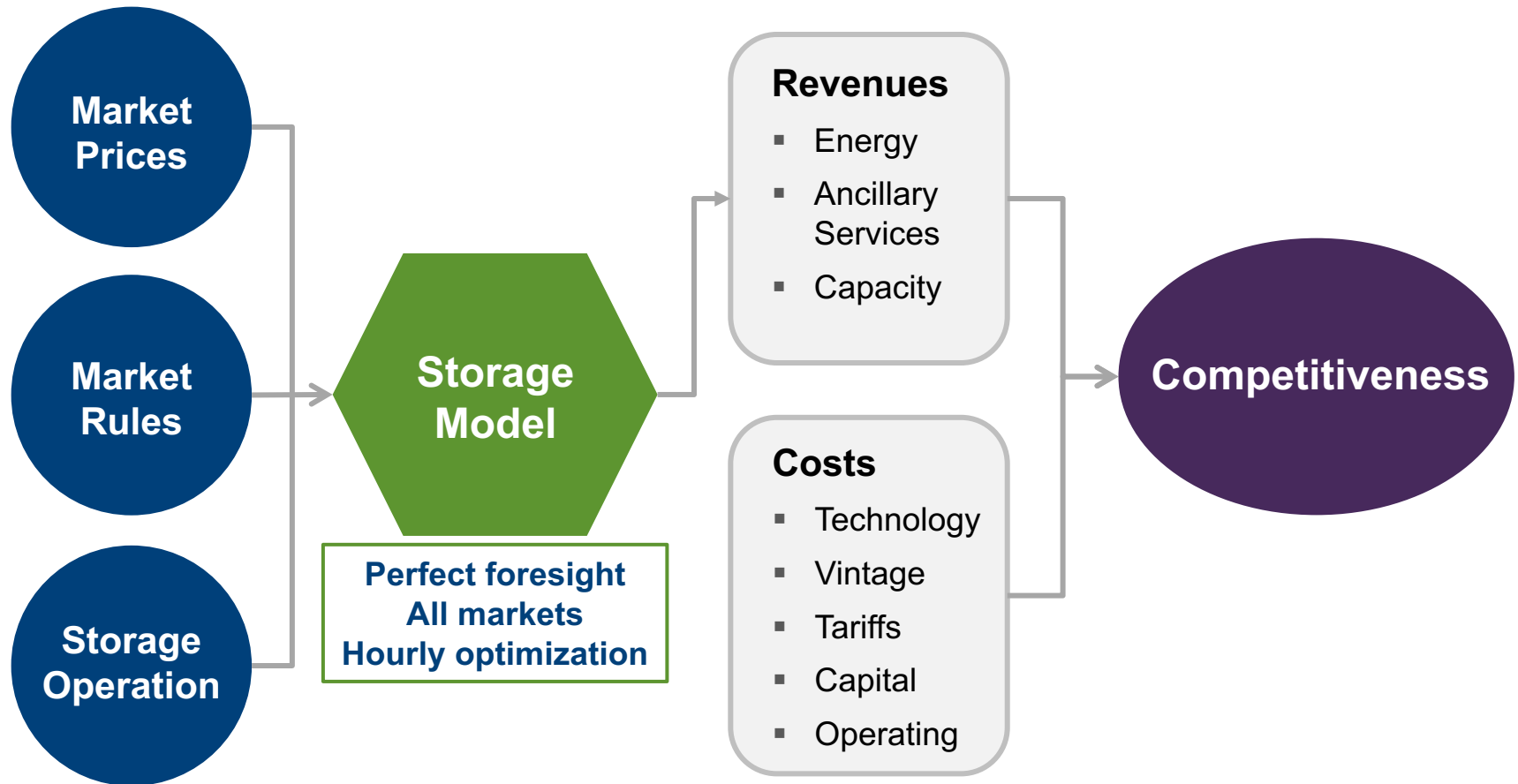


Energy Storage In Alberta

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Ivey Energy Policy and Management Centre
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What is the role for energy storage in Alberta's markets?



We did not assess “wires deferral” or “customer bill” related benefits

A wide range of storage scenarios to understand the economics

Technologies

- **Lithium-ion batteries:** 2-hour, 4-hour and 12-hour
- **Pumped storage hydro:** 6-hour and 12-hour

Market Conditions

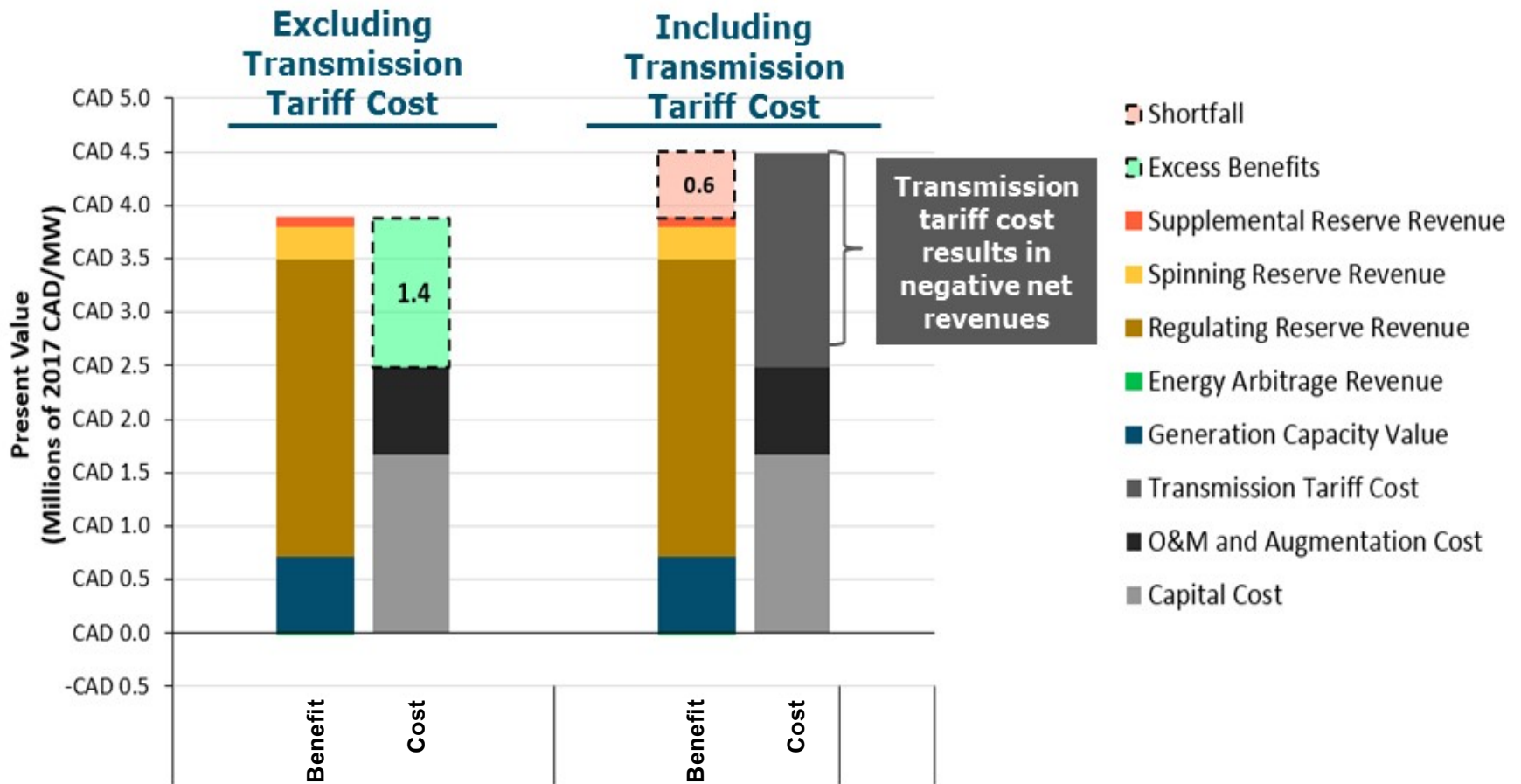
- **Future Alberta generation mix:** moderate vs high coal conversion, no inertia
- **Saturation:** effect of increased storage on operating reserve and pool prices

Cost Projections

- **Technology uncertainty:** range of potential costs for batteries and pumped storage
- **Cost changes by year of installation:** 2021 and 2025

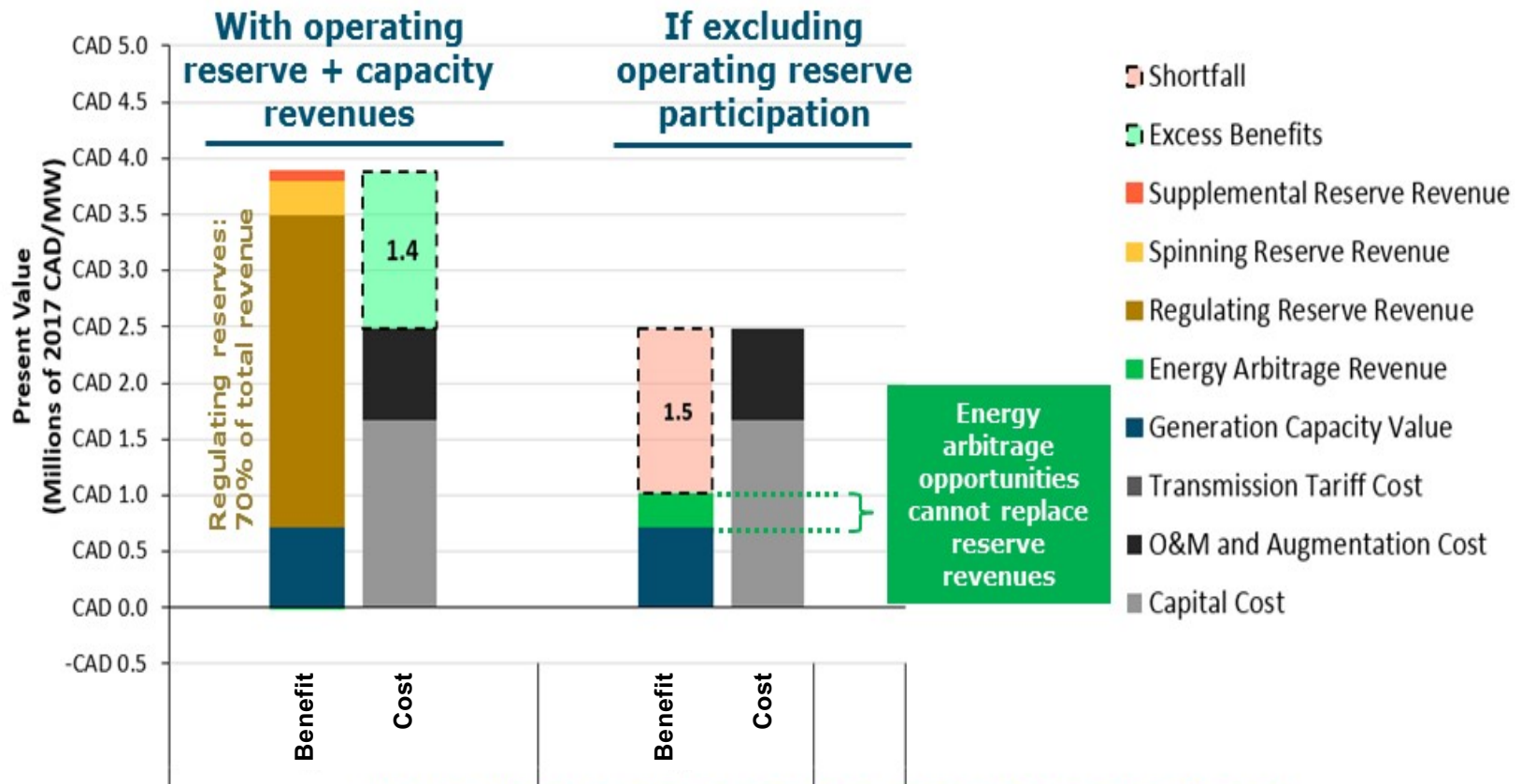
Storage may be cost-effective in operating reserve market, with no transmission tariff costs

1 MW, 4-hour Lithium-Ion Battery
 (2021 Installation, 25 Year Present Value with 8.2 % Discount Rate)



Operating reserve market provides 70% of revenues; energy price arbitrage not very cost-effective

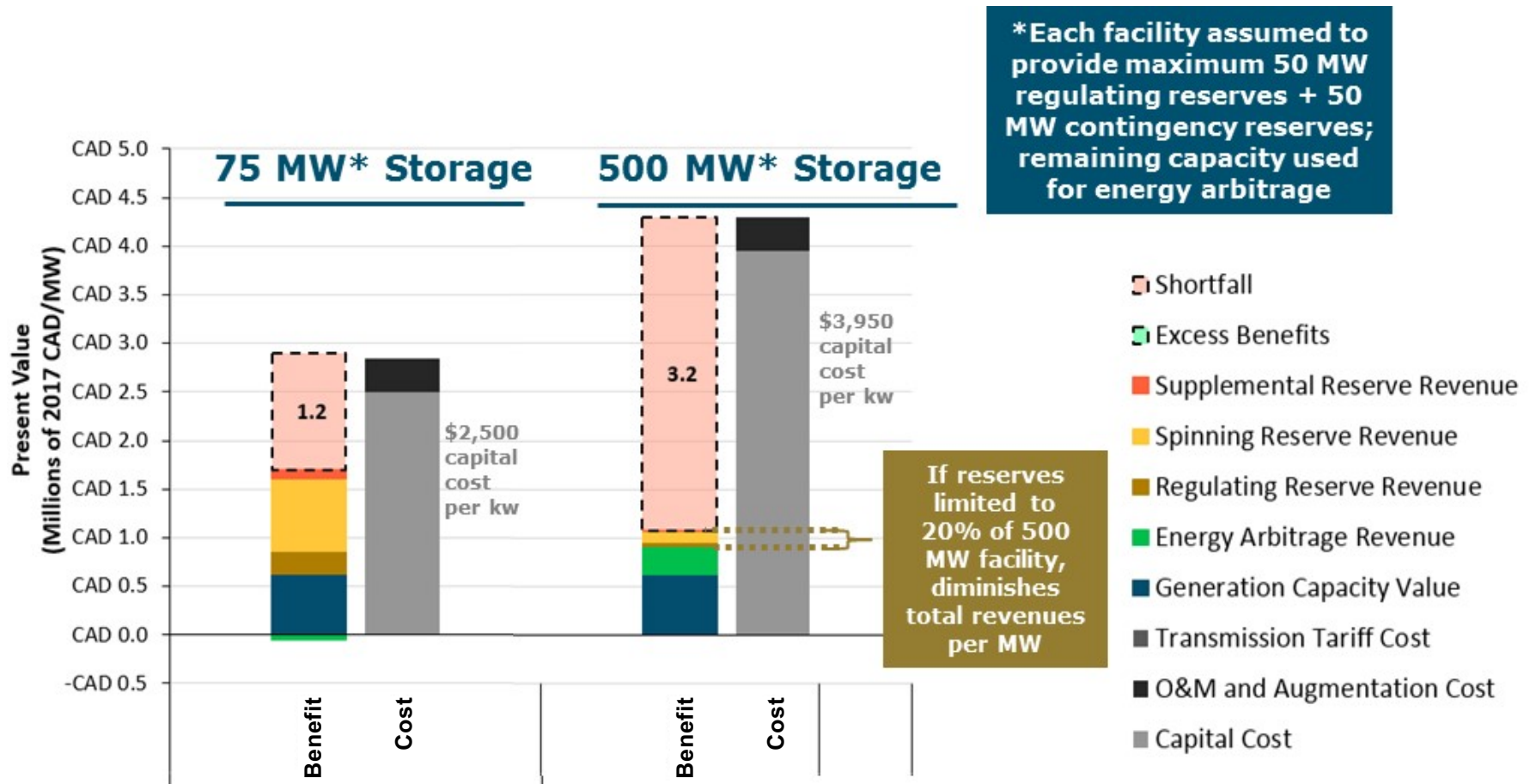
1 MW, 4-hour Lithium-Ion Battery With and Without Regulating Reserve Revenue (2021 Installation, 25 Year Present Value with 8.2 % Discount Rate)



*Note: Results above exclude transmission tariff cost

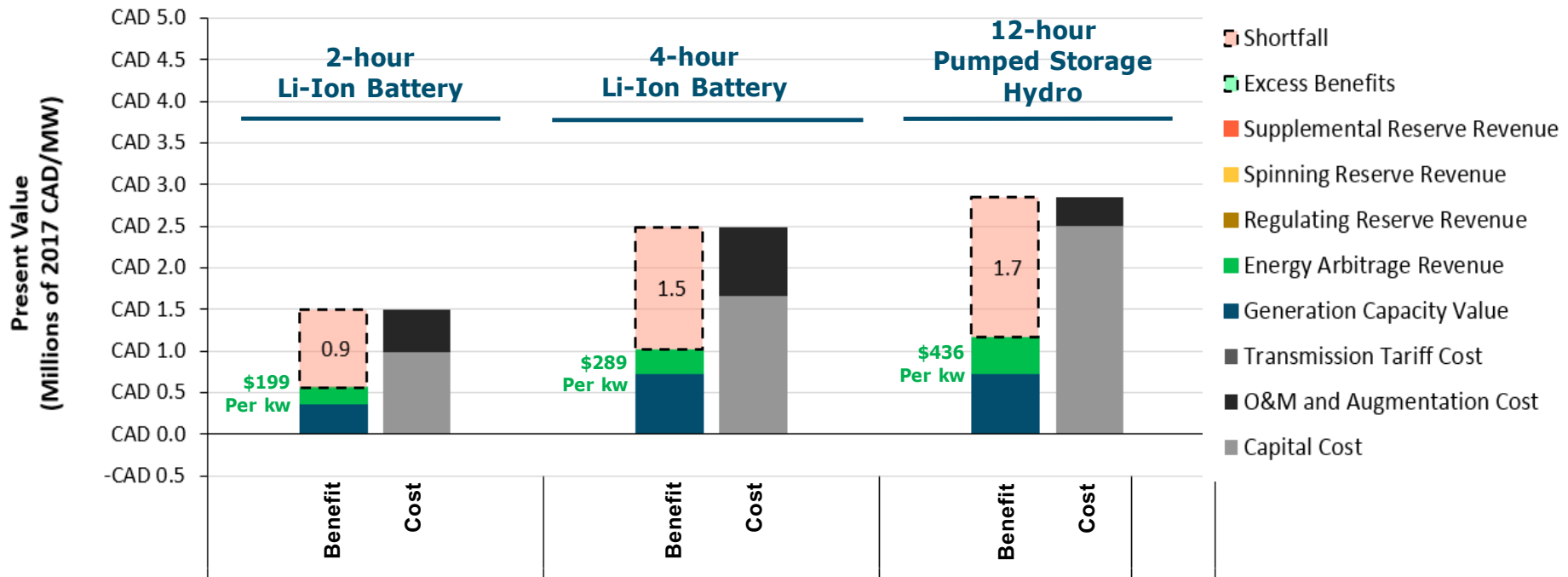
Larger storage projects will likely be less cost-effective

12-Hour Pumped Storage Hydro
 (assuming 50 MW price saturation in regulating and contingency reserve markets)



Storage duration beyond two hours provides diminishing incremental value in Alberta

1 MW Storage; 2021 Install
(excludes operating reserve revenue opportunities)



***Note: Results above exclude transmission tariff cost, do not assume price saturation from storage installation**

Key energy storage findings

- Transmission tariff likely to be a material cost for storage
- Smaller sizes and volume of storage (<50 MW) may be cost-effective, primarily in the ancillary services market
- Larger sizes and volumes of storage (>50 MW) unlikely to be cost-effective due to insufficient energy price spreads
- Storage will be able to participate in the capacity market
- As energy storage costs continue to fall, future cost curves will drive the level of market penetration

Thank you