Potential Benefits of a Regional Wholesale Power Market to North Carolina's Electricity Customers

PREPARED BY
Judy Chang
Johannes Pfeifenberger
John Tsoukalis

April 2019

THE Brattle GROUP

TABLE OF CONTENTS

ACKNOWLEDGMENT

This whitepaper was prepared in accordance with The Brattle Group, Inc.'s engagement terms, and is intended to be read and used as a whole and not in parts. The report reflects the analyses and opinions of the authors and does not necessarily reflect those of The Brattle Group, Inc.'s clients or other consultants.

I. SUMMARY

This whitepaper presents the results of a high-level analysis of benefits that could potentially be realized by Duke's North Carolina customers if Duke joined an organized regional wholesale power market. Due to the significant benefits that have been experienced from these markets in other regions of the country, several Southeastern U.S. industry and consumer groups[1] commissioned this analysis to inform policy markers and motivate a more comprehensive study of the customer benefits that organized wholesale power markets could provide to North Carolina. Our preliminary analysis shows that Duke's participation in a Regional Transmission Organization (RTO)-operated regional market could provide benefits to customers in North Carolina up to almost $600 million a year. Because wholesale market benefits are region-specific, we recommend that a more comprehensive study be conducted to fully evaluate participation in a regional wholesale power market and the benefits that doing so would likely provide for North Carolina customers.

Wholesale power markets administered by RTOs and Independent System Operators (ISOs) cover more than 30 U.S. states, serving over two-thirds of electricity consumers in the U.S. Numerous studies, focusing on different regions of the country, have shown that these regional markets provide significant benefits to electricity customers by reducing the cost of power, increasing reliability, reducing the need for new generation and transmission facilities, aiding the integration of renewable energy resources, and improving system balancing and operations. For example, PJM (the market operator that borders North Carolina) recently estimated that its market resulted in benefits of $2.8 billion to $3.1 billion per year for customers in its region. Due to these benefits, both investor-owned utilities and public power companies continue to join and expand these organized regional power markets with the support of state regulators and policy makers.

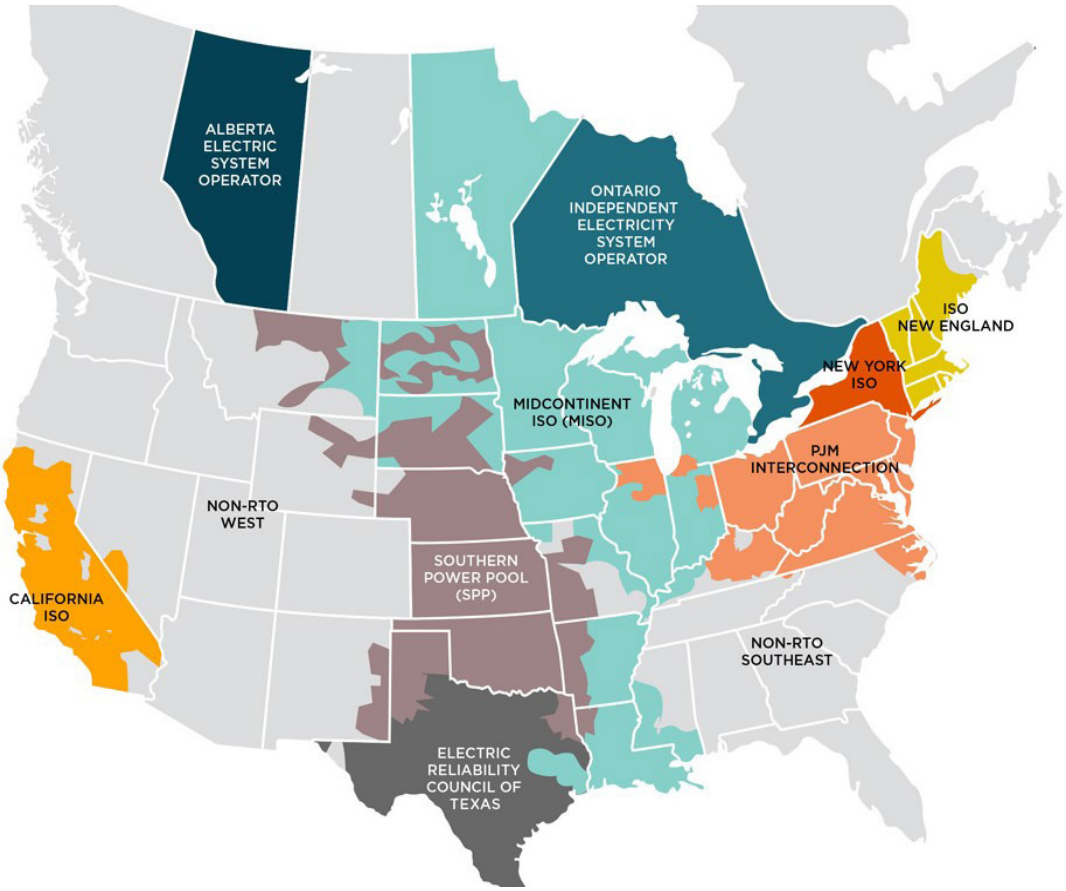
II. INTRODUCTION TO WHOLESALE POWER MARKETS

For over a century, the electric power industry has evolved and adapted to changing technology, regulation, economics, and customer preferences. Today, electric utilities, policy makers, and regulators face increasing pressure to respond to these changes as they work towards providing affordable, reliable, and sustainable electric power to customers. Since their development in the 1990s, the organized regional wholesale power markets operated by RTOs and ISOs ("RTO markets") have successfully helped utilities reduce the cost of providing reliable electricity service to customers. RTO markets have grown in the last two decades to cover the majority of the United States and three Canadian provinces as shown in Figure 1.

[1] North Carolina Clean Energy Business Alliance, Carolina Utility Customers Association, and Conservatives for Clean Energy – North Carolina

In addition to the RTO markets shown in Figure 1, over a dozen utilities covering parts of 10 western states have joined (or have announced plans to participate in) a new Energy Imbalance Market (EIM) in the non-RTO West. These EIM participants are now analyzing the potential benefits of creating a more complete regional wholesale market across the western United States. Currently, the only region in the United States where utilities do not participate in some form of an organized regional power market is the Southeast—most or all of North Carolina, South Carolina, Georgia, Alabama, and Florida.

FIGURE 1 Map of North American RTO Markets



Source: The Brattle Group

An organized regional market is a collection of interconnected utilities that cooperate in providing transmission and in optimizing the power generation needed to serve customers. The RTO or ISO is an independent organization that is tasked with optimally scheduling and dispatching the regional system, conducting regional transmission planning, and operating and administering the regional power market. The RTOs that cover multiple states are governed by an independent board of directors with representation of its members (the load serving utilities and generation asset owners that participate in the market) to help make decisions. While the magnitude of benefits will be region specific, the geographic size, weather and load diversity, and optimized diverse generation mix of the regional market generally provide the following benefits to electricity customers:

- **Lower cost of power production.** Markets are set up so that generation resources compete to produce the power needed to serve customers. Competition means that the region's lowest-cost resources will produce power more frequently, substituting production from the higher-cost generators, and delivering savings to electricity consumers. This category of benefits is referred to as "production cost savings." These savings come from three sources: (1) utilities purchase less fuel and spend less on variable operation and maintenance (O&M) for the power plants that operate less (due to having higher operating cost than the other competing generators in the marketplace), (2) utilities are able to buy power from the market to serve customers at a lower cost than producing it themselves, and (3) utilities with low-cost generation can make more sales into the market and earn higher revenues, which are used to offset other costs charged to customers.
- **Efficient investment decisions.** Regional markets can help participating utilities avoid or defer investments in transmission and generation resources, creating savings for electricity customers. The large regional market, where access to transmission is open to and shared by all participants, requires fewer generation facilities to reliably operate the system. Furthermore, large-scale transmission development is regionally planned to ensure the reliability of the system, which can avoid investment in redundant facilities by neighboring utilities within the region. The market provides a clear price signal to generation owners about which types of resources and at what locations provide the best return on investment, which results in more efficient generation investment and retirement decisions over the long-run.
- **Cost-effective integration of wind and solar generation.** Production from wind and solar resources vary depending on the weather, which can create costly operational challenges for the electric power system. Participating in a regional market reduces these challenges as the variable output from renewable energy production is diversified over a larger region. Local utilities can rely on the transmission and generation assets of their neighbors to balance their systems as renewable generation output varies, rather than having to hold large amounts of costly reserves themselves
- **Improved reliability.** The regional scheduling and dispatch of the transmission and generation allows the RTO or ISO to improve transmission availability and better manage unexpected facility failures on the system. This results in higher reliability without the need for increased investment in additional transmission or generation assets.

III. THE SIZE OF REGIONAL MARKET BENEFITS

Since the formation of RTO-administrated wholesale markets over 20 years ago, there have been numerous studies documenting their benefits.[2] Each study is slightly different and was designed to estimate some or all of the categories of benefits discussed previously for the specific region studied. Generally, all of these studies have estimated production cost savings, which refers to the first benefit category described in the previous section. Certain studies of RTO markets have also estimated the other types of benefits.

Quantifications of these benefits from RTO market participation have been both prospective (which estimate the *expected* benefits of RTO membership) or retrospective (which estimate the *actual* benefits of RTO membership realized). Prospective studies have been carried out by entities that are interested in joining or creating an RTO market and wish to understand the potential benefits for their customers. In recent years, Brattle has conducted several such prospective studies to estimate the expected benefits of RTO membership, which are summarized in Table 1. These prospective studies of RTO membership benefits show production cost savings in the range of 3% to 9%, depending on the region analyzed.

Several retrospective studies to measure the benefits of regional wholesale power markets have been conducted as well. These studies are conducted by the RTOs themselves and typically compare actual costs for the production of power and investments in generation and transmission assets made by utilities with estimated costs that would have been incurred but for the existence of the centrally organized wholesale market. The retrospective studies generally measure more categories of benefits, not only those associated with power production (fuel and variable O&M cost savings).

The magnitude of cost savings can vary for each region or utility depending on multiple factors, including the composition and relative efficiency of the generation fleet for each utility, the quantity of renewable energy resources in the region, and the diversity of customer demand on the system. For example, if electricity usage is high for customers of one utility while it is low for another, sharing the regional resources to meet their electricity usage can create a large benefit to both utilities. Since these characteristics are different from region to region, the benefits of regional markets will also vary across states and regions. We see this in the variation of estimated benefits in the prospective and retrospective studies summarized in Tables 1 and 2.

[2] See Johannes Pfeifenberger et al., "Senate Bill 350 Study Volume XII: Review of Existing Regional Market Impact Studies," The Brattle Group, July 8, 2016 for a summary of several other RTO benefit studies. Accessed at https://www.caiso.com/Documents/SB350Study-Volume12ReviewofExistingStudies.pdf

TABLE 1 Recent Brattle *Prospective* RTO Membership Study Results

REGION	STUDY	YEAR	ESTIMATED COST SAVINGS
Mountain West Transmission Group[3]	RTO market formation in Colorado and Wyoming	2016	Production cost savings of 5% - 9% Did not study other benefits, such as improved long-term investment decisions, renewable integration, or reliability
California SB350[4]	RTO market formation in western U.S.	2016	$1 - $1.5 billion per year in production and investment cost savings for California ratepayers from participation a in Western-wide RTO market
Basin/WAPA/ Heartlands[5]	Benefit from Joining SPP or MISO	2013	Production cost savings of 3% - 4% Did not study other benefits, such as improved long-term investment decisions, renewable integration, or reliability

Source: The Brattle Group

[3] Judy Chang et al., "Production Cost Savings Offered by Regional Transmission and a Regional Market in the Mountain West Transmission Group Footprint," The Brattle Group, December 1, 2016. Accessed at https://www.wapa.gov/About/keytopics/Documents/mountain-west-brattle-report.pdf

[4] Johannes Pfeifenberger et al., "Senate Bill 350 Study Volume I: Impacts of a Regional ISO-Operated Power Market on California," The Brattle Group, July 8, 2016. Accessed at https://www.caiso.com/Documents/SB350Study_AggregatedReport.pdf

[5] Metin Celebi et al., "Integrated System Nodal Study: Costs and Revenues of ISO Membership," The Brattle Group, March 8, 2013. Accessed at https://www.wapa.gov/regions/UGP/PowerMarketing/Documents/ISNodalStudyRedacted030813.pdf

TABLE 2 Recent *Retrospective* RTO Membership Study Results

REGION	STUDY	YEAR	ESTIMATED COST SAVINGS
MISO[6]	2018 Annual MISO Value Proposition Study	2019	$3.2 - $3.9 billion in benefits in 2017 $24 billion cumulative benefit from 2007 - 2017
Entergy (MISO South)[7]	2018 Annual MISO Value Proposition Study	2019	$1 - $1.2 billion of benefits in first year of membership
Western EIM[8]	Cumulative Benefits Study	2019	$565 million of cumulative benefits since 2014 Western EIM is not a fully RTO market, only an energy balancing market
PJM[9]	PJM Value Proposition Study	2015	$2.8 - $3.1 billion per year in benefits $24 billion cumulative benefit from 2007 - 2017
Dominion[10]	2015 PUC filing on Benefits of PJM Membership	2015	$109 million of production cost savings in 2014 $75 million of production cost savings in 2013 Cumulative 2005 - 2015 benefits filed with NC PUC, but not made public Did not study other benefits, such as improved long-term investment decisions, renewable integration, or reliability
SPP[11]	Integrated Marketplace: First Year Update	2015	Production cost savings of 8% Did not study other benefits, such as improved long-term investment decisions, renewable integration, or reliability

Source: The Brattle Group

6. "2018 MISO Value Proposition," MISO, February, 2019. Accessed at https://www.misoenergy.org/about/miso-strategy-and-value-proposition/miso-value-proposition/

7. ibid.

8. "Western EIM Benefits Report: Fourth Quarter 2018," California ISO, January 31, 2019. Accessed at https://www.westerneim.com/Pages/About/QuarterlyBenefits.aspx

9. "2015 PJM Value Proposition," PJM, 2015. Accessed at https://www.pjm.com/about-pjm/~/media/about-pjm/20151016-value-proposition.ashx

10. Direct Testimony of Alan Meekins on Behalf of Virginia Electric and Power Company, Before the State Corporation Commission of Virginia, Case No. PUE-2015-00022, February 27, 2015. Accessed at http://www.scc.virginia.gov/docketsearch/DOCS/318y01!.PDF, and Direct Testimony of Alan Meekins on Behalf of Virginia Electric and Power Company, Before the State Corporation Commission of Virginia, Case No. PUE-2014-00033, May 2, 2014. Accessed at http://www.scc.virginia.gov/docketsearch/DOCS/2xgr01!.PDF

11. Bruce Rew, "Integrated Marketplace: First Year Update, Technical Report," RSC for the Southwest Power Pool, April 27, 2015, Accessed at https://www.spp.org/documents/28607/rsc%20materials%2020150427.pdf

IV. POTENTIAL BENEFITS OF RTO MEMBERSHIP FOR DUKE'S NORTH CAROLINA CUSTOMERS

The full benefit of RTO membership for Duke's North Carolina electricity customers cannot be comprehensively analyzed without conducting a complete cost and benefits study, as described in Section V. Nonetheless, we estimate the potential customer benefits of Duke's North Carolina utilities joining an RTO market by leveraging the studies discussed previously and through a preliminary analysis of the cost of Duke's North Carolina power plants compared to nearby wholesale power market prices.

The studies summarized in Tables 1 and 2 show a range of **production cost benefits** of 3% to 9%. Based on the 2017 operating costs (fuel plus variable operating and maintenance) of Duke's North Carolina thermal power plants (coal, gas, and nuclear) of over $2 billion, saving 3% to 9% of production cost would yield roughly $60 million to $180 million in annual customer savings.

We also undertook a high-level analysis comparing the cost of Duke's North Carolina thermal generation facilities with a nearby PJM regional market pricing point in Virginia, which suggests that the benefits to customers in North Carolina could be higher than the above estimates. The analysis compares the variable operating cost of Duke's North Carolina thermal generation plants with the historical market prices in PJM in 2016 and 2017. We look at each plant and estimate potential production cost savings in each hour of the year by adjusting the output of the plant to produce power when PJM market prices are higher than the incremental cost of operating the plant, or to turn off when market prices are lower than the incremental cost of operation. The analysis takes into account the operating restrictions of Duke's generating units and constraints in the regional transmission system. We assume nuclear plants are inflexible, and set their output equal to the historical level in each hour regardless of market prices. Similarly, we assume coal plants must produce for at least the entire 16-hour on peak period in each day. We use variable operating cost data for each plant obtained from the ABB Velocity Suite database.

Based on this high-level analysis, we estimate that production cost savings from Duke joining PJM could be as high as 9% to 11%, or between $190 million and $220 million per year for Duke's North Carolina thermal fleet. These savings stem from the (1) ability to buy power from the PJM market at a lower cost than generating the power from Duke's own generation facilities whenever the market prices are lower than the costs of Duke's generation, and (2) selling more power to the market when the cost of Duke's generation facilities is lower than the market price. This high-level analysis suggest that North Carolina may be able to disproportionately benefit from a regional market when it comes to production cost savings because it appears that, being far away from coal mines, the fuel cost of Duke's North Carolina coal plants are relatively high.

We have additionally estimated the **broader set of benefits** that Duke's customers would likely realize from joining an RTO market by scaling the results of the PJM value proposition study to Duke's North Carolina service area. The results of this analysis are shown in Table 3. This analysis covers more than just production cost benefits, including the benefits from improved reliability, lower-cost system management (procurement of ancillary services such as regulation and spinning reserves), sharing of regulatory compliance costs, the deferral/avoidance of generation and transmission investment (largely due to the diversity of customer loads in the footprint), improved integration of renewable resources, enhanced generator availability, less the cost of administrating the RTO market. These studies take a long-term view of RTO market benefits, as they incorporate the savings from more efficient generation and transmission investment decisions utilities can make in a regional market, which may accrue to customers only over time as the utility is able to defer or reduce investments.

We have scaled the benefits estimated in the PJM retroactive study to a system the size of Duke's Carolina utilities (Duke Energy Carolina and Duke Energy Progress) in North Carolina.[12] Given that our high-level analysis of production costs benefits suggest that North Carolina could see larger savings than the average of other regions, we supplement the scaled PJM production cost benefits with our Duke North Carolina estimate of estimated production cost benefits. The range of estimated production cost benefits shown in Table 3 is based on the scaled PJM benefit and our preliminary North Carolina-specific analysis.

TABLE 3 PJM Value Proposition Benefits Scaled to Duke's North Carolina System with Adjusted Energy Production Cost Benefits ($ million per year)

BENEFIT CATEGORY	PJM BENEFIT	BENEFIT SCALED TO DUKE'S NC SYSTEM
Grid Services	$100	$17
Reliability	$475	$80
Integrating Efficient Resources	$600	$100
Energy Production Cost	$525	$88 – $220
Generation Investment Savings	$1,100 – $1,400	$185 – $235
Less: RTO Costs[13]	$353	$59
Total Net Benefits[14]	**$2,447 – $2,747**	**$411 – $593**

Source: The Brattle Group

Table 3 shows the additional benefits associated with applying PJM's Value Proposition study to Duke's North Carolina customers for grid services, reliability, integrating efficient resources, and generation investment savings. If Duke's experience was the same as those of the utilities in PJM, then North Carolina customers could expect to receive **benefits between $411 million per year and $593 million per year from Duke's membership in an RTO market.** The estimates of potential North Carolina benefits are only indicative. More accurate estimates could be derived by a detailed study of RTO market benefits for North Carolina, similar to the studies recently conducted for markets in the Western U.S.[15]

12. In 2017, the two Duke utilities made about 77% of their retail sales in North Carolina.

13. PJM operating costs taken from the 2017 PJM Annual Report, Consolidated Statement of Income. Accessed at https://www.pjm.com/-/media/about-pjm/newsroom/annual-reports/2017-annual-report.ashx

14. Note that PJM estimated benefits of $2.8 billion to $3.1 billion per year, but did not include RTO-related costs in their estimate. We subtracted the RTO-related costs from PJM's estimate.

15. Judy Chang et al., "Production Cost Savings Offered by Regional Transmission and a Regional Market in the Mountain West Transmission Group Footprint," The Brattle Group, December 1, 2016. Accessed at https://www.wapa.gov/About/keytopics/Documents/mountain-west-brattle-report.pdf

Johannes Pfeifenberger et al., "Senate Bill 350 Study Volume XII: Review of Existing Regional Market Impact Studies," The Brattle Group, July 8, 2016. Accessed at https://www.caiso.com/Documents/SB350Study_AggregatedReport.pdf

Metin Celebi et al., "Integrated System Nodal Study: Costs and Revenues of ISO Membership," The Brattle Group, March 8, 2013. Accessed at https://www.wapa.gov/regions/UGP/PowerMarketing/Documents/ISNodalStudyRedacted030813.pdf

V. FRAMEWORK FOR ANALYZING THE BENEFITS OF AN RTO MARKET IN THE SOUTHEAST

A more accurate estimate of the benefits of Duke's membership in a RTO market can be derived by conducting a study similar to those listed in Table 1 for the specific circumstances of Duke's footprint. Such an analysis can be developed to estimate most of the benefits listed in Section II of this paper. For example, detailed simulations of the regional power system can be used to estimate how much lower the cost of producing power would be in a specific market. These simulations also can be designed to estimate the benefit from improved integration of renewable energy. Similarly, a study of each utility's resource plan can quantity the extent to which the utility would be able to avoid or defer investments in new generation facilities. More specifically, these analyses would include:

- **Power system and generation production cost simulation.** An analysis that involves a simulation of the entire power system in the region of interest, including the scheduling and dispatch of power plants and transmission assets to serve load. The simulation would rely on data on the variable cost and operating restrictions for all power plants, and the physical limitation of transmission assets to accurately model the operation of the entire regional power system. The simulation would mimic the function of the market, by using the variable operating costs of the power plants in the region to determine the lowest-cost option for producing enough power to serve load – just as a regional wholesale market accomplish by prioritizing the lowest cost units in making scheduling and dispatch decisions. A production cost simulation can also be designed to understand the cost savings from integrating the variable output of renewable energy resources more efficiently into the system. Participating in an organized wholesale power market can reduce the amount of renewable energy that is curtailed, resulting in reduced production from costly thermal generation and savings for customers.
- **Resource planning study.** A utility operating in an organized wholesale power market may be able to avoid or defer investment in generation or transmission assets. The members of an RTO may be able to plan for a lower reserve margin, due to the pooling of generation and transmission assets and the diversity of loads in the larger regional market. This component of the study would look at the resource plans, plus the load and generation diversity of the utilities in the study region to determine if planned investments in generation or transmission might be avoided in a regional wholesale market.

Any study of benefits from participating in an organized wholesale power market would be improved if the utilities in the footprint being studied actively participated by sharing cost data, operational information and expertise, and their latest resource plans. This would allow for more accurate simulations of production costs and the operating limitations of the generation and transmission assets on the system.

We thus recommend that Duke, possibly in conjunction with other utilities in the Carolinas or the Southeast, conduct an analysis to estimate the potential benefit associated with creating or joining an organized wholesale power market. Based on the experience in other regions and our high-level analysis of Duke's system, a regional market would provide significant benefits to North Carolina's electricity consumers.

ABOUT THE BRATTLE GROUP

The Brattle Group answers complex economic, regulatory, and financial questions for corporations, law firms, and governments around the world.

The Brattle Group helps energy and utility market participants worldwide anticipate and navigate the challenges and opportunities in changing markets and regulatory environments.

Brattle's experts are at the forefront of the latest developments and trends facing the energy industry. Our experience spans the full spectrum of complex, high-stakes matters relating to resource planning and approvals, regulatory policy assessments, rate design, contract litigation, market conduct, performance and enforcement, financial analysis, and mergers & acquisitions.

We support a wide range of clients in the U.S., Canada, Europe, and the Pacific Rim, including investor-owned utilities, public utilities, electricity and pipeline customers, power generators, transmission organizations, and regulatory agencies.

For additional information about The Brattle Group's experts and services, please visit **brattle.com**.

BOSTON
BRUSSELS
LONDON
MADRID

NEW YORK
ROME
SAN FRANCISCO
SYDNEY

TORONTO
WASHINGTON

Brattle

THE POWER OF ECONOMICS