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Electricity Market Integration in North America

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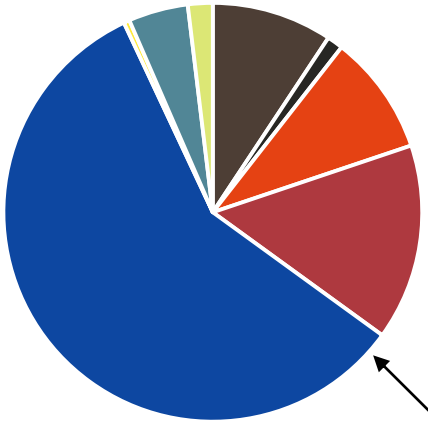
Introduction

- International and national climate goals
- Decreasing costs of renewable energy
- Large, diverse and distributed potential for renewable energy on the North American continent

→ Geographic conditions for establishing a highly integrated grid with 100 % renewables

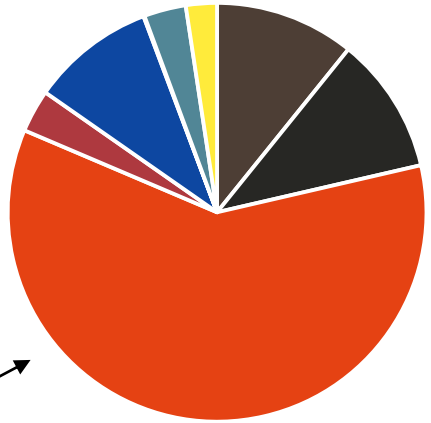
Source: Aghahosseini et al. (2018), Jacobson et al. (2015)

Introduction: Electricity mix and grid integration



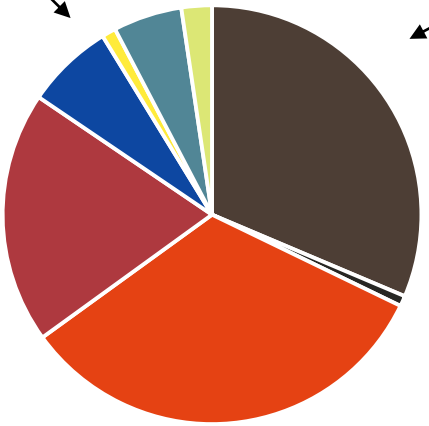
Canada
667 TWh

Mexico
320 TWh



High grid integration (77 TWh)

Almost no grid integration



USA
4316 TWh

- Coal
- Oil
- Natural gas
- Nuclear
- Water
- Sun
- Wind
- Other renewable

Source: IEA Electricity Information (2018)

Research question

Where is (renewable) generation located under different levels of grid integration?

Methodology: Applied model framework

Input assumptions

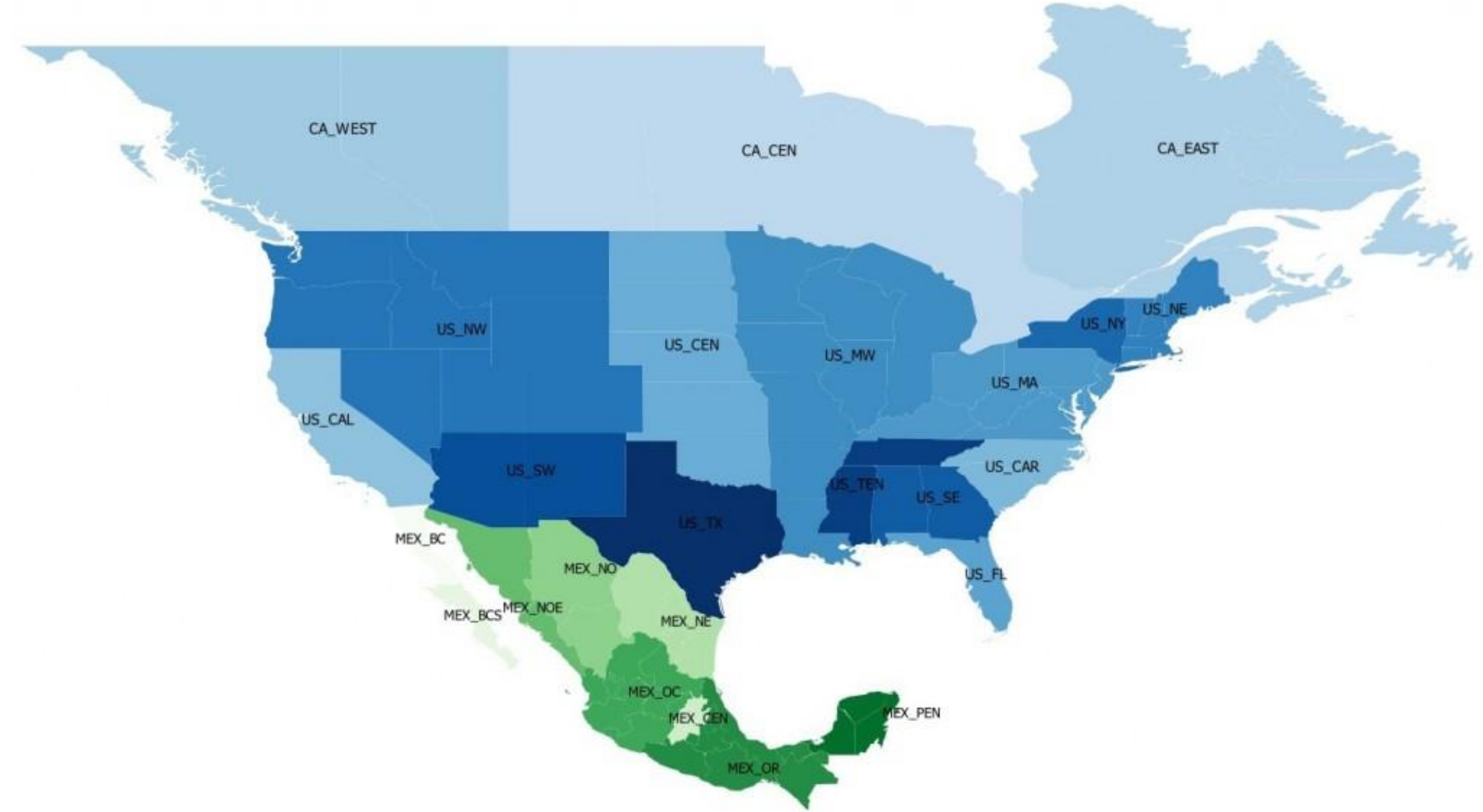
- Renewable timeseries and technical potential
- Demand curves
- Existing power plants
- Cost assumptions for renewable and storage technologies
- Transmission grid infrastructure

Short term: Linear optimization of cost-minimal dispatch with increased cross-border transmission capacity

Long term: Linear optimization of cost-minimal investments in capacity with 100% renewables under different network conditions

Increasing renewable integration

Methodology: Regions

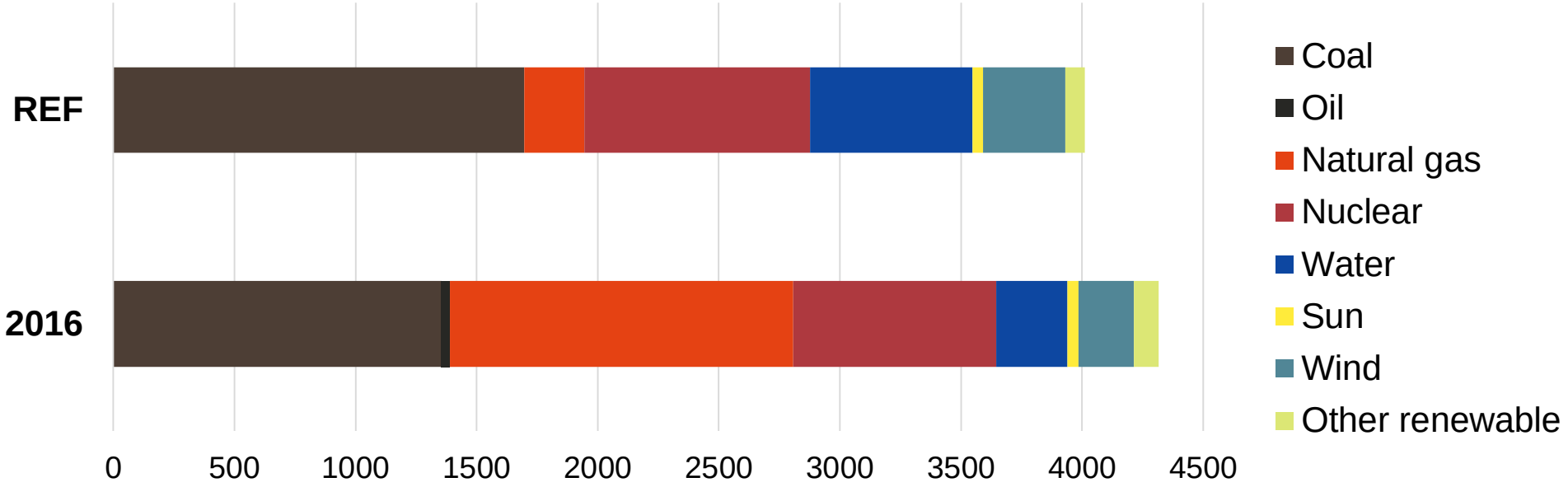


*Alaska, Hawaii and the northern Canadian regions are not included in the model

Methodology: Scenario description (preliminary)

Scenario	REF	RES-REF	DISP-GRID	RES-SF	RES-GRID
Description	• Dispatch with existing power plant portfolio	• Investment in generation capacity, then dispatch	• Dispatch with existing power plant portfolio	• Investment in generation capacity, then dispatch	• Investment in generation capacity, then dispatch
Grid assumption	• Existing grid	• Existing grid	• Increased cross-border transmission capacity	• No electricity exchange between regions	• Grid expansion
Renewable integration	• Not constrained	• 100% renewables	• Not constrained	• 100% renewables	• 100% renewables

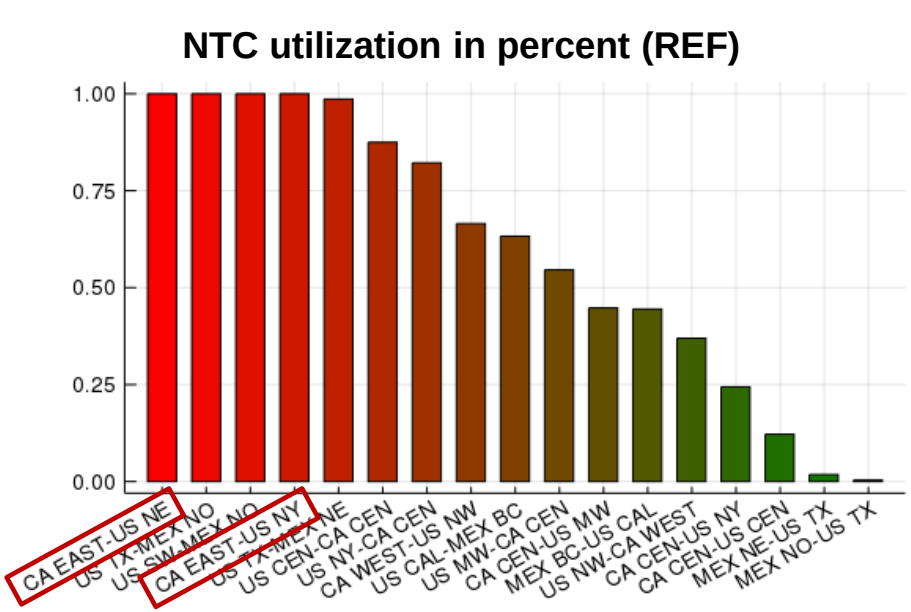
Preliminary results: Modelling the Status Quo in the U.S.

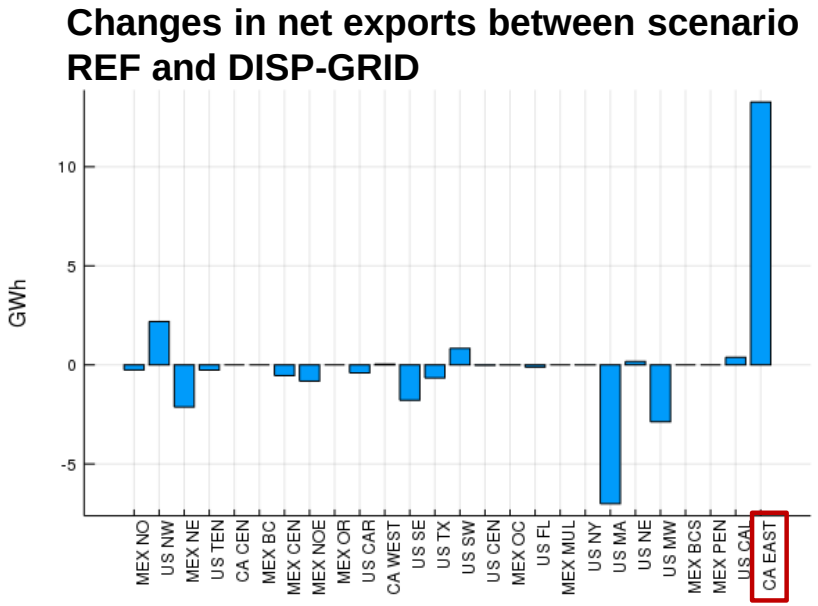


- Underestimation of the natural gas generation
- Overestimation of hydropower generation

→ **Sensitivity to underlying price assumptions**

Preliminary results: Energy exchange between regions

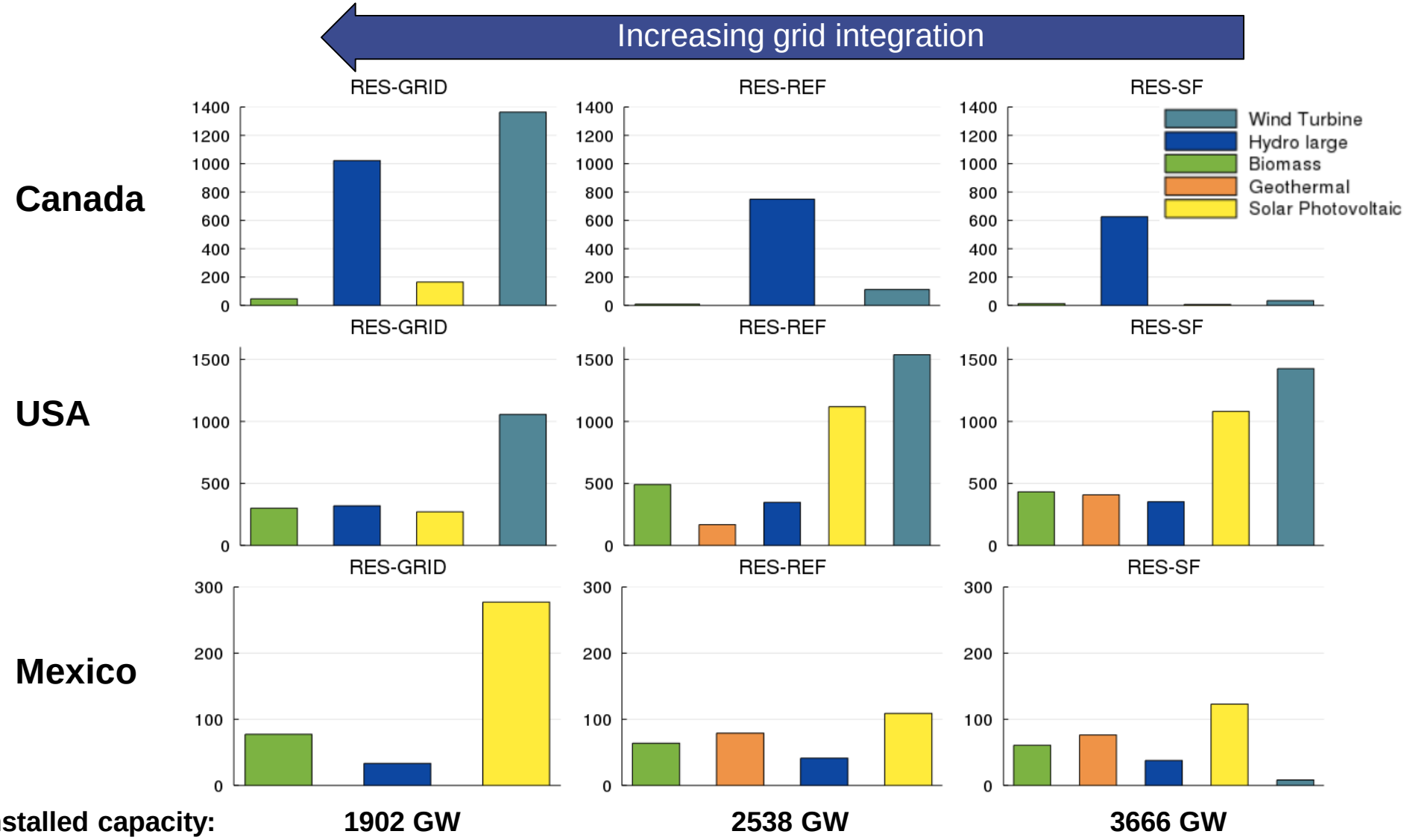




→ Increased cross-border transmission capacity leads to a generation shift

→ **Modelled share of renewable energy generation rises by almost 8 percent**

Preliminary results: Generation by resource [TWh]



Conclusion

Key findings

- Increased cross-border transmission capacity can help to integrate higher renewable shares on the short run, e.g. grid expansion between the East of Canada and the Northeast of the U.S.
- In the long run, increased transmission capacity leads to a more centralized distribution of renewable capacity, while little or no intra-regional transmission capacity leads to a decentralized distribution of renewable capacity

Research outlook

- Reassessment of scenarios considered
- Reassessment of cost assumptions for considered technologies

Thank You for Your Attention!