

Deep Decarb in Northeast Canada and the US: Do We Have the Firm- Flexible Technology We Need?



JOHN PARSONS / EMIL DIMANCHEV / JOSHUA HODGE

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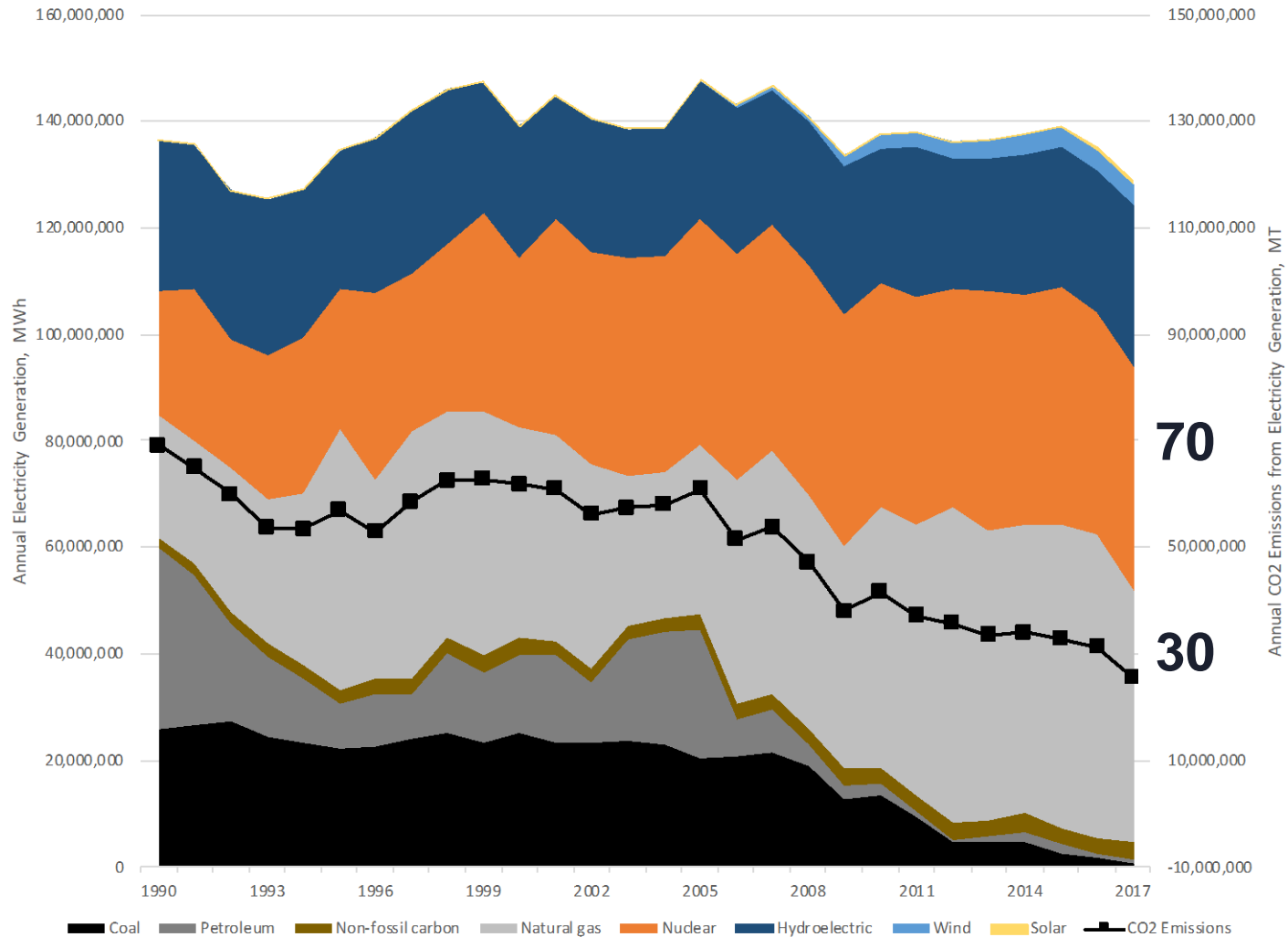
EPRG – CEEPR International Energy Policy Conference

Deep Decarbonization

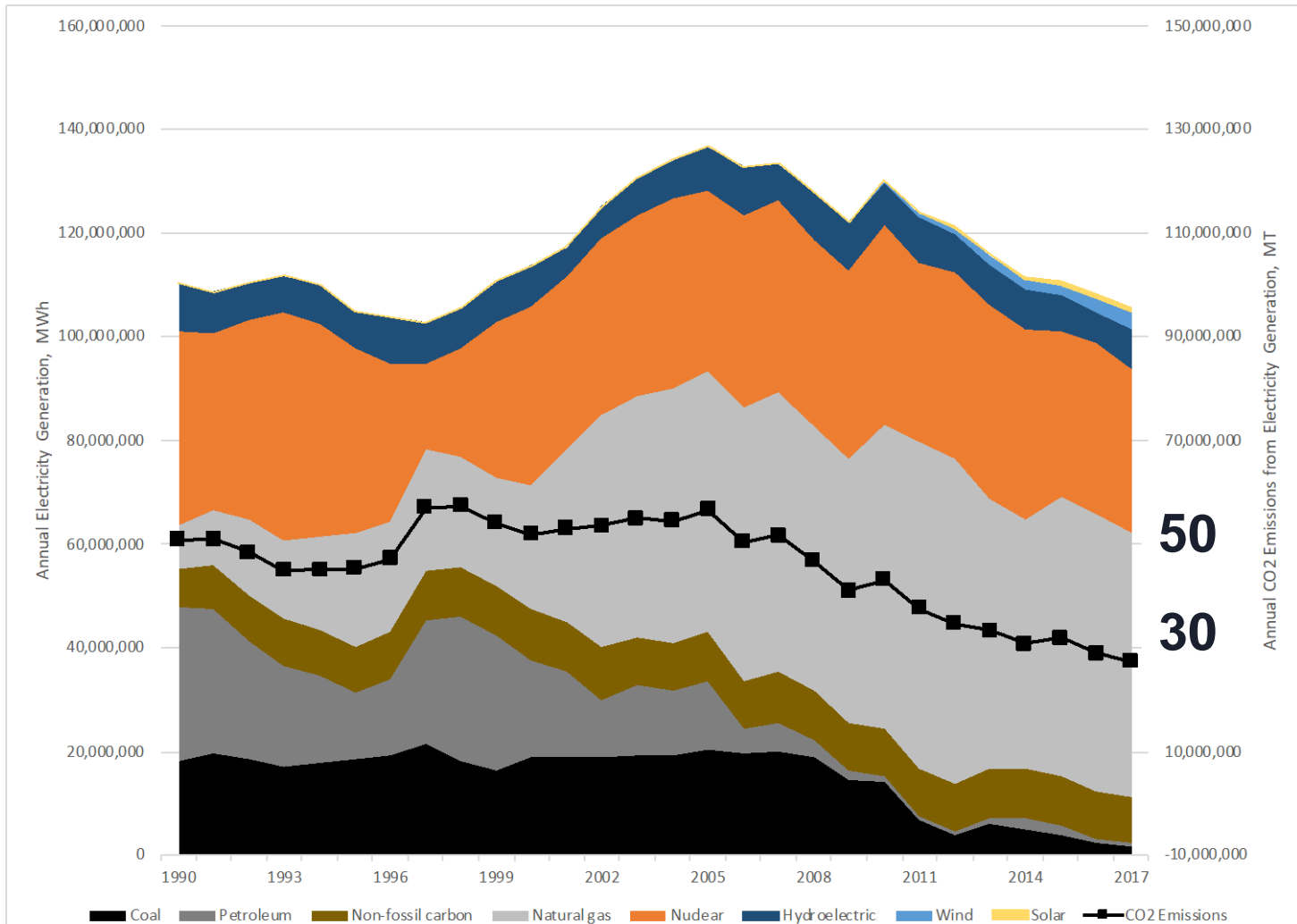
- **What do we mean by deep?**
 - Economy-wide 80% reduction from 1990 levels by 2050.
 - ...or fully carbon neutral by 2050.
 - Electricity systems play a vanguard role: 100% renewable or clean energy by 2040-2050.
 - Substantive action on Transport / Buildings / Industry / Agriculture



Current Status: New York



Current Status: New England



Regional State Commitments (1)

- **New York in June 2019 passed the Climate Leadership and Community Protection Act.**
 - Economy-wide net-zero by 2050. (40% from 1990 by 2030)
 - 85% of reductions from energy and industrial emissions;
 - 15% from offsets, e.g., from forestry or agriculture;
 - Electricity 100% carbon-free by 2040. (70% renewably by 2030)
 - No offsets for stationary electric sources.
 - Climate Action Council to identify mechanisms.
 - Addresses issues of economic justice.



Regional State Commitments (2)

- **Maine in June 2019 passed a package of climate and energy bills.**
 - Targeting 80% reduction economy-wide by 2050.
 - 100% renewable electricity by 2050. (80% by 2030)
 - Supporting electrification of heating and transport.
- **Massachusetts**
 - Targeting 80% reduction economy-wide by 2050.
 - 2008 legislation, with a recent court decision requiring explicit steps and interim targets.
 - Electricity 90% reduction by 2050. (74% by 2030, 83% by 2040)
 - Tenders for 1.6 GW offshore wind, 1.2 GW other clean energy including imported hydropower.
 - Electrification of heating and transport only tentatively/tepidly addressed.

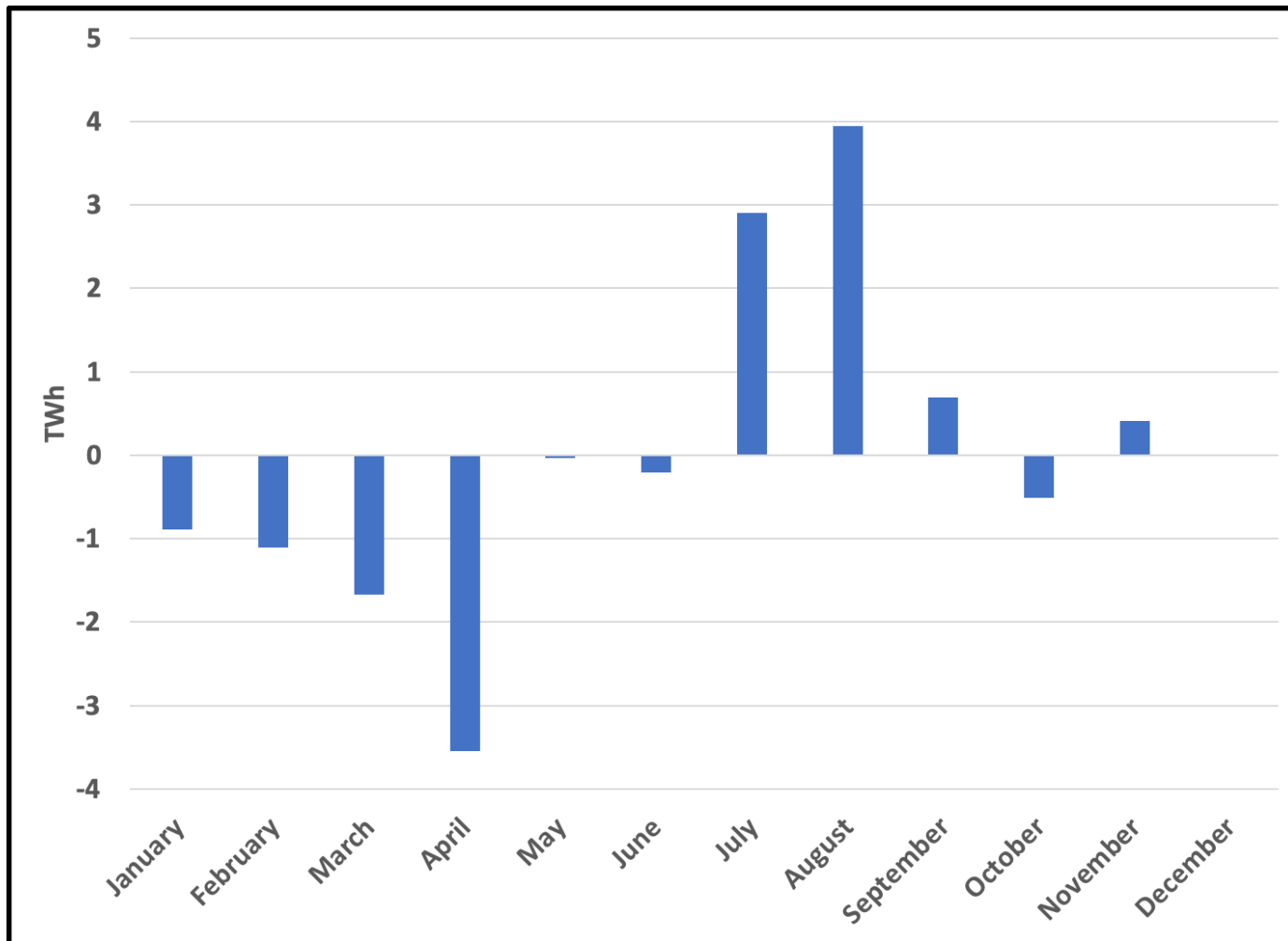


Some Challenges of Deep Decarbonization

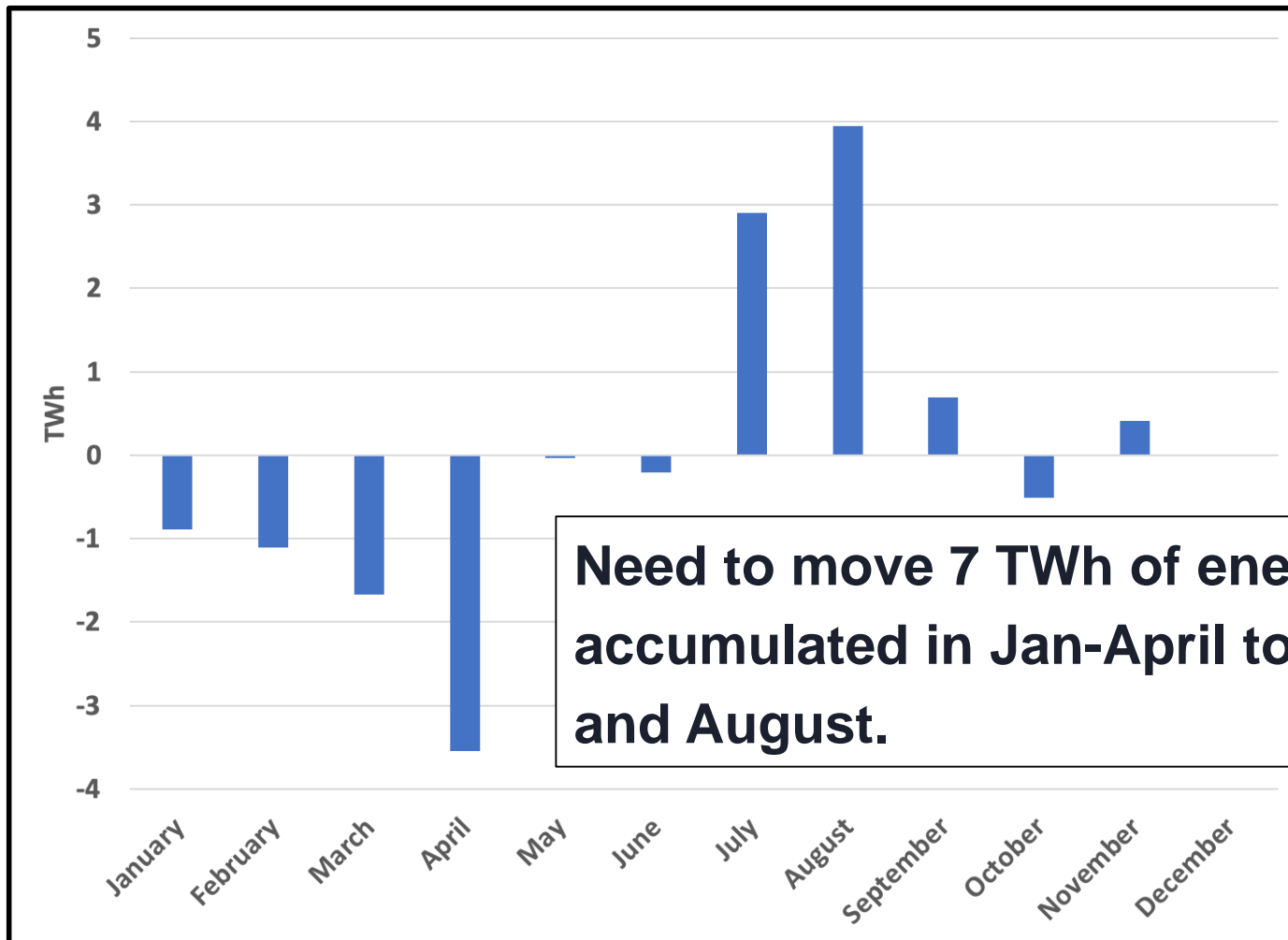
- **The politics of siting.**
 - Offshore wind.
 - Onshore wind and solar PV.
 - Transmission.
- **Intermittancy at short time scales.**
 - E.g., the duck curve and low carbon fast ramping resources.
 - Inertia and frequency response.
- **Variability longer time scales.**
 - Daily.
 - Weeks.
 - Seasonal.



Seasonal Storage Task in New England for 100% Renew. System



Seasonal Storage Task in New England for 100% Renew. System



Need to move 7 TWh of energy accumulated in Jan-April to July and August.



Alternatively, Adjust the Portfolio to include other Low C Generation

- **Nuclear**
 - Some existing plants could have life extensions to 80 years.
 - New nuclear.
- **CCS for NGCC plants**
- **Quebec Hydro + Transmission**
 - New York's Hudson Express line
 - New England's
 - faltered New Hampshire "*Northern Pass*"
 - live Maine "*Clean Energy Connect*"
- **others...**



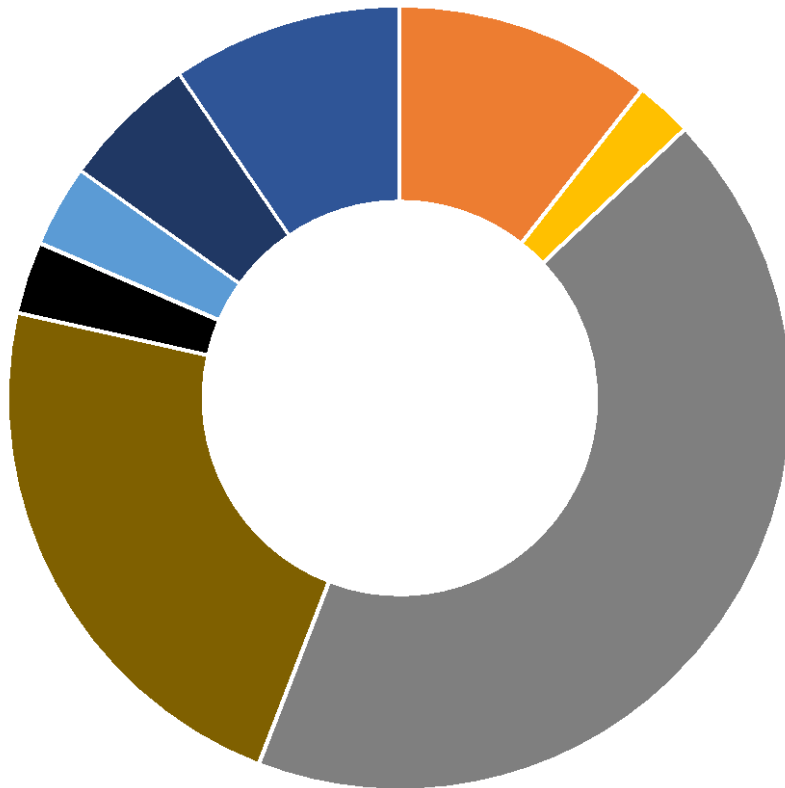
Capacity Expansion Model

- **To meet 2050 load.**
 - Endowments of hydro, nuclear, CCGTs, wind & solar PV.
- **Initial results just NE & QC.**
- **Granularity to the level of hourly dispatch.**
- **Examine different levels of decarbonization.**
- **Examine different levels of transmission.**



Optimization of Capacity for 90% Reduction in 2050

2018



2050



■ Solar ■ Wind ■ Hydro ■ Hydro QC ■ Nuclear ■ NGCC-CCS ■ NGCC ■ Other ■ Coal

The Value of Complementary Low C Generation

90% Decarbonization

	CCS	Transm	Nuke	System Cost	
				Total	Average
Optimal	6.2 GW	4.2 GW	3.5 GW	\$5.1 B	\$39.37 /MWh
No CCS		4.2 GW	3.5 GW	\$5.6 B	\$43.38 /MWh
No New T	6.2 GW	2.2 GW	3.5 GW	\$6.0 B	\$46.48 /MWh
No Nukes	6.2 GW	4.2 GW		\$6.0 B	\$46.31 /MWh
None		2.2 GW		\$8.5 B	\$66.05 /MWh



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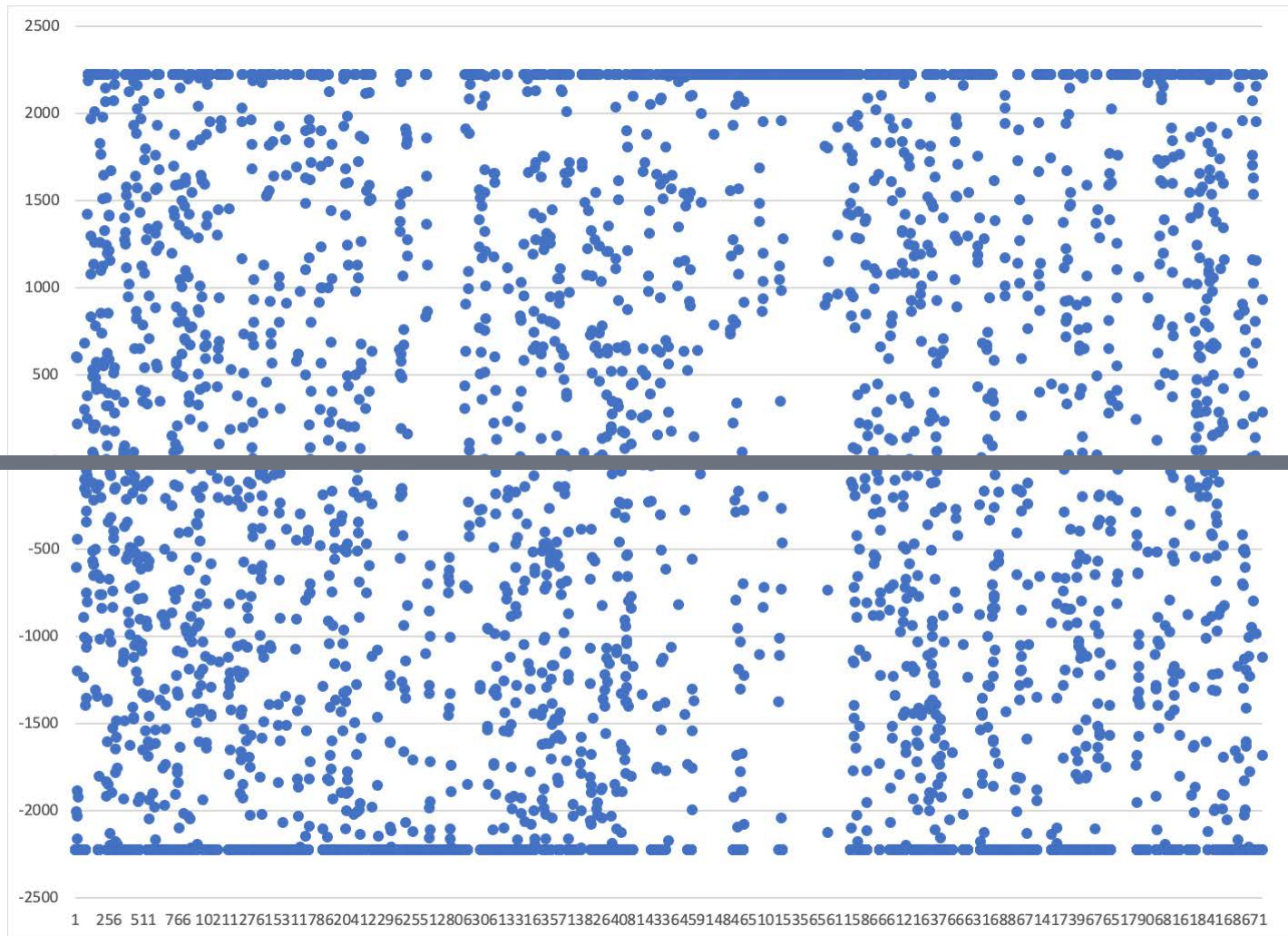
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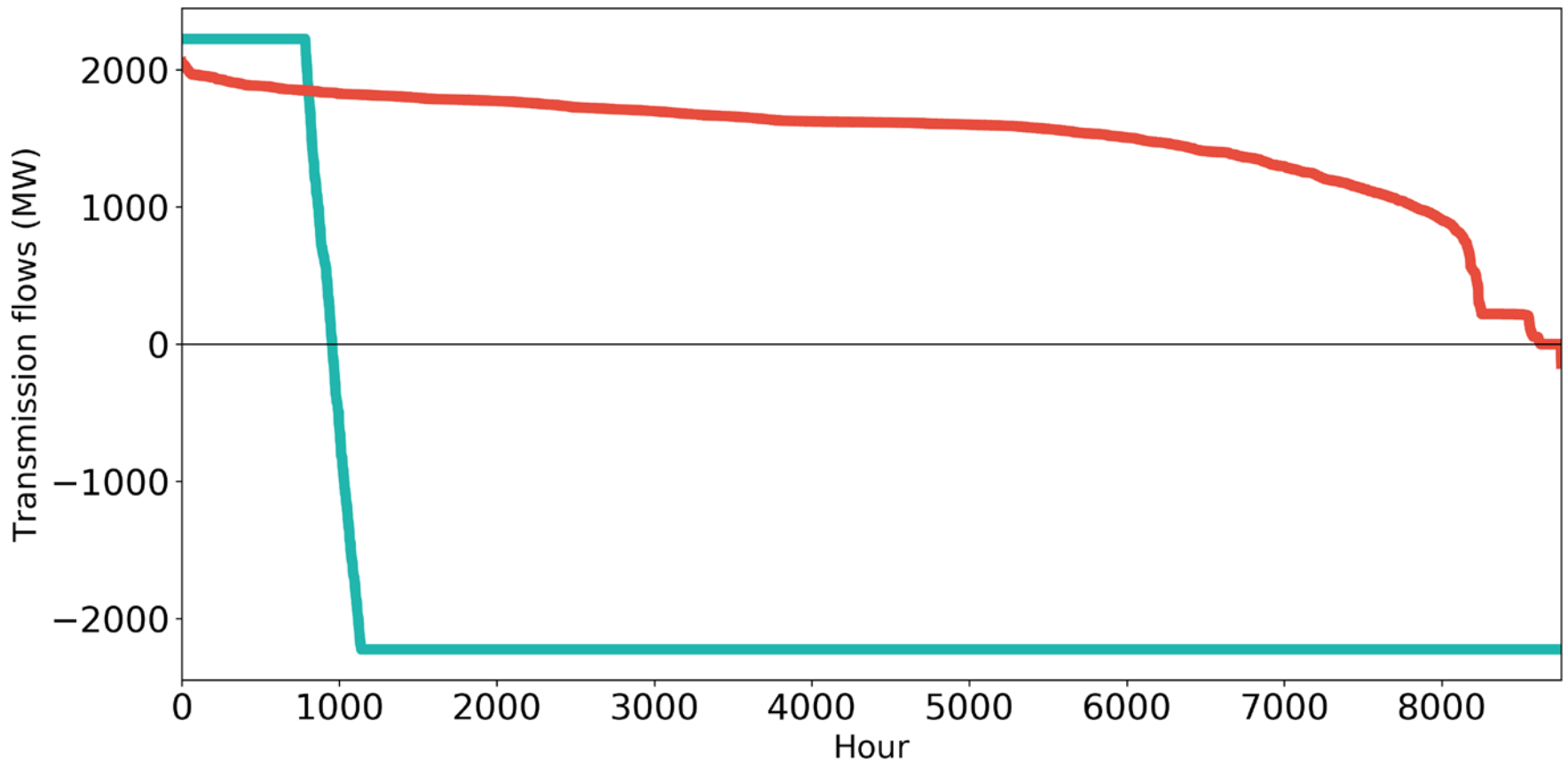
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Hydro Operations Change Dramatically.



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Modeled flows in 2050 (100% decarbonization) Flows in 2012



A RISK MANAGEMENT APPROACH

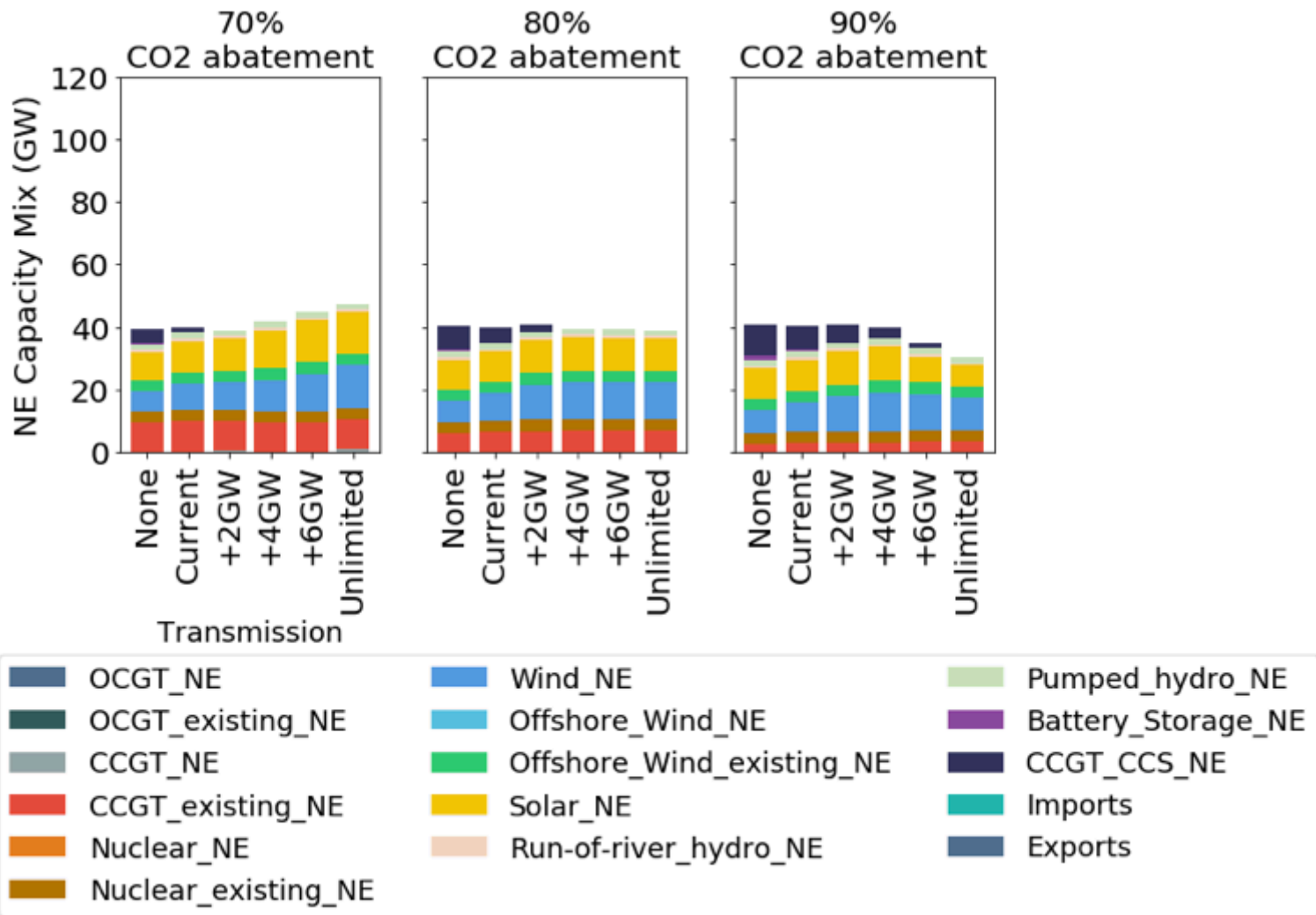


Big Uncertainties

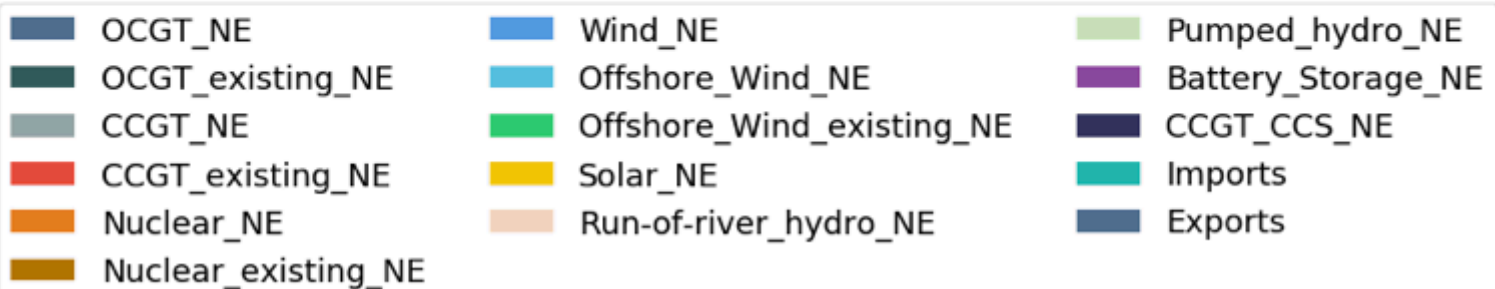
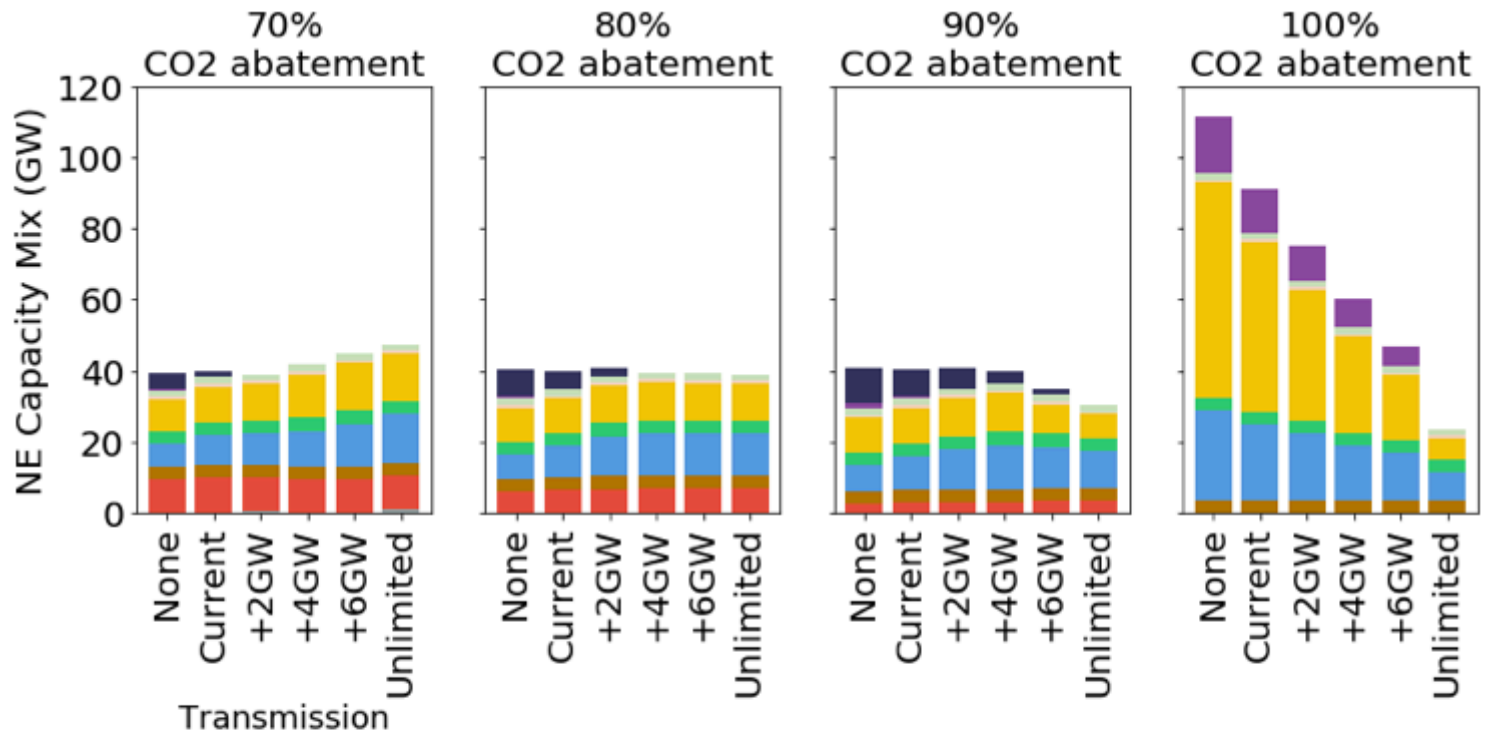
- **Costs and availability of competing technologies.**
- **Acceptability of competing technologies.**
 - e.g., land use for large scale wind and solar expansion (wind=35x 2018 capacity, solar=14x; 3.4 or 5x capacity now planned for 2027)
- **State action, e.g., for off-shore permits and transmission connections.**
- **Pace of decarbonization policies and implementation.**
 - in electricity
 - in other sectors which impact electricity, such as transport and building
- **Energy efficiency.**
- **Social changes, such as demand response, vehicle charging, building management.**



CCS & Hydro Compete



100% Decarb Changes Everything



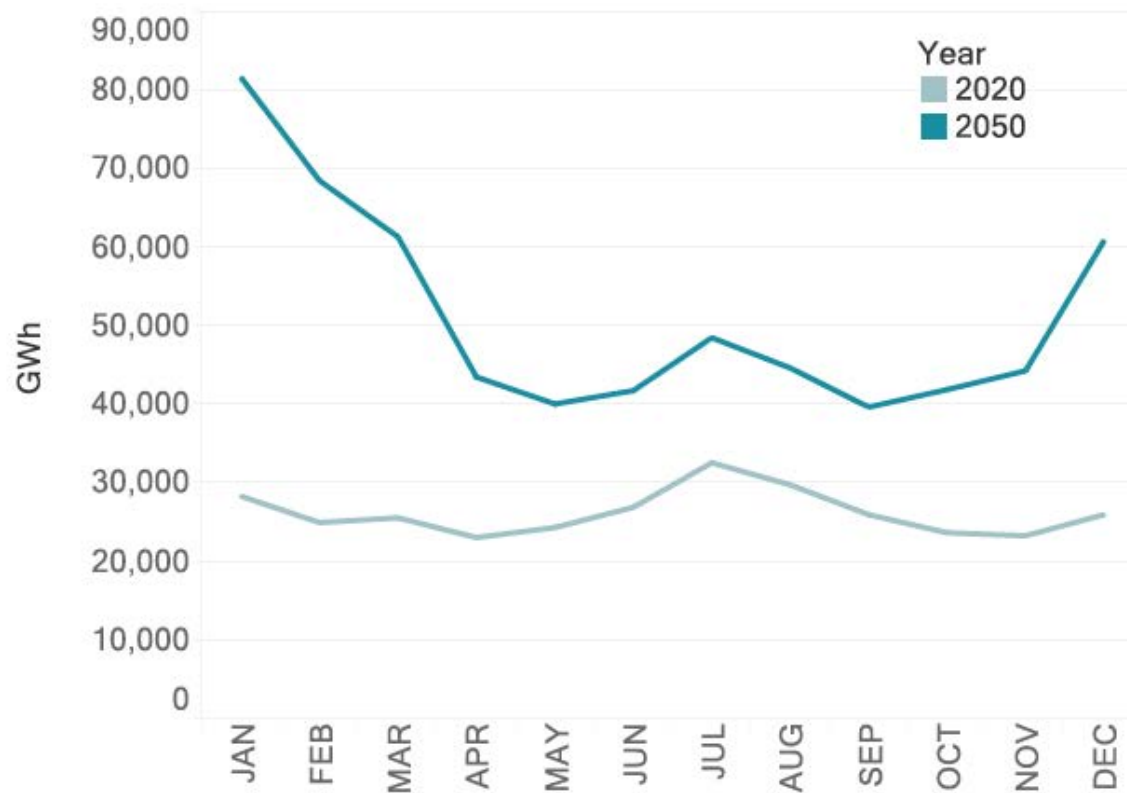
Canadian Hydro

- **Quebec is a winter peaking system**
- **New England and New York are summer peaking**
- **...but, with a shift to electrical home heating, do New England and New York become winter peaking?**



One Forecast

Figure 3. Base DDP Case Monthly Electricity Consumption for the Northeast



Some principles...

- **We're not in the prediction business...**
 - insight about the future only matters if it can inform public policy and industrial strategy
 - which technology wins is not the question
 - with a price on carbon, may the best technology win
- **However, it is useful to ask which public investments are needed to enable winning technologies.**
 - e.g., transmission for hydro, for off-shore wind, etc.
 - and it may be useful to ask where public R&D funding is most needed



Some principles...

(2)

- **Timing is a critical issue.**
- **When are public investments or other policies absolutely needed?**
- **Experimentation is a valuable way to reduce costs.**
 - E.g., in optimizing transmission investments for off-shore wind.
 - Also waiting has information value, e.g., about which technologies will be most useful, reshaping which public investments are needed.
- **The biggest uncertainty is perhaps the pace of decarbonization.**
 - That has a big implication for the right investments, when.
 - If we were really going to get there by 2050, we need to be doing things now that we would not do now if we are going to move more slowly.
 - But which ones?



Financing Investments

- **A large amount of existing low carbon generation was pushed onto the system with dedicated revenue streams.**
- **Investors are anxious about creating sunk investments.**
- **The value of competing investments depend upon the realized pace of decarbonization and various policies. Creates reluctance to commit large sums.**
- **Will states continue to fund investments with dedicated revenues?**

