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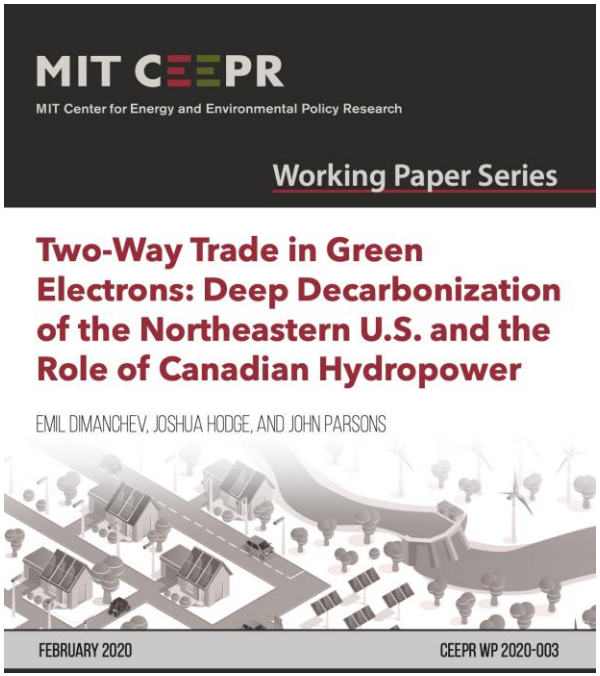

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http://ceepr.mit.edu/publications/working-papers

Integration of Canadian and U.S. power systems for deep decarbonization of electricity

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Massachusetts Institute of Technology

http://mit.edu/ceepr

Topic & Context

- Achieving deep decarbonization requires addressing the intermittency of wind and solar generation.
- Hypothesis: hydro as a **source of energy** when needed
- Conclusion: optimal role of hydro is as an **energy storage resource**

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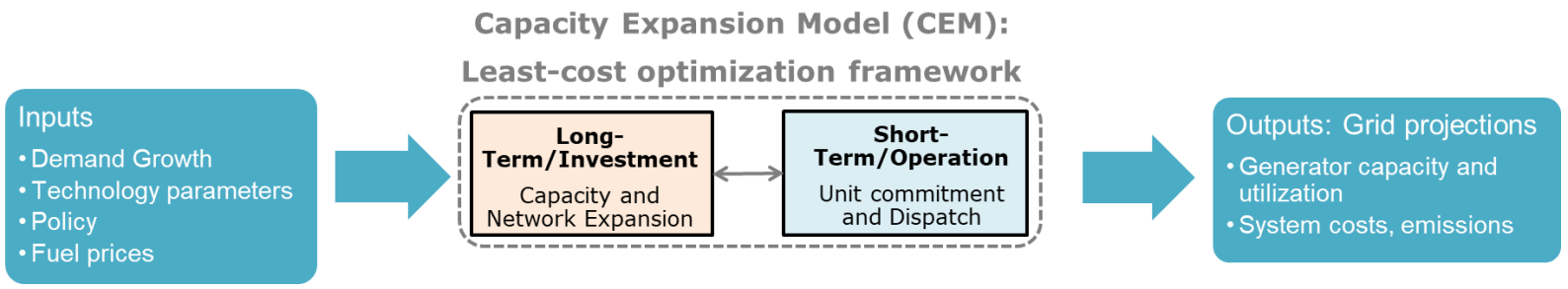
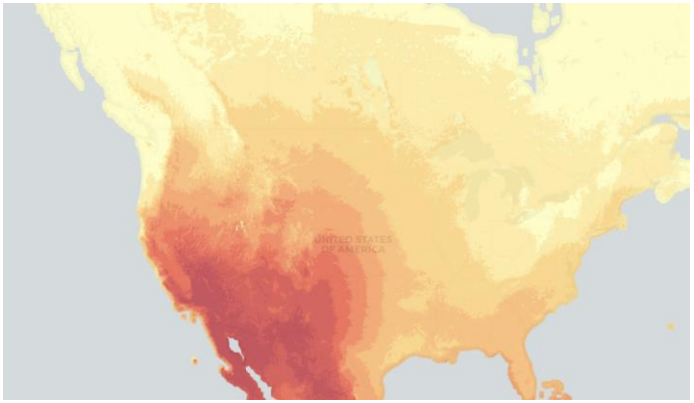
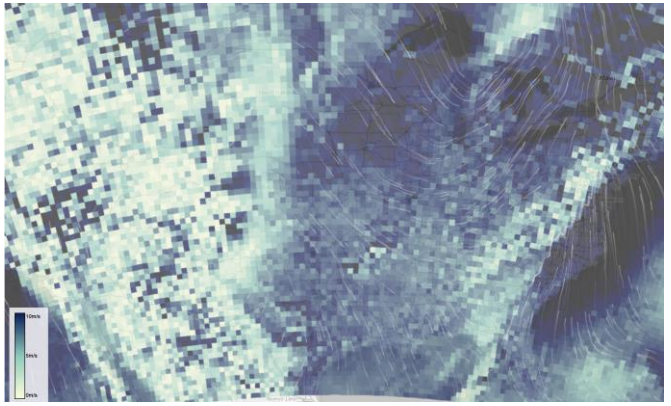
Modeling an optimal power system



Solar irradiance[2]



Wind speed[3]



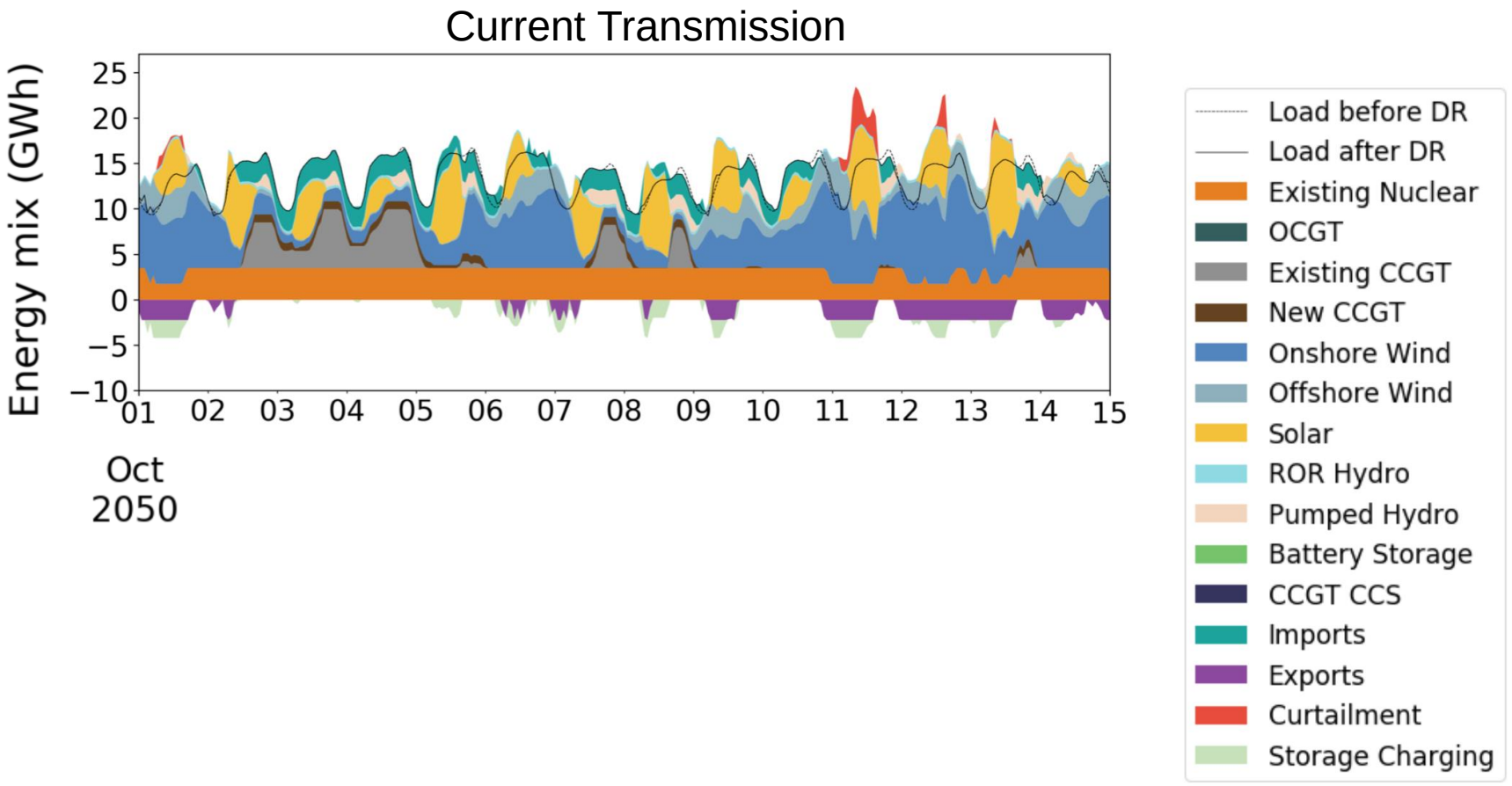
2. NREL NSRDB; 3. NREL Wind Toolkit

- 8760 hours modeled
- Operational detail and unit commitment
- Diverse supply-and demand-side resources

Experiments with two scenarios

- Current transmission
- Additional transmission (+ 4 GW)

Effects of transmission on hourly dispatch under 90% decarbonization



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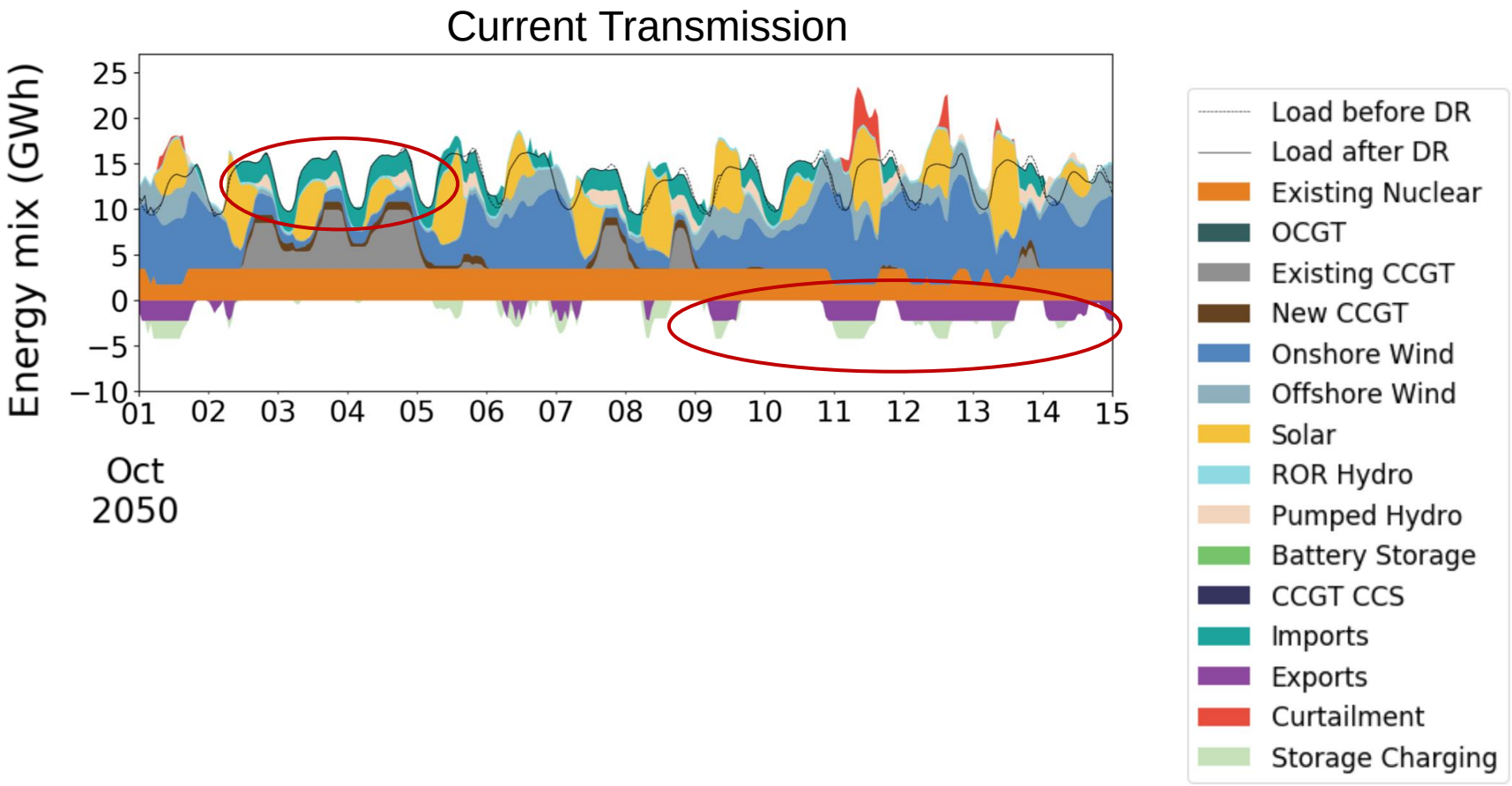

Results

1) QC absorbs excess NE ren. and fills in shortages

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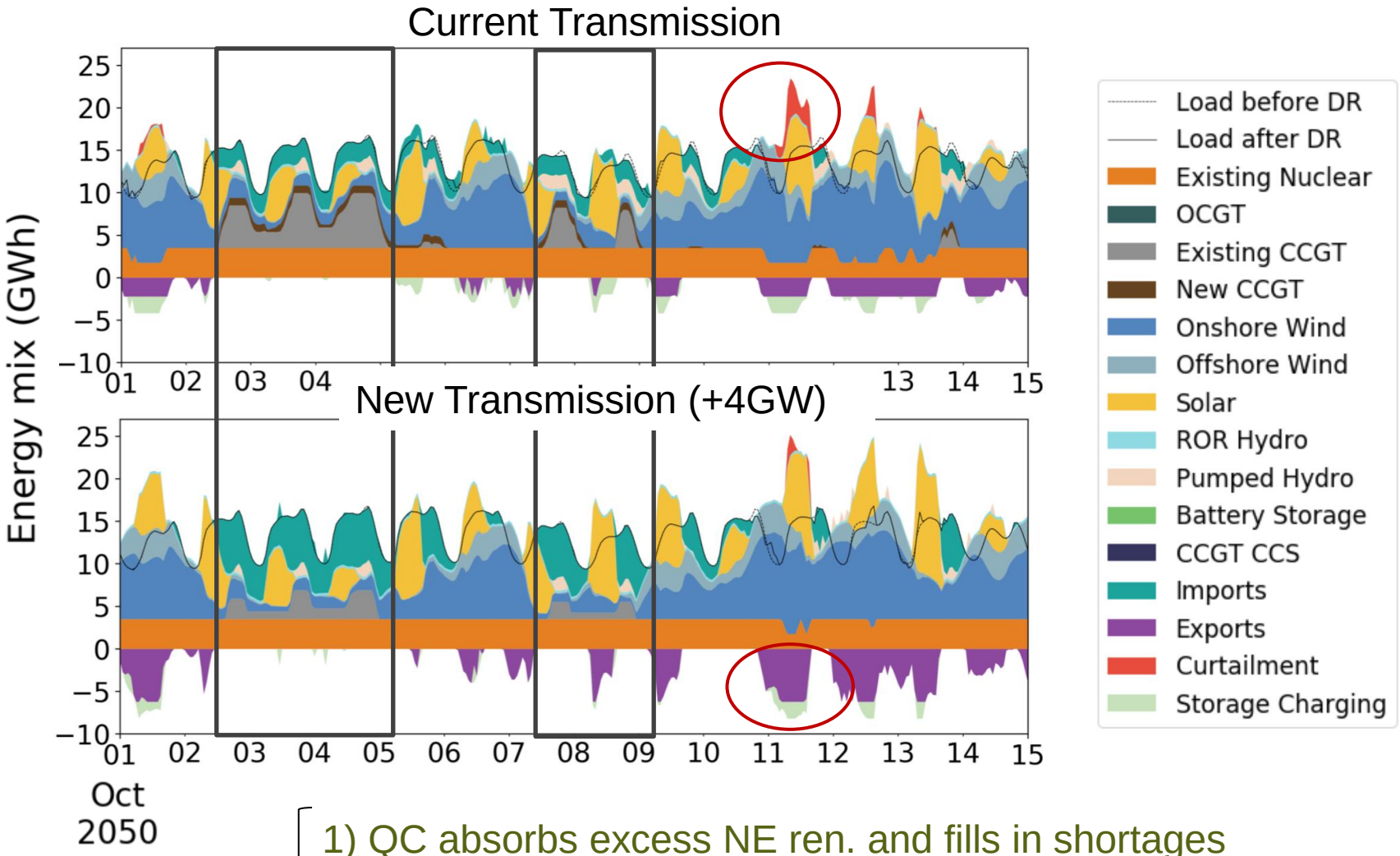

Results

1) QC absorbs excess NE ren. and fills in shortages
2) Increasing transmission allows more balancing

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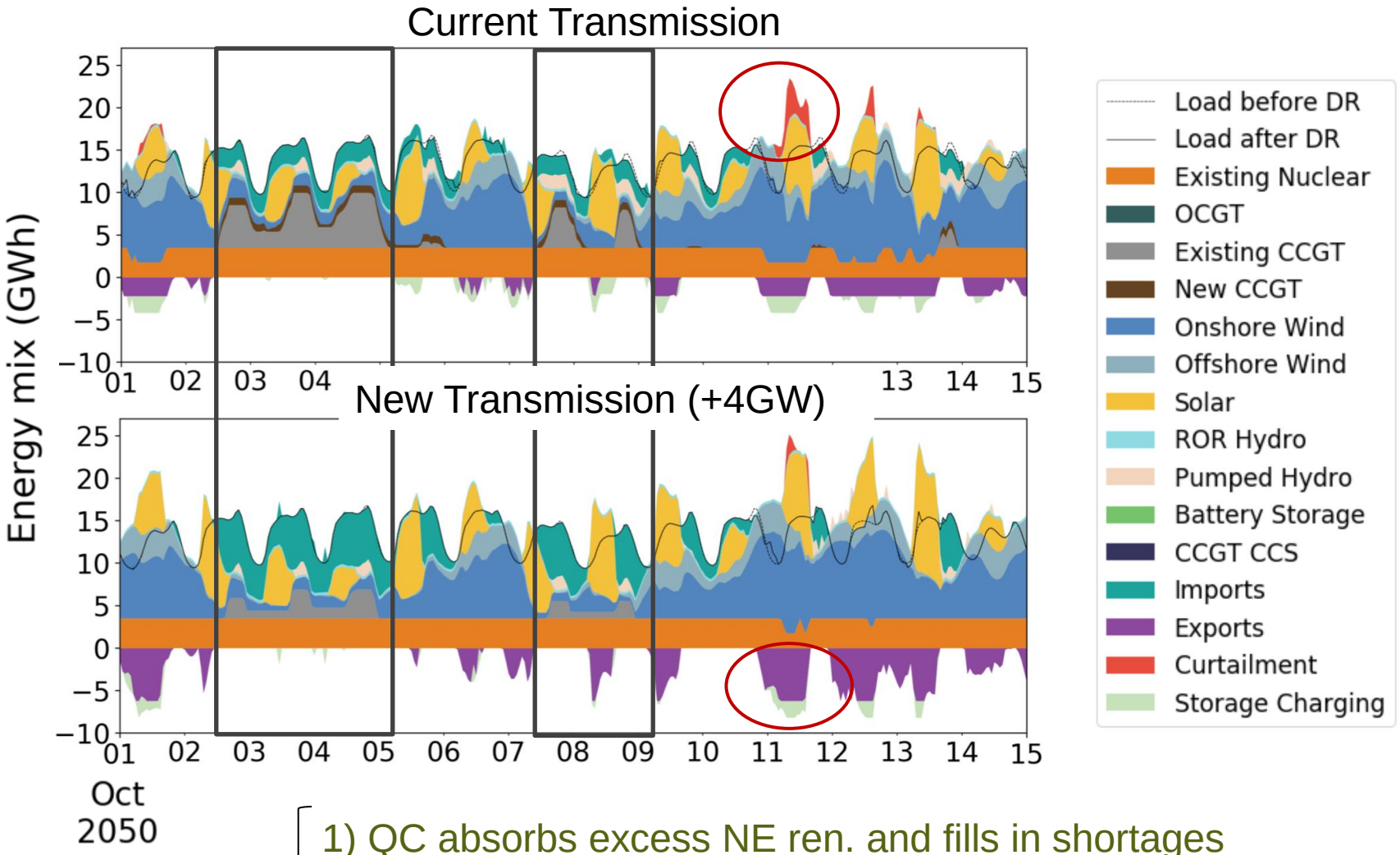
Effects of transmission on hourly dispatch under 90% decarbonization



Results

1) QC absorbs excess NE ren. and fills in shortages
2) Increasing transmission allows more balancing
3) ↓ need for gas, ↑ nuclear utilization, ↓ ren. curtailment

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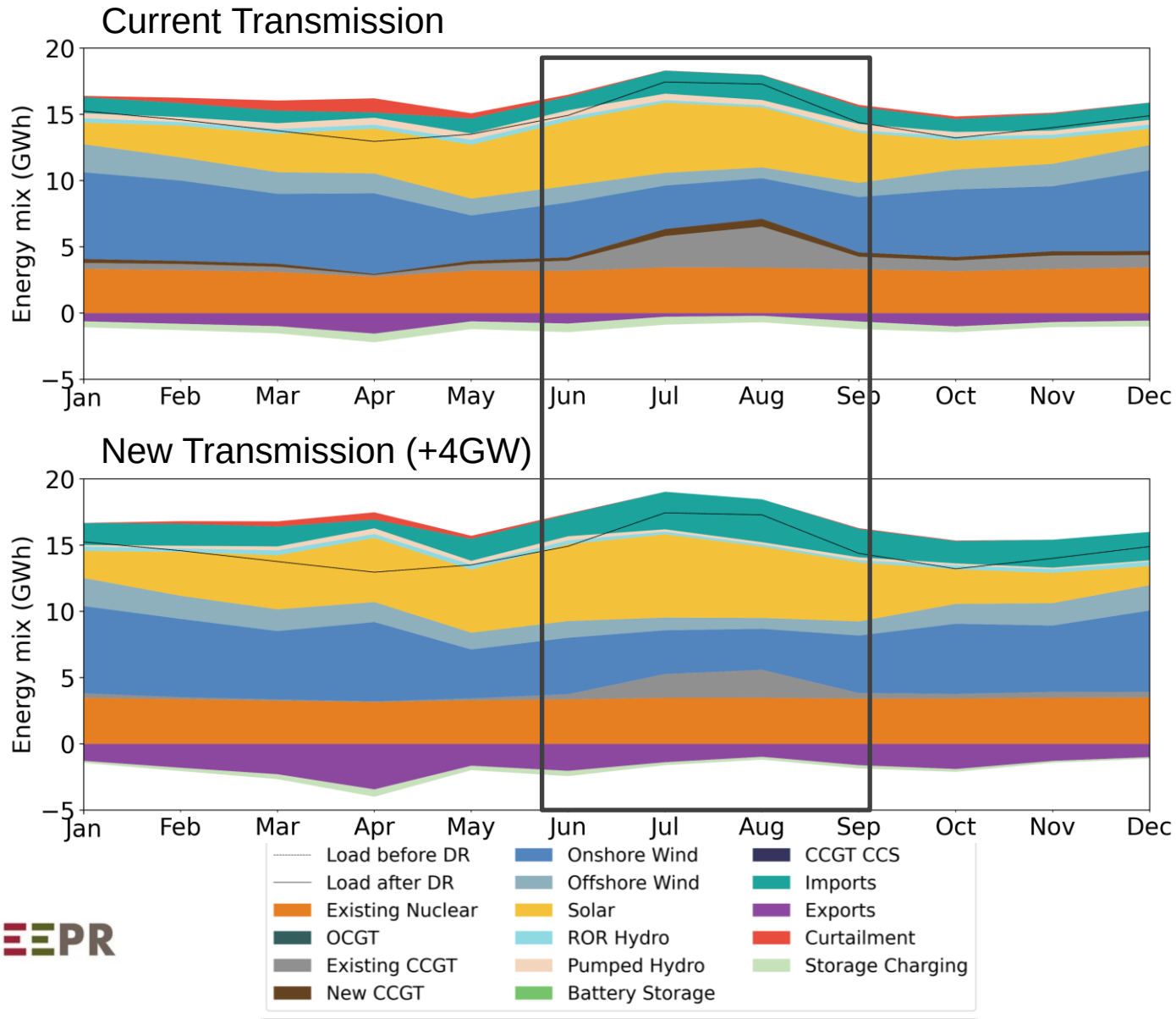
Quebec's hydro reservoirs also provide seasonal balancing



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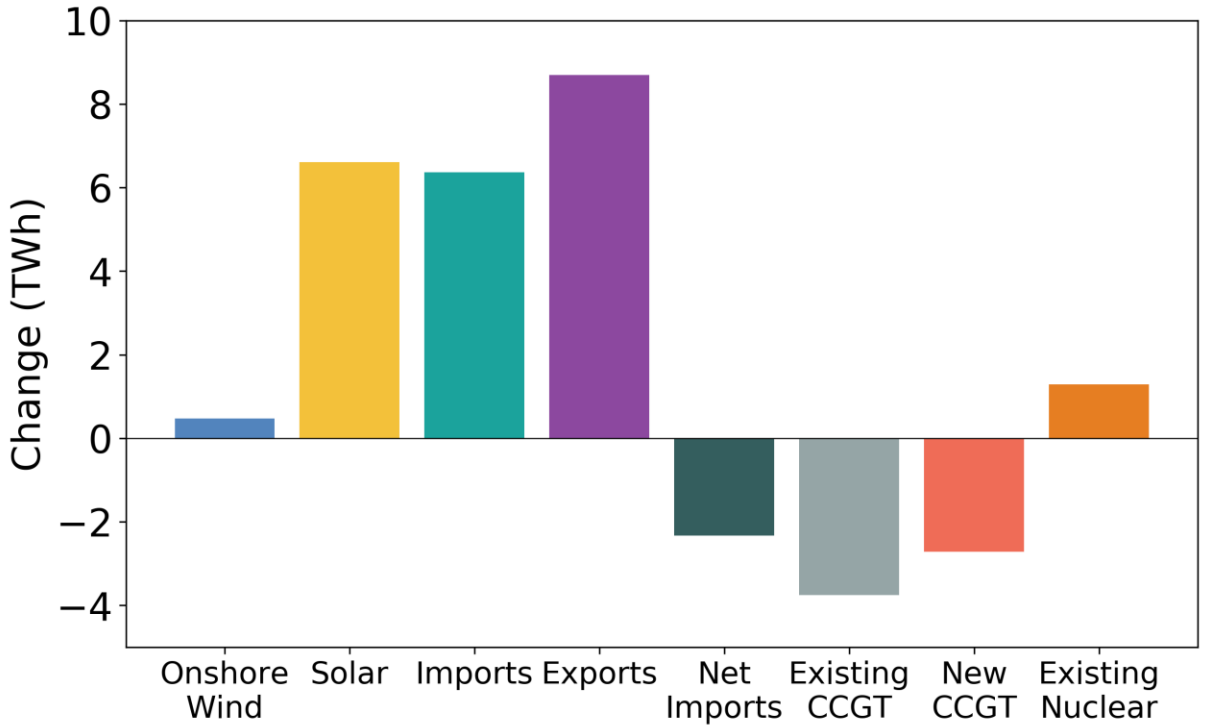
Additional transmission reshapes the optimal energy mix in New England

QC hydro helps New England integrated more RE generation

Gas generation becomes displaced resulting in CO2 reductions

Change in generation by source from Current to New Transmission

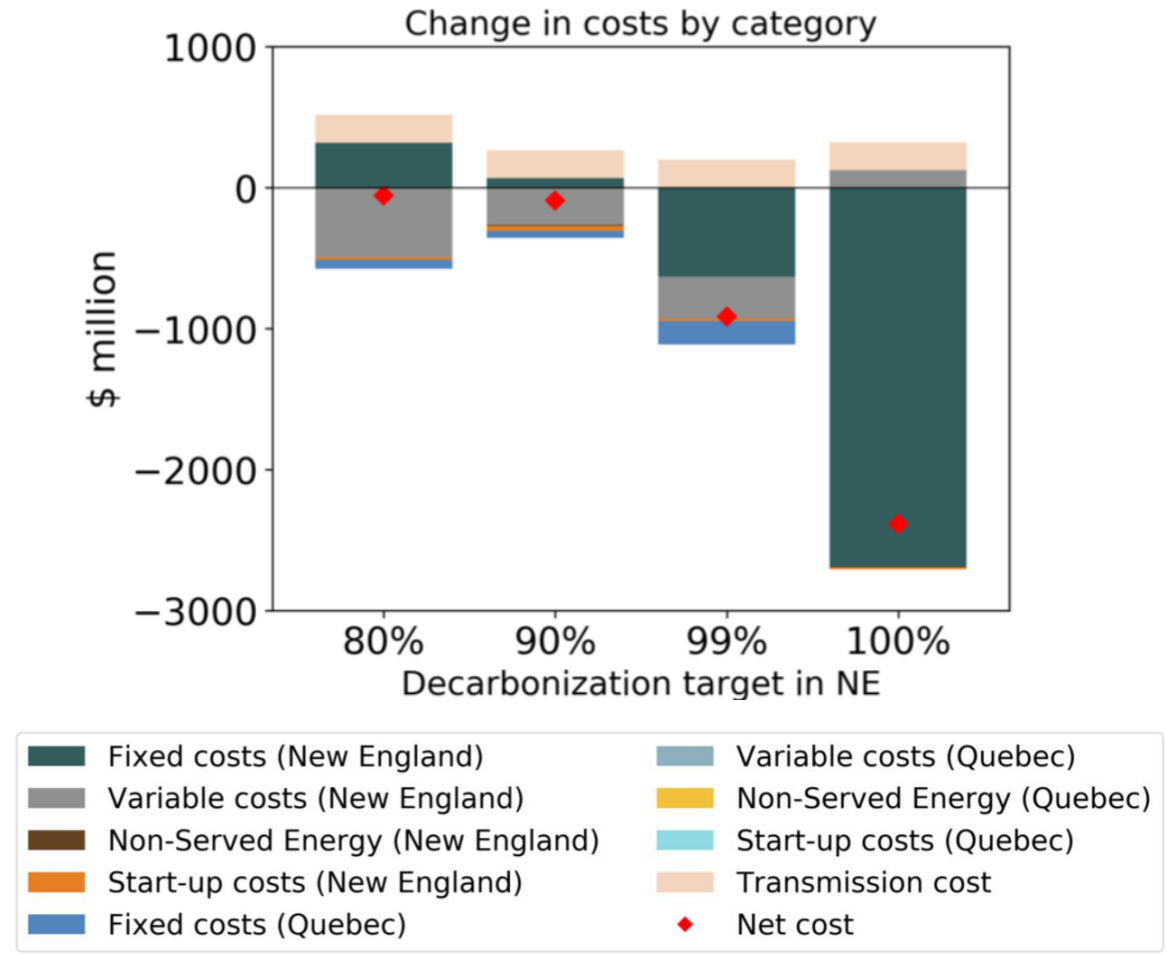


Note: results are for 90% decarbonization scenario

The deeper the decarbonization target, the larger the value of transmission

Value of Quebec hydro grows non-linearly

Value stems from avoiding gas use, CCS investments, or "over-building"



Takeaways

Optimal role of Quebec hydro is as an energy storage resource complementing New England wind and solar

New transmission would enable existing hydro to provide additional balancing for U.S. renewables

How do we adapt planning to maximize complementarity and incentivize optimal two-way exchange of power between Canada and the U.S.?

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Thank you!

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