December 14, 2017

Dr. Vincent E. Price, President
Duke University
Durham, North Carolina

Subject: Proposed CHP Plant and Alternatives

Dear President Price:

NC WARN congratulates you on your selection as the president of Duke University and welcomes you as our neighbor in western Durham. As president of one of the nation's leading universities, you are in a position to implement projects that reflect Duke University's leadership role and that inspire students, other campuses and industry.

A central challenge of our time is climate change, caused largely by the use of fossil fuels for power generation and transportation. In the face of this momentous and unprecedented challenge, Duke University is considering increasing the combustion of natural gas on campus by 60 percent,[1] in the form of a 21-megawatt (MW) combined heat and power (CHP) plant that would be owned and operated by Duke Energy. This project would exacerbate climate change, not help slow it. We urge you to end CHP plant contract negotiations with Duke Energy. We also urge you to commit to an open dialogue with the campus and the people of Durham, the communities that would bear the air pollution and economic burdens imposed by the CHP plant, with the objective of defining a campus energy solution that is: 1) truly path-breaking, 2) addresses the climate challenge and 3) is worthy of Duke University's leadership reputation.

With assistance from consultant Bill Powers, P.E. of San Diego, we have prepared this update to earlier reports and communications with the University.

The Proposed CHP Plant Is the Wrong Project for Duke University

At the time Duke Energy filed its application to build the plant with the North Carolina Utilities Commission in October 2016, University leaders did not realize the CHP plant would burn mostly shale gas from regional gas fields employing hydraulic fracturing. After NC WARN pointed out the source of the fuel, University officials emphasized that burning shale gas on

[1] This would also increase on-campus greenhouse gas emissions (GHG) by over 60 percent, considering only CO_2 emissions. When upstream venting and leakage of methane from shale gas production is accounted for, GHG emissions associated with the CHP plant would be in the range of 40 percent greater than that of Duke Energy grid power. See Attachment 1, NC WARN, *Analysis of and Alternatives to the Proposed Duke University Natural Gas-Fired CHP Plant*, October 24, 2016, pp. 15-16 (mid-range methane leakage case).

campus is not what the University wants. This issue alone should be sufficient to end contract negotiations with Duke Energy.

The CHP plant would not reduce the University's reliance on emergency diesel generators to support critical facilities during a grid power outage. The University has 13 megawatts (MW) of emergency generators to provide reliable back-up power. These generators are required by North Carolina law to serve critical hospital loads and would not be replaced by the CHP plant.

The hope that the CHP plant built might someday be converted to burn biogas derived from swine waste is highly speculative due to technical, economic and social justice challenges that are many years from being resolved after more than a decade of concerted effort. While we share the University's concern about methane emissions from swine waste (along with the other pollutants harming local residents for many years), and appreciate the University's continuing efforts to solve that seemingly intransigent challenge, we urge you to keep that work separate from the question of a Duke Energy CHP plant on campus.

The CHP proposal itself is far from cutting-edge even for CHP technology. Duke Energy has chosen not to use the best available air pollution controls for the proposed CHP plant. Nitrogen oxide (NO_x) emissions would be at least ten times greater, per kilowatt-hour, than those from a CHP plant of similar design using state-of-the-art NO_x controls, such as at Cornell University.

NC WARN provided Duke University with two analyses, in October 2016 and January 2017, outlining deficiencies in the CHP proposal and superior alternatives. The first of these is "*Analysis of and Alternatives to the Proposed Duke University Natural Gas-Fired CHP Plant*," October 24, 2016. The second is "*A Nitrogen Oxide Limit of 2.5 ppm or Less Is the Best-In-Class Control Level for the Proposed Duke University 21.7 MW CHP Plant, Not 25 ppm as Proposed by Duke Energy*," January 9, 2017. They are attached to this letter as **Attachments 1 and 2**.[2]

Cutting-Edge Universities and Utilities Are Focusing on Solar Power and Batteries as the Climate Solution

The spectacular declines in the cost of solar power and batteries in recent years are revolutionizing the options available to cost-effectively provide clean, reliable electric power. Even Duke Energy has apparently recognized this, with an executive recently admitting that battery systems "will blanket the U.S." within a few years.[3] Duke Energy is moving into batteries in some states, but only at utility scale. In its monopoly territories, it prefers to build gas-fired peaking plants and is not openly planning investments in batteries for homes and other on-site uses in any states.

---

[2] The issue of steam production from the CHP plant is not covered in this report. That issue was addressed in the NC WARN October 2016 analysis (see Attachment 1).
[3] Forbes, *In 5 Years, Batteries Will Blanket The U.S., Duke Executive Says*, October 22, 2017.

Duke Energy has also highlighted that medical centers are well suited for cost-effective battery deployments.[4] As a result, leading universities and utilities are focusing on solar and battery solutions over conventional power approaches like CHP plants. Notable examples of this trend include Stanford University, Green Mountain Power, Kauai Island Electric Cooperative, Minster Municipal Utility and Brunswick Electric Membership Corporation. The innovative clean power solutions being developed by these pioneers are described in the following paragraphs.

Stanford University

Stanford University once relied on CHP and has now moved past this technology to all-electric technologies. Stanford cited mechanical complications, and a lack of adequate reliability, as reasons for closing its CHP plant. Officials indicated that the University's CHP plant experienced unscheduled outages one to three times per year for several hours at a time.[5] Stanford opted for an all-electric combined heating and cooling plant, along with considerable investment in on- and off-campus solar installations, and it now has 4.5 MW of on-campus solar on rooftops and parking lots and 67 MW of off-campus solar.[6,7] These solar resources meet over 50 percent of Stanford University's annual electricity demand.

Green Mountain Power (Vermont)

Green Mountain Power, an investor-owned utility in Vermont, provides retail customers with 14 kWh Tesla Powerwall™ battery storage units for $15 per month, or a one-time charge of $1,500, in 2017.[8] Green Mountain Power can offer these storage units to customers at such a low cost by: 1) monetizing the grid value of aggregating the output of these battery storage systems to serve as a virtual peaking power plant and 2) providing grid services like frequency regulation.

A primary motivator for the battery program is to enable customers to ride through relatively frequent seasonal short-duration blackouts. Green Mountain Power also asserts that deploying batteries and grid software, combined with use of smart thermostats, smart water heaters, solar panels and other distributed resources it is integrating in pilot projects, will be cheaper than more typical capital improvements on the distribution system.[9] The July 31, 2017 Green

---

[4] Charlotte Business Journal, *Experts see Duke Energy poised for rapid growth of battery storage on the grid*, October 2, 2017.

[5] Attachment 1: NC WARN, *Analysis of and Alternatives to the Proposed Duke University Natural Gas-Fired CHP Plant*, October 24, 2016, Attachment A, "Case Study: Stanford Energy Systems Innovation (SESI)."

[6] See: https://news.stanford.edu/2017/04/17/sun-rooftop-photovoltaic-panels-electricity-stanford/.

[7] See: https://news.stanford.edu/2016/12/05/stanford-unveils-innovative-solar-generating-station/.

[8] Energy Storage News, *Tesla launches first aggregated 'virtual power plant' in US*, May 16, 2017: https://www.energy-storage.news/news/tesla-launches-first-aggregated-virtual-power-plant-offering-in-us. Green Mountain Power was the first utility in the U.S. to offer (Tesla) Powerwalls to customers with a 'no money down' option in a business model that depended on the customer then making some of the batteries' capacity available to the utility to use for grid-balancing or peak demand reduction.

[9] GreenTech Media, *Tesla and Green Mountain Power: Get Your Behind-the-Meter Battery for $15 a Month,* May 12, 2017, https://www.greentechmedia.com/articles/read/tesla-and-green-mountain-power-get-your-behind-the-meter-battery-for-15-a-m.

Mountain Power application to the Vermont Public Utility Commission for this program is provided as **Attachment 3**.[10]

Kauai Island Utility Cooperative

Kauai Island Utility Cooperative (KIUC), a public utility with 30,000 customers and peak load and annual energy demand of 78 MW and 430 million MWh, respectively,[11,12] has taken the lead in transitioning from a fossil fuel-based grid to a model built on solar combined with battery storage. The KIUC peak load and annual energy demand are similar to those of Duke University. KIUC will replace about 40 percent of overall demand provided by fossil fuels with renewables in the 2015 to 2025 timeframe, increasing the percentage of renewables to 76 percent in 2025. KIUC has two major projects combining solar and battery storage: 1) the SolarCity project consisting of 20 MW of solar and 52 MWh of battery storage that went online in 2017, and 2) the AES project consisting of 28 MW of solar and 100 MWh of battery storage that will be online in 2018.

Minster Municipal Utility

Minster, Ohio, is another example of innovation by a small municipal utility. Minster's normal load is about 16 MW, and its peak load is about 24 MW. The Minster municipal utility contracted for a 3 MW solar array and a 3 MWh battery energy storage system with 7 MW peak output that became operational in December 2015 under a power purchase agreement.[13]

The power purchase agreement sets the Minster utility's price for solar energy-generated electricity at $0.07 per kWh. The resulting all-in price with storage of $0.095 per kWh matches the utility's average retail electricity rate.

The economic benefit to the Minster utility is achieved through three specific services provided by the energy storage system. The project was contracted with the regional transmission operator PJM to bid into PJM's frequency regulation market.[14] The batteries also provide the utility with both 1) peak-shaving capability and 2) power quality stabilization and voltage regulation.

[10] See also: New York Times, *Utility Helps Wean Vermonters from the Electric Grid*, July 29, 2017: https://www.nytimes.com/2017/07/29/business/energy-environment/vermont-green-mountain-power-grid.html?emc=eta1.
[11] MIT Technology Review, *Hawaii's Solar Push Strains the Grid: Kauai's utility takes a second stab at battery storage as solar heads toward 80 percent of peak power*, January 20, 2015, https://www.technologyreview.com/s/534266/hawaiis-solar-push-strains-the-grid/.
[12] KIUC, "HRS [§269-16.4] Annual Fuel Mix Disclosure," http://kiuc.coopwebbuilder2.com/sites/kiuc/files/PDF/rates/FuelMixDisclosure_2016.pdf. 2015 sales = 432,084 MWh.
[13] Utility Dive, *Inside the first municipal solar-plus-storage project in the US,* July 5, 2016: http://www.utilitydive.com/news/inside-the-first-municipal-solar-plus-storage-project-in-the-us/421470/.
[14] PJM website: http://www.pjm.com/.

Brunswick Electric Membership Corporation

Brunswick Electric Membership Corporation, a North Carolina nonprofit rural cooperative, is following a model comparable to the Minster approach. Twelve separate solar with storage projects are being developed in Brunswick EMC territory that will have a combined storage capacity of 12 MWh. The projects are under construction and expected to be online by the end of 2017. The contracts will utilize a new power purchase agreement structure that allows the cooperative to purchase solar energy at its avoided cost while realizing the economic benefits of the battery storage.[15]

Duke University Should Expand on the Solar Target in Its Climate Action Plan and Aggressively Develop Battery Storage

Duke University has a large amount of solar photovoltaic potential, up to 60 to 80 MW on West Campus alone (see Figure 1). Market pricing for solar power in late 2017 is substantially lower than the level Duke University officials indicate they need to develop solar power on campus[16] – and lower than Duke University is paying Duke Energy for grid power. We recommend that, as a first step toward updating the University's 2009 *Climate Action Plan*, the University conduct a comprehensive assessment of on-campus solar potential with particular focus on rooftops and parking facilities.

In order to displace the non-nuclear component of the Duke Energy Carolinas power mix, Duke University would need to displace approximately 35 to 40 percent of its grid power demand with renewable energy.[17] In 2012, the year the Duke University *Climate Action Plan* indicated that 4 MW of solar power would be in operation on campus,[18] the total Duke University annual electricity demand was about 450 million megawatt-hours (MWh) per year. The University is making strides in reducing loads through energy efficiency (EE) and demand response (DR) measures. Assuming the University continues to aggressively pursue EE and DR, with a target to reduce annual electricity demand by 25 percent by 2030 over a 2012 baseline,[19] thereby stabilizing demand at no more than 340 million MWh per year, the fossil fuel component of this electricity usage will be about 130 million MWh per year.[20] Approximately 93 MW of solar

---

[15] Utility Dive, *Cypress Creek to develop 12 solar + storage projects for North Carolina co-op*, July 5, 2017: http://www.utilitydive.com/news/cypress-creek-to-develop-12-solar-storage-projects-for-north-carolina-co-/446290/.

[16] During multiple discussions with NC WARN in 2016, Duke University officials indicated that the University would purchase solar with a production cost of $0.08/kWh if available. The approximate production cost of commercial rooftop or parking lot solar in North Carolina at the end of 2017 is approximately $0.05/kWh. See: NC WARN, *NC Clean Path 2025*, August 2017, Tables 18a and 18b, p. 43.

[17] Duke Energy Carolinas 2015 power mix: nuclear = 61%, coal = 27%, natural gas = 11%, renewable and Other = 1%. See: DEC 2016 IRP Annual Report, Sept 1, 2016, p. 80.

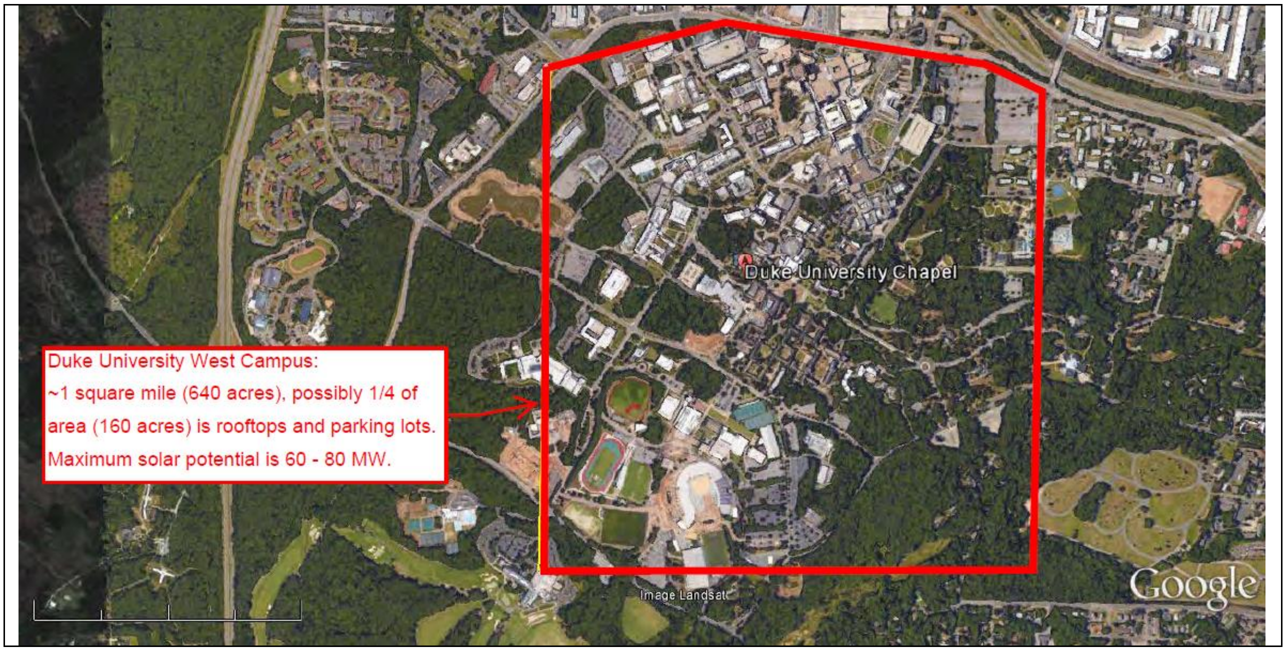
[18] Duke University, *Duke Climate Action Plan*, October 15, 2009, p. 63.

[19] The *Climate Action Plan* targeted a 15 percent reduction in electricity demand by 2030 via energy conservation measures compared to a 2007 baseline demand of 350 million MWh-yr. This is equivalent to a 2030 demand of approximately 300 million MWh-yr. See: Duke University, *Climate Action Plan*, October 15, 2009, pp. 62-63.

[20] 0.38 x 340 million MWh-yr = 129 million MWh-yr.

power would be necessary to displace 130 million MW per year of electricity demand with solar power.[21]

Figure 1. Rooftop and Parking Lot Solar Potential on Duke University West Campus[22]



An ambitious Duke *Climate Action Plan* could achieve a solar installation rate of 4 MW per year over the next five years, reaching 20 MW of installed solar power by 2022.
An increase to a solar installation rate of 8 MW per year beginning in 2023 would allow the University to reduce the fossil fuel component of its grid power supply by nearly 50 percent by 2025.[23] Continuing at this solar installation rate of 8 MW per year through 2030 would offset nearly all of the fossil fuel component of the grid power purchased from Duke Energy by 2030.[24]

Not all of this solar capacity necessarily needs to be installed on the University's East or West Campuses. The City of Durham has memorialized its right to supply power within its jurisdiction in its 2005 franchise agreement with Duke Energy.[25] Duke University may determine that the readily achievable on-campus solar potential is not sufficient to meet the 93 MW solar target

---

[21] 1 MW of installed solar capacity would produce about 1,400 MWh per year of electricity. See: NC WARN, *NC Clean Path 2025*, August 2017, p. 68, footnote iv: http://www.ncwarn.org/wp-content/uploads/NC-CLEAN-PATH-2025-FINAL-8-9-17.pdf. 130 million MWh-yr ÷ 1,400 MWh-yr/MW = 93 MW.

[22] Solar potential calculation assumes use of high-efficiency solar panels, such as SunPower or equivalent.

[23] 2018-2022 solar capacity additions = 20 MW. 2023-2025 solar capacity additions = 24 MW. 44 MW ÷ 93 MW = 47 percent (reduction in fossil fuel component of power mix).

[24] Solar additions through 2025 = 44 MW. Solar additions 2026-2030 = 40 MW. 84 MW ÷ 93 MW = 90 percent reduction in fossil fuel component of power mix.

[25] City of Durham Ordinance No. 13168, *An Ordinance Granting a Franchise to Duke Energy Corporation*, approved by Durham City Council on October 3, 2005. Addendum, Paragraph 3.

without major ancillary impacts, such as cutting down forest cover on the campus to make land available for solar arrays. To address this potential challenge, the University should begin discussions now with the City of Durham about contracting for solar power from sites within Durham city limits that may be more suitable than available sites on the University campus.

Duke University is an excellent site to implement large-scale distributed battery storage in North Carolina. Duke Energy has been publicly extolling the virtues of battery storage in 2017, stating that medical centers are excellent hosts for battery power, and that in five years the country will be blanketed with battery projects.[26,27] NC WARN recommends that the University replicate and expand on the Green Mountain Power distributed battery project in collaboration with Duke Energy.

Batteries located in individual campus buildings will not require $7 million in grid islanding circuitry, Duke University's proposed contribution to the CHP project, to isolate from the Duke Energy grid. Under the same economic parameters established in the Green Mountain Power battery program, the $7 million that Duke University is currently proposing to invest in the CHP project would result in 23 MW of battery storage on campus.[28]

Conclusion

Duke University is at a crossroads. It can pursue a status quo gas-fired project that exacerbates the climate crisis, or it can embrace the role of clean energy pioneer, as Stanford University has, and lead North Carolina and the nation in developing clean, reliable and cost-effective energy solutions. NC WARN would be honored to partner with you in exploring a clean energy solution for the campus that is worthy of the University's reputation as a national leader in academics and innovation.

Sincerely,

Jim Warren
Executive Director

cc: Mayor Steve Schewel, City of Durham

---

[26] Charlotte Business Journal, *Experts see Duke Energy poised for rapid growth of battery storage on the grid*, October 2, 2017.
[27] Forbes, *In 5 Years, Batteries Will Blanket The U.S., Duke Executive Says*, October 22, 2017.
[28] 2,000 Powerwall units x $1,500/unit = $3 million. This provides 10 MW of aggregated peak output for 2 to 2.5 hours. A $7 million investment would provide: ($7 million/$3 million) x 10 MW = 23 MW of aggregated peak output for 2 to 2.5 hours.