Clean Air Task Force
114 State Street, 6th Floor
Boston, MA 02109

P: 617.624.0234
F: 617.624.0230

May 30, 2019

Lora W. Johnson, Clerk of Council
New Orleans City Council

Re: Informal comment letter in Docket. No. UD-19-01, *In Re: Resolution and Order Establishing a Docket and Opening a Rulemaking to Establish Renewable Portfolio Standards*

Dear Ms. Johnson:

My name is Armond Cohen, and I am Executive Director of the Clean Air Task Force (CATF), a nonprofit environmental organization that has been dedicated for nearly a quarter century to advancing public policies that reduce or eliminate harmful air pollution and climate-warming emissions from the world's energy system.[1] We have worked with environmental groups and governments in nearly all states, including Louisiana, to advance state and city policies that can also be models for national policy. I appreciate the opportunity to submit this letter today and request that it be placed in the record of the above docket.

I will address my comments mainly to question #1 in RESOLUTION, R-19-109 establishing the above docket:

---

[1] CATF is an independent philanthropically supported organization that does not accept donations from for-profit corporations or federal, state or local governments. More information on CATF can be found at www.catf.us.

1. *What would an appropriate RPS target for New Orleans be, and should it be a requirement or a goal?*
    a. *What percentage of ENO's load should be met through renewable resources, and what data or other information exists indicating that the target is achievable in New Orleans?*

CATF urges Council members to follow five progressive states – California, Colorado, Washington State, New Mexico and Nevada – who have recently established a "clean energy standard" in preference to a renewable-only RPS.[2] ***Such a standard would require ENO to provide, by a date certain such as 2045 or 2050, all of the City's electricity from zero-carbon energy sources***. These sources could include, of course, renewable energies such as wind and solar, but could also include other zero carbon sources that are commercial today or, over time, those that are in commercial demonstration today.

Focus on carbon, not technologies

Why focus on a goal of zero carbon energy rather than a specific set of technologies such as solar and wind?

First and foremost, because the dominant environmental objective must be, given the scientific evidence at hand, the fastest reduction of ***carbon emissions*** we can achieve at an affordable cost.

The world's climate, and Louisiana's, is changing rapidly. At present rates of change, half the world's population can expect, by 2030, to experience much different climates than we experienced in the late 20th century. [3]

I do not have to tell elected representatives of this great City the stakes in limiting catastrophic climate change which will likely include, among other things, an increase in

[2] Amy Harder, "States and companies ramp up clean energy targets," (May 7, 2019), https://www.axios.com/clean-energy-targets-states-companies-43b9a60e-c866-45c5-b1a1-d93005bddf3b.html

[3] See Diffenbaugh, Noah S., et al. "Quantifying the influence of global warming on unprecedented extreme climate events." *Proceedings of the National Academy of Sciences* 114.19 (2017): 4881-4886.

the intensity of tropical storms. Katrina was just one example of extreme weather we can expect from our warming of the oceans.[4] Global warming has increased the probability and severity of extremely hot and wet weather worldwide.
While the political shouting in Washington DC continues, there is a broad scientific consensus that these climatic changes are driven by the heating of Earth's atmosphere from carbon dioxide released by the burning of fossil fuels: oil, gas and coal.[5] If we are going to limit extreme climate change, we need to make every effort to utilize every non-fossil energy source we have as fast as we can.

Second, timing matters. Because of the high levels of carbon dioxide already in the atmosphere, the additional amounts that emitted in coming decades even if we begin a rapid decline in our emissions rate, and the century-scale natural decay rate of carbon dioxide, the only way to limit global warming is to reach net zero emissions of greenhouse gases in the coming decades. Indeed, as the recent report of the Intergovernmental Panel on Climate Change demonstrates, we will not just need to drop emissions to zero around mid-century; we will likely eventually need *negative* emissions technologies to *remove* carbon from the atmosphere.[6] (See Figure 1 below)

---

[4] See Trenberth, Kevin E., John T. Fasullo, and Theodore G. Shepherd. "Attribution of climate extreme events." *Nature Climate Change* 5.8 (2015): 725-730.

[5] See Intergovernmental Panel on Climate Change, *Understanding and Attributing Climate Change* (2007), http://www.ipcc.ch/publications_and_data/ar4/wg1/en/spmsspm-understanding-and.html

[6] IPCC, 2018. *Special Report: Global Warming of 1.5 °C.* "Chapter 00: Summary for Policymakers." Intergovernmental Panel on Climate Change. https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/

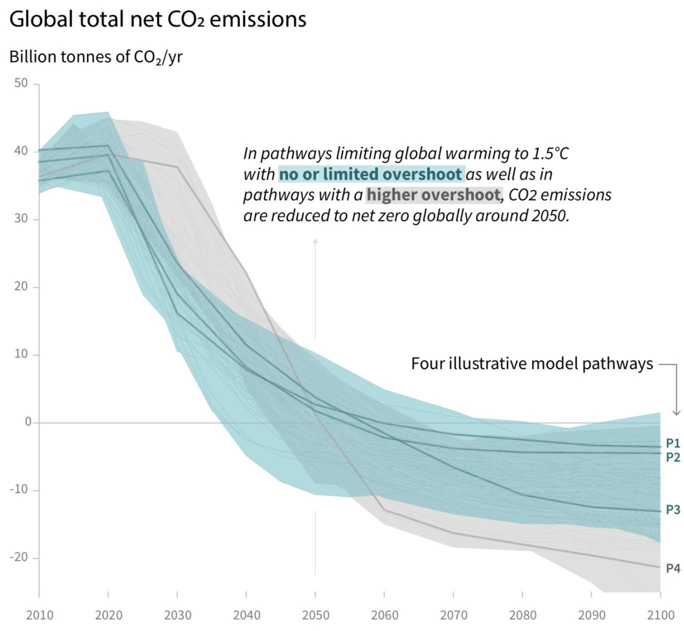


Figure 1: Carbon emissions reductions required by mid-century to manage climate change. Note “negative emissions” are required after mid-century. Source: see footnote 6.

Every molecule of carbon dioxide put in the atmosphere today will continue to warm the earth for centuries. So every molecule we emit today matters - essentially forever. And because carbon simply accumulates in the atmosphere, accelerating warming, the only way to avoid the worst climate change scenarios is, ultimately, to avoid emitting carbon altogether: We need a zero carbon energy system by 2050 or soon after and maximum feasible reductions possible until then.[7] It is likely that a combination of resources will achieve the needed targets faster than just a select few.

And, third, cost matters. While climate change is important, its remedies cannot come at any cost..

Dozens of recent studies have shown that, ***in achieving a very low carbon power grid, maintaining a diversity of zero and low carbon sources, especially those that are “dispatchable” or “firm,” available 24/7, results in significantly lower***

[7] See Rockström, Johan, et al. "A roadmap for rapid decarbonization." *Science* 355.6331 (2017): 1269-1271.

costs than just allowing on renewable energy such as wind and solar.[8] As I'll explain further in a minute, this is because of the seasonal nature of wind and solar output, which makes gap-filling through energy storage or back-up generation a very expensive proposition.

We have an abundance of potential technology options available now and likely to be available in the future to meet the goal of zero carbon emissions on the New Orleans power grid. Solar and wind energy costs have come down substantially in recent years. Energy storage that can balance variability of solar and wind has also dropped in price. New Orleans is blessed to be part of a region with abundant solar resources. Technologies are in place today, and more are coming forward, which can utilize natural gas for power generation without carbon dioxide emissions to the atmosphere, utilizing carbon capture and sequestration.[9] In addition, we have both existing nuclear energy plants, which today provide nearly all of New Orleans' carbon free electricity today, and the potential for future nuclear plants which may be less expensive and even safer than today's technology.[10] There may be the opportunity for advanced geothermal power using injection of water into deep hot rock formations, which could provide on-demand steam to generate electricity.[11] And a good deal of attention is going to electricity systems that allow combustion of zero-carbon fuels such as hydrogen or ammonia derived from electrolysis from zero carbon energy, steam reforming of natural gas combined with carbon capture, or nuclear energy.[12]

---

[8] See Jenkins, Jesse D., and Samuel Thernstrom. "Deep Decarbonization of the Electric Power Sector Insights from Recent Literature." *Energy Innovation Reform Project* (2017);
Sepulveda, Nestor A., et al. "The role of firm low-carbon electricity resources in deep decarbonization of power generation." *Joule* 2.11 (2018): 2403-2420;

[9] See R. Service, "Goodbye smokestacks: startup invents zero emissions fossil power," *Science,* May 24, 2017, https://www.sciencemag.org/news/2017/05/goodbye-smokestacks-startup-invents-zero-emission-fossil-fuel-power

[10] See Clean Air Task Force, "Advanced Nuclear Energy: Need, Characteristics, Projected Costs, and Opportunities" (April 2018), https://www.catf.us/resource/ane-need-characteristics-project-costs/

[11] See https://www.energy.gov/eere/geothermal/how-enhanced-geothermal-system-works and https://www.hotrockhero.org

[12] See Clean Air Task Force, "Fuels Without Carbon: Prospects and the Pathway Forward for Zero-Carbon Hydrogen and Ammonia Fuels" (December 2018) https://www.catf.us/resource/fuels-without-carbon/

If we keep all of our options and work to make them even more viable, we stand a good chance of meeting a mid-century zero carbon target. Nations and regions such as Sweden, France, Ontario, and Brazil have already achieved very low electricity carbon emission rates through use of some of these technologies, chiefly hydroelectric, wind and nuclear energy.

Why favor diversity: a New Orleans example

Here I want to focus specifically on the importance of keeping the door open for “firm” zero carbon energy sources to play a significant role in New Orleans’ electric system as part of the design of a zero-carbon electricity standard. Firm sources are those that are available on demand and are not dependent on weather.

It may be technically possible, as some have argued,[13] to power New Orleans’ electric grid entirely or almost entirely, on renewables such as solar and wind energy. However, the evidence suggests this would be a highly risky path to mandate today.

Above all is the issue of cost. As alluded to earlier, a recent review of 40 studies concluded that combining wind and sun with firm energy, rather than relying exclusively or overwhelmingly on wind and sun, would substantially reduce the cost of deeply reducing carbon emissions in the electricity sector.[14] A more recent detailed analysis of the role of firm energy in a Northeast US system found a dramatic cost difference between electric systems driven by wind and sun, and systems with substantial amounts of firm zero carbon energy in the mix.[15] Other non-cost risks attach to a wind- and sun-dominated strategy, which I will address later. But let’s now focus on cost, using New Orleans and California as well as some national data to illustrate.

---

[13] Jacobson, Mark Z., et al. "100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for the 50 United States." *Energy & Environmental Science* 8.7 (2015): 2093-2117.

[14] Jenkins, Jesse D., Max Luke, and Samuel Thernstrom. "Getting to Zero Carbon Emissions in the Electric Power Sector." *Joule* 2.12 (2018): 2498-2510. (Link here)

[15] Sepulveda, Nestor A., et al. "The role of firm low-carbon electricity resources in deep decarbonization of power generation." *Joule* 2.11 (2018): 2403-2420. (“Across all cases, the least-cost strategy to decarbonize electricity includes one or more firm low-carbon resources. Without these resources, electricity costs rise rapidly as CO_2 limits approach zero. Batteries and demand flexibility do not substitute for firm resources. Improving the capabilities and spurring adoption of firm low-carbon technologies are key research and policy goals.”) (Link here).

It is commonplace to say that "the wind doesn't always blow and the sun doesn't always shine." But this statement does not capture the real challenge of a wind- and sun-dominated electric system. Wind and sun don't just vary on ***daily*** cycles; they vary substantially over ***weekly*** and ***monthly*** periods.

Let's first take the example of solar energy – where most of the focus of discussion has been in New Orleans.[16] As shown below in Figure 2, solar energy[17] shows a seasonal pattern of production – with production noticeably lower in the fall and winter months.

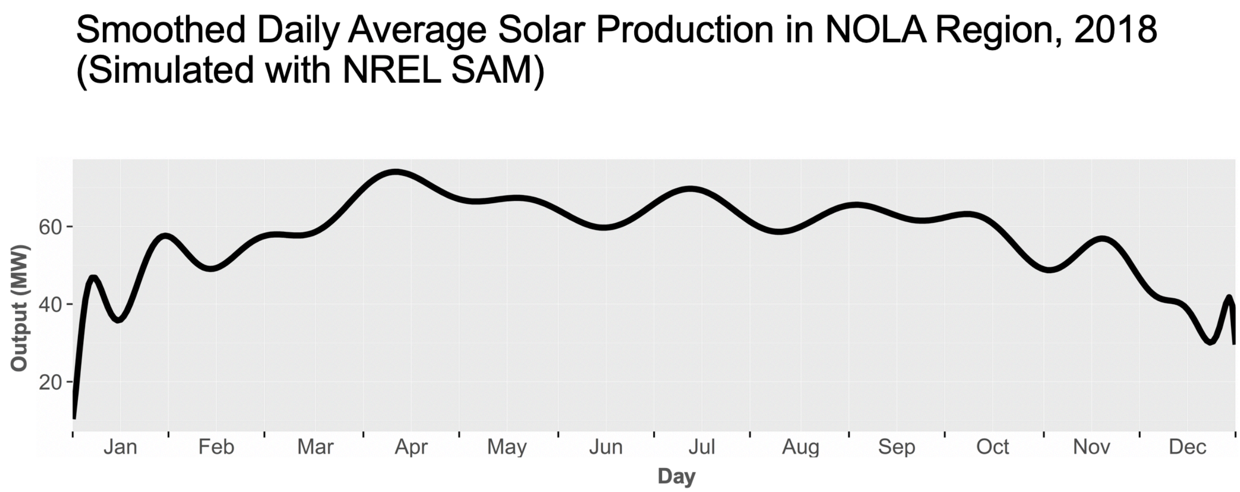


Figure 2: Monthly variance of centralized solar PV output in New Orleans, assuming 100 MW of installed capacity. Source: CATF, from data sources discussed in Appendix 1.

Let's now look at the seasonal demand of the City. Shown in Figure 3 below:

---

[16] As noted below, the wind resource in the region is generally inferior to solar and, and, as part of a 100% variable renewable energy scenario, could make the daunting numbers for solar, described below, even worse.

[17] Here we discuss the production pattern for centralized solar PV but the results would be the same for rooftop PV.

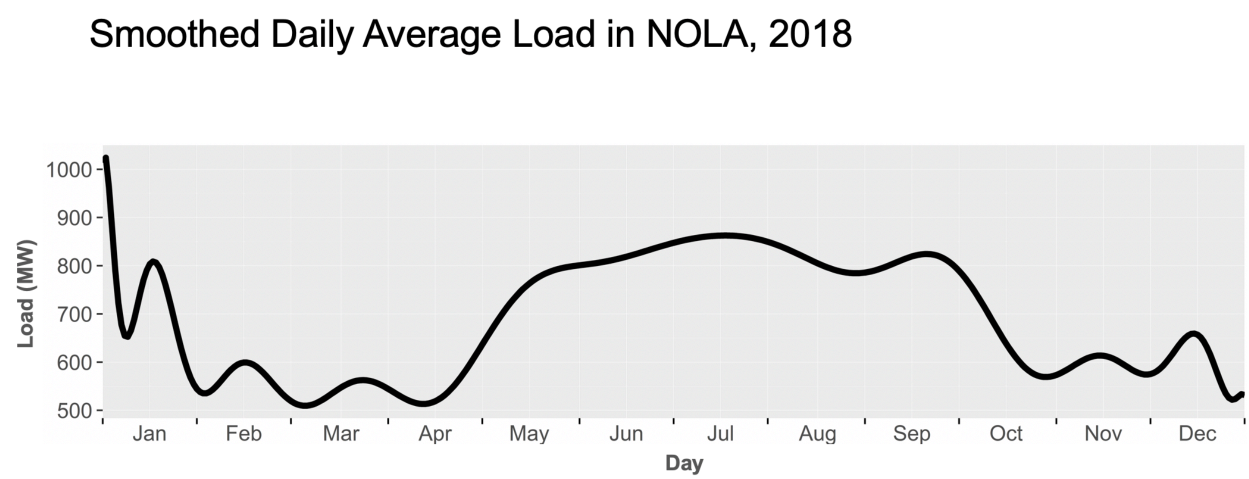


Figure 3: Average daily electric demand, smoothed by week. Source: CATF from data sources in Appendix 1.

At first blush, there would appear to be good correlation between solar availability and City demand. But what happens when we contract for enough solar to cover 100% of the City's annual electric demand? This is shown in Figure 4 below, where we overlay NOLA demand and solar supply. We see there are some significant mismatches: overproduction in the Spring, and significant deficits in the Spring, as well as in June and August and September.

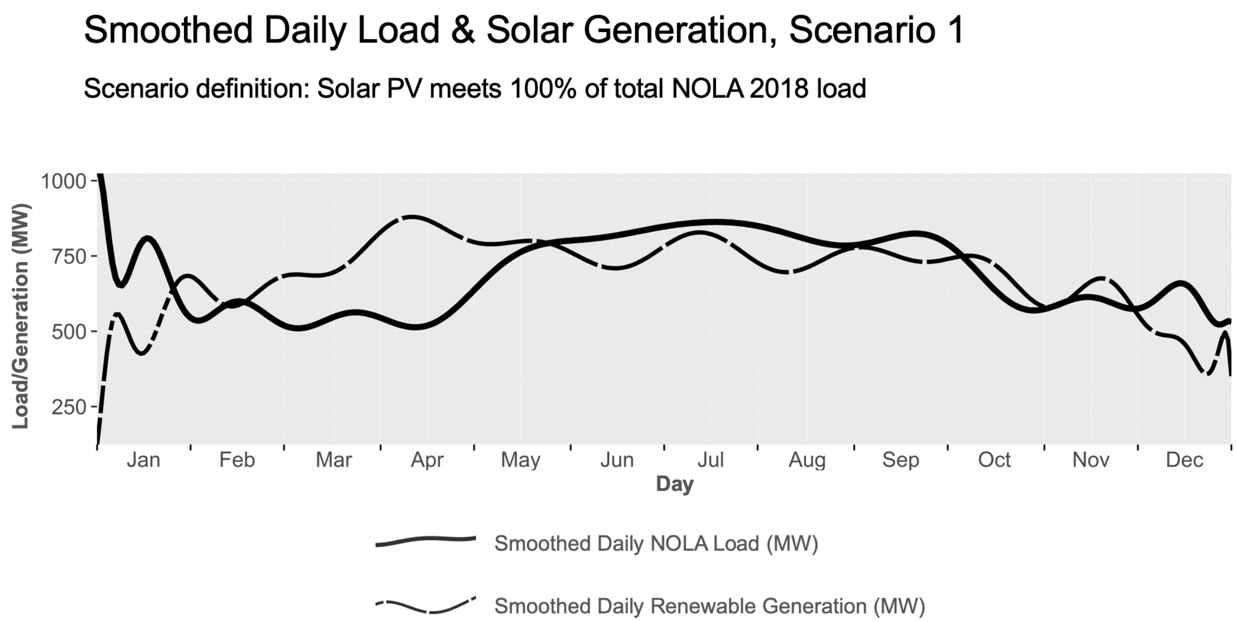


Figure 4: NOLA load (heavy black line) versus solar production (dotted line) assuming solar meets 100% of annual production. Source: CATF from data sources in Appendix 1.

What about storage?

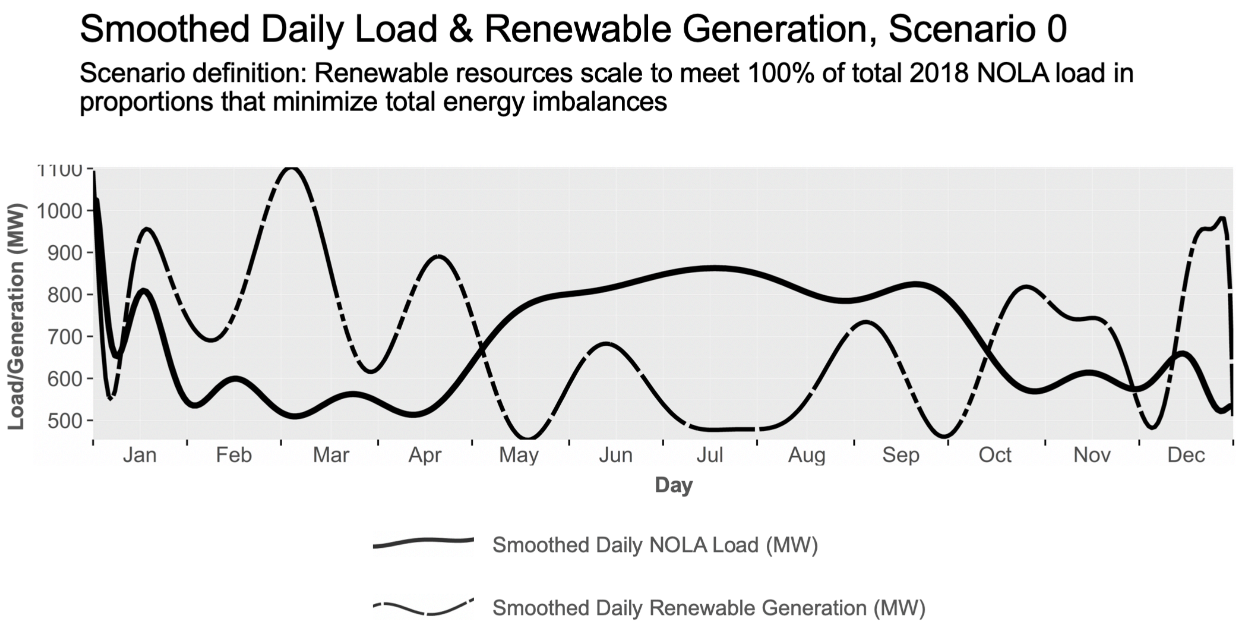
In theory, we could use energy storage to harvest surpluses and use them in deficit periods. But this is where cost comes in. The sheer amount of storage that must be built to capture maximum surplus, and then used at a fraction of its capacity, becomes cost prohibitive, even at very low storage costs.

In the case of a 100% solar commitment to meet NOLA's load, we would need 460,000 MWH of storage. Storing that energy will first of all incur a very large capital expense. The US Department of Energy estimates the current cost of grid scale energy storage to be just under $500/kwh of capacity.[18] Let's assume we drop that cost by 80% to $100/kwh. The total cost of such a battery storage system would be ***$46 billion, or roughly eighty times the City's annual electric bill of $570 million.*** This excludes, of course, the cost of the solar energy installations and associated transmission and distribution infrastructure. Even if storage costs were to drop by fifty times to $10/kwh, a target which has not been demonstrated to be feasible, the storage costs of such an all-

[18] US EIA, "U.S. Battery Storage Market Trends "(May 2018) https://www.eia.gov/analysis/studies/electricity/batterystorage/pdf/battery_storage.pdf

solar system would be $4.6 Billion, or eight times the city's total annual electric costs – again, without counting the cost of the solar installations themselves.

Nor is the situation improved by mixing solar with wind energy. Figure 5 below shows the load and production patterns of a system which includes onshore and offshore wind as well as solar, in a manner that minimizes seasonal imbalances. The figure shows even greater surpluses and deficits, which would require 960,000 MWH of storage capacity – at cost of $96 Billion.



[3]

Figure 5: NOLA load (heavy black line) versus optimized solar and wind production (dotted line) assuming solar and wind meet 100% of annual production. Source: CATF from sources in Appendix 1.

But just to cite these astronomical storage costs in some way understates the problem, because this storage capacity would be used at a very low rate – just a few percent of capacity in an average year. That is because only a small amount of the storage capacity would be used regularly to balance daily variations in solar output. Most of the storage capacity would need to be built to store peak seasonal surplus and thus only cycle seasonally. That means large capacity divided by little use, resulting in very large per unit costs for stored energy.

An analysis of a similar surplus and deficit problem in California, depicted in Figure 6 below, shows that the escalating costs of storage per unit output required, as wind and sun percentages become higher, drive very large system cost increases of roughly tenfold as wind and sun go from 50% of total supply to 80%, and roughly thirty-fold as wind and sun provide all system energy.

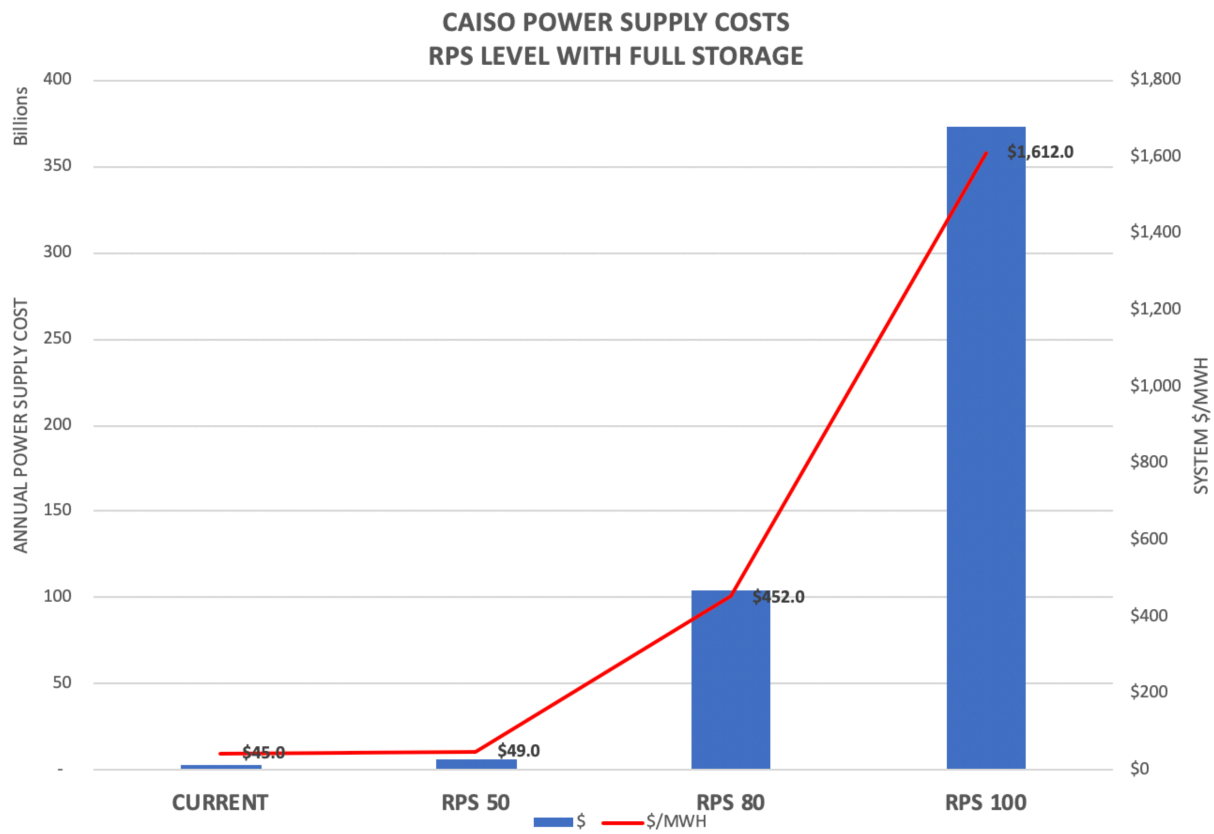
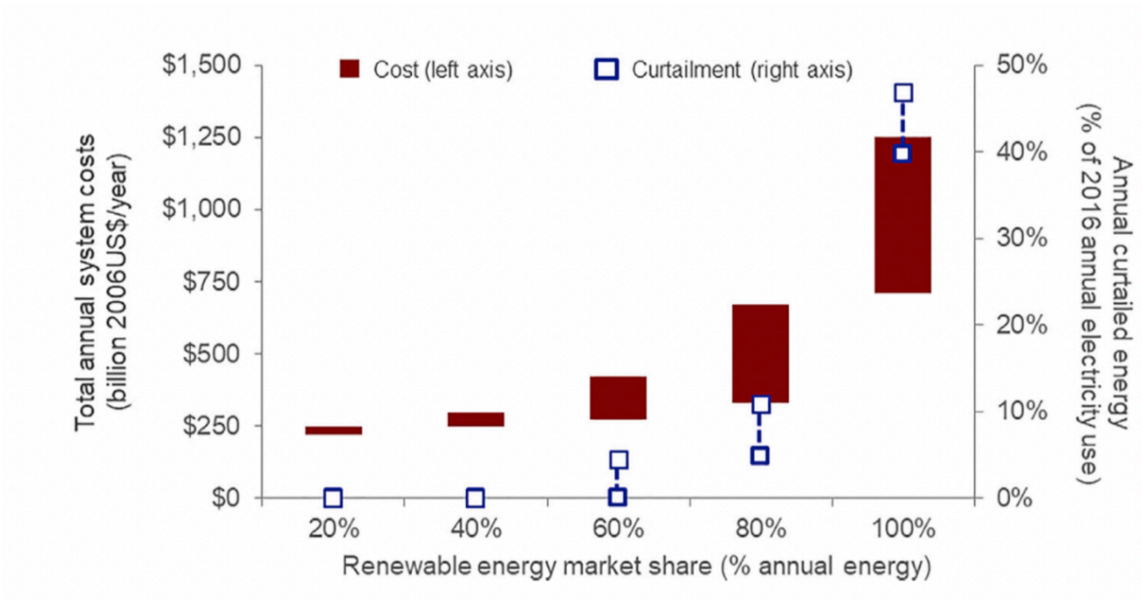


Figure 6. Source: Clean Air Task Force calculated from California Independent System Operator data

A similar cost escalation pattern has been seen in national studies, such as a recent one conducted by National Renewable Energy Laboratory analyst Bethany Frew, which assumed a transcontinental electric grid and optimal demand response mechanisms (see Figure 7 below):



Jenkins et al., Getting to Zero Carbon Emissions in the Electric Power Sector, Joule (2018), https://doi.org/ 10.1016/j.joule.2018.11.013, adapted from Frew, Bethany A., Jacobson, M. et al. "Flexibility mechanisms and pathways to a highly renewable US electricity future." *Energy* 101 (2016): 65-78.

Figure 7

Keeping options open

None of this is to gainsay a substantial role in the future for solar and perhaps wind energy in cost-effectively achieving a zero-carbon electricity supply for New Orleans. And it is always possible that technological breakthroughs could occur that would make it possible to increase the percentage of economically affordable wind and solar to very high levels, such as near-zero cost electricity storage.[19] But at this stage CATF believes

[19] It is sometimes argued that “demand response,” that is, the ability to curtail customer load, will alleviate the surplus and deficit problems outlined in this testimony. But these agreements are generally understood to require interruptions for a few hours a few times a year. By contrast, as Figures 4 ad 5 demonstrates, 100% wind and solar scenarios produce power deficits equal to 25% or more of peak demand ***over weeks and months***. It is not likely that New Orleans businesses, industries and consumers would effectively agree to seasonal curtailments, or that this would be good for the New Orleans economy if they did.

It also may be argued that interconnection of New Orleans to other control areas will alleviate the surplus and deficit problem. While greater interconnections can help at the margins, we must assume that other regions will be pursuing similar levels of decarbonization and are likely to adopt similar levels of variable energy. And wind and solar tends to be highly correlated on a daily and weekly across the nation. As a it would be bad public policy to ***assume*** such breakthroughs will occur in time to make a difference.

The unavoidable fact is that there are real risks with all single technological pathways to zero carbon. Nuclear energy, while comprising the vast majority of the nation's zero carbon energy today, has recently experienced cost overruns in the building of new first of a kind U.S. plants, and continues to face public concern around waste disposal and safety. The use of natural gas with carbon capture and storage to generate power, although based on well-demonstrated technologies, will likely face challenges from those opposed to the use of any fossil fuels as a matter of principle. And a large build-out of wind and solar energy capacity, along the substantial increase in transmission capacity that would be necessary to serve a wind- and sun-dominated system, may well face substantial and well organized opposition which has already emerged around relatively small scale proposals. Hard trade-offs may be required.

Conclusion

There is no more pressing environmental issue today than managing earth's climate. That will require a drastic reduction in carbon emissions within a few short decades. The power sector will play a significant role in that effort. New Orleans can help lead the way by focusing on policies that speed maximum reduction in carbon at the lowest cost. No one knows yet what an economically and practically feasible zero carbon grid in 2050 will look like in New Orleans. Precisely because of that fact, CATF urges you to follow the examples of some of the nation's leading environmentally progressive states such as California, Colorado and New Mexico and ***enact a zero carbon clean energy target for midcentury***, allowing many technology paths to remain open to offer the greatest chance of success.

---

result, even with seamless national interconnection, as is assumed in the study referenced in Figure 7, substantial surplus and deficit problems are experienced at very high levels of wind and solar, with the resulting cost impacts shown in the figure.

Sincerely,

Armond Cohen

Executive Director

Clean Air Task Force

M: 617-680-0341

Appendix 1: Methodology for Figures in Testimony

We obtained hourly electrical load data for New Orleans for the year 2018, from Entergy. We simulated hourly electricity generation data for wind (onshore and offshore) and solar photovoltaic units using National Renewable Energy Laboratory (NREL) System Advisor Model (SAM)[20] in the following manner:

- For onshore wind, we simulated wind farms of 30 MW each in central locations in each of four states: Louisiana, Arkansas, Mississippi, and Alabama. None of the four states have significant capacities of installed wind so 30 MW was chosen arbitrarily.
- For offshore wind, we simulated a single wind farm in the Gulf of Mexico 50 miles from New Orleans.[21] While no such offshore windfarm is planned, we selected such a location as a plausible future location of offshore wind development, should such development occur. We simulated an offshore wind farm with a 30 MW capacity.
- For solar photovoltaic, we simulated solar arrays in central locations of each of four states: Louisiana, Arkansas, Mississippi, and Alabama. The simulated solar arrays' capacities are the same capacities of the total installed solar photovoltaics in each state in 2017. Such values were obtained from the U.S. Energy Information Administration.

We loaded the hourly data into R programming language. We developed two hypothetical scenarios where renewable energy meets 100 percent of New Orleans' total annual 2018 load. Our scenarios are:

1. Optimized scenario ("Scenario 0"): onshore wind, offshore wind, and solar photovoltaics scale to meet 100% of total 2018 NOLA load in proportions that minimize total energy imbalances
2. Solar only ("Scenario 1"): solar photovoltaics meet 100% of total NOLA 2018 load

In each scenario, we scale renewable energy generation so total annual renewable energy generation exactly meets total annual NOLA load. Hourly wind and solar generation scale in proportion to their hourly output in 2018. For example, if in a given

[20] https://sam.nrel.gov/

[21] https://www.equinor.com/en/what-we-do/empirewind.html

scenario wind meets a total demand of 10 MWh in two hours, and its actual generation in NOLA during those two hours were 1 MWh and 3 MWh, its generation in the two scenario hours are 2.5 MWh and 7.5 MWh. In other words, for each scenario and each hour *h*, renewable energy output equals actual output of the renewable resource in hour *h*, times the ratio of the total annual demand and total annual actual renewable energy output.

We use R programming language, and a related programming package “ggplot2,” to create heat maps that show the percent of NOLA load met by renewable resources in each hour of every day of 2018, in each 100 percent renewable energy scenario. We also use R and ggplot2 to plot time series’ of daily average NOLA loads and renewable energy output in each 100 percent renewable energy scenario. Additionally, we use R and ggplot2 to plot time series’ of smoothed daily average NOLA loads and renewable energy output in each 100 percent renewable energy scenario. We smooth daily average time series’ with least squares smoothing (i.e., fitting polynomials to daily average time series’). Smoothed time series’ conceal more drastic variation in daily and hourly time series’. Finally, we plot daily average energy surpluses and deficits in each scenario.