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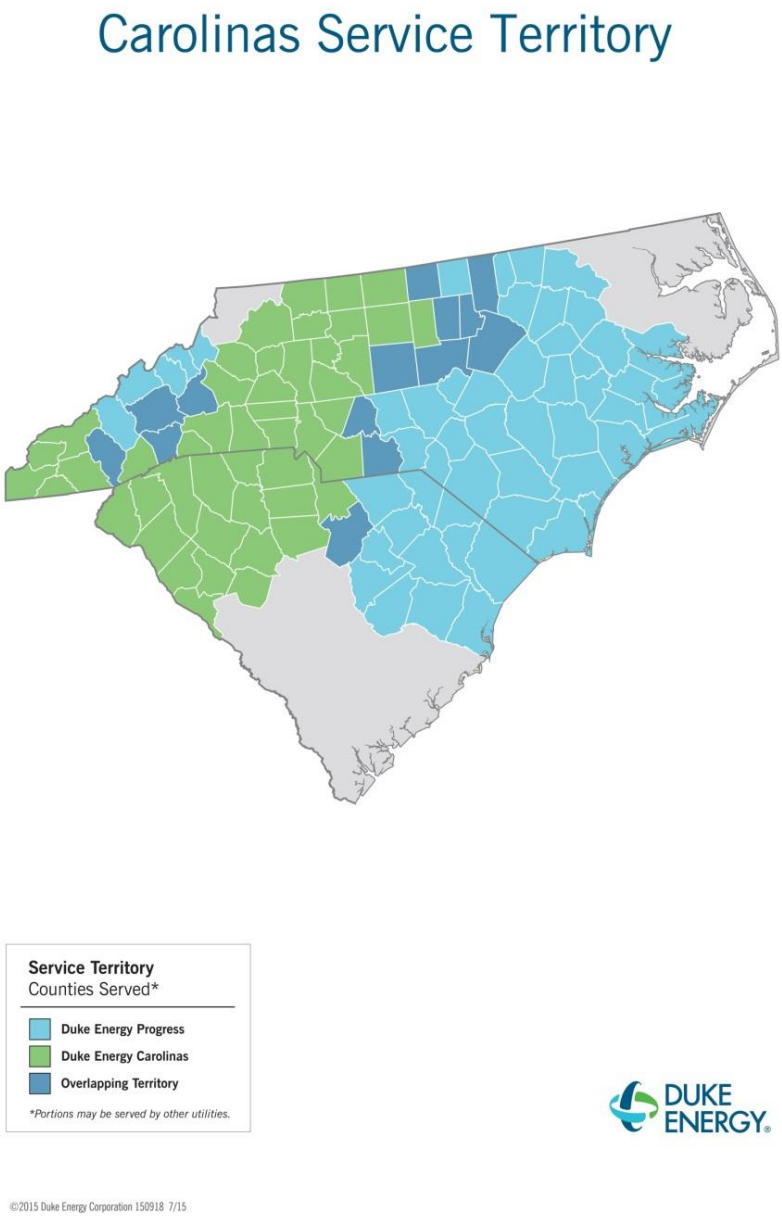
Overview

Duke Energy offers energy services to approximately 7.4 million customers in the Carolinas, Florida, Ohio, Kentucky and Indiana. The Carolinas area is comprised of Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP). The DEC service territory is approximately 24,000 square miles and serves 2.5 million residential, commercial and industrial customers. Primary transmission voltages in DEC are 500kV, 230kV, 161kV, 100kV, 66kV, and 44kV. The DEP service territory is approximately 32,000 square miles and serves 1.5 million residential, commercial and industrial customers. Primary transmission voltages in DEP are 500kV, 230kV, and 115kV.



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Planning the Transmission System

The analysis performed by Duke Energy in planning the transmission system is based on good utility practice and NERC Reliability Standards. The analysis is performed to ensure reliable service can be provided to all customers considering that outage events (lightning, car accidents, equipment failure, faults, etc.) that cause transmission and generation elements to be removed from service can and do occur. Outage events can impact the voltage levels and the power flows on the transmission system in ways that would stress the system beyond its capabilities if the system were not properly planned, resulting in customer outages or poor power quality. Addition of new transmission and distribution connected load and generation requires ongoing analysis to ensure continued operation within limits. When analysis indicates limits will be exceeded, modifications or upgrades to the system must be identified to ensure continued reliable operation. The decisions to upgrade or modify system elements are made by applying reliability standards on an equivalent basis to all interconnection requests, and selected solutions to system issues are identified to minimize costs to the total body of Duke Energy customers.

When a new generation project requests transmission interconnection, Duke Energy is required to assess the impact of the new generation on the electric system. The assessment identifies locations where modification or upgrade of the transmission system will be necessary to maintain reliable service to all interconnected electricity customers, including consideration of possible outage events. The assessment includes the impacts of distribution-interconnected generation projects, which also affect transmission system loadings.

As a result of analyses performed to date, Duke Energy has identified areas where modification and upgrade of the system would be required if generator projects in the queue were to be interconnected. The areas where proposed projects have already indicated a need for transmission upgrades are identified on the constrained area maps. In other words, projects already under consideration, located in constrained areas, have resulted in demands exceeding the transmission grid capability and, if they are pursued to commercial operation, will require additional transmission capacity. Any new or additional transmission or distribution interconnection requests submitted in these constrained areas, after those currently in the queue for analysis, will possibly contribute to additional upgrade needs that may add project costs.

The need for transmission system upgrades is subject to the final disposition of the individual projects, i.e., whether or not they are pursued to commercial operation. Thus the need for transmission system upgrades can be subject to change as additional projects are analyzed or individual projects decide not to continue with the interconnection process. Therefore, the identification of constrained areas should be considered a snapshot based on conditions known at the time. However, developers of potential projects in the identified constrained areas should be aware that there is a risk of additional transmission grid upgrades, which could result in additional costs and lead time requirements for the project. This would include distribution interconnected projects, which also impact transmission system loadings.

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DEC Generator Interconnection Requirements - Overview

Transmission level projects participating in CPRE are likely to interconnect to either the 100 or 44 kV system. Unless a project is interconnecting directly to an existing 100 kV station, the project will interconnect via a tap to a single 100 or 44 kV transmission circuit. For 100 kV projects tapping a single circuit, this design will typically include a three-way gang operated air break switch in line with the main line and a breaker (or circuit switcher) on the tap line at the point of change in ownership. For 44 kV projects tapping a single circuit, this design will typically include a 4-pole bent in line with the main line, disconnect switches, and a breaker (or circuit switcher) on the tap line at the point of change in ownership. For both 100 kV and 44 kV projects, the design will include a transfer trip scheme for faults anywhere on the main or tap line.

Transmission level projects participating in CPRE might be permitted to interconnect directly to an existing 230 kV station. Any 230 kV interconnections not directly into an existing station require the generation aggregated at a new station to exceed 120 MW.

For additional details, refer to the DEC Facility Connection Requirements located under Generator Interconnection Information at the DEC OASIS website[1].

Constrained Areas in DEC

For DEC, the constrained area map (Attachment 1) represents areas of the transmission system where there are either known transmission constraints that would be aggravated by increased generation or transmission constraints that would be created by queued generation. These transmission constraints have been identified by either Transmission Planning or System Operations and have been confirmed through transmission studies of one or more generator interconnection requests. New additions to the areas identified in the Tranche 1 CPRE process are shaded darker red than the prior existing constrained areas. Queue requests received through 10/8/2018 and for which a power flow study have been completed were considered; however, the change of queue dates for non-late stage losers in Tranche 1 has not yet been considered. Transmission upgrades to mitigate the constraints already identified would exceed $10 million, and lead time is dependent upon the scope of work but would exceed 1 year, and possibly be as long as 3-4 years. Generator interconnection requests in areas not identified as constrained may also require transmission upgrades, but transmission studies are required in order to make this determination.

There are three constrained areas identified in DEC. In Caswell, Guilford and Rockingham counties, off-peak conditions can drive post-contingency thermal loading issues on 100 kV lines that emanate from Dan River. Increased generation in these two counties will make the 100 kV lines in the Dan River area more susceptible to both off-peak and on-peak loading issues. The other two constrained areas shown are areas on DEC's system with the highest penetration of queued solar generation. The eight county area near DEC's southern border including Abbeville, Anderson, Greenville, Greenwood, Laurens, McCormick,

[1] https://www.oasis.oati.com/duk/index.html

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Newberry and Union (SC) counties has over 2200 MW of queued solar generation. The other is a four county area located near the DEC/DEP border including Chester, Lancaster, Union (NC) and York counties that has over 600 MW of queued solar generation.

A DEC constrained infrastructure list is available that documents the individual transmission lines and substations that are in the constrained areas.

Additional transmission line mapping information can be found at the Energy Zones Mapping Tool website[2].

DEP Generator Interconnection Requirements - Overview

To connect to the DEP 230 or 115 kV transmission system, a generating plant should be at least 20 MW in size. Plants between 20 and 100 MW will typically be tapped off a 230 or 115 kV transmission line. This design will typically include line switches added to the main line on either side of the tap, a single radial breaker in the tap line, and a transfer trip scheme for faults anywhere on the main or tap line. DEP will typically build and own the transmission tap line and the breaker station adjacent to the generator substation. To connect to the DEP 500 kV system, a generating plant must be at least 500 MW.

If the total generation at a single site (or within a one mile radius) exceeds 100 MW, then a full transmission switching station (e.g. a three-breaker ring bus) will be required. If the total tapped generation along an entire line exceeds 200 MW, then a full transmission switching station (e.g. a three-breaker ring bus) will be required somewhere on the line (location to be determined on a case-by-case basis considering specific local conditions). If a generating plant connects to a DEP switching station, the generator owner will typically build and own the radial transmission line from the generating plant to the DEP switching station.

For additional details, refer to the DEP Facility Connection Requirements located under Generator Interconnection Information at the DEP OASIS website[3].

Constrained Areas in DEP

For DEP, the constrained area map (Attachment 1) represents areas of the DEP transmission system where additional generator interconnections have a high likelihood (depending on ultimate development decisions) of causing transmission problems requiring significant, expensive, and long-lead-time transmission upgrades. New additions to the areas identified in the Tranche 1 CPRE process are shaded darker red than the prior existing constrained areas. The constrained areas were determined by Transmission Planning from prior studies and knowledge of the DEP transmission system. This includes power flow studies of queue requests received through 6/30/2017. The change of queue dates for non-late stage Tranche 1 bidders has not yet been considered.

[2] https://ezmt.anl.gov/
[3] https://www.oasis.oati.com/cpl/index.html

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Generator interconnections in regions that are not identified as constrained are not guaranteed to be without transmission problems. Studies will determine if there are any issues requiring transmission upgrades caused by generator interconnection requests in areas not identified as constrained.

In the greater Cumberland and Richmond County regions of North Carolina, extending across the state line into much of DEP's service territory in South Carolina, significant solar generation additions in the 2014-2017 timeframe, on both the transmission and distribution systems, have loaded the DEP transmission system to its limits. Any new generation in this area will cause transmission line overloads. Identified solutions exceed $200 million in transmission upgrades and will take at least 4 years to complete.

In the greater Brunswick County region of North Carolina, existing limits on the transmission system can cause limitations in operation of the Brunswick nuclear generators. These thermal and dynamic stability limitations require that the output of the Brunswick nuclear generators be substantially reduced following the outage of any one transmission line in the area. This includes forced outages or planned maintenance outages of transmission lines in the Brunswick County region. Any additional generation in this region would cause additional, unacceptable limitations in operation of the Brunswick nuclear generators without the addition of costly transmission solutions. The estimated cost of the identified transmission solution for this issue exceeds $100 million and would take at least 5 years to complete.

One new addition to the DEP constrained area is the transmission corridor from Clinton 230kV substation through Mt. Olive 230kV substation and up to Lee 230kV substation. The 115kV transmission lines in this corridor have shown heavy loadings in recent queue studies. Generator interconnections in this corridor, or in the existing Cumberland/Richmond area constrained zone, may aggravate this issue. This constraint can be relieved by reconductoring approximately 28 miles of 115kV line for approximately $42 million.

The other new addition to the DEP constrained area is the transmission system near Spring Hope 115kV Switching Station, including lines to Franklinton, Rocky Mount, and Zebulon. The 115kV transmission line to Rocky Mount has shown heavy loadings in recent queue studies. This constraint can be relieved by reconductoring approximately 10 miles of 115kV line for approximately $15 million.

A DEP constrained infrastructure list is available that documents the individual transmission lines and substations that are in the constrained area.

Additional transmission line mapping information can be found at the Energy Zones Mapping Tool website[4].

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[4] https://ezmt.anl.gov/

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Connecting Smaller Generators to the DEC and DEP Distribution Systems

Guidelines for the connection of smaller generators to the DEC and DEP Distribution Systems are provided in the Duke Energy Method of Service Guidelines[5]. In general, projects between 10 and 20 MW may be able to connect directly to a retail substation depending the voltage class of the distribution circuit, the voltage class of the transmission line serving the retail station, and other specific local factors described in the guidelines. Projects less than 10 MW may be able to connect to a general distribution circuit depending the voltage class of the distribution circuit, the voltage class of the transmission line serving the retail station, and other specific local factors described in the guidelines.

[5] https://www.duke-energy.com/home/products/renewable-energy/generate-your-own

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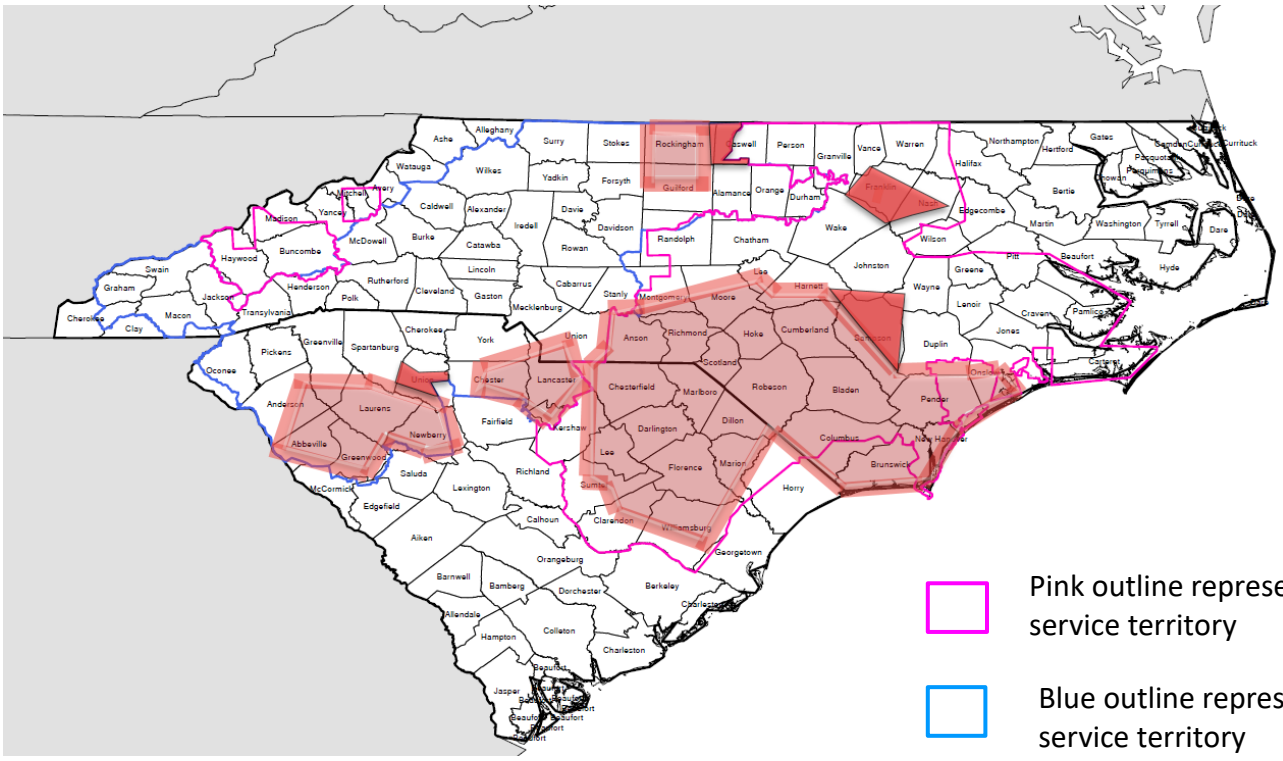
Attachment 1

DEC and DEP Constrained Areas