The cost of decarbonizing the Northeast electricity sector

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Joint work with
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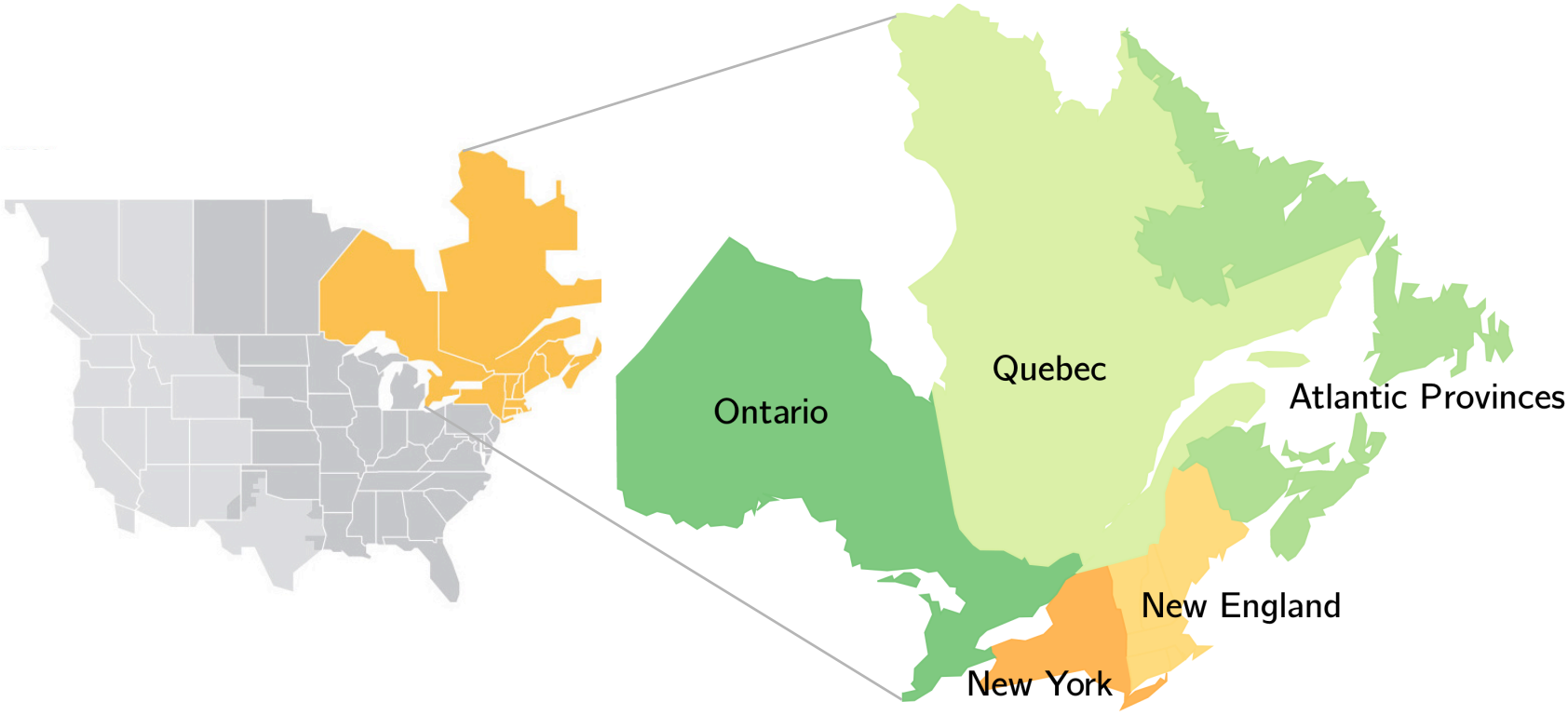
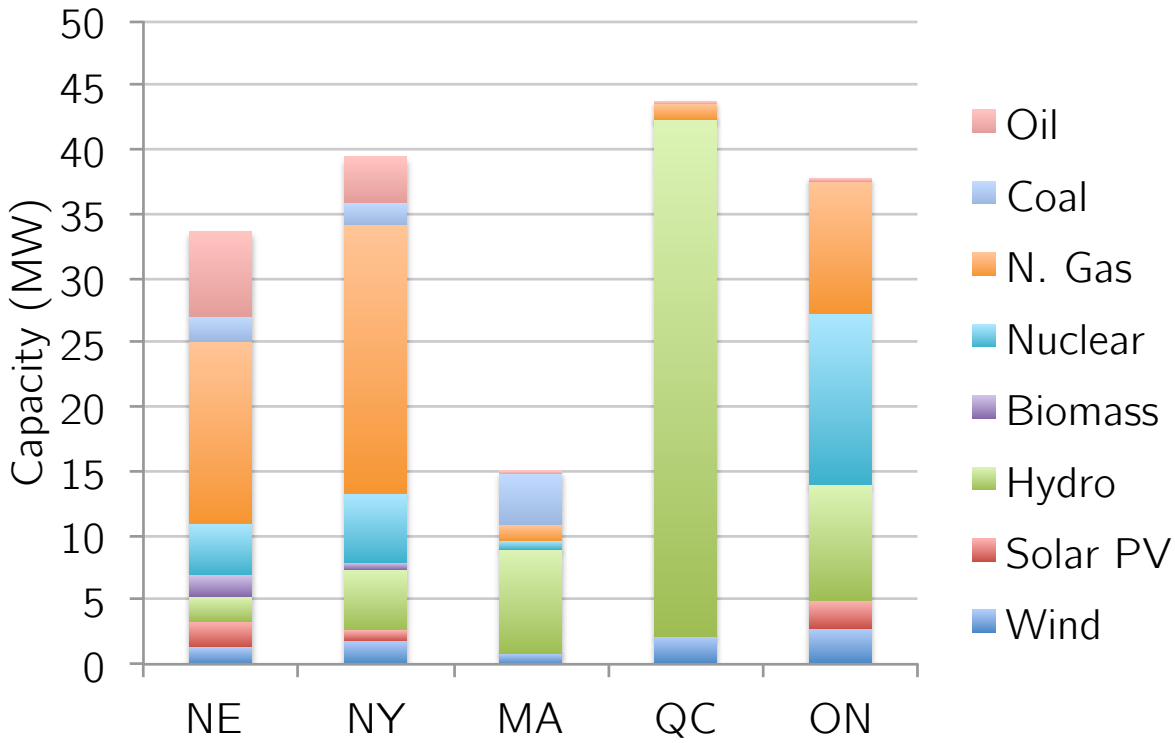
North American Northeast Electricity Sector (NES)

Jurisdictions of the NES



ISO-NE (2017) and Mapchart.net

Installed generation capacity in NES (2017)



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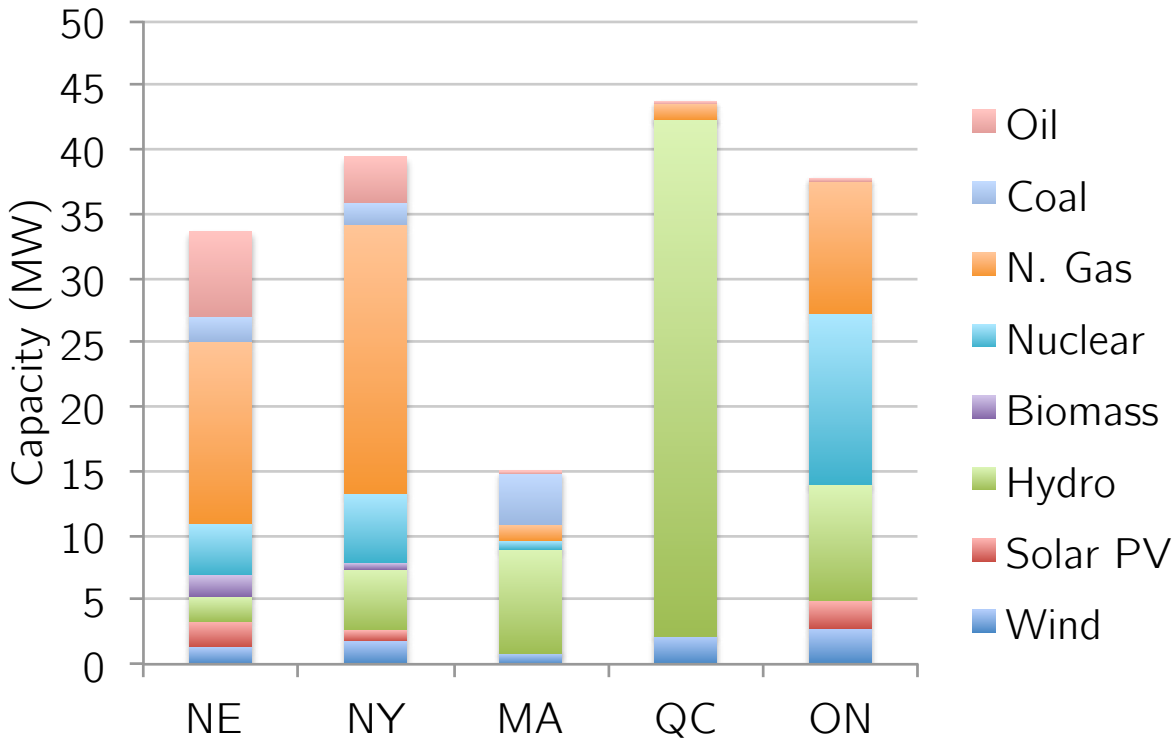
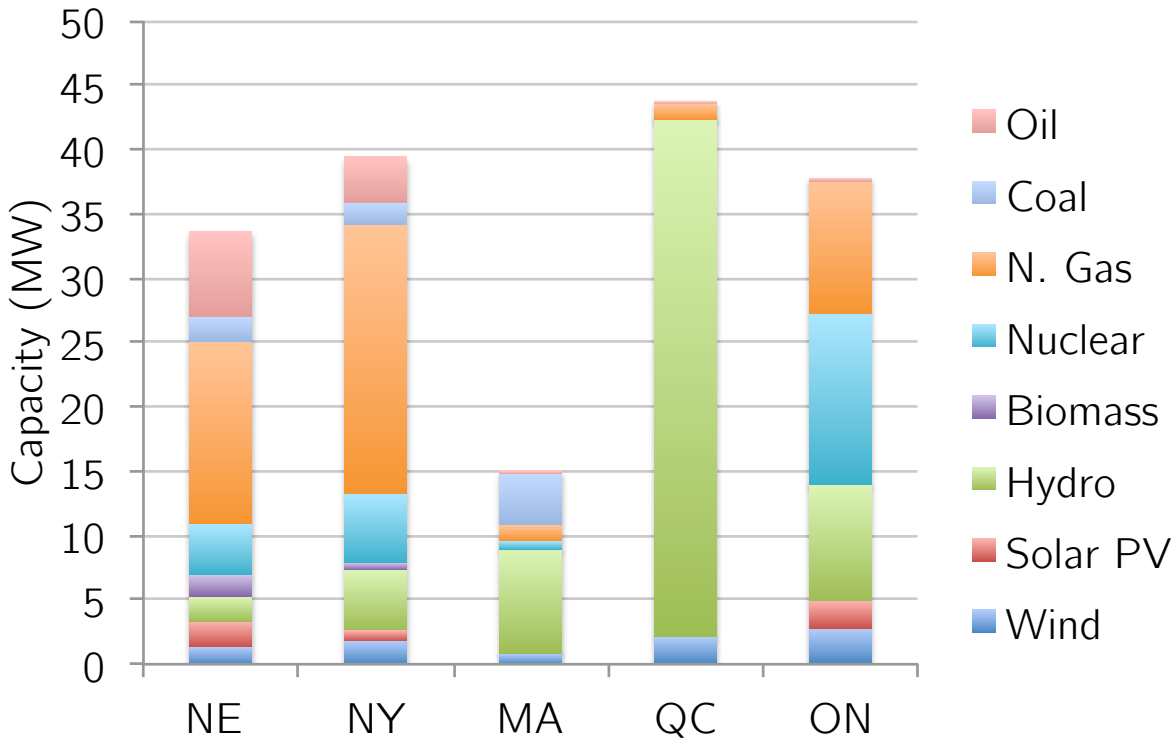


One-third of reduction in Ontario's nuclear production by 2025 (FAO-ON, 2017)

Installed generation capacity in NES (2017)



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$\Rightarrow$ Opportunity to exploit complementaries

Drivers and challenges of decarbonization in the NES

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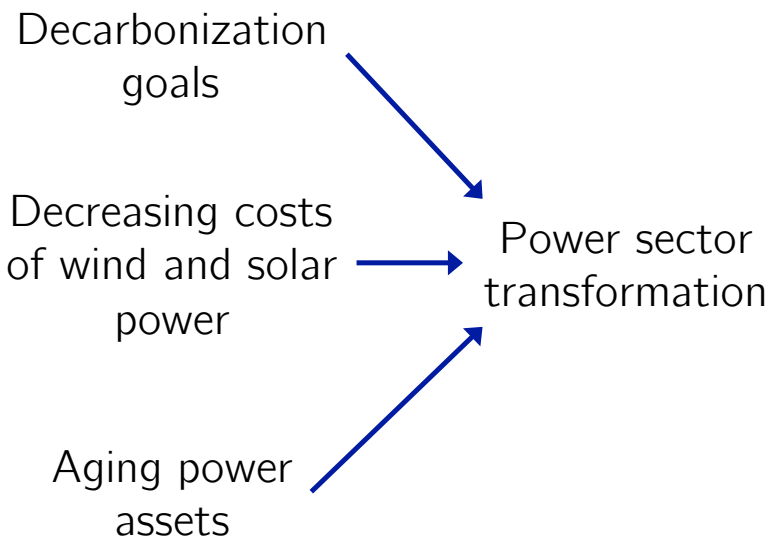
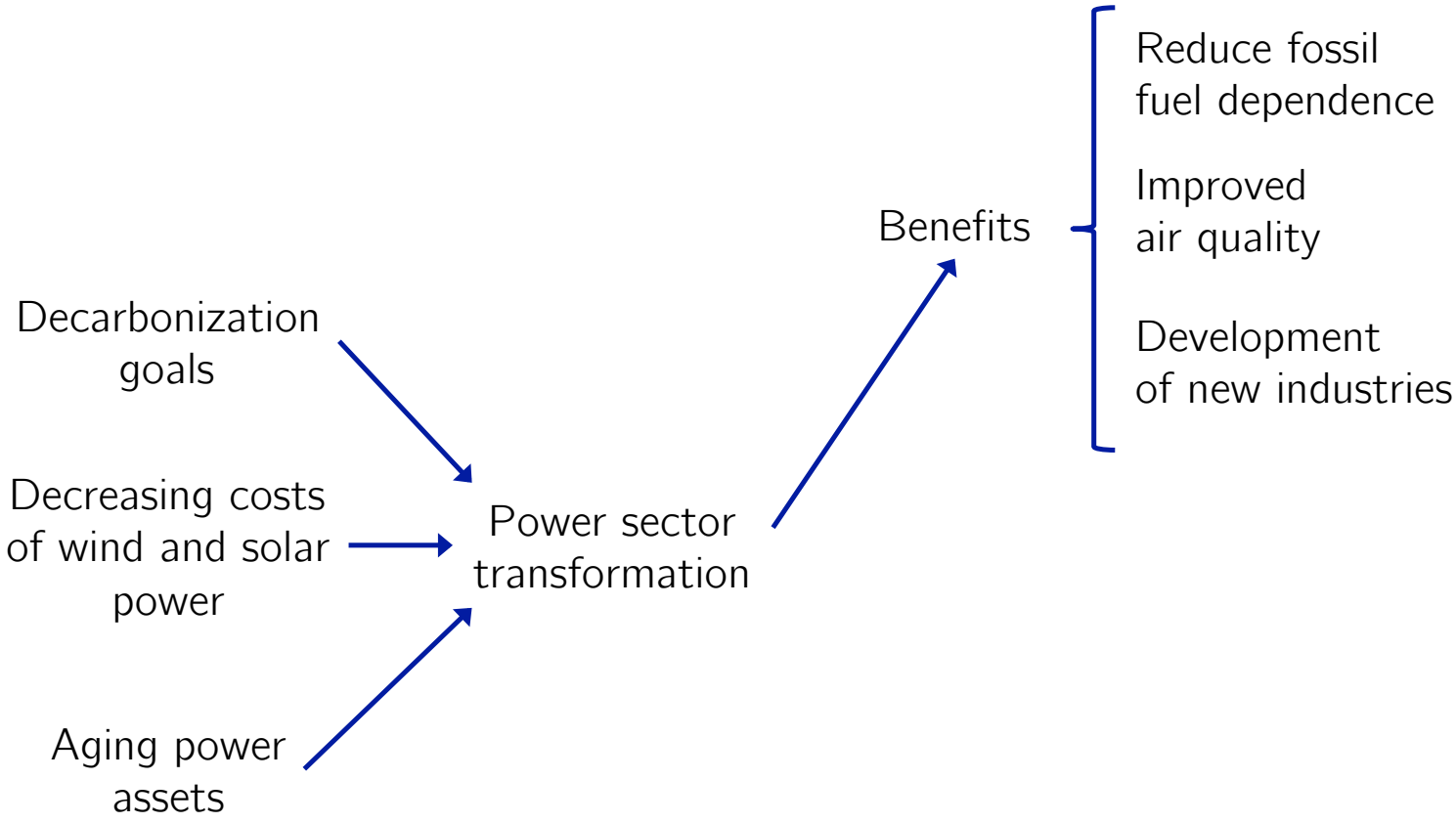


Drivers and challenges of decarbonization in the NES



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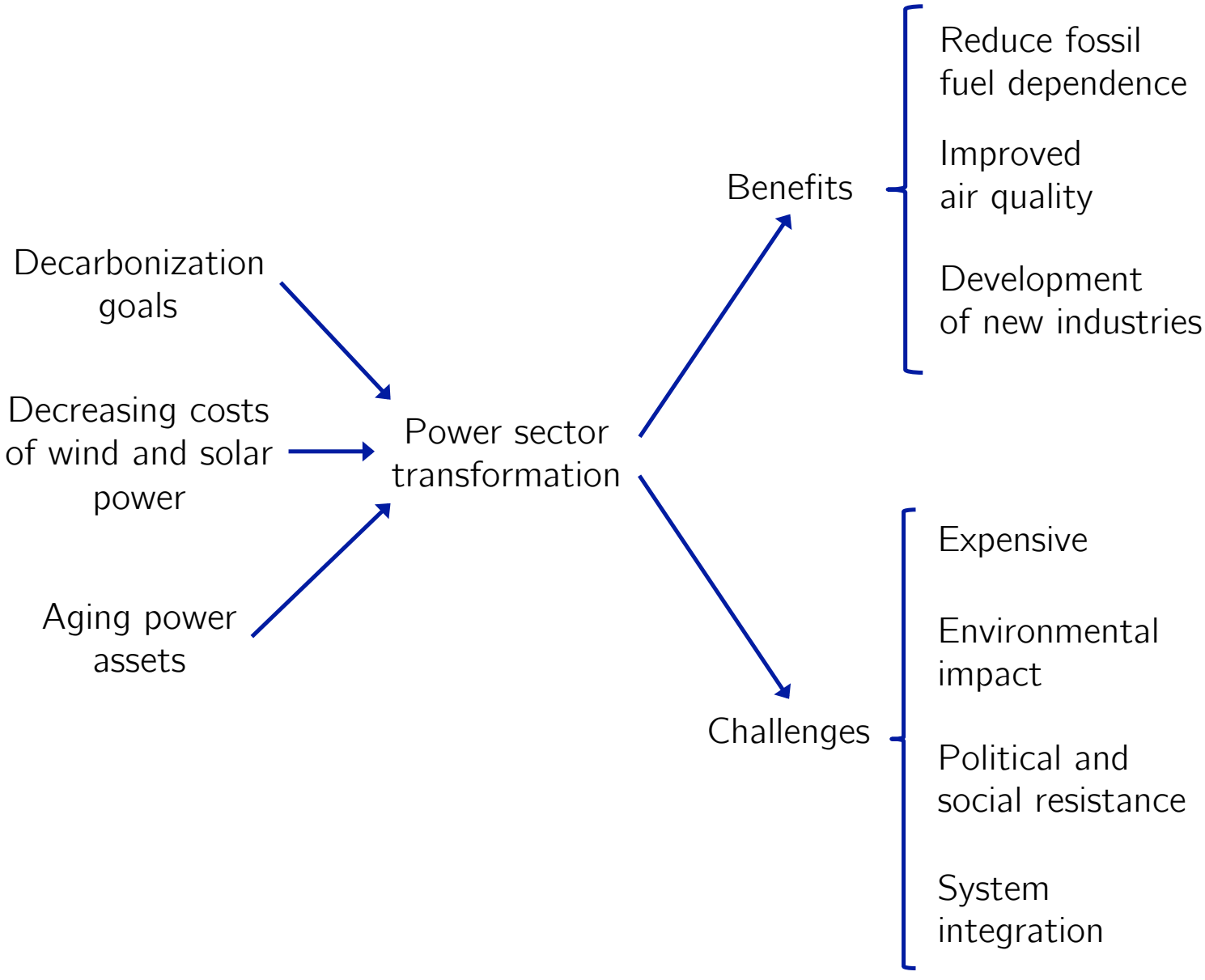

Key questions

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- Which investments would be required to meet the decarbonization goals in the NES?
- What are the potential gains of multi-regional collaboration in decarbonizing the NES?
  - Physical integration: Coordinated transmission investments
  - Institutional integration: Neighbouring jurisdictions contribute to capacity requirements
- What would be the contribution of hydropower to decarbonize the NES?

Capacity expansion problem

Capacity expansion problem

We determine optimal capacity levels of:

- Cross-border transmission
- Wind
- Solar
- Nuclear
- Natural gas (CT and CCGT)
- Energy storage
- Increamental hydro
- Demand response / load shedding

given the current hydropower and transmission capacity

Challenges of hydropower and intermittent renewables

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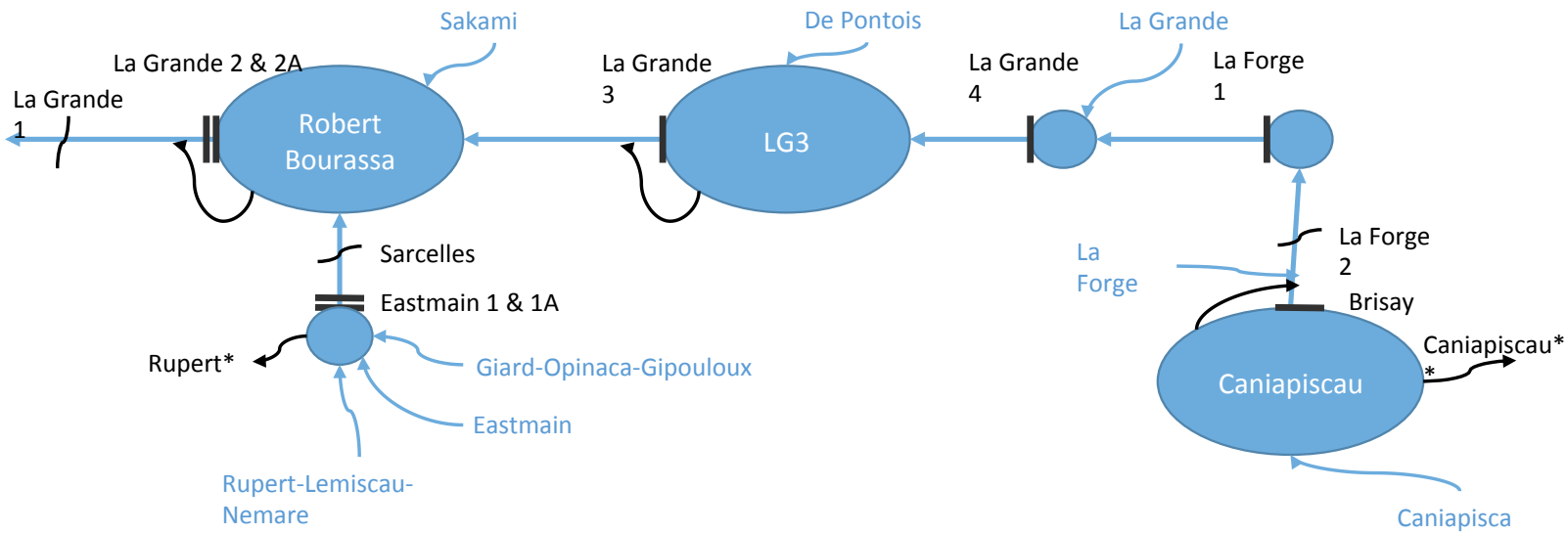
La Grande system in Quebec.



Modelling approach

Linear programming model to minimize the annualized costs of capacity investment and operation

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Constraints:

- Hourly load in each region
- Installed capacity requirement
- Operation constraints of generation technologies
- Transmission capacity
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After model reduction, more than 1M variables and 1M constraints.

Results: generation portfolio

Assuming limited nuclear capacity
Decarbonization scenarios: 50% to 99% w.r.t. 1990 emissions in the NES

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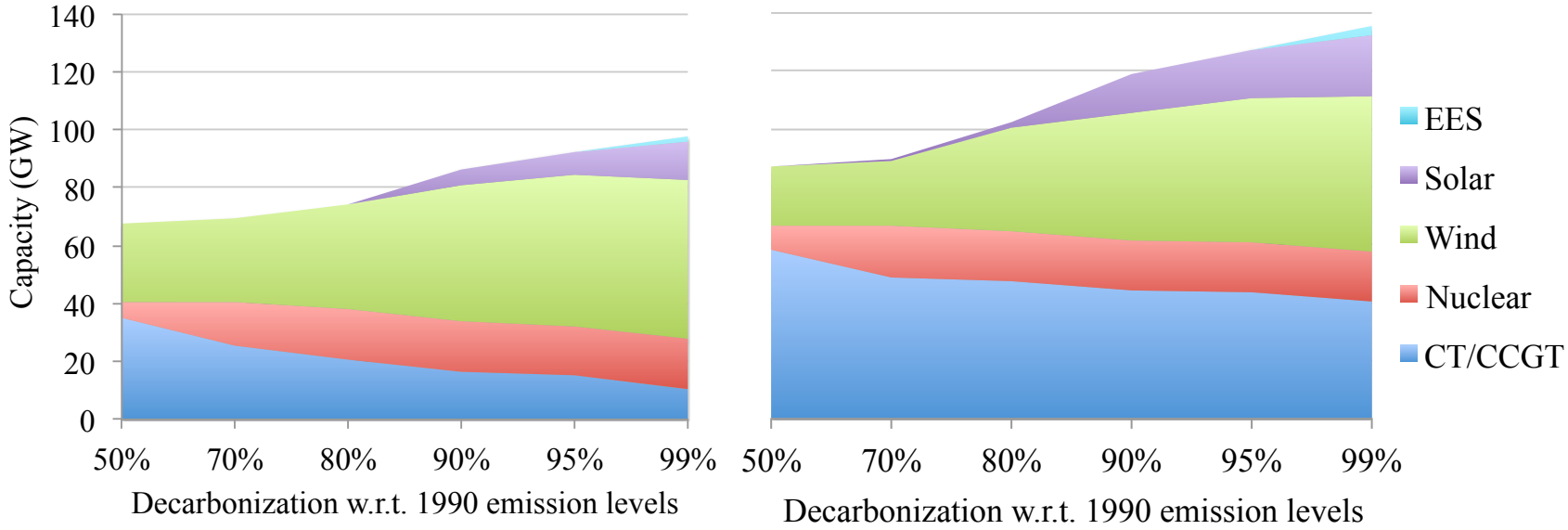
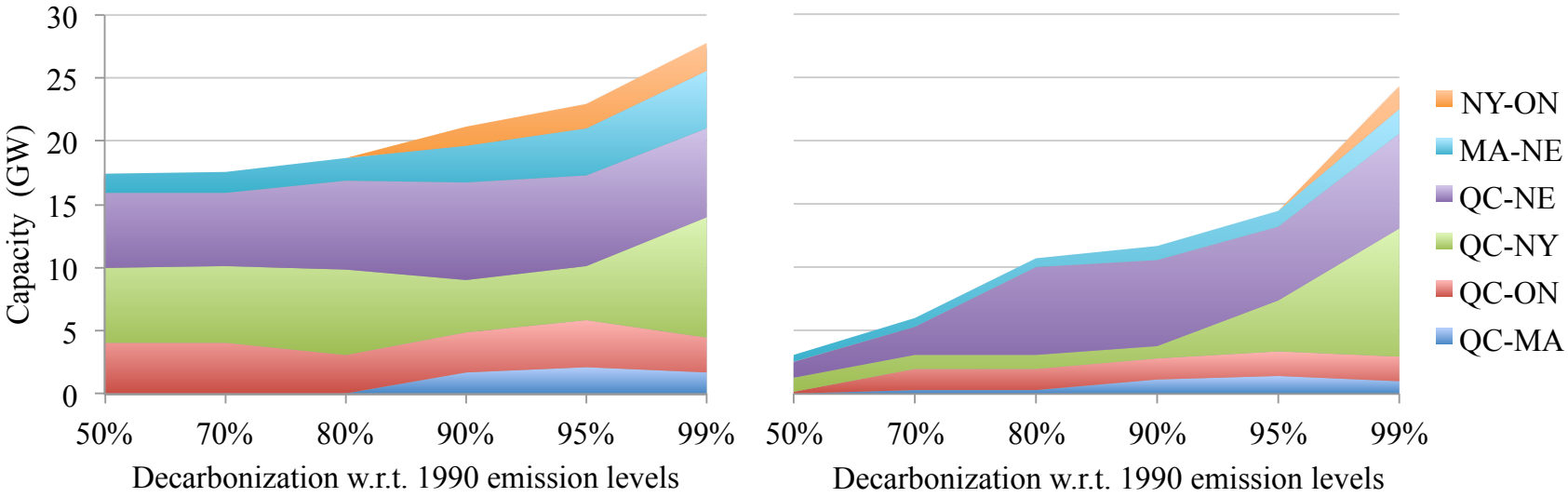


(c) Shared capacity

(d) Business as usual (BAU)

$\Rightarrow$ Large natural gas generation must be overbuild in BAU scenarios

Results: transmission expansion

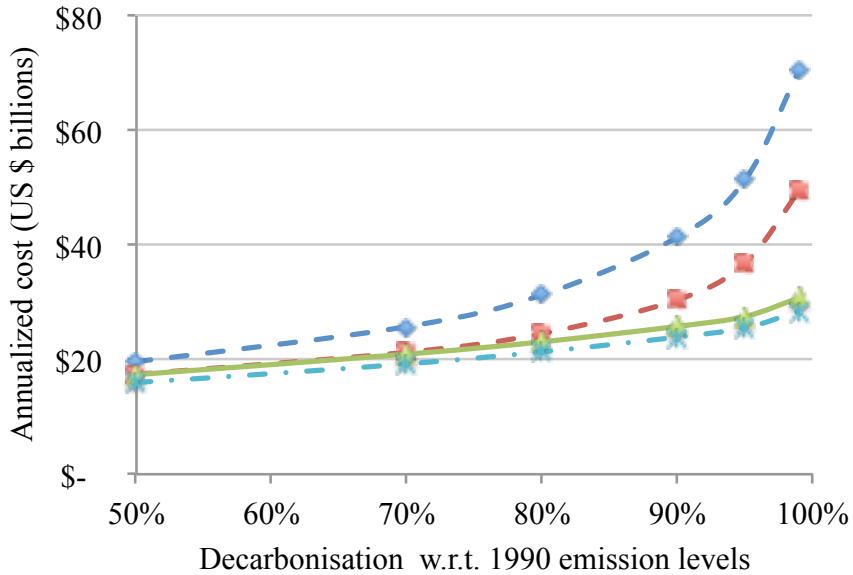


(e) Shared capacity

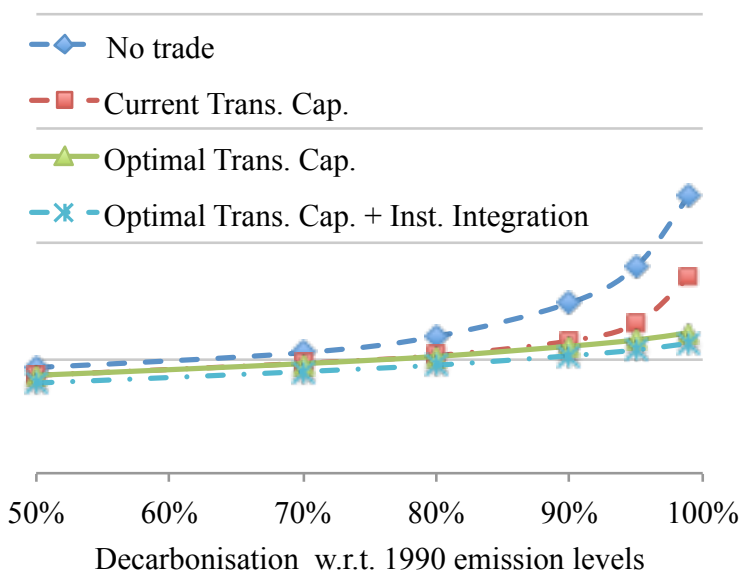
(f) Business as usual

$\Rightarrow$ Shared capacity justify large transmission investments in all scenarios.

Results: annualized cost



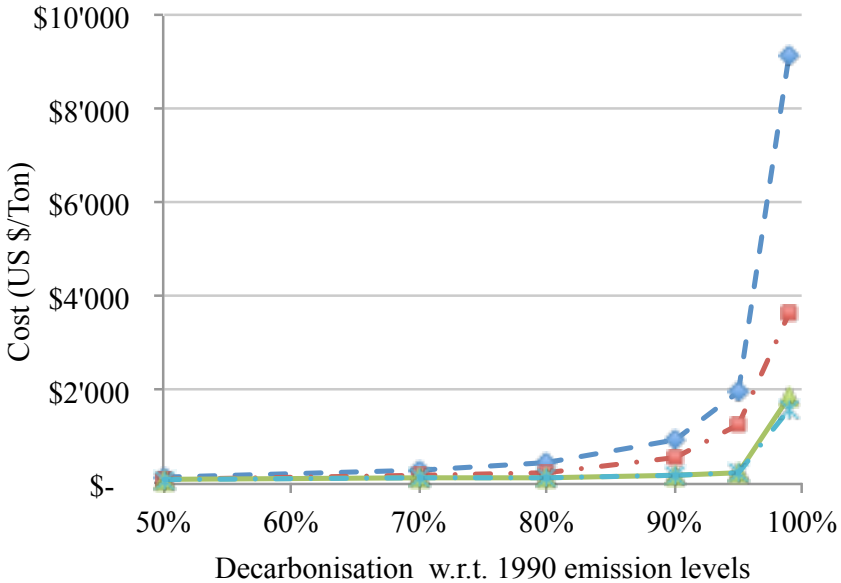
(g) No nuclear



(h) Limited nuclear

$\Rightarrow$ Nuclear capacity and regional integration cut by a half the full decarbonization cost.

Results: marginal price of carbon



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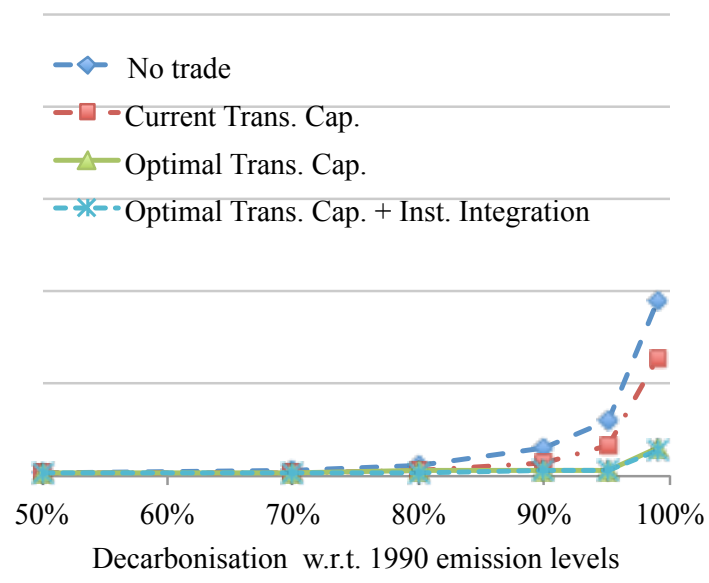
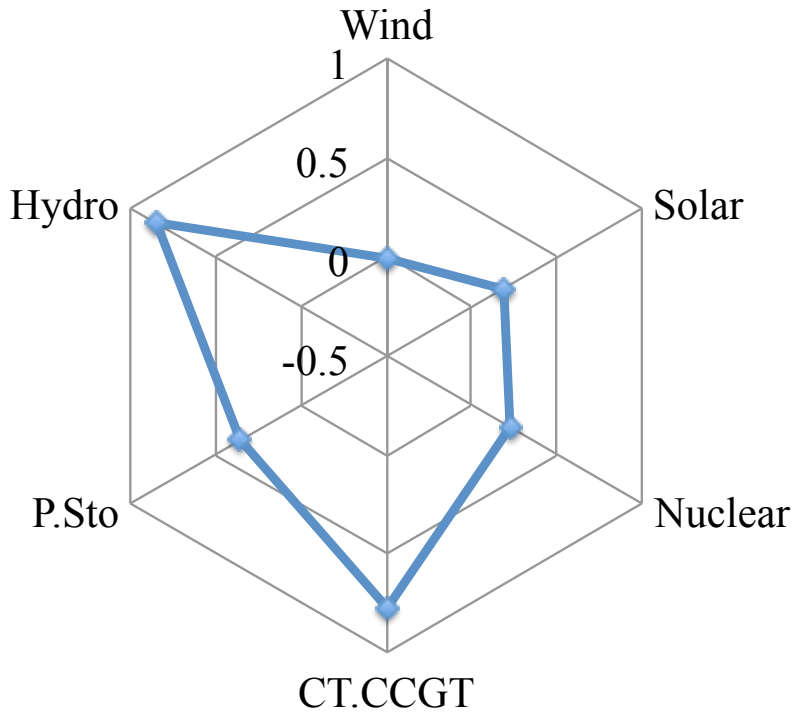


(j) Limited nuclear

$\Rightarrow$ Marginal price of carbon steeply increases beyond 80% decarbonization.

Role of hydropower in a decarbonized NEC

Correlation between generation and load in BAU with 80% decarbonization.



Concluding remarks

- Multi-regional cooperation will be essential to efficiently achieve deep decarbonization in the NES.
- Nuclear power would be part of an efficient decarbonized NES.

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Future work should address:

- Deep uncertainty
- Additional policy options
- Technical feasibility
- Life cycle impact and political acceptance of policy alternatives

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Thank you!

References

- FAO-ON (2017). *Nuclear Refurbishment*.
- ISO-NE (2017), *Maps and diagrams*, Retrieved Mach 29, 2019. `https://www.iso-ne.com/about/key-stats/maps-and-diagrams/`