MIT CEEPR
Center for Energy and Environmental Policy Research

WP-2026-17
Research Brief

Cross-Border Electricity Trade and the Future of the Grid in Northeastern North America

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Advances in the technologies for wind generation are opening up new possibilities for affordable and clean electricity. The quality of wind resources varies across the provinces and states of the northeastern North America—Ontario, Québec and the four Atlantic provinces, and New York state and the six states of New England. Expanded cooperation on cross-border trade maximizes the benefits of this resource. This has two dimensions. One is the improved utilization of existing transmission, facilitating expanded two-way trade. The second is expanded cross-border transmission capacity. Altogether, across both dimensions, expanded cooperation reduces system costs by nearly $1.2 billion annually. Curtailment is reduced by nearly 1 TWh annually.

Electricity Trade in Northeastern North America

This report delivers the result of a two-year study of the future 2050 electric grid across a large portion of northeastern North America spanning several provinces of Canada and several of states of the U.S. These include Ontario, Québec and the four Atlantic provinces, and New York state and the six states of New England. Our focus was on the potential benefits from two types of increased cross border cooperation.

First, we look at opening up existing key transmission interfaces to two-way trade. While the grid is often thought of as a single, interconnected system, the reality is that it has "seams" at the boundaries joining certain states and provinces. The systems on either side of the seam are administered by different entities with different protocols determining operations and pricing. Arrangements must be made to enable and facilitate cross-border trade. At one extreme, these arrangements unify the system. For example, the six states of New England operate a single system. More often, specific contracts and other governance arrangements enable specific transactions as with the various export contracts between Hydro Québec and neighboring regions. Currently, the governance arrangements across the U.S. and Canadian borders have generally not been negotiated to take full advantage of the potential benefits of two-way trade. Recently, flows of power from New York and New England into Québec have been notable, precisely because it is an exception to the longstanding pattern of flow from Canada down to the U.S.. This stands in contrast to east-west trade between New England and New York, which regularly sees flows in both direction. This research explores what gains may be had by enabling a fuller two-way trade between the U.S. states and Canadian provinces.

Second, we look at further expanding transmission capacity, both across the U.S.-Canada border as well as east-west between the Canadian provinces. We examine expanded transmission within the current framework of one-way trade, and then we consider the combination of expanded transmission together with the facilitation of two-way trade.

Our experiments utilized the capacity expansion and dispatch model GenX, developed at the MIT Energy Initiative in partnership with Princeton University's Zero Lab and New York University's Sustainable Energy Transitions group. In earlier work, we had used GenX in a study focused on the utilization of Québec's hydro resources and the expansion of transmission between Québec and New York and New England. This new study surveys options for a wider territory and for a broader array of resources and includes updated system assumptions to more accurately capture the future regional energy market dynamics. GenX allows us to examine investments in alternative portfolios of generation and transmission, detailed by individual region, and to explore the system cost by region as well as the CO_2 emissions.

A key result that surfaces from the research is the critical importance of decisions about the exploitation of wind resources across the many provinces and states. Driving this is the fact that the technology for wind generation has dramatically improved over the last decade, and that further technology improvement is expected in the coming decades. This is likely to drive down the relative cost of wind generation in the long run. Wind resources that have long been an endowment of each province and state, will become increasingly exploitable as a valuable source of affordable electricity. Prudent electricity sector planning should take advantage of this opportunity and identify how to best integrate this resource as a part of the portfolio of generation technologies.

While this can be done individually by each province and state, maximizing the returns from developing this resource also warrants examining opportunities for interregional cooperation. The quality of wind resources is greater in some provinces and states than in others, so there are significant benefits to be had from cooperation. Because of the modeling tool used, this study highlights the benefits from better exploitation of on-shore wind resources, although there are also unique regional opportunities for off-shore wind resources. The best wind resources appear to be in the north and east of the region, especially in Québec and the Atlantic provinces. Neighboring provinces and states could benefit from enabling the expansion of wind capacity in those provinces, which would require expanded interregional transmission. Enabling two-way trade between U.S. and Canadian regions can also benefit parties on both ends of any transmission interconnection. Québec and the Atlantic provinces benefit from minimizing required investments in expensive peaking capacity including that provided by storage assets. While expanding wind generation alone provides part of the solution, its value exhibits diminishing returns at high penetration levels unless paired with flexibility resources. In the near term, this flexibility is largely provided by storage, and in the longer term by long-duration storage or other firm balancing resources. It can also be provided by expanding transmission access across a larger territory.

To fully understand the benefits of each of our two types of expanded cooperation, we examine each independently and also as a pair. This gives us four cases to compare and contrast against one another, starting with a baseline 2050 power system with only one-way trade across the Canada-US border and with only existing transmission capacity (C1). We then examine a case that allows northbound trade to Québec with existing transmission (C2), a case that expands transmission capacity while maintaining one-way trade (C3), and finally a case with both northbound trade to Québec and with expanded transmission capacity (C4).

The main results use a conservative set of assumptions: moderate load growth, a modest carbon policy (reducing 2050 emissions 80% from 2005 levels), and a significant penetration of new nuclear capacity. The full report features extensive analyses of key sensitivities including the level of emissions reduction, availability of zero-carbon firm technologies, and varying load growth rates. Even under our conservative assumptions, a 2050 least-cost portfolio is expected to look different from today’s grid. For our baseline 2050 case, total capacity increases 60%. There are large retirements of thermal capacity. New capacity is primarily wind, solar, and storage, as well as nuclear. Under this mix, fossil fuel generation drops 42% while generation from hydro, wind, solar and nuclear all increase.

The Benefit of Expanded Coordination

The constraint of one-way trade and the existing transmission capacity limits the exploitation of the highest quality wind

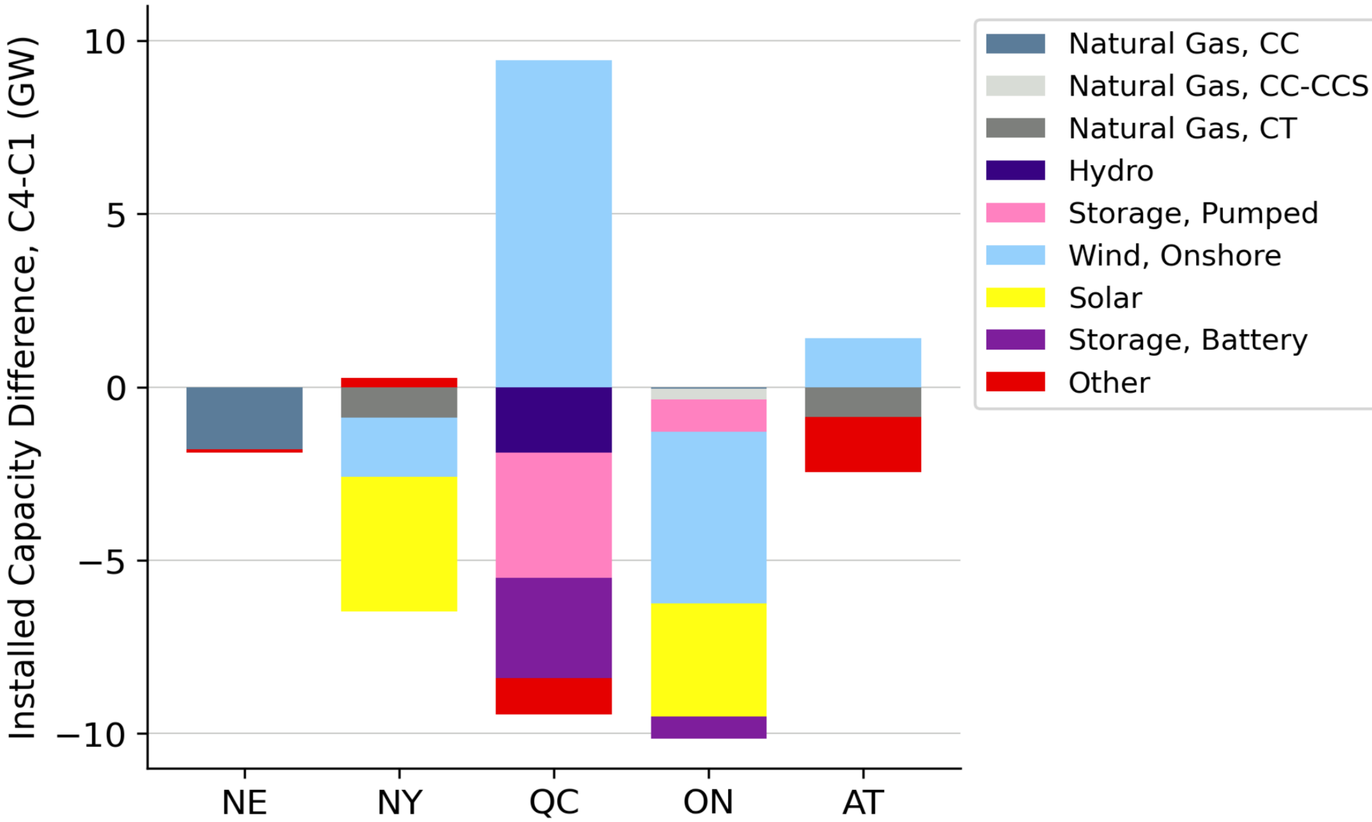


Figure 1. Change in Installed Capacity by Technology and Region When Adding Two-Way Trade and Transmission Expansion.

resources. Lower quality wind and solar resources are exploited instead, which makes the system more costly. In addition, the system is forced to maintain or invest in complementary dispatchable resources–be they batteries or pumped storage or fossil fuel plants. Figure 1 shows the change in installed capacity when two-way trade is enabled together with expanded transmission, i.e., moving from Case 1 to Case 4. Keep in mind, that this shows a change across alternative future systems. Relative to today, both future systems have dramatically expanded renewable capacity portfolio across every region. Figure 1 reflects the marginal comparison across the two future scenarios. Each region shows a net negative change in invested capacity. Québec and the Atlantic provinces show an increase in installed wind capacity, while this is offset by a decrease in other capacity in the respective regions. The utilization of more productive wind capacity in Québec and the Atlantic provinces also enables the reduced capacity investments in less productive areas in the U.S. and Ontario. With new outlets for surplus power, curtailment falls from 1 TWh in the 2050 baseline to near zero. Gross trade increases by 35%. Net exports grow in Québec, the Atlantic Provinces, and New England but fall in Ontario and New York where investments in new renewables decrease.

Primarily by avoiding capacity investments, total annual cost savings of enabling two-way trade and investing in expanded transmission come to over $1 billion. This reduces incremental system costs by about 4%.

Two-way trade also expands the options for assuring reliability. When the system in one region is stressed, with net load potentially exhausting capacity, the ability to access generation in another region reduces the stress. An example of this benefit can be seen in Figure 2. The figure contains two graphs. The left-hand graph is for Case 1, when there is only one-way trade and only existing transmission capacity. The right-hand graph is for Case 4, when there is two-way trade and expanded transmission capacity. In each graph, each dot represents a different hour of the year. The dots are color coded to reflect the modeled 'System Lambda' in Québec. System Lambda is the marginal cost of serving an extra megawatt of load that hour. The scale for the System Lambda is logarithmic, so whereas the green events have a marginal cost of only $100, the most extreme purple events have a marginal cost of $20,000/MWh, flagging the extreme stress on the system. The axes of each graph show different combinations of wind availability and load. To the left of each graph, wind availability is low, and to the right

Figure 2. System Lambda in Québec Across Wind Resource Availability Factors and Load.
Left: With One-Way Trade and Existing Transmission. Right: With Two-Way Trade and Transmission Expansion.

wind availability is high. At the bottom of each graph load is low, while at the top load is high. We should expect stress to show up most often when wind availability is low and load is high–i.e., in the top left of each graph. In the top left of the left-hand graph, there are several events where the System Lambda reaches an extreme. In contrast, in the top left of the right-hand graph the number of hours of extreme stress have been reduced to only two (although they appear like a single event given their similarly high load and low wind).

Conclusions

Our modeling results highlight these key messages:

- The 2050 grid will be fundamentally different. In our base case scenario, load is 50% higher than today. As generation capacity increases, the profile shifts dramatically. Some of the most carbon intensive fossil plants are retired. Although a large amount of gas-fired capacity is retained, its utilization drops. New capacity investment is primarily in wind, solar, storage, and clean firm resources, including nuclear power.
- The relative cost of wind capacity is likely to continue falling over the long run, raising the value of each province and state's available wind resources. However, the quality of these resources varies significantly across provinces and states in the territory studied. This fact drives the value of interregional trade.
- The constraint of one-way trade and the existing transmission capacity limits the exploitation of the highest quality wind resources. Lower quality wind and solar resources are exploited instead, which makes the system more costly. In addition, the system is forced to maintain or invest in complementary dispatchable resources–be they batteries or pumped storage or fossil fuel plants.

- Transmission expansion enables efficient resource allocation, shifting new capacity toward the highest-quality renewable regions and reducing redundant investments elsewhere.

- Two-way cross-border trade unlocks hydro flexibility, reducing renewable curtailment, lowering storage and peaking investment needs, and improving reliability.

- Combining two-way trade and expanded transmission reduces system costs by nearly $1.2 billion (4%) annually, while improving reliability.

- The value of regional cooperation grows under deeper decarbonization and higher load growth and remains robust across nuclear deployment assumptions.

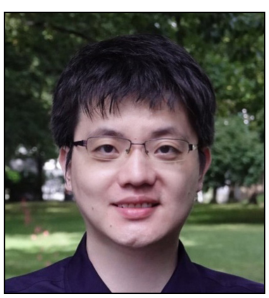
Through bidirectional trade and expanded transmission capacity, interregional cooperation allows the power systems of northeastern North America to forego investments in expensive peaking capacity, including that provided by storage. Instead, planners can double down on the highest quality renewable resource in the region – onshore wind in Québec and the Atlantic Provinces – and balance its intermittency through bidirectional trade. By reducing investment costs, reducing curtailment, and reducing stress hours with high System Lambda, interregional cooperation and cross-border trade enable a more efficient power system.

References

Link to the full working paper discussed in this brief:

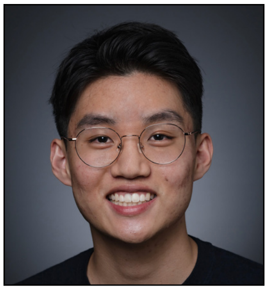
Wang, Shen, Jack Morris, Grant Lee, Joshua Hodge, and John E. Parsons (2026), "Cross-Border Electricity Trade and the Future of the Grid in Northeastern North America," MIT CEEPR Working Paper 2026-17, September 2026

About the Authors



Shen Wang is a Postdoctoral Associate at the MIT Center for Energy and Environmental Policy Research. His research foci include power resource planning, electricity market design, and the environmental and energy policies associated with the energy transition. At CEEPR, Shen investigates the role of the hydropower of Quebec and transmission expansion in Northeastern North American, the impacts of flexible data centers on US power system and weather-informed capacity accreditation and resource adequacy. Before joining CEEPR, Shen completed his Ph.D. in Energy Economics & Management at Johns Hopkins University, where he also received M.S. in Applied Mathematics and M.S.E. in Environmental & Health Engineering.

Jack Morris is a Ph.D. student and GE Vernova Fellow studying energy systems modeling at the MIT Institute for Data, Systems, and Society, advised by Professor Christopher R. Knittel at the Center for Energy and Environmental Policy Research. His current work explores the impact of residential heating electrification on electric load and its implications for grid-level planning. Jack has contributed to the development of MIT's open-source capacity expansion model GenX and uses it, along with other models, to identify pathways to more affordable, reliable, and clean electric power systems. Jack hold a B.S. in Applied Mathematics from William & Mary and completed an S.M. in MIT's Technology & Policy Program in 2022.



Grant Lee graduated with a master's degree from MIT in the Technology & Policy Program where he did and continues to do research focused on energy systems modeling, economics, and policy. As a research assistant at the MIT Center for Energy and Environmental Policy Research (CEEPR), his research included works on cross-border transmission planning and capacity accreditation for integrated fusion and thermal energy storage systems. He graduated from the University of Texas at Austin with a B.A. in Government and a B.S. in Environmental Engineering. In addition to his work on North American electricity markets, he also has experience working in the energy sectors of India and Bhutan.

Joshua Hodge is the Executive Director of the MIT Center for Energy and Environmental Policy Research, Research Director at the MIT Climate Policy Center, and a Lecturer at the MIT Sloan School of Management. His work focuses on domestic and international climate and energy policy, with recent emphasis on energy affordability, power markets, and the growing interaction between artificial intelligence and electricity demand. Before joining MIT, he led the Commodities Research and Forecasts business for the Americas at Thomson Reuters and served as Managing Director, North America, at Point Carbon. Joshua received an MBA from the University of Virginia Darden School of Business.

John Parsons is the Deputy Director for Research at the MIT Center for Energy and Environmental Policy Research (CEEPR). His research focuses on the valuation and financing of investments in energy markets. Recent publications have touched on interregional transmission investments, including the interaction with hydro assets and expanded penetration of renewables, the value of investments in life extensions of nuclear power plants, the economics of new microreactors. He has served as an Associate Member of the U.S. Commodity Futures Trading Commission's Energy and Environmental Markets Advisory Committee and has been a Visiting Scholar at the Federal Energy Regulatory Commission. John received his B.A. in economics from Princeton University, and an M.A. and Ph.D. in economics from Northwestern University.