Chair in Energy Sector Management

HEC MONTRÉAL

A Decarbonized Northeastern North America: the Key Role of Market Integration

Pierre-Olivier Pineau

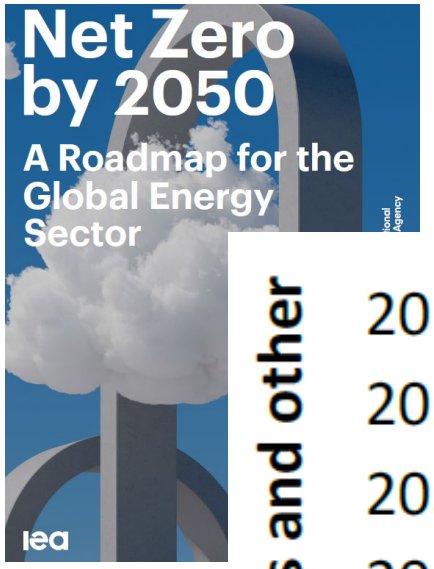
May 25th 2022 – 10h35 - 11h35

North American Grid Integration: An essential Tool to our Economies Decarbonisation

ABC room, Hotel Pur, AQPER colloque 2022

Outline

1. Context
2. Integration and cooperation: the missing link
3. Gains from integration



Global total final consumption by fuel in the Net-Zero Emissions by 2050 Scenario

Fuels and other
2010
2020
2030
2040
2050
Oil
Natural Gas
Coal
Bioenergy
H_2

Electricity use
2010
2020
2030
2040
2050
Wind & Solar

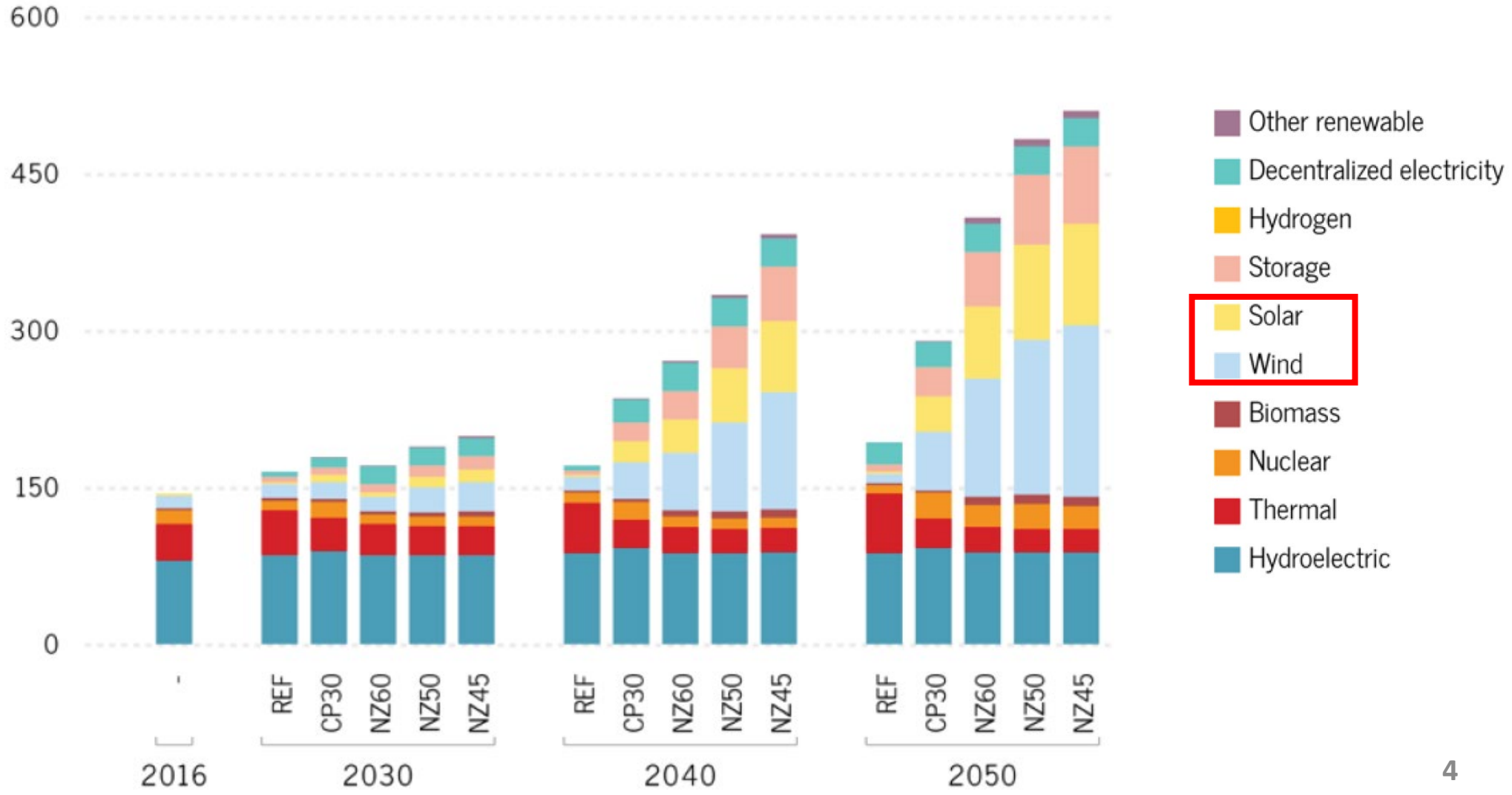
Reduced by 150 EJ (45%)

Grows by 95 EJ (2.25x)

50 100 150 200 EJ 250 300 350

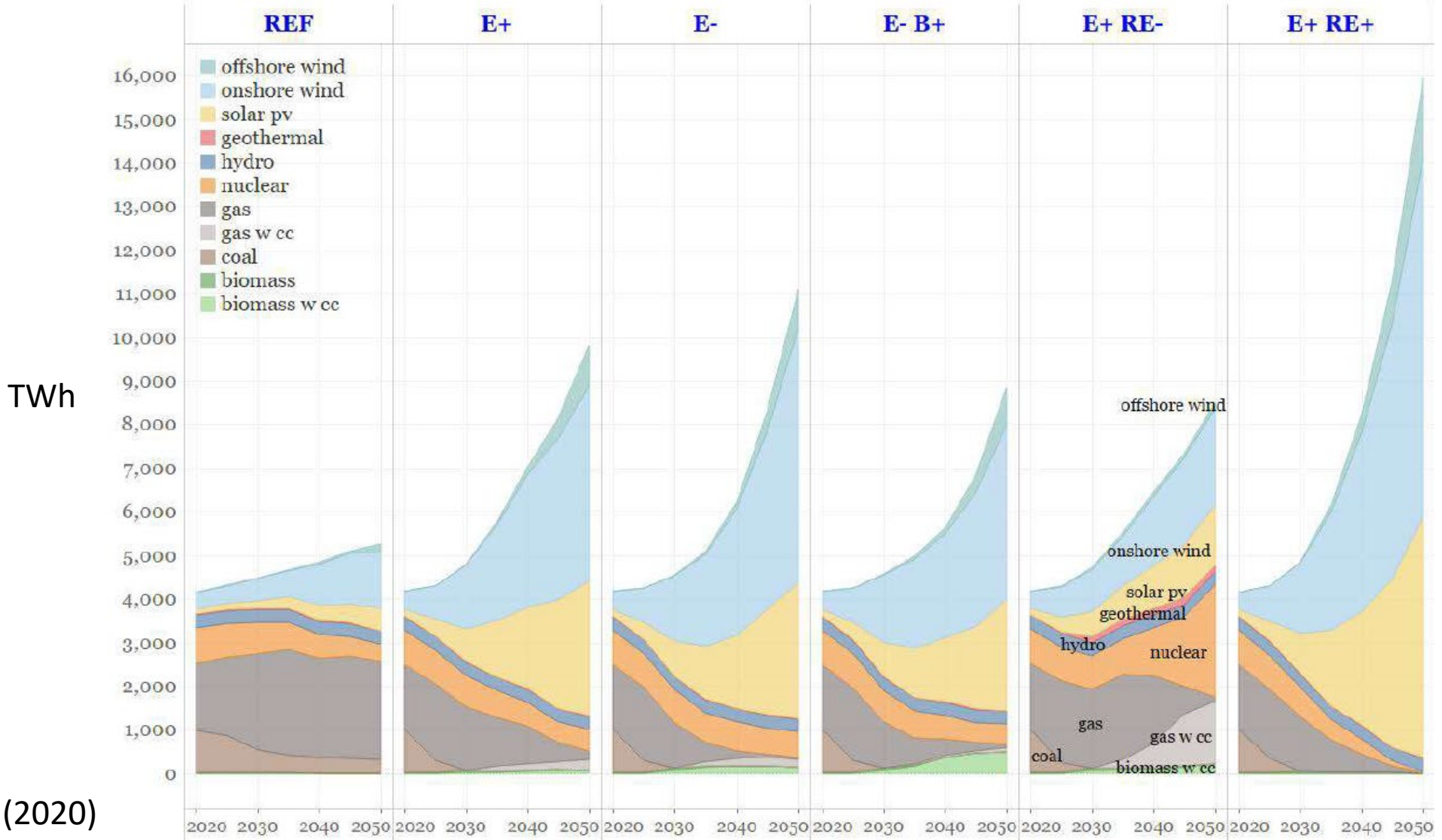
IEA (2021)

Required Renewable Capacity in Canada for net-zero in 2030, 2040 and 2050



IET (2021)

Required Renewable Generation in the United States for net-zero by 2050

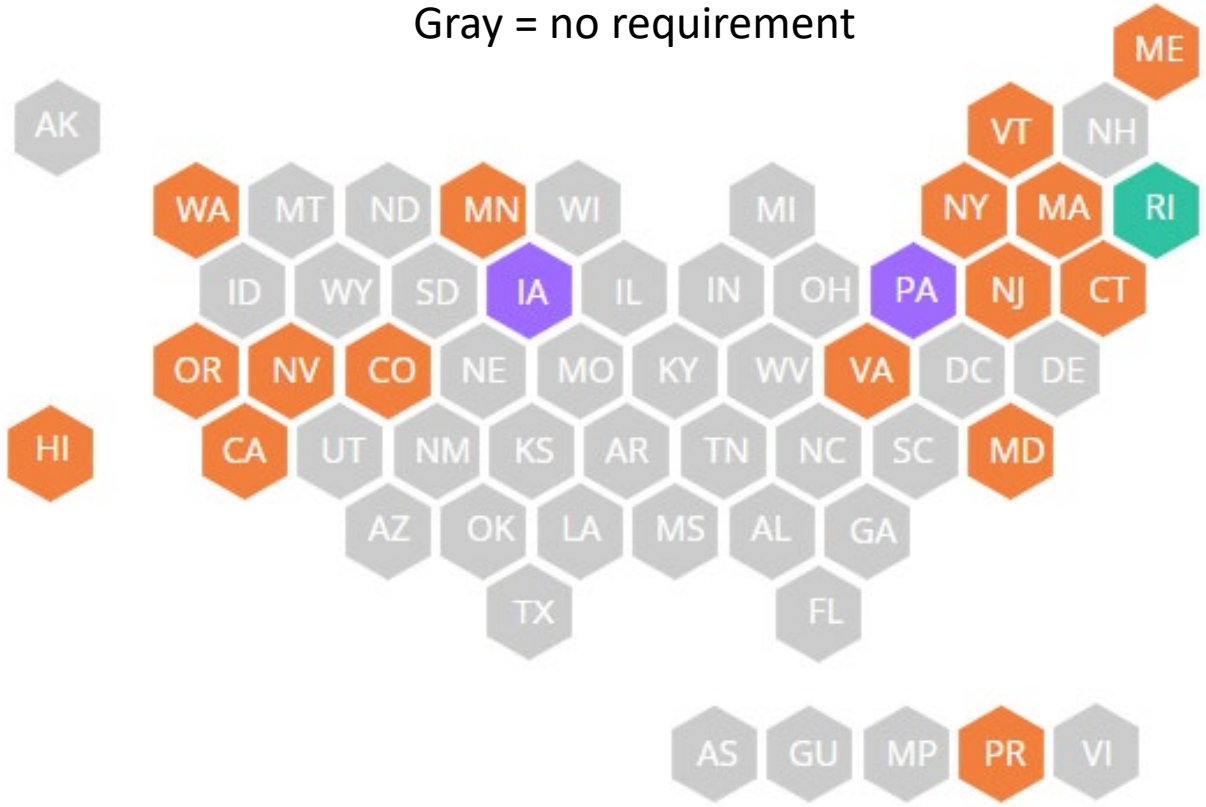


Princeton (2020)

States with Statutory GHG Reduction and Reporting Requirements and Market-Based Policies

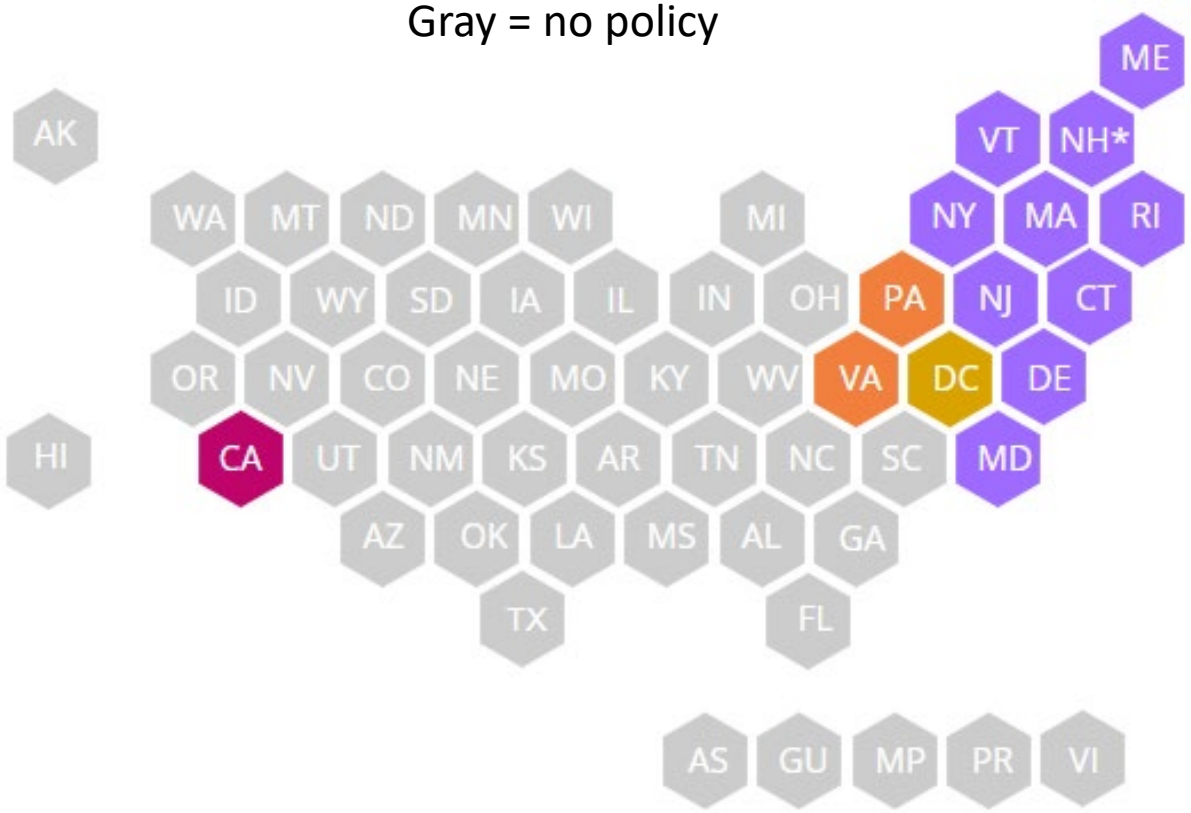
Reduction and Reporting Requirements

Gray = no requirement



Market-based Policies

Gray = no policy

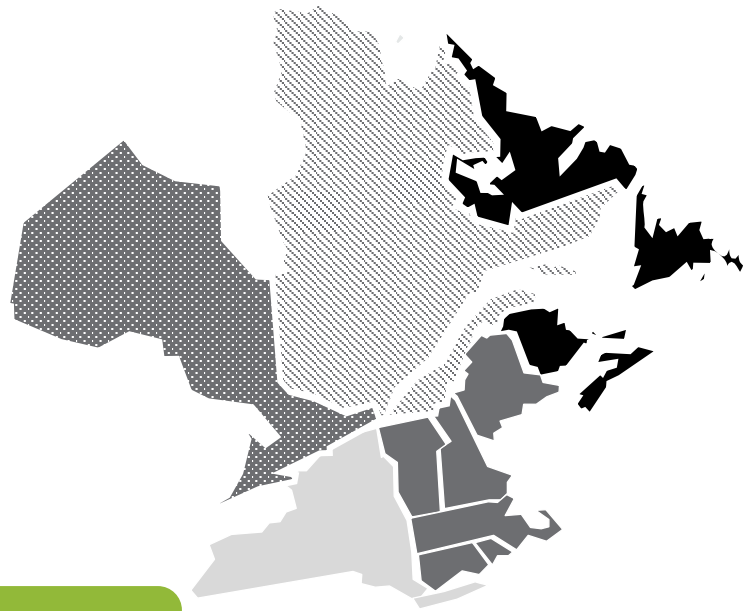


Shields (2021)

GHG Emissions Reduction Targets 2030 / 2050

Quebec
37.5% / Net-zero

Ontario
37% / 80%



New York
40% / 85%

Note: GHG emissions targets are measured below 1990 levels except for * (below 2002 levels) and ** (below 2005 levels)

Atlantic provinces

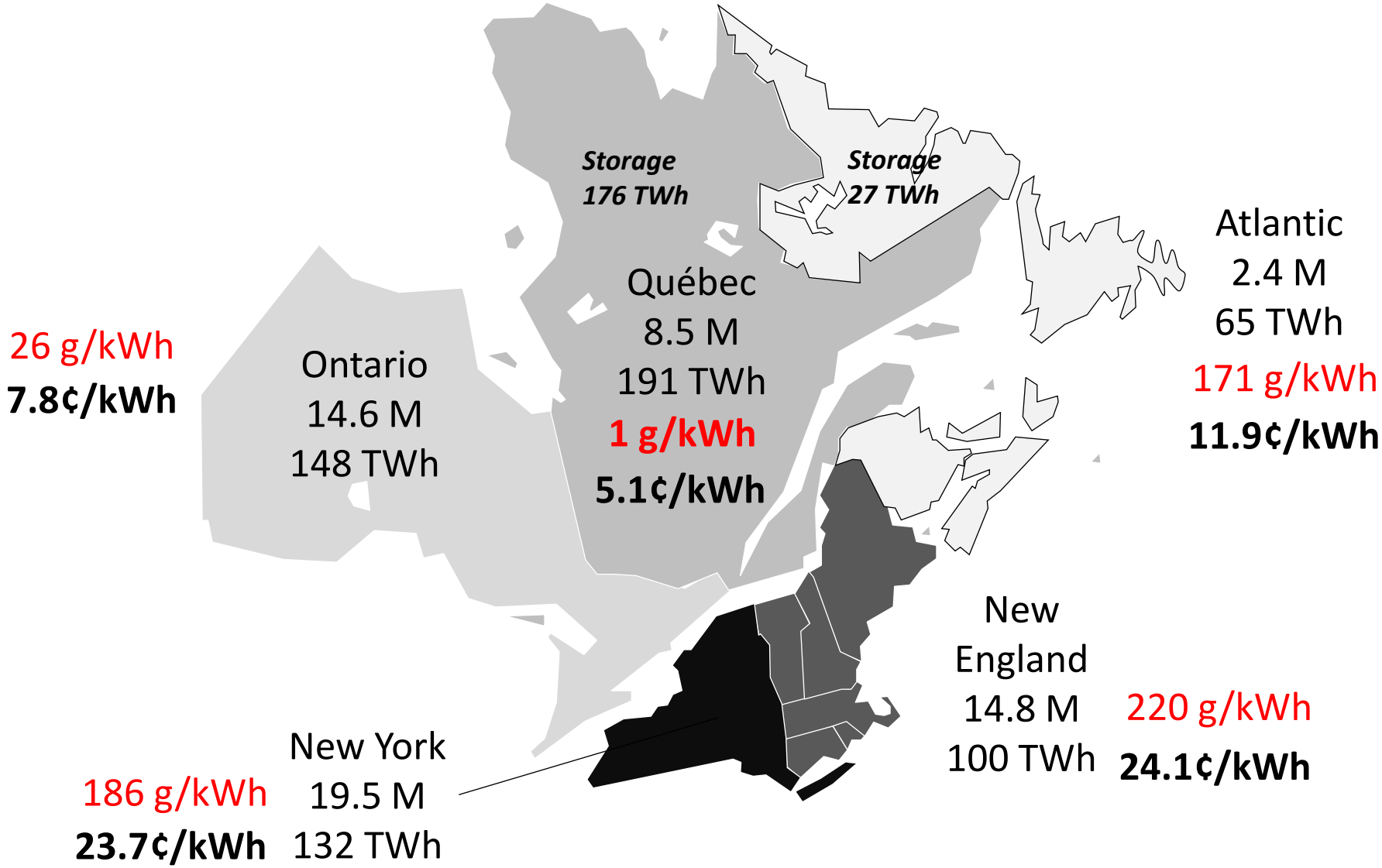
NB: 35% / 80%*
NL: 30%** / 75%*
NS: 53%** / Net-zero
PEI: 40%** / Net-zero

New England

CT: 45%* / 80%*
MA: 50% / Net-zero
ME: 45% / Net-zero
NH: 20% / 80%
RI: 45% / 80%
VT: 40% / 85%

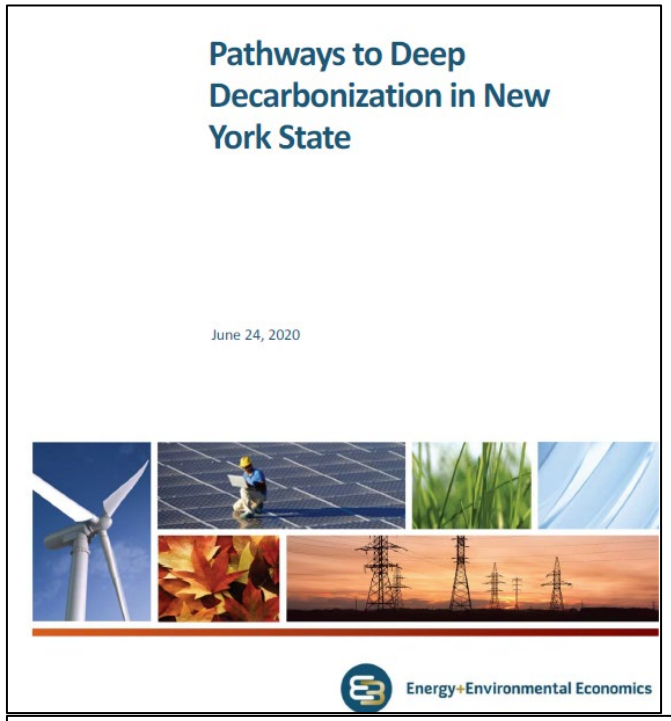
Sources: C2ES - the Center for Climate and Energy Solutions - for US and Canada GHG Emissions Targets (2021); Energyhub - Clean Energy Targets Canada (2021); National Conference of State Legislatures (NCSL) - State Renewable Portfolio Standards and Goals (2021)

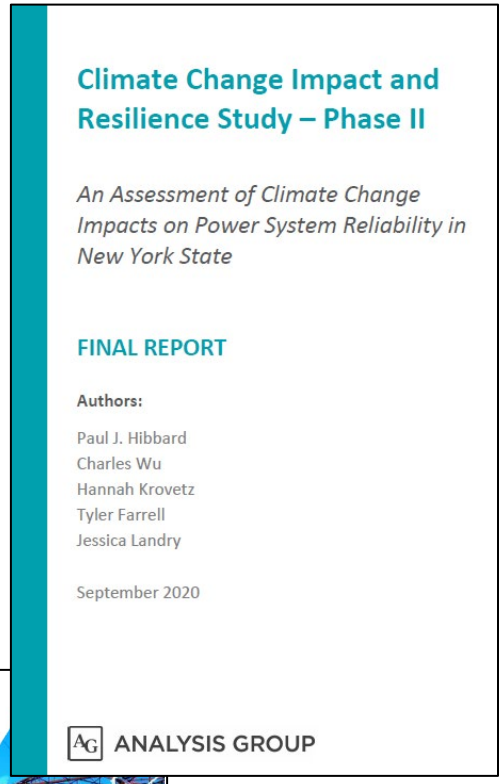
Northeast: Population, Generation, carbon intensity and residential price (US$)

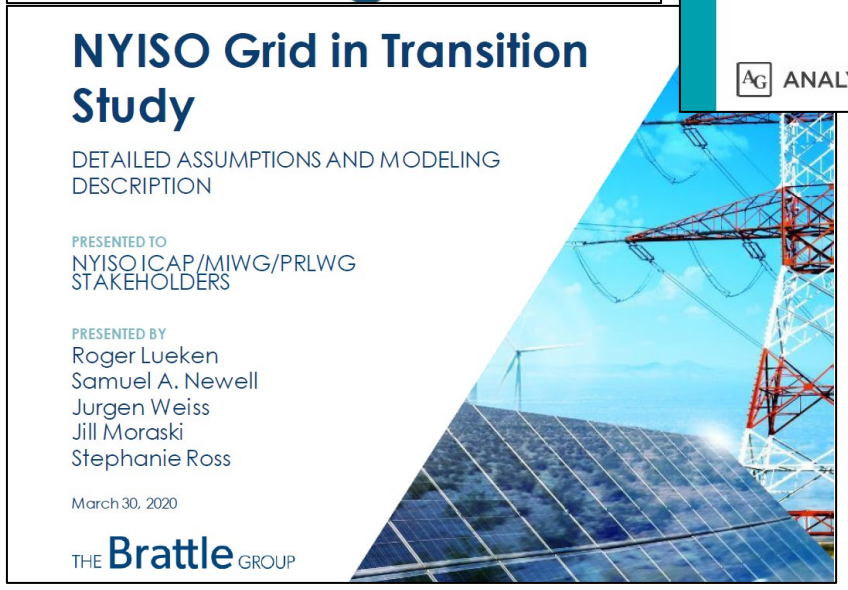


2. Integration and cooperation: the missing link

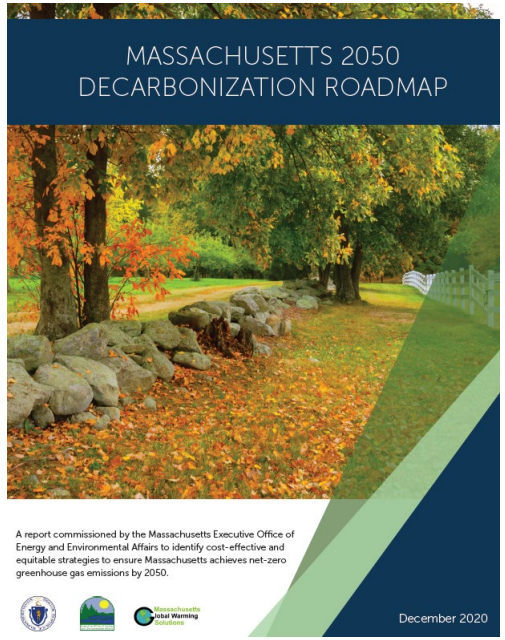
New York

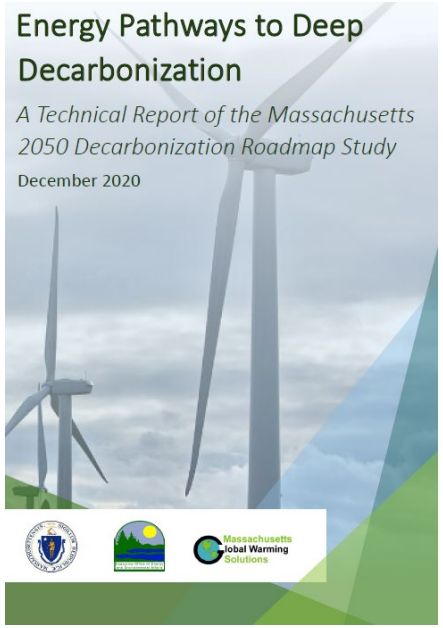




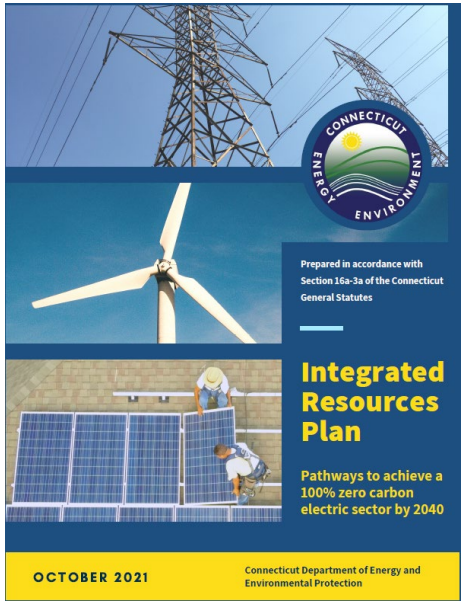


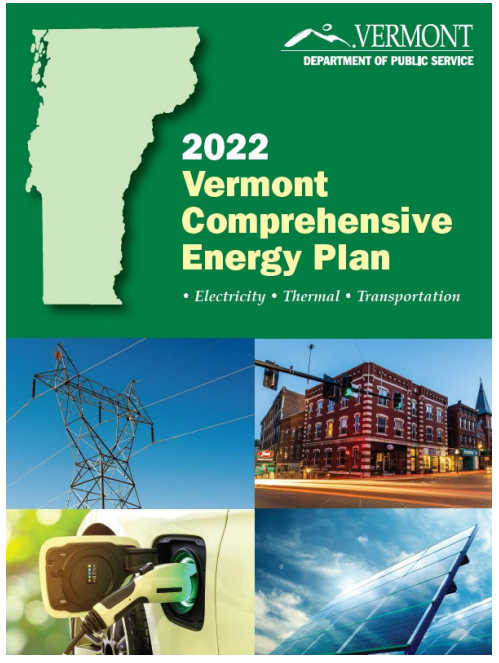
Massachusetts





Connecticut



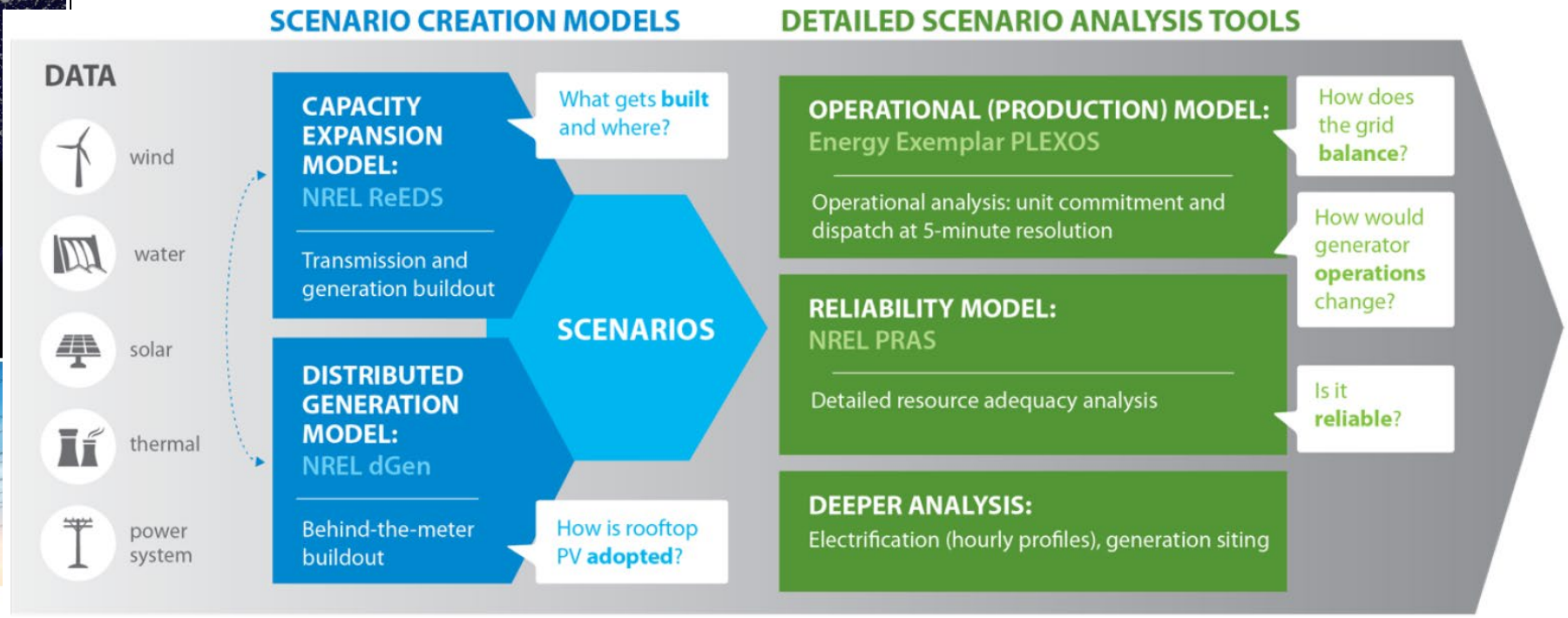


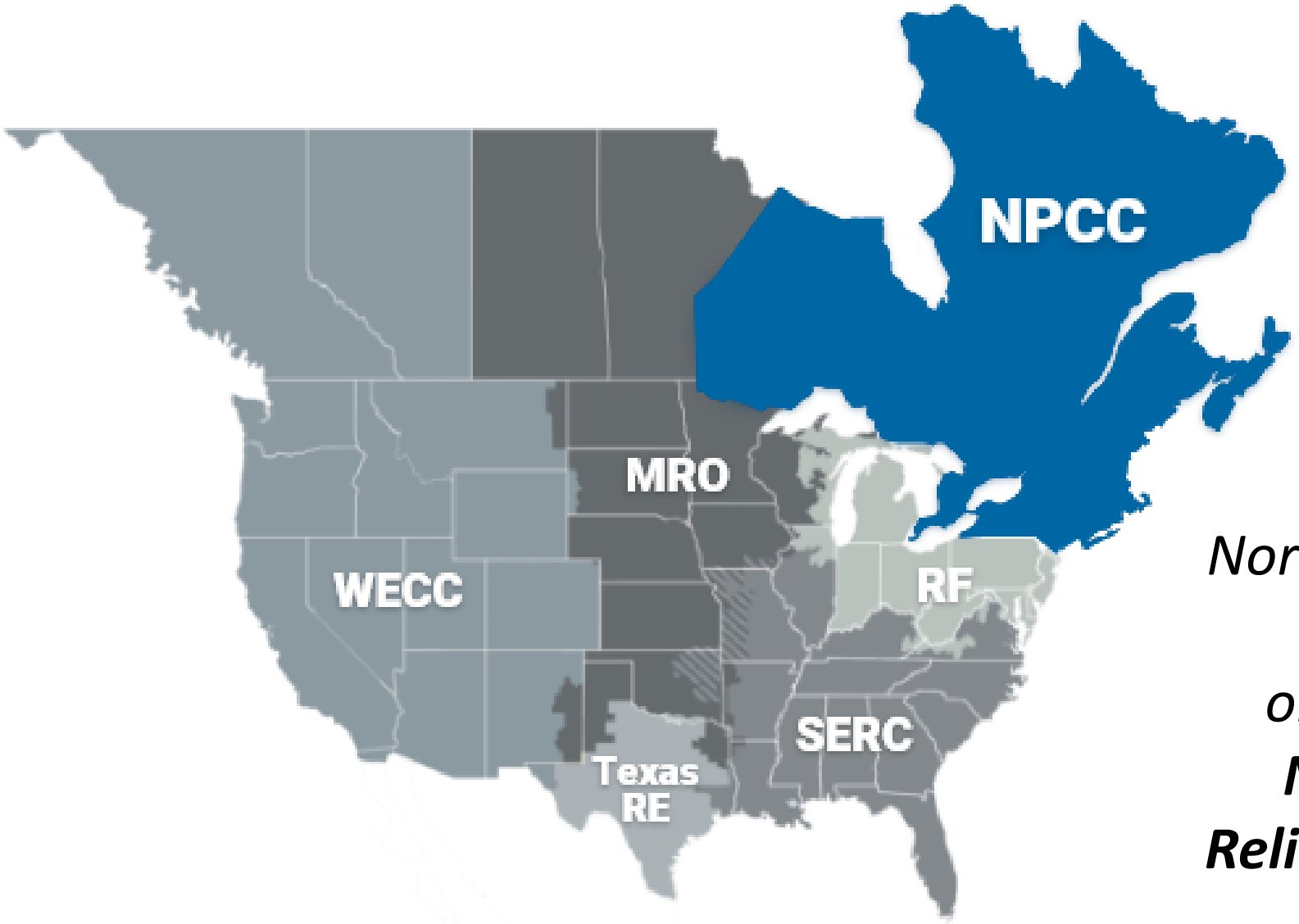
North America

Gregory Brinkman,[1] Dominique Bain,[1] Grant Buster,[1] Caroline Draxl,[1] Paritosh Das,[1] Jonathan Ho,[1] Eduardo Ibanez,[2] Ryan Jones,[3] Sam Koebrich,[1] Sinnott Murphy,[1] Vinayak Narwade,[1] Joshua Novacheck,[1] Avi Purkayastha,[1] Michael Rossol,[1] Ben Sigrin,[1] Gord Stephen,[1] and Jiazi Zhang[1]

[1] National Renewable Energy Laboratory
[2] GE Energy
[3] Evolved Energy Research

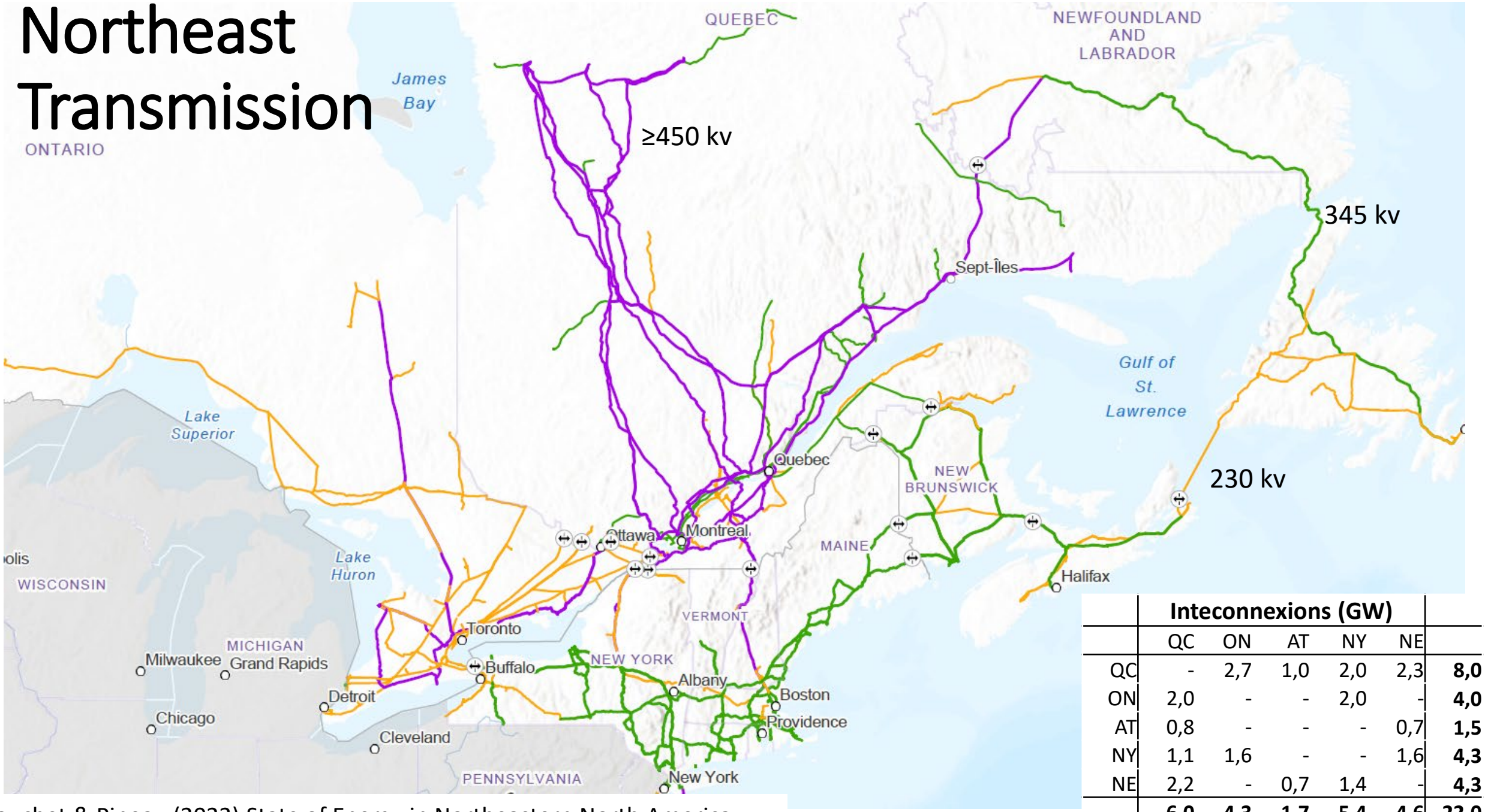
2021





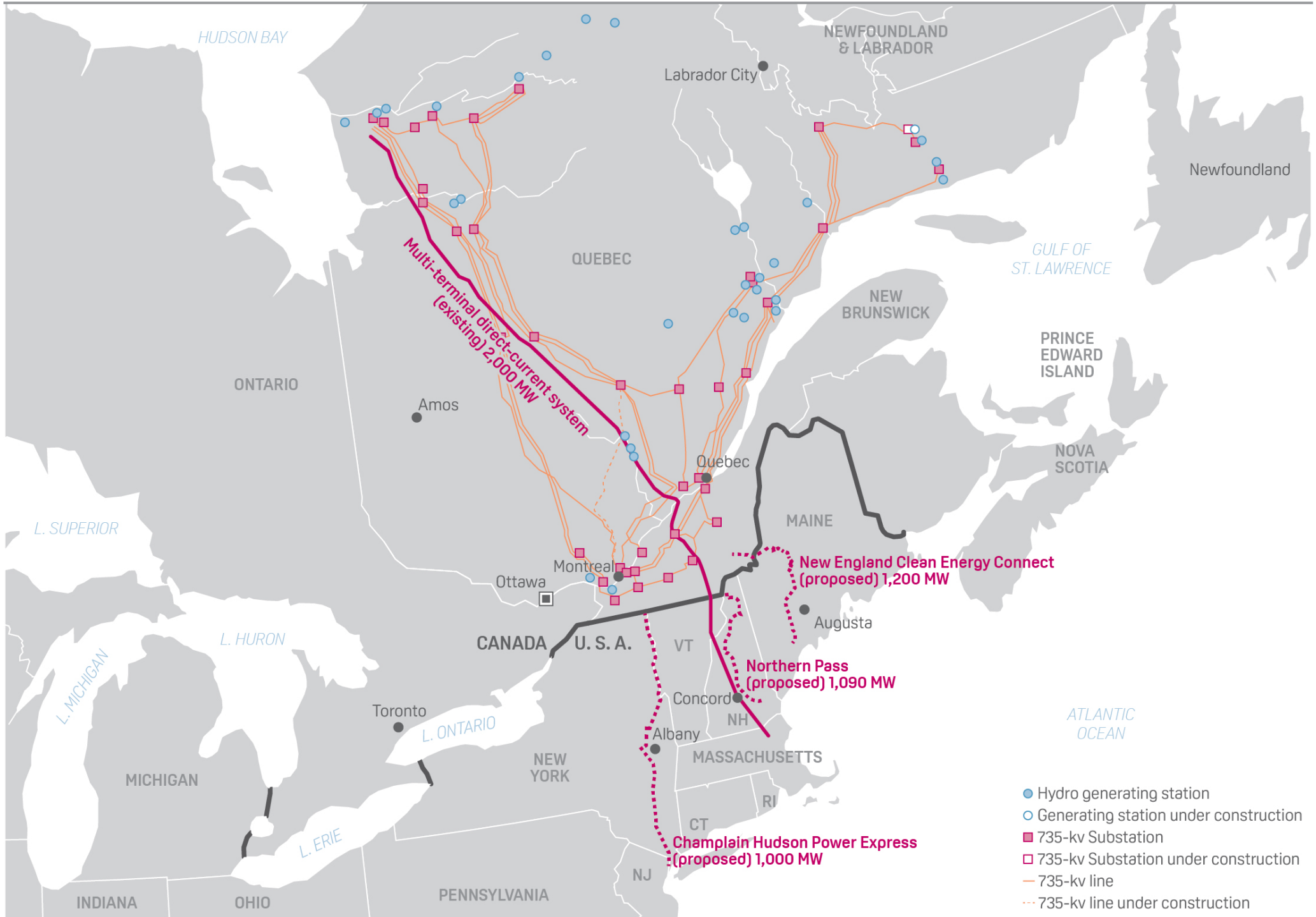
Northeast Power Coordinating Council (NPCC):
one Regional Entity of the
North American Electric Reliability Corporation *(NERC)*

Northeast Transmission



	Inteconnexions (GW)					
	QC	ON	AT	NY	NE	
QC	-	2,7	1,0	2,0	2,3	**8,0**
ON	2,0	-	-	2,0	-	**4,0**
AT	0,8	-	-	-	0,7	**1,5**
NY	1,1	1,6	-	-	1,6	**4,3**
NE	2,2	-	0,7	1,4	-	**4,3**
	6,0	**4,3**	**1,7**	**5,4**	**4,6**	**22,0**

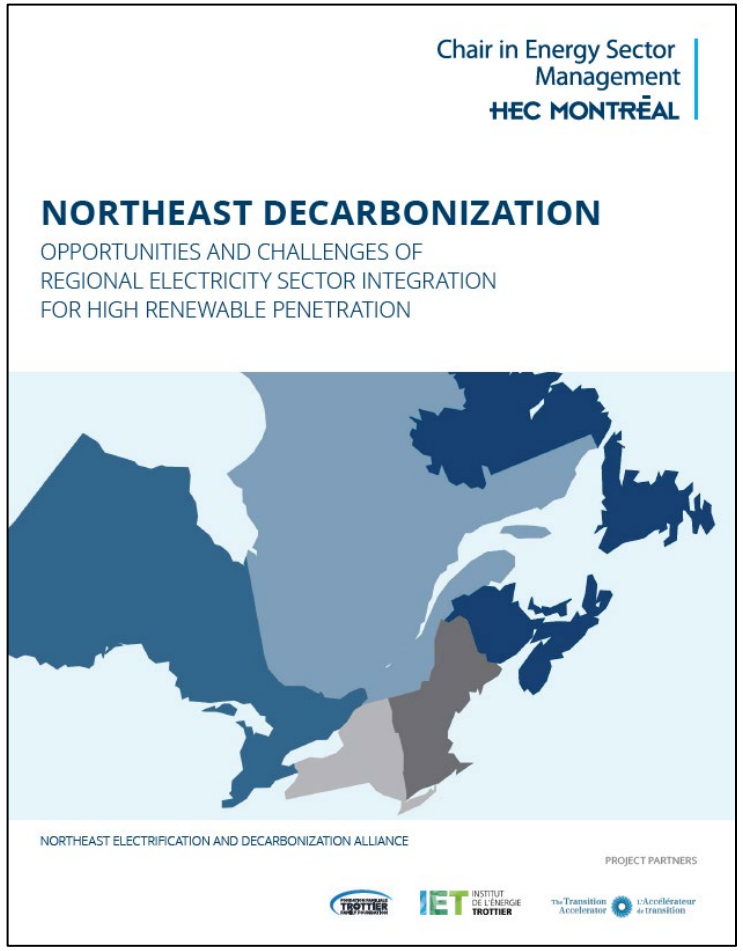
Bouchet & Pineau (2022) State of Energy in Northeastern North America



S&P Global Platts (2019)

3. Gains from integration

Some publications



https://transitionaccelerator.ca/northeast_decarbonization/
https://energie.hec.ca/npcc-2/


Energy Policy 152 (2021) 112210

Contents lists available at ScienceDirect

Energy Policy

journal homepage: http://www.elsevier.com/locate/enpol

Deep decarbonization in Northeastern North America: The value of electricity market integration and hydropower

Jesús A. Rodríguez-Sarasty, Sébastien Debia, Pierre-Olivier Pineau *

Department of Decision Sciences, HEC Montreal, 3000 Chemin de la Côte-Sainte-Catherine, Montréal, QC, H3T 2A7, Canada

ARTICLE INFO

Keywords:
Electricity sector integration
Decarbonization
Hydropower
Northeastern North America

ABSTRACT

In several countries, electricity systems are under strong decarbonization pressure. In particular, the Canadian provinces of Quebec and Ontario as well as the states of the northeastern United States have committed to cut their greenhouse emissions by more than 70% (with respect to emission levels of 1990). Increased collaboration and integration between jurisdictions could decrease such decarbonization costs, especially when important hydropower resources are available.

Using a capacity expansion and dispatch model of the Northeastern North American electricity sector, we analyze the impact of emission reduction targets, load levels and availability of power technologies in a range of scenarios, in order to assess the benefits of regional cooperation. Our results show that for deep decarbonization, the electricity system costs can be significantly reduced through integration, especially by adding more interconnection capacity. These costs savings and benefits are however not evenly allocated between jurisdictions, creating potentially difficult collaboration incentives.

1. Introduction

Emission pathways consistent with 1.5 °C (or 2 °C) global warming require reaching net zero emissions by 2050 (or 2070), according to IPCC (2019). Such level of decarbonization will require profound changes in the energy systems and a greater role for electricity (Williams et al., 2012). Key sub-national governments in Northeastern North America committed to limiting emissions to 80–95% below 1990 levels by 2050 by joining the Under2 Coalition: New York and all New England states (except Maine) in the United States and Ontario and Quebec in Canada (Under2 Coalition, 2019). In addition to state-level clean energy policies in New York, Maine and Connecticut, several local governments in New England have committed to 100% clean or renewable energy (Trumbull et al., 2019). Such decarbonization initiatives are supplemented with regional carbon cap-and-trade markets covering the electricity sector in the Northeastern states of the U.S. (RGGI, 2019) and in the Canadian provinces of Quebec and Nova Scotia (WCI, 2019). However, cooperation in the North American northeast electricity sector has been mostly limited to bilateral trade of surplus power (CEA, 2016). While the region includes five areas (New York, New England, Ontario, Quebec and the Atlantic provinces), there are currently more than five very different electricity market designs. They share one reliability coordinating institution, the Northeast Power Coordinating Council (NPCC, 2019), but they otherwise plan their respective power systems in almost complete disregard of integration benefits and regional resources potential.

In this multi-region setting, electricity market integration and cooperation can occur in multiple ways, for example, through coordinated capacity planning, pooled capacity resources or electricity trade. Such cooperative actions can support the transformation of power systems to achieve decarbonization goals, through:

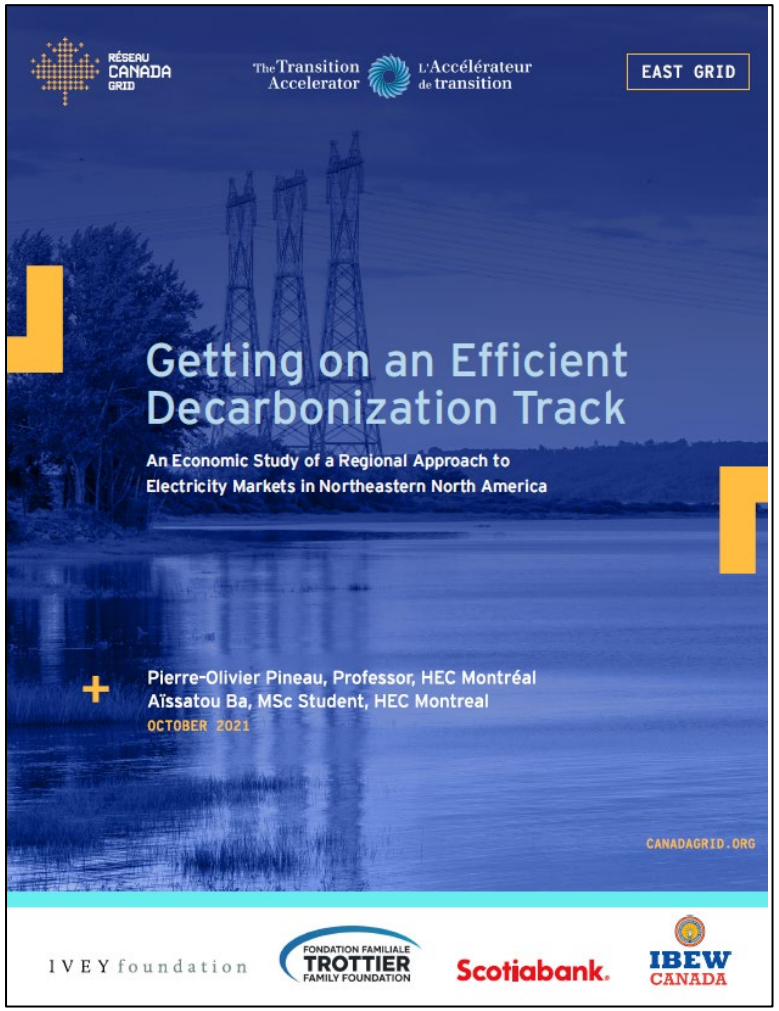
- Access to low-cost renewable energy across regions.
- Economies of scale in large capacity investment projects.
- More efficient power dispatch (Newbery et al., 2016).
- Load balancing and smoother generation in a wider territory (Bahar and Sauvage, 2013).
- Greater economic value of renewable generation, by reducing electricity curtailment (Newbery et al., 2016).

This paper illustrates the value of electricity market integration in a context of a region strongly committed to deep decarbonization. It also explores the enabling role of hydropower in such decarbonization, as the large hydropower capacity in Quebec (40.44 GW, corresponding to 22%

* Corresponding author.
E-mail addresses: jesus.rodriguez@gerad.ca (J.A. Rodríguez-Sarasty), seb.debia@gmail.com (S. Debia), pierre-olivier.pineau@hec.ca (P.-O. Pineau).

https://doi.org/10.1016/j.enpol.2021.112210
Received 9 May 2020; Received in revised form 10 January 2021; Accepted 11 February 2021
0301-4215/© 2021 Elsevier Ltd. All rights reserved.

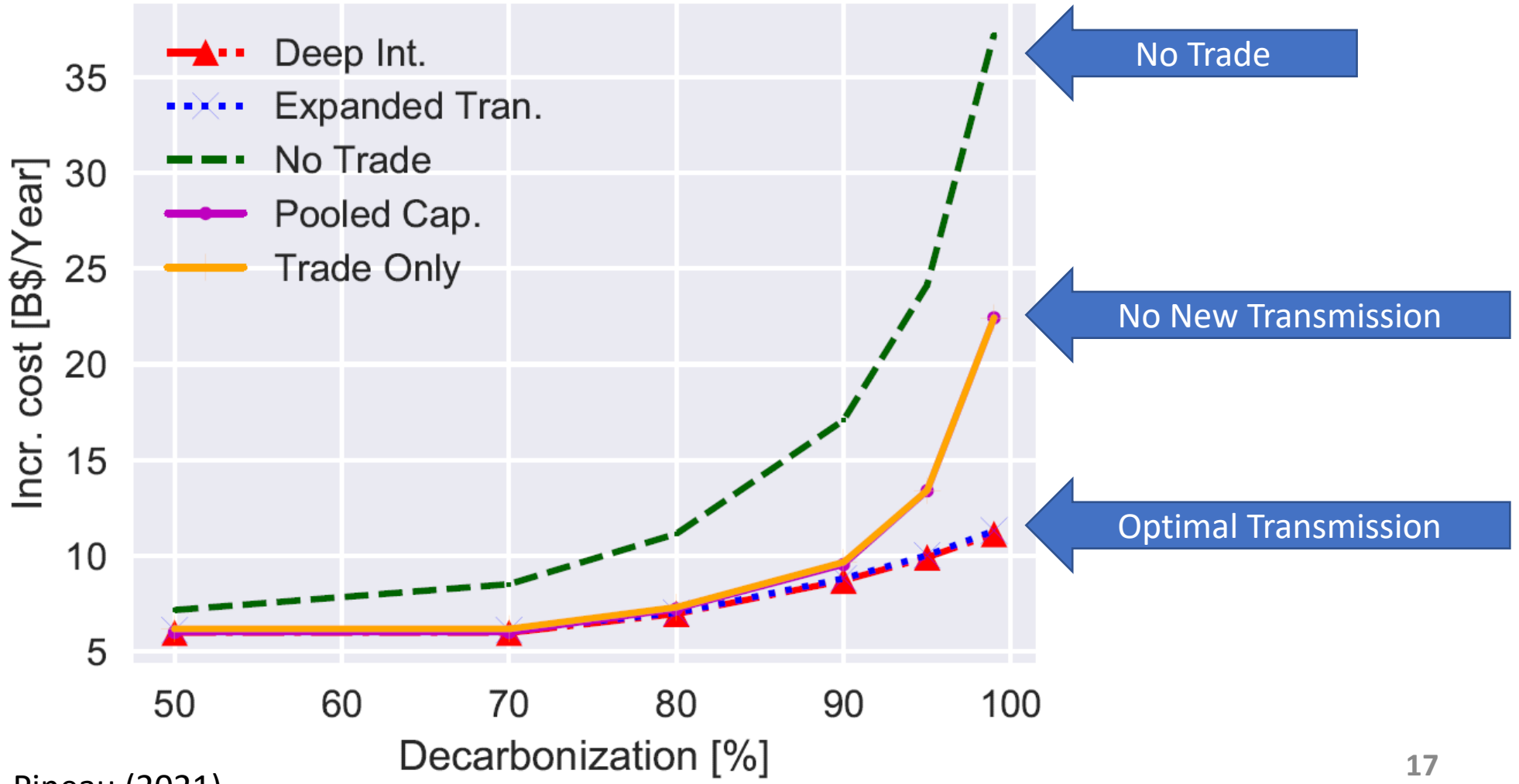
Energy Policy April 2021 paper
https://www.sciencedirect.com/science/article/abs/pii/S0301421521000793



https://www.canadagrid.org/

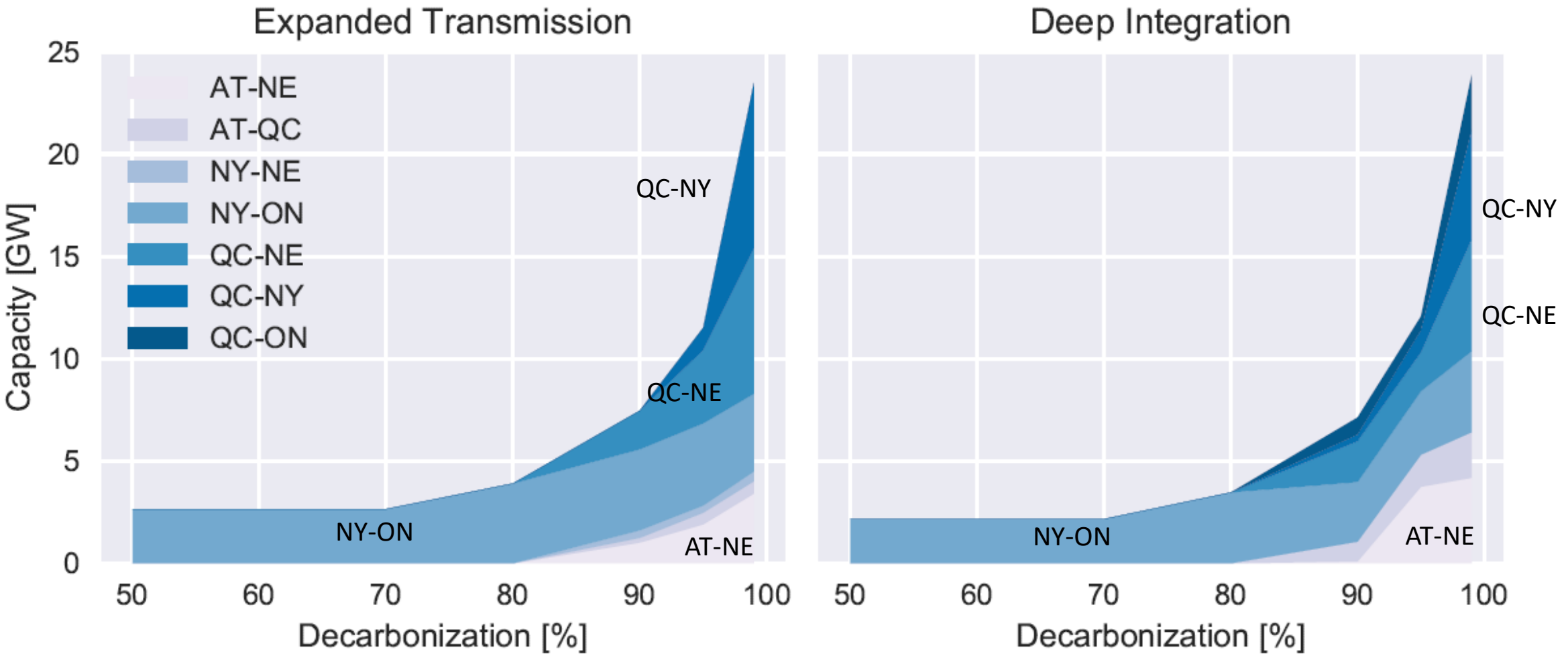
Annual decarbonization cost

No Trade / No New Transmission / Optimal Transmission

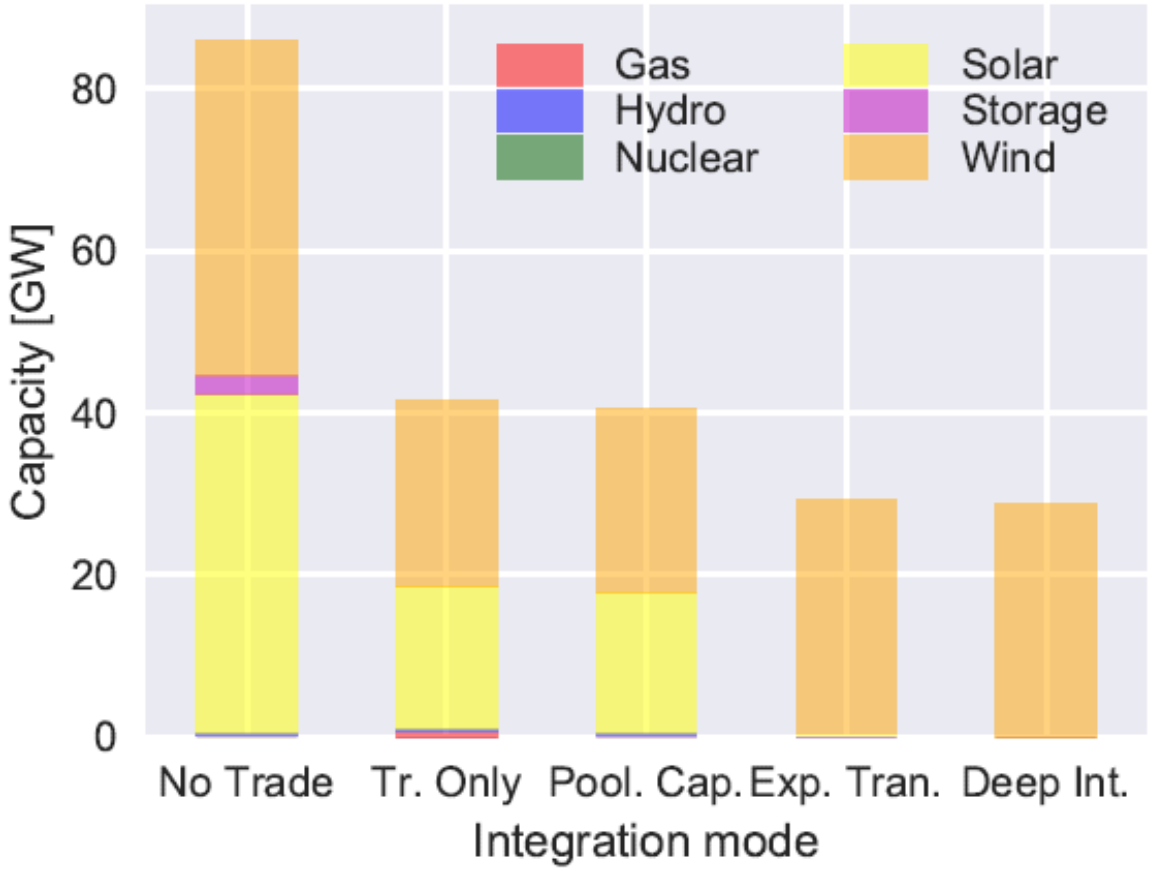


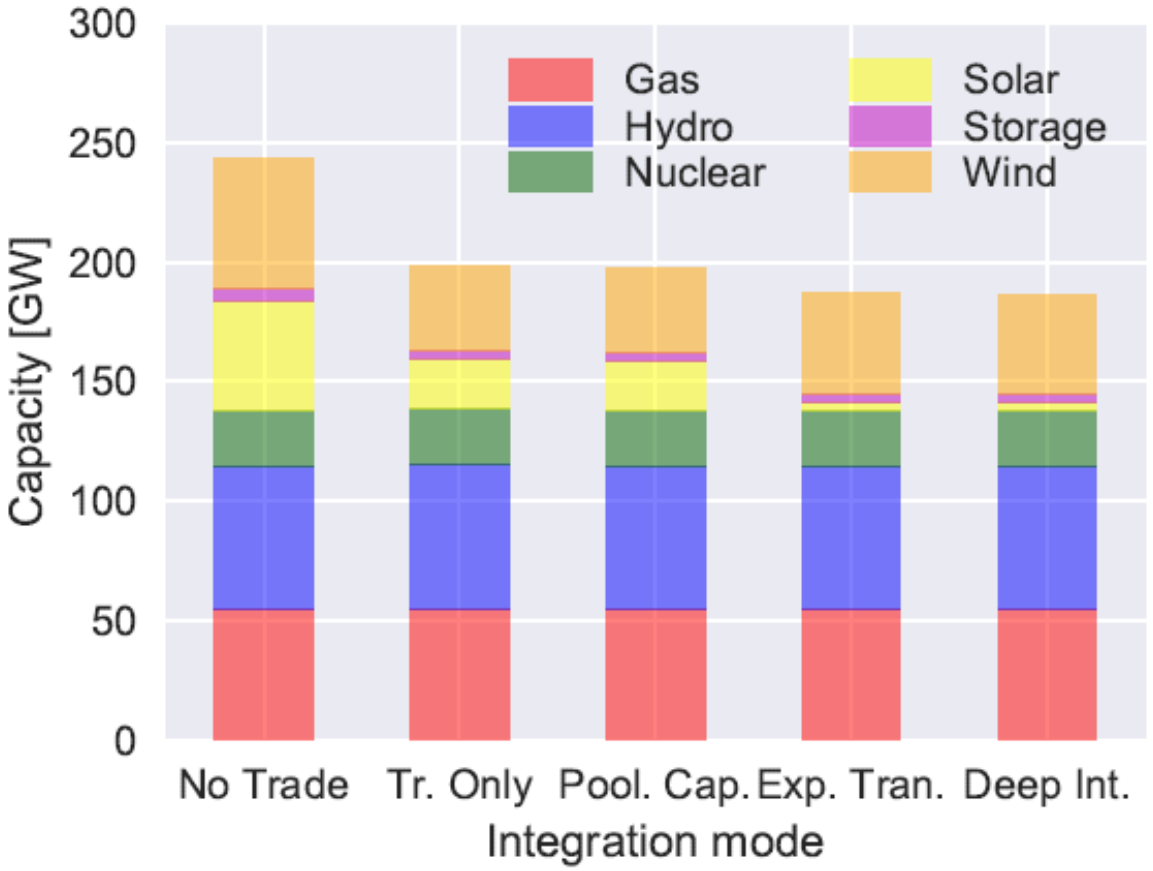
Rodríguez-Sarasty, Debia, Pineau (2021)

Interties are critical



Important Wind and Solar requirements (90% decarbonization)





More interies = More wind

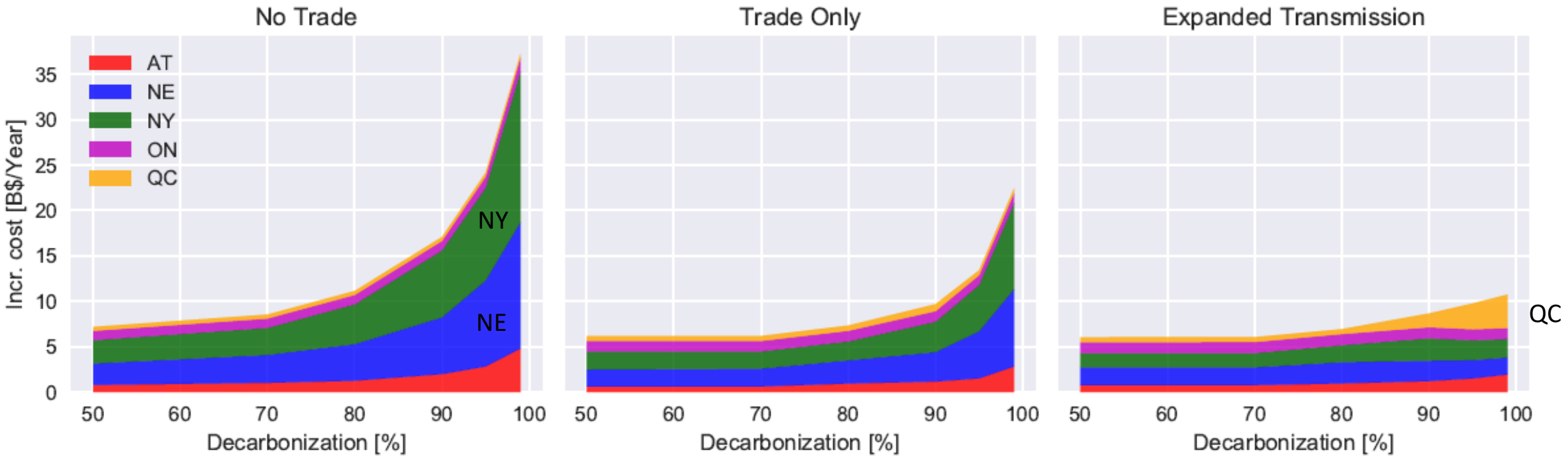
With Optimal Transmission :

- Hydro-Wind correlation: from -0,06 to **-0,28**
- Wind generation: from 102 to **120 TWh**
- Wind curtailment: from 1,5 % to **0,1 %**

Rodríguez-Sarasty, Debia, Pineau (2021)

Regional Cost Impacts

Annualized cost of operation and incremental investments by decarbonization level



Conclusion

- Lots of areas to study
- Sadly, there is limited institutional capacity to adequatly use models and their results
- This is where people like me can (maybe) help bridge the gap between OR models and their use to support decision making and policy

Chair in Energy Sector Management
HEC MONTRÉAL

Internet energie.hec.ca
Twitter @HECenergie
Courriel energie@hec.ca

MERCI !

Partners of the Chair in Energy Sector Management:

BORALEX · ENBRIDGE · énergir · Evolugen · GREENFIELD GLOBAL

Hydro Québec · Québec · Schneider Electric · Valero · wsp