption is devised, we will be unable to mitigate climate change in a timely manner.

For those of us who believe that drastic reductions in carbon dioxide are critically necessary to mitigate against the adverse effects of climate change, non-carbon sources of primary energy must replace fossil fuels. We must be prepared to accept that electrical energy will cost significantly more in the future. We will need to accept the social impacts of the change, even to the point of using less electricity. In Germany, the "Energy Transition" resulted from the fear of a nuclear power plant disaster like Chernobyl or Fukashima. The fear of creating a planet inhospitable to humans is more unthinkable. We have no choice but to stop using fossil fuels as an energy source.