Moving North Carolina Forward: The Case for Local Solar-Plus-Storage

An NC WARN proposal with technical support from Bill Powers, P.E.

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Executive Summary

North Carolina has a large and virtually untapped potential for local solar power that could be deployed quickly, inexpensively and equitably while benefiting renewable energy companies and speeding realization of the state's zero-carbon mandate for the electricity sector. In this report "local solar" is used to mean solar installations with storage located near the point of use and connected to the electricity grid at the neighborhood level.

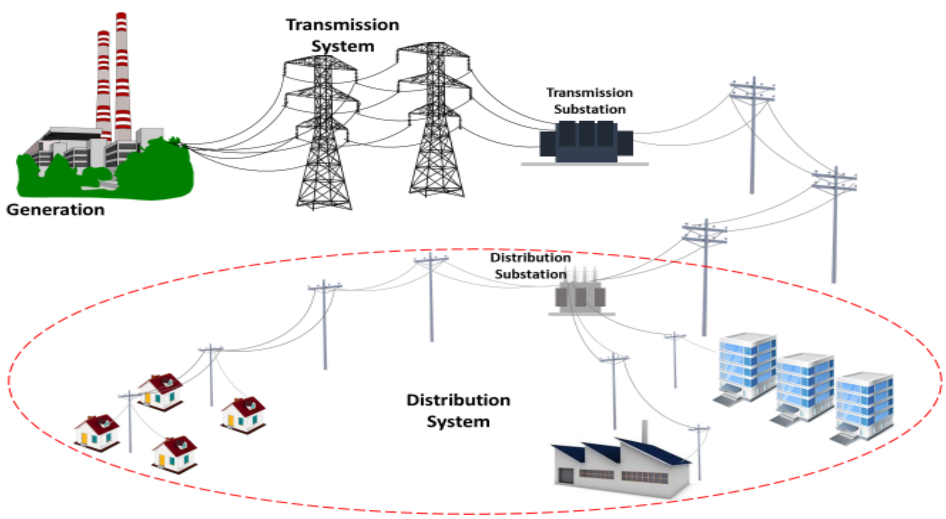
There is 2.5 times as much practical space on roofs, in parking areas, on unused urban land and on various contaminated lands as is needed to meet state goals using solar power, based on federal solar energy potential studies. As an added benefit, solar panels in most locations could be paired with on-site batteries (solar-plus-storage, or SPS) to create 'round-the-clock electricity and resilience during power grid outages.

In fact, Duke Energy's 2022 carbon-reduction proposal identified demand reduction, including net energy metered (NEM), customer-owned solar as a "first priority," and the North Carolina Utilities Commission (NCUC) agreed. However, both Duke Energy and the NCUC proposed very low levels of actual *development* of such solar. A recent South Carolina study shows NEM solar is a net benefit to all utility customers.

NC WARN's proposal for decarbonizing North Carolina makes local solar the top priority, including ground-mounted, rooftop, and parking lot solar, all of which can be connected to local distribution grids with relatively little cost or constraint. This local solar capacity would include both customer-owned systems and systems owned by solar developers or utilities.

The transmission system is made up of high voltage electricity lines that transport energy over long distances from power plants to transmission substations and then to distribution substations. The distribution system then delivers lower voltage energy to homes and businesses, as depicted below.

Interrelationship of transmission and distribution grid



Locating local solar near areas of high electricity use could eliminate the need for hundreds of miles of new and expanded transmission corridors that Duke Energy proposes to build, mostly in rural southeastern counties, and which could add many billions of dollars to customers' collective power bills across the utility's service areas.

On top of the long-standing advantages of local solar, the 2022 Inflation Reduction Act (IRA) provides strong incentives for renewable energy projects, particularly local solar located in low-income communities most in need of reliable, low-cost electricity.

North Carolina has many excellent rooftop-scale and large-scale solar companies that would benefit from a statewide plan that unlocks the full potential benefits of generating and storing solar power near where electricity is most used.

Duke Energy's Plan Would Constrain Solar Development for Years

The local solar approach – also known as "distributed generation" – runs counter to growing efforts by many US utility monopolies to invest billions of dollars in new, expanded and upgraded transmission corridors that would be required to serve very large solar and wind projects located far from towns and cities. That plan is consistent with the utilities' years of effort to limit the growth of local solar in North Carolina and other states.

In fact, Duke Energy’s proposed Carbon Plan in 2022 evaluated no local solar alternatives. Instead, Duke proposed (and the NCUC largely accepted) a plan to build solar projects from 75 megawatts (MW) up to 300 MW, 15 to 60 times larger than the 5 MW solar farms that have comprised 95% of the utility-scale solar projects built in North Carolina through 2022. Duke Energy states that the cost of new transmission and upgrades necessary for this solar development would reach $1.8 billion by 2030 and an additional $8-9 billion beyond 2030.

Under Duke Energy’s plan, the amount of new large-scale solar would be restricted for at least seven years while Duke designs, builds and upgrades transmission corridors in rural “red zones,” mostly in southeastern NC, which Duke Energy says are needed in order to allow more solar development in that region.

If this approach is not changed when the Carbon Plan is updated in 2024, large-scale solar could be added at an annual rate barely half that of the peak North Carolina solar year of 2017. The Carbon Plan as it stands would amplify the existing complexities of the current state-mandated solar project bidding system, thus adding uncertainty for solar developers, reducing the likelihood of reaching carbon reduction objectives and diminishing public well-being.

Moreover, Duke Energy’s proposed 10- to 15-year timeframe for new transmission to support future solar projects, even if achieved, is indicative of its “foot-dragging” pattern of proposing huge, expensive capital projects when cheaper alternatives (such as local solar) can be deployed much more quickly to help reduce its carbon impacts.

According to the current bidding system, when Duke Energy or a solar developer builds a large-scale solar project, the cost of upgrades to the transmission grid, or new transmission lines and associated transmission corridors that are needed to support the project, must be added to the cost of the solar bids to determine the all-in cost of each bid. In its proposed Carbon Plan, Duke anticipated that this "transmission adder" would be around 20 cents per watt for the near-term transmission upgrades - ones that will take 4-5 years to complete.

However, elsewhere in its proposed Plan, Duke's data indicates that the new or “greenfield” transmission adder for solar projects 10 to 15 years down the road will actually be 60 cents per watt. By preferentially selecting solar projects located largely on already congested parts of the transmission grid, North Carolina is creating a need for what would otherwise be an unnecessary transmission build-out expense. The very large solar projects being proposed would likely fail to meet the law's “least cost” requirement for new generation if 60 cents per watt is assumed to be the cost of the new transmission needed to support these projects.

Duke Energy's plan would create solar fields that could exceed 2-3 square miles of solar panels per project. The new transmission corridors supporting these projects will pass by rural communities and across forests and farmlands, potentially causing negative local impacts and controversy.

Key Elements of the Local Solar Proposal

NC WARN proposes that most new solar be tied in to the local distribution system, an approach that will require little or no additional cost to upgrade the grid. The key elements of this proposal are local net metered solar and wholesale projects as outlined below.

1) Local Net Metered Solar
Residential, commercial and publicly-owned rooftops and parking lots can benefit from net metered solar, where the solar power is used onsite and excess solar power is sent to the grid. Net metered solar is now routinely being paired with battery storage to enable customers to shift demand for grid power to low-cost time intervals. In some states, customer batteries are increasingly being used collectively as "virtual power plants" so the utility can tap the stored power of many customer batteries to balance the grid during periods of high demand. This is one way that local solar-plus-storage can add efficiency and stability to the electricity grid.

2) Wholesale Customer- or Utility-Owned Solar
Solar power generated on commercial and government rooftops and parking lots can be sold wholesale directly to the local distribution grid, and has been developed at scale in at least one other state. This solar electricity is produced and used locally and thereby reduces the need for remote power delivered over the transmission grid.

One- to two-MW warehouse rooftop solar arrays in California have been aggregated to provide utility-scale generation while earning praise from regulators and a utility CEO. There is no technical or economic reason warehouse solar cannot play a similar role in North Carolina.

Publicly- or privately-owned commercial rooftops, parking decks, and vacant areas in or near cities and towns could be made available for local solar at little or no cost. Municipal or state government partners eager to meet their own carbon reduction targets can implement this solution. This solution would reduce or eliminate the cost of land acquisition or roof leasing.

3) Wholesale Solar on Brownfield Lands
A federal inventory of formerly contaminated brownfield sites that are potentially suitable for renewable energy development includes hundreds of sites in North Carolina involving 100s of thousands of acres. Because many of these sites are forested, far from urban areas or on active military bases, NC WARN projects that only

about 5,000 MW of solar power would be developed on these sites. Development of solar projects on brownfield sites should be used selectively in such a way as to minimize the need for new transmission infrastructure.

Achieving NC Carbon Targets

We feel that this proposal could accomplish NC Carbon Plan targets much more quickly and equitably, create thousands of jobs and pass on much lower cost to ratepayers than Duke Energy's vision of large systems requiring costly and controversial transmission projects.

NC WARN and the Charlotte-Mecklenburg NAACP filed a shorter version of this strategy in the 2022 Carbon Plan docket. The NCUC did not conduct an evidentiary hearing where the strategy's merits could be fairly debated. However, in its Carbon Plan order the NCUC did briefly but accurately describe the local solar alternative in general terms:

> *". . there will be times when the most cost-effective solution to a constraint on the transmission system is not more transmission, but rather generation assets located near load."*

Unfortunately, the cost-benefit of locating generation assets near load compared to utility-scale solar in the red zone was ignored in the NCUC Carbon Plan order.

NC WARN is eager to work with other parties to refine this approach to determine the optimal combination of renewable energy and energy-saving resources. In doing so, we seek to foster broad and open discussion about the best possible path for moving North Carolina forward in the public interest.

Introduction

North Carolina became a leader in solar power years ago primarily due to a favorable regulatory interpretation of the "avoided cost" value of solar power relative to grid power. The controlling federal legislation at the time limited most solar projects to 5 megawatts[1] (MW_{ac}) or less in capacity.[2] Under this paradigm, North Carolina added about 4,200 MW_{dc} of utility-scale solar capacity by the end of 2017, and for a time was the second leading state in the nation after California in installed solar capacity.[3] (See Attachment A.) In contrast, relatively little local solar has been installed in North Carolina, a total of 252 MW_{ac} as of the end of 2021.[4]

Based on data from the National Renewal Energy Laboratory (NREL) and other sources, there is ample solar potential, more than two-and-a-half times the available capacity required to meet North Carolina's decarbonization mandates[5] using:[6]

1. Customer-owned residential, commercial and nonprofit net energy metered (NEM) rooftop and parking lot solar,

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[1] A solar panel produces "direct current" (DC) electricity. Grid power is "alternating current" (AC). DC power produced by a solar panel must be converted to AC power using an inverter to be compatible with grid power. Some losses occur in the DC-to-AC conversion. Commercial rooftop solar has a DC-to-AC conversion efficiency of about 90 percent. Utility-scale solar developers typically undersize the inverter(s) to limit the solar system output to a pre-determined MW maximum, and thereby "clipping" peak output at mid-day, while adding extra solar panels to generate more solar power in the morning and afternoon. With this type of configuration, the DC-to-AC conversion efficiency is about 70-75 percent.

[2] NC Solar Now, *How PURPA Helped Boost Utility-Scale Solar In North Carolina*, August 25, 2016: https://ncsolarnow.com/blog/how-purpa-helped-boost-utility-scale-solar-in-north-carolina/ (accessed on April 7, 2023).

[3] In 2017, HB 589 limited the impact of PURPA by instituting a competitive bidding system for utility-scale solar that was capped at a certain amount per year: https://www.ncleg.net/Sessions/2017/Bills/House/PDF/H589v6.pdf.

[4] EIA, *North Carolina Electricity Profile 2021*, November 10, 2022, Table 11 (NEM solar): https://www.eia.gov/electricity/state/northcarolina/.

[5] The state mandated that Duke Energy reduce its carbon dioxide emissions 70% below 2005 levels by 2030 and reach net zero CO2 emissions by 2050. NC General Assembly, HB 951, p. 1: https://www.ncleg.gov/Sessions/2021/Bills/House/PDF/H951v5.pdf (accessed on April 7, 2023).

[6] Initial Comments of NC WARN and CBD, Attachment 1 - Review of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's 2020 Integrated Resource Plans, NCUC Docket No. E-100, Sub 165, March 1, 2021, p. 24. "A retail sales growth of 0.3 percent per year was assumed, consistent with the average of the 2010-2019 DEC and DEP actual retail sales growth rates, to estimate combined 2035 DEC and DEP retail sales in North Carolina of
100,800,000 MWh/yr. Both the DEC and DEP IRPs state that about one-half of retail sales are met with nuclear power. This means that about 50,000,000 MWh/yr of non-nuclear carbon-free energy must be produced in 2035 to achieve a 100 percent clean energy target." There is approximately 8,000 MW_{dc} of existing solar capacity in North Carolina, producing about 10,000,000 MWh/yr. This reduces the net 2035 need to ~40,000,000 MWh/yr.

2. Commercial building rooftop and parking lot solar owned by the utility or sold wholesale directly to the grid,
3. Smaller utility-scale (≤ 5 MW_{ac}), ground-mounted solar-plus-storage that ties into the distribution grid near demand centers and predominantly serves local demand (defined here as "in-fill" SPS) and
4. Utility-scale solar located on formerly contaminated "brownfield" lands that ties into the distribution grid.

We think this plan could accomplish NC Carbon Plan targets more quickly and equitably, and at much lower cost to ratepayers, than Duke Energy's vision of large systems ≥ 75 MW located in the transmission-constrained "red zone." Duke Energy's proposed Carbon Plan evaluated no alternatives to rural red zone solar development.

We outline the concept below, making the following main points:

1. The NC Carbon Plan's focus on locating solar in the rural "red zone" will pass the high cost of new transmission and upgrades to customers and constrain solar development for years.
2. The Carbon Plan does not accurately account for the high cost of new transmission to the overall cost of remote large-scale solar.
3. Net energy metered (NEM) solar is an untapped resource in North Carolina and a job-creating engine compared to utility-scale solar.
4. There is no transmission upgrade cost for commercial/government/industrial building wholesale rooftop or parking lot solar, or in-fill solar near demand centers interconnected at the distribution grid level.
5. Individual commercial wholesale rooftop/parking lot solar projects can be combined to form much larger projects and can be built quickly.
6. The combination of Federal IRA tax credits and avoided grid upgrade costs potentially make smaller utility-scale SPS projects a better value than large, remote solar projects.
7. Utility-scale solar located on brownfield lands is an untapped resource in North Carolina.

Our Current Situation

A total of about 7,900 MW_{dc} of utility-scale solar had been installed in North Carolina by the end of 2021.[7] There is currently no commercial building rooftop and parking lot

[7] See SEIA, State Solar Spotlight, *available at* https://www.seia.org/sites/default/files/2023-01/North%20Carolina.pdf (accessed on April 7, 2023). SEIA identifies a total of 8,147 MW_{dc} of solar capacity in North Carolina at the end of 2021. 252 MW_{ac} of NEM solar converts into 280 MW_{dc} at a dc-to-ac conversion ratio of 0.90. 8,147 MW_{dc} – 280 MW_{dc} = 7,867 MW_{dc}.

solar being sold directly to the grid. There are many operational ground-mounted solar projects 5 MW_{ac} in size or smaller located near North Carolina population centers.[8] NEM and wholesale rooftop/parking lot projects can be built quickly. Wholesale rooftop/parking lot projects can potentially be aggregated into much larger projects to improve economies-of-scale. Table 1 summarizes the potential of local solar alternatives and brownfields in North Carolina.

Table 1. Estimate of North Carolina local solar and brownfield PV potential[9,10]

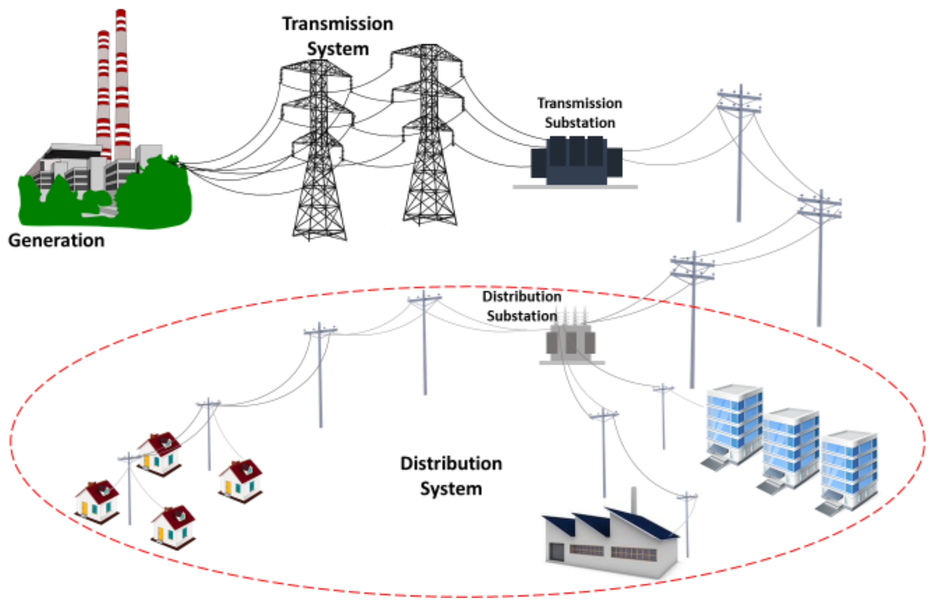
Unit	Residential rooftop	Commercial/ industrial rooftop	Commercial parking lot	Undeveloped urban parcels, 1 – 5 MW_{ac}	Brown-fields	Total
MW_{ac}	23,900	11,100	11,100	43,000	5,000	**94,000**
GWh/yr	30,600	14,700	14,700	68,000	8,000	**136,000**

In-fill public land and brownfields sites, along with publicly owned rooftops and parking lots, could potentially be made available for use at little or no cost by municipal or state government partners, especially those eager to meet their own carbon reduction targets. This would reduce or eliminate land acquisition cost, or roof leasing cost, and advantage these sites located in or near population centers.

Figure 1 shows the interrelationship between the high voltage transmission and lower voltage distribution systems. Many of North Carolina's solar projects are interconnected to rural distribution grids but, because of the rural location, rely on the transmission system to deliver the solar power to major North Carolina demand centers.

[8] SEIA, Project Location List, updated January 2023 (see "Project Location Map"): https://www.seia.org/research-resources/major-solar-projects-list (accessed on April 7, 2023).
[9] This estimate is based on National Renewal Energy Laboratory (NREL) estimates of North Carolina: 1) residential and commercial/industrial rooftop solar (2016, residential rooftop = 23,900 MW_{ac}, commercial rooftop = 11,100 MW_{ac}) and 2) urban in-fill ground-mounted solar potential (2012, urban ground-mount 38,000 MW_{ac}). Commercial/industrial parking lot estimate assumes only 25 percent of surface area is covered with solar = 11,100 MW_{ac}.
[10] The Google Project Sunroof estimate of North Carolina residential and commercial building rooftop solar potential = 34,000 MW_{dc} (43,300,000 MWh per year): https://sunroof.withgoogle.com/data-explorer/place/ChIJgRo4_MQfVIgRGa4i6fUwP60/ (accessed on April 7, 2023). The Project Sunroof estimate accounts for tree shading and tracks closely with NREL rooftop solar potential estimates for North Carolina.

Figure 1. Interrelationship of transmission and distribution grid[11]



Point 1: Focusing on Locating Solar in the Rural "Red Zone" Will Pass High Cost of Transmission onto Ratepayers and Constrain Solar Development for Years

Duke Energy's proposed NC Carbon Plan, which was given preliminary approval by the NCUC in December 2022, includes about $500 million in near-term transmission upgrade costs to existing transmission lines.[12] These costs are projected by Duke Energy to rise cumulatively to $2.6 billion by 2030 and $4.4 billion by 2035.[13] In addition, Duke Energy projects it will develop over $7 billion in new transmission capacity in new and existing transmission corridors to meet Carbon Plan solar development targets.[14, 15]

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[11] U.S. DOE, *Quadrennial Technology Review 2015, Transmission and Distribution Components*, Figure 3.F.1, p. 1, 2015: https://www.energy.gov/sites/prod/files/2015/09/f26/QTR2015-3F-Transmission-and-Distribution_1.pdf (accessed on April 7, 2023).

[12] Carbon Plan Order, NCUC Docket No. E-100 Sub 179, (December 30, 2022), at p. 114.

[13] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix P, Table P-4, p. 19.

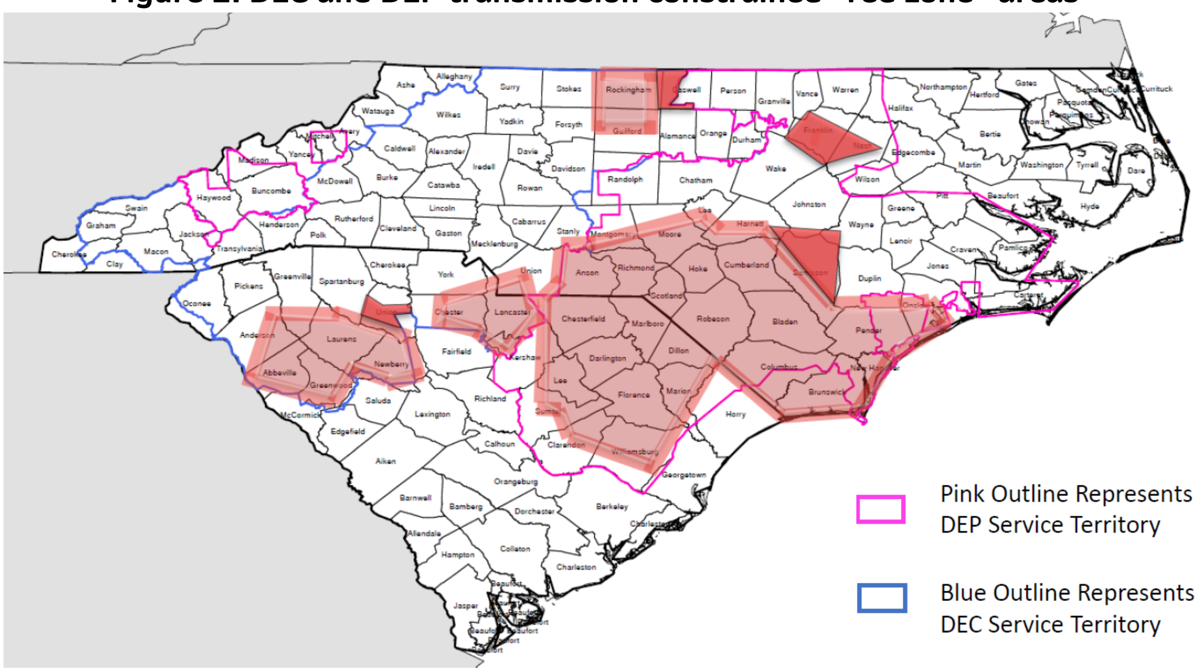
[14] The scope of this $7+ billion capital investment in North Carolina includes ~160 miles of greenfield 230 kV transmission in new ~150-foot-wide corridors, ~160 miles of greenfield 500 kV transmission in ~200-foot-wide new corridors, and ~210 miles of new 230 kV or 500 kV transmission in expanded existing transmission corridors. In South Carolina it includes ~170 miles of greenfield 230 kV transmission, 190 miles of greenfield 500 kV transmission, and ~125 miles of new 230 kV or 500 kV transmission in expanded existing transmission corridors. The total greenfield transmission mileage is ~1,000 miles. See Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix P, Figure F-3, p. 21.

[15] Duke Energy proposed Carbon Plan, Appendix P, p. 19. Duke Energy transmission network upgrade cost for Portfolio P1, 2030 = $2.6 billion; 2035 = $4.4 billion (note: These are not the project interconnection upgrade costs that are the responsibility of solar developers.); also p. 21: "The highlighted transmission on this map (Figure P-3) likely represents over $7 billion of greenfield transmission and system impact study identified common upgrades needed for inter-connecting Carbon Plan resources." Note: The right-of-way

According to Duke Energy, the major expansion of transmission capacity reflects solar project developer preference to locate utility-scale solar projects in rural areas where land costs are low.[16] The projects proposed by solar developers are predominantly located in counties, identified in Figure 2, as transmission constrained by Duke Energy.[17] The Carbon Plan identifies these areas as the “red zone”.[18]

The North Carolina peak solar deployment was ~1,000 MW_{ac} (1,250 MW_{dc}) in 2017. Many of these distribution grid-connected projects are in remote locations and must rely on the transmission grid to reach demand centers. Duke Energy is now proposing to limit the annual solar installation rate to a maximum of 500-770 MW_{ac} for seven years due to transmission grid congestion in the rural “red zone.”[19]

Figure 2. DEC and DEP transmission constrained “red zone” areas[20]



width of these 230 kV and 500 kV greenfield transmission lines will be 150 to 200 feet. See: https://www.duke-energy.com/Community/Trees-and-Rights-of-Way/What-can-you-do-in-Right-of-Way/Transmission-Lines-Guidelines (accessed on April 7, 2023).

[16] B. Powers’ Direct Testimony, Carbon Plan proceeding, NCUC Docket No. E-100 Sub 179, September 2, 2022, p. 49.

[17] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix P, Figure P-1, p. 13.

[18] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix P, p. 2.

[19] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Ch. 3, p. 20, Table 3-3: Summary of Portfolio Results, Incremental System Solar, start of year 2030. Portfolio 1 average, 2023-2029 (7 years) = ~770 MW_{ac}; Portfolios 2-4 average, 2023-2029 = ~500 MW_{ac}.

[20] Duke Energy, SCPSC – 2019-224-E proceeding, May 4, 2021, pp. 3-4. “New additions to the areas identified in the Tranche 1 CPRE process are shaded darker red than the prior existing constrained areas.”

Duke Energy's proposed Carbon Plan points out that the historic pattern in the Carolinas of building smaller 5 MW_{ac} utility-scale solar arrays, interconnected at the distribution level, has allowed the incorporation of over 4,000 MW_{ac} of solar capacity with little transmission upgrade expense. Duke Energy states:[21]

> *Of the 4,350 MW of solar connected today, over 95% of installed solar projects are smaller, distribution-tied (utility-scale) projects . . .*
>
> *. . . the State incented a truly unparalleled amount of 5 MW and smaller utility-scale solar generation that required interconnection to the distribution system. As explained in prior proceedings, the Companies' nation-leading solar historic interconnection success is even more remarkable given that such outcomes required interconnection of hundreds of distribution-connected utility-scale projects.*
>
> *One of the key barriers to adding resources, particularly solar, to the system is increasing transmission network upgrades required to interconnect new resources.*

NC WARN's position is that the state should continue with this successful interconnection formula, but redirect the project locations to urban and suburban distribution grids. This approach would eliminate transmission build-out constraints, the negative impacts of massive solar development and associated new transmission corridors in rural communities in the red zone.

Reliance on local solar on rooftops and parking lots selling power directly to the grid,[22] as well as smaller (< 5 MW) in-fill ground-mounted systems, would largely eliminate costs for transmission upgrades and new transmission corridors that would otherwise be necessary to interconnect utility-scale solar proposed in areas of the state with inadequate transmission capacity.

The Carbon Plan evaluated no alternative to transmission-dependent utility-scale solar projects located in the red zone. This was acknowledged by Public Staff witness Metz in his 2022 Carbon Plan testimony.[23] However, the Carbon Plan Order accurately describes

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[21] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix I ("Solar"), p. 1 and p. 6.
[22] Power delivered directly to the grid, as opposed to net-energy metered (NEM), is also known as "wholesale" power.
[23] Public Staff (Metz) Direct Testimony, NCUC E-100 Sub 179, Sept. 2, 2022, p. 39, footnote 22. *". . . I am not aware of the existence of any other alternate analysis that was completed to compare or contrast the line upgrades Duke selected. This does not imply that Duke's solution is not least cost; it is not clear whether there were other alternatives that could have achieved the same mitigation, such as alternate line analysis, non-wires alternatives, etc."*

the alternative in general terms: "... *there will be times when the most cost-effective solution to a constraint on the transmission system is not more transmission, but rather generation assets located near load*."[24] Those "generation assets located near load" can be residential or commercial rooftops, parking lots, or smaller utility-scale solar interconnected at the distribution grid level. However, the cost-competitiveness of these alternatives relative to utility-scale solar in the red zone is ignored in the Carbon Plan.

The 2022 Carbon Plan Order approved fourteen transmission upgrades in the red zone that it assumed to be necessary for solar developers to bid red zone projects into the 2023 and 2024 solar procurement process. However, it is essential that the 2024 iteration of the Carbon Plan maximize solar on the distribution grid before approving more transmission investment.

Duke Energy is uniquely positioned to be part of developing utility-scale distributed solar and battery storage on commercial rooftops and parking lots. Fifty-five percent of new solar and storage capacity to be developed under the Carbon Plan will be owned by Duke Energy.[25] Duke Energy also owns the transmission and distribution grid, allowing it to readily address any interconnection issues.

Commercial rooftop and parking lot solar is a substantial part of total installed solar capacity in some states, such as California. (See Attachment A.) California has averaged 400 MW_{ac} per year of new commercial rooftop and parking lot solar over the last seven years, from 2016 through 2022.[26] There is no technical or economic reason commercial rooftop and parking lot solar cannot play a similar or larger role in North Carolina.

Duke Energy's proposed 2022 Carbon Plan relies on the 2021 NREL "Annual Technology Baseline" (ATB) spreadsheet for renewable energy resource cost decline rates.[27] The NREL ATB spreadsheet includes cost estimates through 2050 for utility-scale solar, commercial rooftop solar, onshore and offshore wind power, and other

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[24] The Commission's Carbon Plan Order, Docket No. E-100 Sub 179, at p. 121 (December 30, 2022), https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=7b947adf-b340-4c20-9368-9780dd88107a.

[25] NC General Assembly, HB 951, p. 2: https://www.ncleg.gov/Sessions/2021/Bills/House/PDF/H951v5.pdf (accessed on April 7, 2023).

[26] California Distributed Generation Statistics (non-residential): https://www.californiadgstats.ca.gov/charts/ (accessed on April 7, 2023).

[27] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix E – Quantitative Analysis, pp. 99-100. "For developing the price forecast over time, the Companies applied NREL's 2021 Annual Technology Baseline ("ATB") Advanced Case's cost declines for the renewable and storage technologies."

generation technologies. The NREL ATB assumes that utility-scale solar is single-axis tracking, while commercial rooftop solar is fixed.[28]

The NREL ATB solar cost data makes clear that commercial rooftop/parking lot solar cost is converging with utility-scale solar cost. The projected cost difference between utility-scale solar and commercial rooftop solar is $16/MWh in 2027, and less than $10/MWh in 2035, as shown in Table 2. This difference in cost could be eliminated for projects using additional Inflation Reduction Act (IRA) incentives for projects $\leq$ 5 MW_{ac}. Locating generation and storage near where it is used also avoids the need (and costs) for transmission upgrades and new transmission corridors.

Table 2 compares the cost of utility-scale solar and commercial rooftop solar for the years 2023, 2027, 2035, and 2050 using the 2022 NREL ATB and the Class 6 solar insolation category for the Carolinas.[29] Duke Energy assumed the NREL ATB “Advanced” scenario in its proposed 2022 Carbon Plan.[30] For that reason the solar cost values for the “Advanced” scenarios are used in Table 2 below.

Table 2. Convergence of utility-scale and commercial rooftop solar cost over time

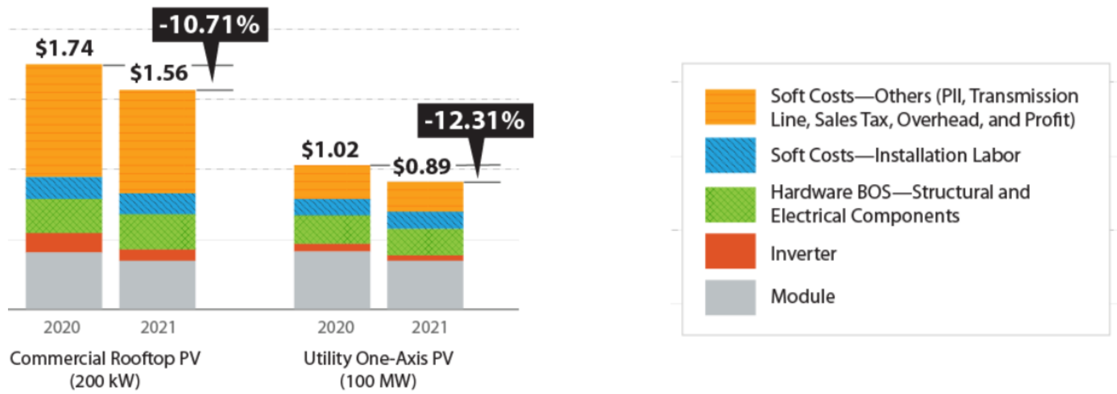
Year	Utility-scale solar, Class 6, “Advanced”, ($/MWh)	Commercial rooftop solar, Class 6, “Advanced”, ($/MWh)
2023	30 ($1.04/W)	56 ($1.40/W)
2027	22 ($0.80/W)	38 ($1.01/W)
2035	16 ($0.58/W)	24 ($0.66/W)
2050	12 ($0.47/W)	19 ($0.53/W)

The economies-of-scale are realized quickly for solar projects. Figure 3 is a 2021 NREL comparison of the cost elements of a 200 kW_{dc} commercial rooftop solar array and a ground-mounted, 100 MW_{ac} single-axis tracking solar array. There is little difference in the $/watt cost of the hardware and installation labor between the two project types. The cost difference is in the level of effort (soft costs in orange) required by solar installation firms to secure individual commercial rooftop projects compared to a single

[28] NREL 2021 Corrected Annual Technology Baseline (ATB) Workbook from 8-12-2021: https://data.openei.org/submissions/4129. See line 12 in “Solar - Utility PV” tab, see line 14 in “Solar – PV Distrib. Comm” tab.
[29] NREL ATB 2022 spreadsheet, V2 corrected, July 21, 2022: https://data.openei.org/submissions/5716; Solar insolation category for Carolinas: https://atb.nrel.gov/electricity/2022/utility-scale_pv. Solar Class 6 capacity factor (in MW_{ac}) = 0.258.
[30] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix E, pp. 99-100.

100 MW_{ac} utility-scale project. Combining many of the smaller projects into a single bid with a total capacity of 5 MW_{ac}, 10 MW_{ac}, or 50 MW_{ac} (for example), is an effective way for solar developers, and Duke Energy, to substantially reduce the soft costs associated with developing a single commercial project.

Figure 3. NREL comparison of solar cost elements, 200 kW_{dc} commercial rooftop and 100 MW_{ac} single-axis tracking utility-scale[31]



Point 2: The Carbon Plan Does Not Accurately Account for the High Cost of New Transmission to the Overall Cost of Remote Large-Scale Solar

Duke Energy indicated in its proposed 2022 Carbon Plan that, in addition to the $2.6 billion to be spent on transmission upgrades by 2030, it will need to spend $8.8 billion on new 230 kV and 500 kV transmission lines over the next 10 to 15 years in order to interconnect new Carbon Plan resources that will come online after 2030.[32] The proposed new and upgraded 230 kV and 500 kV lines are laid out by Duke Energy in the red zone solar development areas.[33] See Attachment B for a comparison of the red zone map and the proposed new and upgraded 230 kV and 500 kV transmission lines.

A specific example of new transmission capacity, which enables calculation of the future transmission solar cost adder, is provided by Duke Energy. A cost of $225 million is identified for the greenfield (new corridor) Erwin-Richmond 230 kV transmission line to enable interconnection of 375 MW_{ac} of future red zone solar capacity (five 75 MW_{ac} solar projects).[34] (On the map in Attachment B, p. 2, Erwin-Richmond is the green line running roughly from Rockingham to Dunn.) The transmission cost adder for the solar

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[31] NREL, *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2021*, November 4, 2021: https://www.nrel.gov/news/program/2021/new-reports-from-nrel-document-continuing-pv-and-pv-plus-storage-cost-declines.html (accessed April 7, 2023).
[32] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix P, p. 21.
[33] Ibid, Figure P-3.
[34] Ibid.

capacity to be interconnected to the new Erwin-Richmond 230 kV transmission line = \$225 million ÷ (375 MW x 1,000,000 watt/MW) = \$0.60/watt.

The \$0.60/watt adder for the proposed Erwin-Richmond 230 kV line translates into a solar cost adder of \$37/MWh.[35] The high cost of new transmission lines and associated corridors means the alternative (smaller-scale, distribution-tied solar) costs less than larger-scale red zone solar that is reliant on new greenfield transmission. This is true for all years covered by the Carbon Plan, as shown in Table 3.

Table 3. Red zone 100 MW_{ac} solar reliant on new transmission would be higher cost than 1 MW_{ac} distribution-tied solar in all years covered by the Carbon Plan

Year	Red zone 100 MW solar cost + new transmission adder (\$/MWh)	1 MW distribution-tied solar (\$/MWh)
2023	30 + 37 = 67	56
2027	22 + 37 = 59	38
2035	16 + 37 = 53	24
2050	12 + 37 = 49	19

The new transmission cost adder, \$0.60/watt, is three times higher than the average solar transmission cost adder assumed by Duke Energy in its proposed 2022 Carbon Plan, which ranges from \$0.17/watt (2026) to \$0.24/watt (2038+).[36] The entire range of solar transmission cost adders modeled by Duke Energy in its proposed Carbon Plan is shown in Table 4.

Table 4. Solar transmission cost adder modeled in Duke Energy's proposed Carbon Plan

Year range	DEC (\$/watt)	DEP (\$/watt)
2026	0.17	0.17
2027-2030	0.19	0.19
2031-2037	0.21	0.21
2038+	0.24	0.24

Sufficient information is provided in the proposed 2022 Carbon Plan to cross-check the transmission cost adders. The cross-check, summarized in Table 5 for Portfolio P1,

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[35] Capital recovery factor (CRF) over 40 years for transmission is 0.1375 (this is CRF for \$1.883 billion San Diego Gas & Electric 500 kV Sunrise Powerlink greenfield renewable energy transmission line). Annualized transmission cost = 0.1375 x \$225 million = \$30.94 million/yr. Annual solar generation = 0.258 x 8,760 hr/yr x 375 MW_{ac} = 847,530 MWh/yr. Therefore, unit transmission cost adder = \$30.94 million/yr ÷ 847,530 MWh/yr = \$36.51/MWh.

[36] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Ch. 2, p. 19, Table 2-9.

indicates that the transmission cost adders projected by Duke Energy are under-estimated by a substantial margin for solar projects that will require new transmission capacity to be deliverable.[37] As shown in Table 5, after 2030 the solar transmission cost adder will be about \$0.60/watt, the same as the new Erwin-Richmond 230 kV transmission line cost adder projected by Duke Energy.

Table 5. Revised P1 transmission cost adders, pre- and post-2030

	pre-2030 P1 transmission (T) adder			2030 – 2050 P1 transmission (T) adder		
Resource	New MW, Portfolio P1	T cost,[38] $ million	Revised T adder, $/W	New MW, Portfolio P1	T cost,[39] $ million	Revised T adder, $/W
Solar	5,400	1,848	0.34	14,500	8,517	0.59
Onshore wind[40]	600	144	0.24	1,200	288	0.24
Offshore wind[41]	800	632	0.79	0	0	NA
Totals	**6,800**	**2,624**		**15,700**	**8,805**	

The large majority, 14,500 MW_{ac}, of new solar capacity in Portfolio P1 in Duke's proposed Carbon Plan would be added after 2030.[42] As a result, in the next iteration of

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[37] Duke Energy indicates that it will preferentially locate new CT/CC at retired coal plant sites to take advantage of existing (transmission) infrastructure [Duke Energy proposed Carbon Plan, Appendix M, p. 7], yet includes a transmission adder for new CT/CC capacity of \$0.19/watt (DEC) and \$0.22/watt (DEP) [Chp. 2, 2-15, p. 24]. NC WARN assumes new CT/CC capacity, if built, will be preferentially located at retired coal plant brownfield sites and no new CT/CC transmission adder is warranted. NC WARN also assumes that advanced nuclear reactors, if built, would be located at existing nuclear sites and not require transmission upgrades. Duke Energy assumes no transmission adder for small modular reactors (SMRs), which would presumptively be located in demand centers.

[38] Ibid, Appendix P, Table P-4, p. 19 (Portfolio P1 2030 Transmission Upgrade Cost, \$2,624 million).

[39] Ibid, Appendix P, Table P-4, p. 19 (cumulative Portfolio P1 2035 Transmission Upgrade Cost, \$4,429 million); p. 21 (". . . significant greenfield transmission that will be needed as the Companies move beyond 2030 . . . over \$7 billion of greenfield transmission and system impact study identified common upgrades . . . can require 10 to 15 years from project start date to in-service date."). \$8,805 million = \$7,000 million (greenfield post-2030) + \$1,805 million (P1 2030-2035 cumulative upgrades). Duke Energy does not identify any cumulative transmission upgrade costs beyond 2035.

[40] Ibid, Appendix E, Table E-44, p. 39 (2030 onshore wind transmission adder = 0.24, DEC onshore wind is assumed to be imported via PJM.).

[41] Ibid, Appendix E, Table E-44, p. 39 (2030 DEP offshore wind transmission adder = 0.79).

[42] Ibid, Chapter 3, Table 3.3, p. 20 (2030); Appendix E, p. 77, Tables E-70 (2035), and E-71 (2050). Scenario P1, 2030: solar = 5,400 MW, onshore wind = 600 MW, offshore wind = 800 MW; 2035: solar = 13,800 MW, onshore wind = 1,200 MW; 2050: solar = 19,900 MW, onshore wind = 1,800 MW; NCUC Carbon Plan Order, December 30, 2022, p. 115. "*Furthermore, Duke estimated that DEC (transmission) Project #4 will take 48 months to build, and that DEP (transmission) Project #7 will take 54 months. Id. at 132-33.*"

the Carbon Plan scheduled for 2024, the modeled solar transmission cost adder for solar capacity procured after 2024, which will be online after 2030, should be based on the new Erwin-Richmond 230 kV transmission line cost of $0.60/watt.[43] It should not be based on the much lower transmission cost adder Duke Energy used in its proposed Carbon Plan.

Point 3: NEM Solar is an Untapped Resource in North Carolina and a Job-Creating Engine Compared to Utility-Scale Solar

Only about 3 percent of solar capacity in North Carolina is NEM solar.[44] In contrast, NEM solar is about one-third of total solar capacity in California, the leading solar state in the nation. NEM solar comprised about 40 percent of new solar capacity added in California in the most recent 2017 – 2021 period. Over 6,000 MW_{ac} of NEM solar was added in this five-year span. (See Attachment A.)

Duke Energy's proposed 2022 Carbon Plan identifies NEM solar as a first priority, stating "The Companies first plan to "shrink the challenge" by reducing energy requirements and modifying load patterns through grid edge and customer programs allowing more tools to respond to fluctuating energy supply and demand."[45] Grid edge programs include energy efficiency (EE), demand-side management (DSM), customer self-generation (NEM solar), voltage management and other distributed energy resources.[46] However, Duke Energy's proposed Carbon Plan projects an NEM addition rate of only 26.5 MW_{ac} per year in North Carolina going forward, the equivalent of an additional 371 MW_{ac} by 2035.[47] Only nominal gains in EE and DSM are projected despite being identified as first priority climate action steps by Duke Energy.

The Carbon Plan adopted by the NCUC also reduces the role of NEM solar, relative to earlier forecasts, despite identifying NEM solar as a first priority in reducing carbon emissions. The NC WARN concept of a North Carolina solar development plan actually makes NEM solar a first priority. Accelerating deployment of NEM solar in the demand

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[43] This projected new transmission cost adder is consistent with major operational renewable transmission projects. The largest recently constructed renewable energy transmission line in California, the 500 kV TRTP transmission line, cost $3.06 billion to build and has a design capacity of 4,500 MW_{ac} of solar and wind resources. The TRTP transmission adder at full build-out = $3.06 billion ÷ 4,500 MW_{ac} = $0.68/W. Source of $3.06 billion TRTP capital cost (Table 11, p. 40): https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/office-of-governmental-affairs-division/reports/2021/senate-bill-695-report-2021-and-en-banc-whitepaper_final_04302021.pdf (accessed on April 7, 2023); Source of 4,500 MW_{ac} TRTP design capacity: https://www.sce.com/about-us/reliability/upgrading-transmission/TRTP-4-11 (accessed on April 7, 2023).

[44] 280 MW_{dc} ÷ 8,147 MW_{dc} = 0.034 (3.4 percent)

[45] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Executive Summary, p. 9.

[46] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Appendix G, p. 1.

[47] Powers Report on Assumptions Used in Duke Energy, NCUC Docket No. E-100 Sub 179, May 2022 Carbon Plan, July 15, 2022, p. 39.

centers of North Carolina where Duke Energy customers are concentrated would potentially eliminate the need for new transmission between these demand centers and rural southeastern North Carolina utility-scale solar farms.[48]

Much of NEM solar is consumed onsite, thereby eliminating the transmission and distribution losses associated with grid power. Transmission and distribution losses average about five percent on a nationwide basis.[49]

In the most recent NEM proceeding in the Carolinas where a comprehensive NEM "value of solar" analysis was conducted, the Public Service Commission of South Carolina found that the robust NEM tariff it approved for Dominion Energy South Carolina would not cause a cost-shift between solar and non-solar customers.[50] In other words, NEM solar would have a neutral effect on customer rates when the benefits of NEM solar are comprehensively quantified and recognized by regulators.

NEM solar is increasingly paired with battery storage to enable shifting customer demand to low-cost time intervals. NEM solar with battery storage has the reliability benefit of allowing the customer to auto-supply with onsite backup power if a grid outage occurs. Customer batteries are also being used collectively as "virtual power plants" to support the grid and reduce costs.[51]

Local solar creates more jobs than utility-scale solar per MW installed, while avoiding expensive new transmission infrastructure. Labor cost is a relatively small component of the cost of either rooftop or utility-scale solar. However, residential rooftop solar utilizes about two times the labor per MW of installed capacity as utility-scale solar.[52] Commercial and industrial rooftop and parking lot solar utilize about one-and-a-half times the labor as utility-scale solar.[53] Assuming a solar plus storage (SPS) configuration, residential SPS labor is 5 times that of utility-scale SPS labor, and

[48] Joint Initial Comments of NC WARN, NCCSC and Sunrise Durham, Docket No. E-100, Sub 180 (NEM solar), March 29, 2022, pp. 30-31.
[49] U.S. Energy Information Administration, *Frequently Asked Questions – How much electricity is lost in electricity transmission and distribution in the United States?*, November 14, 2022: https://www.eia.gov/tools/faqs/faq.php?id=105&t=3 (accessed on April 7, 2023).
[50] Joint Initial Comments of NC WARN, NCCSC and Sunrise Durham, Docket No. E-100, Sub 180 (NEM solar), March 29, 2022, p. 31.
[51] Canary Media, *This utility keeps customers cool during heat waves while saving them money*, August 11, 2022: https://www.canarymedia.com/articles/batteries/this-utility-keeps-ac-on-during-heat-waves-while-saving-customers-money (accessed on April 7, 2023).
[52] NREL, *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2021*, November 4, 2021 (report webpage overview graphic): https://www.nrel.gov/news/program/2021/new-reports-from-nrel-document-continuing-pv-and-pv-plus-storage-cost-declines.html (accessed on April 7, 2023).
[53] Ibid.

commercial rooftop SPS labor is 3 times of utility-scale solar-plus-storage labor.[54] Rooftop solar companies also tend to hire in the communities where they work.

Point 4: There is No Transmission Upgrade Cost for Local Solar

North Carolina has a rooftop and parking lot solar potential of 38,000 MW_{ac}.[55] According to NREL, the state has an undeveloped urban land wholesale SPS potential of 43,000 MW_{dc}.[56] NREL evaluated the potential of > 1 MW_{dc} solar arrays located on unutilized lands within city limits by state. NREL defined urban utility-scale solar as > 1 MW_{dc} solar deployed within urban boundaries on urban open space. The NREL assessment process excluded unsuitable areas deemed unlikely for development, including landmarks, parks, wetlands, and forests.

There is ample solar potential to meet the Carbon Plan reduction targets with rooftop, parking lot, and in-fill projects that tie into the local distribution grid and predominantly serve local demand. There are no transmission constraints to the wholesale urban SPS installation rate.

As of mid-2022, over 95 percent of North Carolina utility-scale projects are 5 MW_{ac} or less and connected to the distribution grid. The proposed 2022 Duke Energy Carbon Plan forecasts an average new solar installation rate of 500-770 MW_{ac} per year between now and 2029, predominantly in the red zone.[57] In contrast, ~1,000 MW_{ac} of solar (1,250 MW_{dc}) was installed in North Carolina in 2017, the solar installation peak year.[58] (See Attachment A.)

Smaller, ground-mounted projects, 5 MW_{ac} or less, located in or near demand centers do not face the transmission constraints that limit solar development in the red zone. These projects would be coupled with ample battery storage and can also take

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[54] Ibid.

[55] B. Powers – Powers Engineering, *NC Clean Path 2025*, Table 25, p. 57. Original sources of this data are: 1) NREL, *Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment*, January 2016, Table 3, p. 26 and Table 5, p. 32, http://www.nrel.gov/docs/fy16osti/65298.pdf (accessed on April 7, 2023), 2) assumption that commercial parking lot solar MW potential ~= commercial rooftop solar MW potential, Synapse Energy Economics, Inc., *Distributed Solar in the District of Columbia - Policy Options, Potential, Value of Solar, and Cost-Shifting*, April 12, 2017, pp. 98-99, https://www.synapse-energy.com/sites/default/files/Distributed-Solar-in-DC-16-041.pdf (accessed on April 7, 2023), and 3) NREL, *U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis* (urban ground-mounted solar > 1 MW), July 2012, Table 2, p. 10: https://www.nrel.gov/docs/fy12osti/51946.pdf (accessed on April 7, 2023).

[56] Ibid.

[57] Duke Energy proposed Carbon Plan, Chp. 3, p.20. Table 3-3: Summary of Portfolio Results. New solar added over 7-year period, 2023-2029: P1 = 5,400 MW_{ac}; P2 – P4 = ~3,500 MW_{ac}. Average 2023-2029 new solar installation rate: P1 = 5,400 MW_{ac} ÷ 7 years = ~770 MW_{ac}/yr; P2-P4 = ~3,500 MW_{ac} ÷ 7 years = ~500 MW_{ac}/yr.

[58] See SSEIA, State Solar Spot Light, *available at* https://www.seia.org/sites/default/files/2022-09/North%20Carolina%20State-Factsheet-2022-Q3.pdf (accessed on April 7, 2023).

advantage of additional IRA incentives. Similarly, prioritizing wholesale local solar on roofs and parking lots would eliminate current transmission constraints on the solar build-out in North Carolina.

Point 5: Individual Commercial Wholesale Solar Projects Can Be Combined to Form Much Larger Projects

There are no aggregated solar projects to date in North Carolina. However, other states, specifically California, have developed and aggregated 1 to 2 MW_{dc} warehouse rooftop solar arrays at utility-scale, with the output sold wholesale directly to the utility. Future projects should be coupled with ample battery storage to maximize the grid reliability benefits of these systems.

One U.S. investor-owned utility has built a large-scale aggregated warehouse rooftop project producing wholesale power delivered over the distribution grid. In March 2008, Southern California Edison (SCE) proposed to build 250 MW_{ac} of solar on warehouse rooftops in urban Southern California. The project involved aggregating a large number of 1 to 2 MW_{ac} rooftop projects.[59, 60] The California Public Utilities Commission ultimately approved a larger 500 MW_{ac} SCE warehouse rooftop solar project in June 2009, stating:[61]

> *Unlike other generation resources, these (large-scale rooftop solar) projects can get built quickly and without the need for expensive new transmission lines. And since they are built on existing structures, these projects are extremely benign from an environmental standpoint, with neither land use, water, or air emission impacts.*

The CEO of SCE, John Bryson, was an advocate for the warehouse rooftop solar project, explaining how it benefitted the SCE grid:[62]

> *These new solar stations, which we will be installing at a rate of one megawatt a week, will provide a new source of clean energy, directly in the fast-growing regions where we need it most.*

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[59] Rooftop leasing fees are paid to the property owners.

[60] Commercial real estate companies often have portfolios consisting of many commercial buildings.

[61] CPUC press release, *CPUC Approves Edison Solar Roof Program* (June 18, 2009), *available at* https://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/NEWS_RELEASE/102580.PDF (accessed on April 7, 2023).

[62] SCE press release, *Southern California Edison Launches Nation's Largest Solar Panel Installation*, March 27, 2008, *available at* https://newsroom.edison.com/releases/southern-california-edison-launches-nations-largest-solar-panel-installation (accessed on April 7, 2023).

The focus on warehouse rooftops lost its champion when former California Gov. Schwarzenegger left office. SCE installed about 100 MW_{ac} of warehouse rooftop solar before the program was subsequently modified to convert the remaining capacity to remote, transmission-dependent solar projects.[63] It is reasonable to assume that, had the warehouse rooftop program retained support at the highest levels of state government, there would now be 1,000s of MW of warehouse rooftop solar in California and substantially less pressure to build new transmission lines to remote utility-scale solar project sites.

Figure 4. Southern California Edison warehouse solar rooftops

Point 6: The Combination of Tax Credits and Avoided Grid Upgrade Costs Potentially Make Smaller SPS Projects a Better Value than Large, Remote Solar Projects

The August 2022 IRA legislation differentiates between projects 1 MW_{ac} or less, less than 5 MW_{ac}, and equal to or more than 5 MW_{ac}. All project sizes are eligible for the base tax credit of 30 percent, the domestic content bonus of 10 percent, and the "siting in energy community" bonus of 10 percent.[64,65]

There are two important incentive differentiators based on project size: 1) Projects 1 MW_{ac} or less are not subject to the requirement to pay prevailing wage to be eligible for the base tax credit of 30 percent or the 10 percent domestic content and energy

[63] D.16-06-044, Decision Granting Petition for Modification and to Terminate the Solar Photovoltaic Program (June 28, 2016), p. 5.

[64] SEIA, *Inflation Reduction Act: Solar Energy and Energy Storage Provisions Summary*, p. 5: https://www.seia.org/sites/default/files/2022-10/Inflation%20Reduction%20Act%20Summary%20PDF%2010.13.22.pdf (accessed on April 7, 2023).

[65] "Energy communities" are "communities that have seen significant job loss in the fossil fuel economy, or due to the closure of a coal mine or coal-fired power plant, or are host to a brownfield site," according to Blue Green Alliance, *A User Guide to the Inflation Reduction Act*, p. 12: https://www.bluegreenalliance.org/wp-content/uploads/2022/10/BGA-IRA-User-GuideFINAL-1.pdf (accessed on April 7, 2023).

community adders[66] and 2) Projects less than 5 MW_{ac} are eligible to apply for low-income bonus incentives of 10 percent for siting in a low-income community or 20 percent for powering a low-income residential building or economic benefit project.[67]

Projects under 5 MW_{ac} that take advantage of all IRA incentives would receive 70 percent of project costs as tax credits. Projects $\geq$ 5 MW_{ac} would be limited to tax credits of 50 percent of project costs, as these projects would not be eligible for the low-income siting incentives.

Also, interconnection costs qualify for the tax credit if total project size is less than 5 MW_{ac}.[68] These costs can be substantial. Interconnection costs on a 1 MW_{ac} warehouse rooftop project can add up to $100,000 - $200,000, depending on the complexity of the interconnection.[69]

In addition, Duke Energy estimates an average transmission upgrade "surcharge" for near-term solar projects located in the red zone and not requiring new greenfield transmission (new corridors), of about $0.20/watt.[70] This is 10 to 15 percent of the gross cost of a utility-scale SPS project. The NCUC competitive evaluation criteria for solar projects requires that this grid upgrade cost be included in the bid price.[71]

To put all this in perspective, assume a 1 MW_{ac} solar project with 4-hour battery storage with a gross cost of $2.00/watt[72] that qualifies for all the IRA credits (70 percent of project value) and avoids the NCUC transmission surcharge of $0.20/watt. It competes against a $1.50/watt 100 MW_{ac} red zone project with 4-hour storage that qualifies for all IRA credits for projects $\geq$ 5 MW_{ac} (50 percent of project value).

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[66] The penalty for not paying prevailing wage is substantial. A developer not paying prevailing wage would qualify for only a 6 percent base tax credit, a 2 percent domestic content adder, and a 2 percent energy community adder.

[67] SEIA, op. cit., p. 5. Low-income bonus credits are capped at 1.8 GW/year, so projects must apply to receive them.

[68] SEIA, op. cit., p. 4.

[69] SCE, Application A.08-03-015, Solar Photovoltaic (PV) Program Testimony, March 27, 2008, p. 42 ($70,000 to $150,000 in 2008 dollars, adjusted for inflation since 2008 using Consumer Price Index).

[70] Duke Energy proposed Carbon Plan, NCUC Docket No. E-100 Sub 179, Ch. 2, Table 2-9, p. 19. Note: This is the cost Duke Energy assumed in its capacity expansion model. This modeled transmission expansion cost does not account for the $7 billion in "hypothetical" red zone greenfield transmission costs estimated by Duke Energy to interconnect Carbon Plan resources beyond 2030 (see Appendix P, p. 21).

[71] NCUC, DEC/DEP Petition for Approval of Competitive Procurement of Renewable Energy Program, November 27, 2017, pdf p. 34.

[72] NREL, *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021*, November 2021, Figure 20. Cost benchmark for (collocated) commercial PV-plus-storage systems, p. 32 ($2.00/watt); Figure 24. Cost benchmark for (collocated) utility PV-plus-storage systems, p. 40 ($1.68/watt).

1 MW_{ac} net cost = \$2.00/watt – (\$2.00/watt x 0.70) = \$0.60/watt

100 MW_{ac} net cost = ((\$1.50/watt + \$0.20/watt) – (\$1.50/watt x 0.50)) = \$0.95/watt

The net unit cost of the 1 MW_{ac} project would be two-thirds the unit cost of the 100 MW project in the red zone. Even if the 1 MW_{ac} project was not located in a low-income community and serving low-income customers, reducing the tax credit benefit by 20 percent, the net unit cost of the 1 MW_{ac} project would be about the same as that of the 100 MW_{ac} project.

1 MW_{ac} net cost = \$2.00/watt – (\$2.00/watt x 0.50) = \$1.00/watt

100 MW_{ac} net cost = ((\$1.50/watt + \$0.20/watt) – (\$1.50/watt x 0.50)) = \$0.95/watt

These examples do not include land/roof leasing cost or land ownership cost. However, public land or brownfields could potentially be made available at little or no cost by municipal or state government partners, especially those eager to meet their own carbon reduction targets. The same may be true for publicly-owned rooftops and parking lots. Any such arrangements would reduce or eliminate land acquisition cost and advantage these smaller sites in or near the demand centers.

Point 7: Utility-Scale Solar Located on Brownfield Lands[73] is an Untapped Resource

The U.S. Environmental Protection Agency (EPA) has developed a nationwide inventory of brownfield sites that are potentially suitable for renewable energy development, many of which are located in rural areas. The EPA inventory includes hundreds of sites in North Carolina totaling approximately 350,000 acres. This area is equivalent to a solar power potential of almost 60,000 MW_{ac}. About 90 percent of these brownfield sites are on military bases. See Attachment C for a list of the largest brownfield sites in North Carolina.

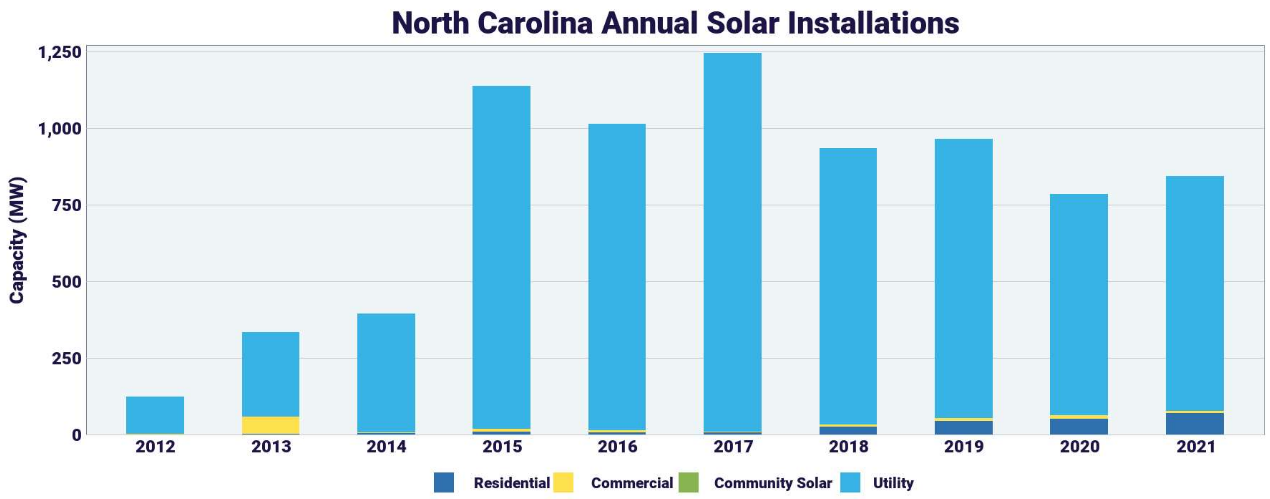
Much of the land on North Carolina military bases is forested. These sites are also distant from major North Carolina load centers, like Charlotte and Raleigh. For this reason, the NC WARN solar plan proposes that only about 5,000 MW_{ac} of solar power be developed on North Carolina brownfields included in the EPA site list. This would provide approximately 8,000 GWh per year of electricity generation.

[73] Powers Engineering, NC Clean Path 2025, August 2017, p. 60.

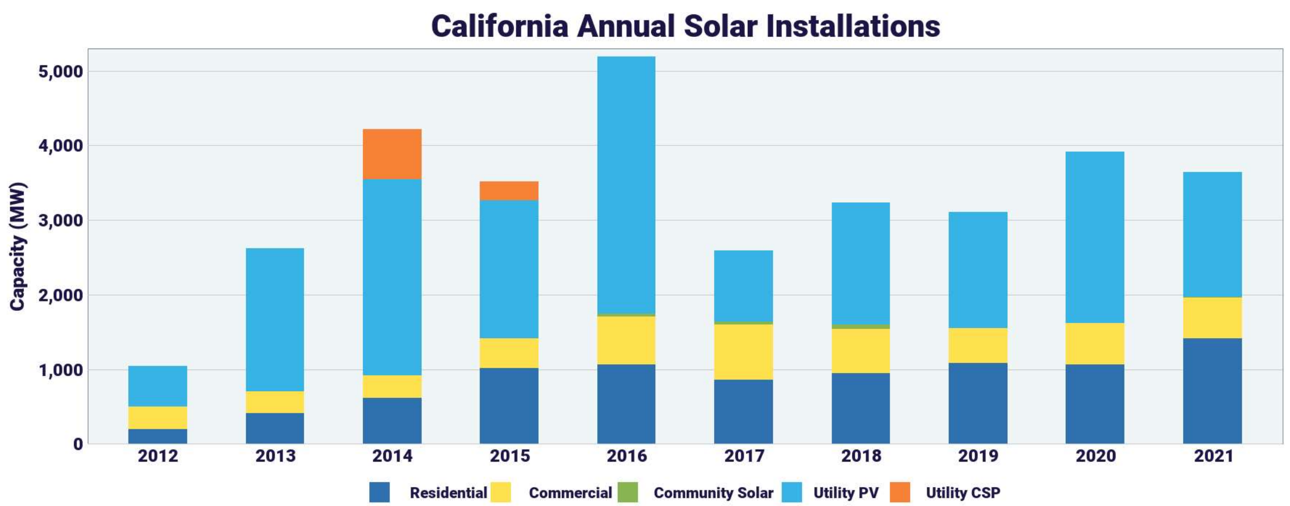
Conclusion

NC WARN believes that the concept outlined above, in which solar development in the state is focused primarily on distribution-tied systems $\leq$ 5MW_{ac}, has the opportunity to meet Carbon Plan targets much more quickly, affordably and equitably than a plan that prioritizes very large solar installations in the red zone. The high cost of new greenfield transmission construction would be avoided, and utilization of IRA tax credits for low-income communities would save money for the most vulnerable North Carolinians while increasing the pace of development of the North Carolina solar industry.

Attachment A. Solar Installation Rates, North Carolina and California, 2012 through 2021



Source: SEIA, *North Carolina Solar Through Q3 2022*, https://www.seia.org/state-solar-policy/north-carolina-solar

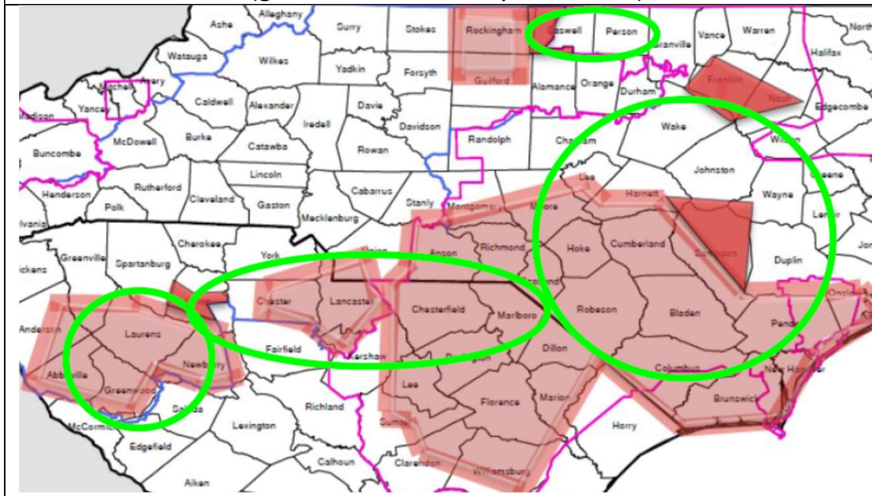


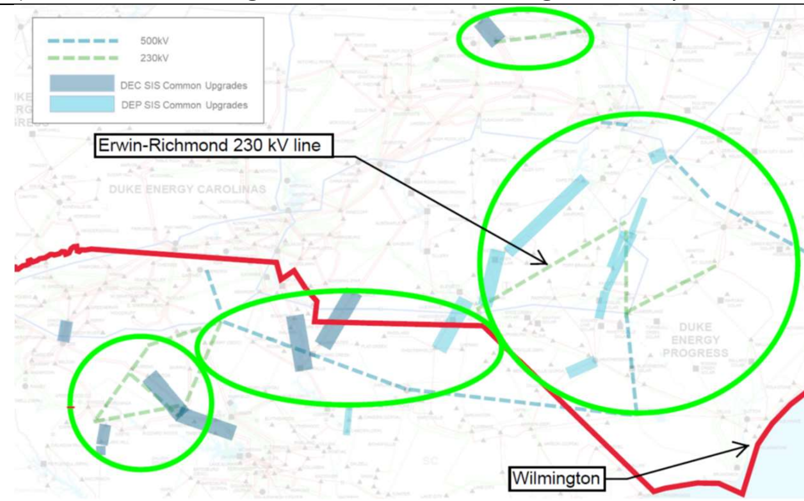
Source: SEIA, *California Solar Through Q3 2022*, https://www.seia.org/state-solar-policy/california-solar (yellow bar = commercial rooftop)

Attachment B

Location of (a) Duke Energy Solar Project Red Zones and (b) New (greenfield) Proposed 230 kV and 500 kV Transmission Lines

Red Zones (green ovals added by B. Powers)	Duke Energy 2030 New Transmission Build-Out (red NC-SC border, green ovals, and black tags added by B. Powers)





Ref: red zone map (p. 7 of 7): https://dms.psc.sc.gov/Attachments/Matter/23996e63-4655-4e11-8eb1-2c610112d489; Carbon Plan, App. P, Figure P-4, p. 21.

Example in Carbon Plan of new (greenfield) transmission cost, new Erwin-Richmond 230 kV transmission line (App. P, p. 21):
An example of where this need has already been reflected is shown in the System Impact Study -Partial results associated with DEP Generator Interconnection Requests, Q389 - Q393, for 375 MW of solar facilities in Richmond and Scotland Counties, NC. Analysis of the network upgrades needed to interconnect these facilities revealed the need for a new 75-mile Erwin - Richmond 230kV transmission line at a cost estimated at $225 million. **Transmission cost adder of Erwin - Richmond 230 kV transmission line**: $225 million ÷ (375 MW x 1,000,000 watt/MW) = $0.60/watt.[1]

Right-of-way width for 230 kV and 500 kV greenfield transmission lines:[2]

- 230,000-volt lines typically require a 125- to 150-foot corridor
- 500,000- to 525,000-volt lines typically require a 180- to 200-foot corridor

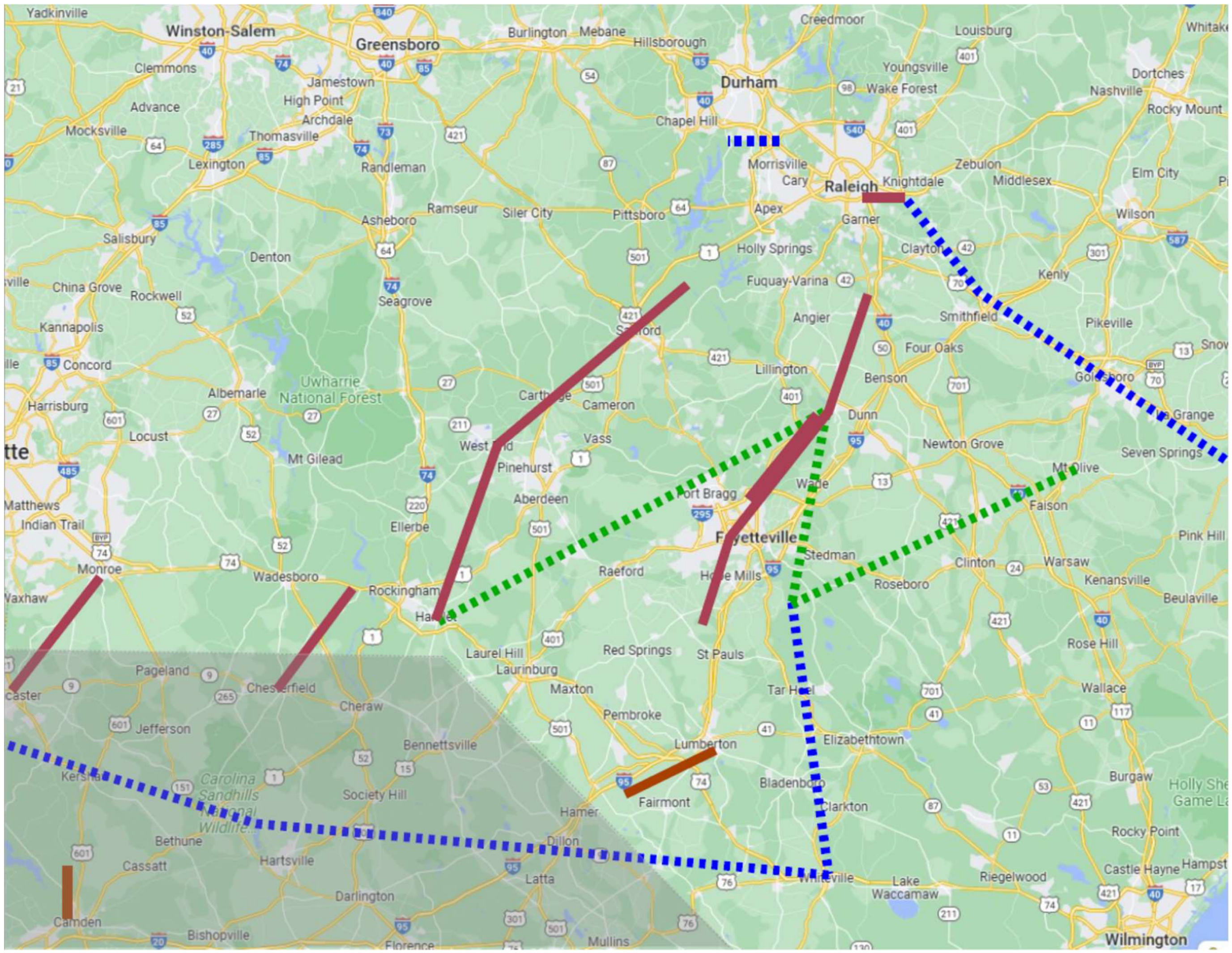
230 kV and 500 kV transmission line capacity:[3]

500 kV: 1,000 – 1,500 MW
230 kV: 300 – 500 MW

[1] This $/watt cost is low. The source document, DEP, *Generator Interconnection Impact Study Report, Richmond and Scotland Counties, NC 375.0 MW of Solar Farms Queue #389-393*, November 2017, p. 9, identifies the all-in cost of the 230 kV line and associated Duke-provided interconnection facilities as $250.466 million, not $225 million. This increases the $/watt cost to $0.67/watt ($250,466,000/375,000,000 watts = $0.67/watt) in 2017 dollars. The 2017 source document is also six years old. It is reasonable to assume the cost will be higher when this project is approved for construction.
[2] See: https://www.duke-energy.com/Community/Trees-and-Rights-of-Way/What-can-you-do-in-Right-of-Way/Transmission-Lines-Guidelines.
[3] See: M. Patterson, P.E. – Idaho Power, *Wood River Electric Plan – Transmission Lines Parameters*, 2007, p. 7.

New (Greenfield) Transmission Lines and Transmission Upgrades Proposed by Duke Energy in NC

new 500 kV corridors
new 230 kV corridors
upgrades to existing transmission
40 miles



Notes: Base map from Google Maps. Location of new transmission lines from Duke Energy Carbon Plan, App. P, Figure P-3, p. 21. Overlay of new transmission lines by B. Powers.

Major Brownfield Sites in North Carolina Potentially Available for Solar Development[1]

Site	Site size, acres	PV potential of site, MW [assuming 6 acres = 1 MW]
Camp Lejeune, USMC (Jacksonville)	151,040	25,173
Fort Bragg, Army (Fayetteville)	150,000	25,000
Cherry Point, USMC (Havelock)	13,164	2,194
Seymour Johnson AFB (Goldsboro)	3,216	536
E.I. Dupont Fayetteville Works (Fayetteville)	2,587	431
DAK Americas LLC (Leland)	2,077	346
Clariant Corporation (Mount Holly)	1,500	250
Neptco Incorporated (Lenoir)	1,027	171
Chemtronics, Inc. (Swannanoa)	1,027	171
Weyerhaeuser Corporation (Plymouth)	1,017	170
U.S. Coast Guard (Elizabeth City)	800	133
Carolina Stalite Company (Norwood)	689	115
FMC Corporation (Bessemer City)	650	108
DuPont (Kinston)	650	108
Mallinckrodt Pharmaceutical Plant (Raleigh)	600	100

[1] Reprinted from Powers Engineering, NC Clean Path 2025, August 2017, Table 29, p. 61, Source: Environmental Protection Agency, "RE-Powering Mapping and Screening Tools," RE–Powering Screening Dataset, updated May 9, 2017, https://www.epa.gov/re-powering/re-powering-mapping-and-screening-tools/.