Canadian Energy Storage Study

Market opportunity, technical analysis and socio-economic assessments of grid-scale energy storage in Canada

"Overview"

September 29, 2020

National Research Council Canada
Conseil national de recherches Canada
Canada



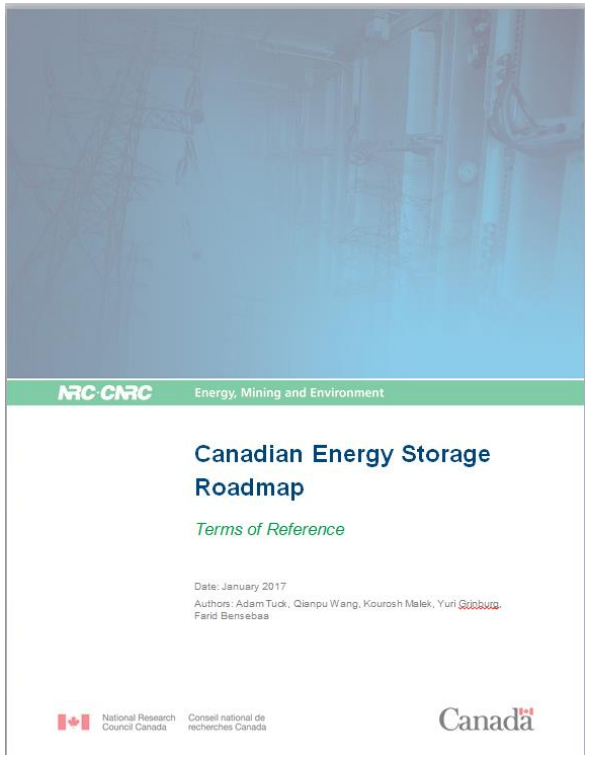
Helps advance the Canadian energy storage sector by working on leading edge research and managing the technical risks inherent in the development and adoption of new technology.

National Research Council Canada

Canadian ES Roadmap Project

A holistic approach to develop a multi-year (2016-2030) energy storage (ES) comprehensive study for Canada

- co-funded between **NRC and NRCan** Energy Innovation Program
- Objectives:
  - To understand grid energy storage system needs in each jurisdiction in Canada
  - To assess technical and market readiness by jurisdiction
  - To evaluate economic and environmental impacts of energy storage system implementation
  - **IN SCOPE: 13.8kV and above (bulk, sub-station, commercial/industrial system)**
  - **OUT OF SCOPE: 13.8kV and below (residential/small commercial)**



Canadian energy storage roadmap: terms of reference
https://doi.org/10.4224/23001380

Canadian energy storage report: 2017 case study for the Alberta market
https://doi.org/10.4224/40001909

Canadian energy storage report: 2019 case study for the Ontario market
Oct. 2020

Canadian energy storage report: Market opportunity assessment in Atlantic Canada
Jan. 2021

Canadian ES Study - Scope

Pillar 1 - Grid Needs and ES Market Opportunity

- Identify ES use cases
- Define specific application requirements
- Identify the impacts on grid power planning and operations
- Review the current market structure

Pillar 2 - Technology Assessment and Valuation

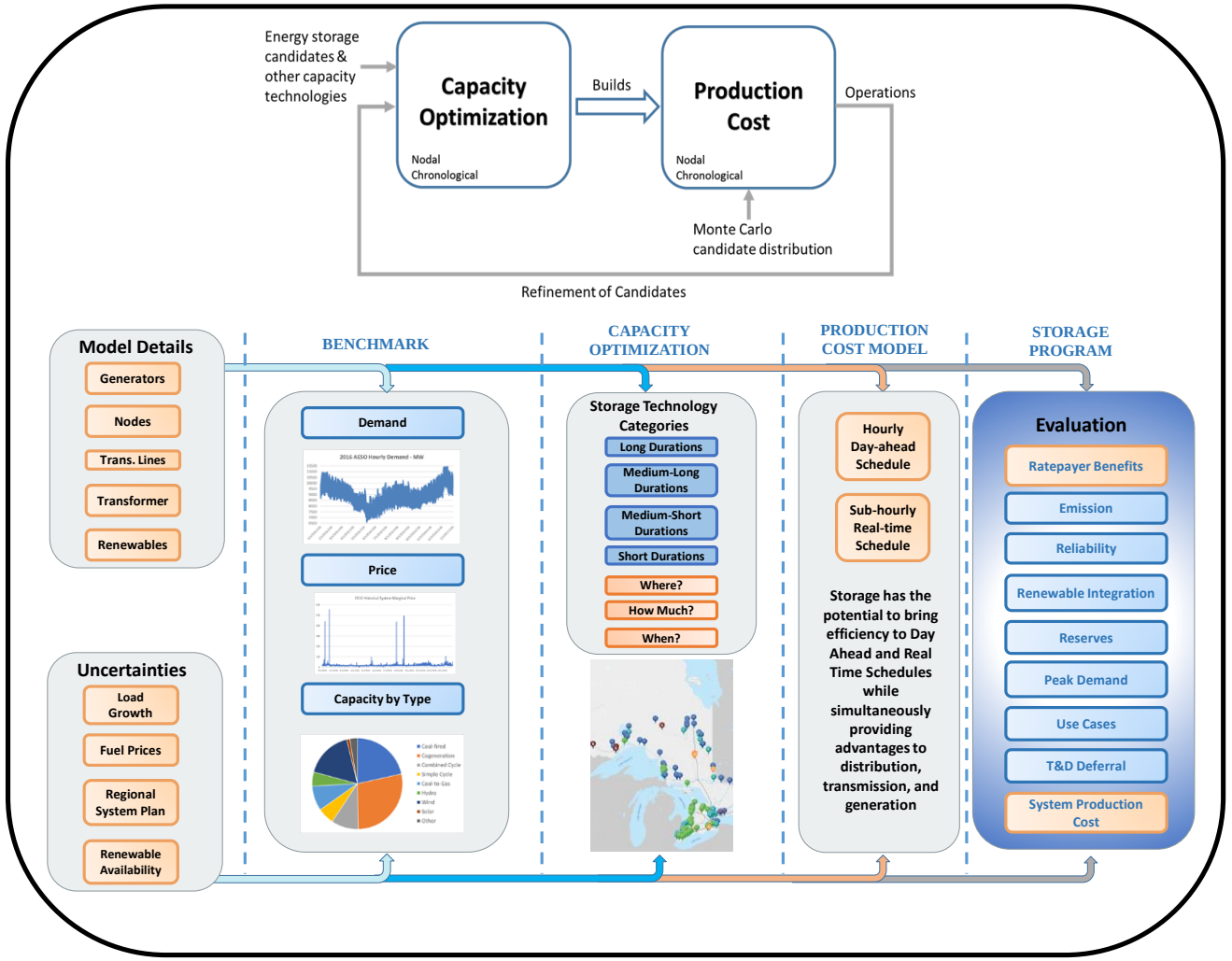
- Assess ES Technologies and trends
- Match technology and application requirements
- Propose valuation and performance frameworks
- Evaluate individual ES profitability and dispatch on the electricity grid

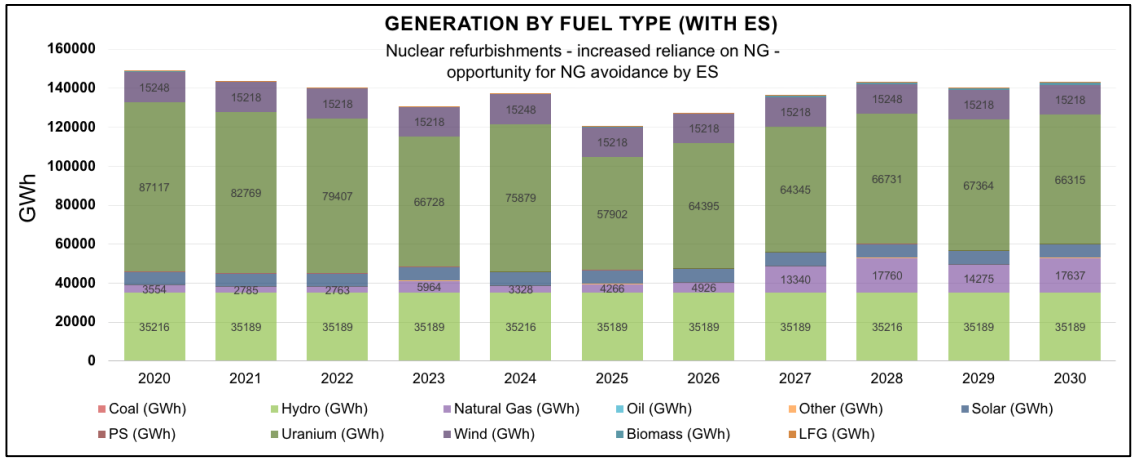
Pillar 3 - Environmental and Socio Economic Assessment

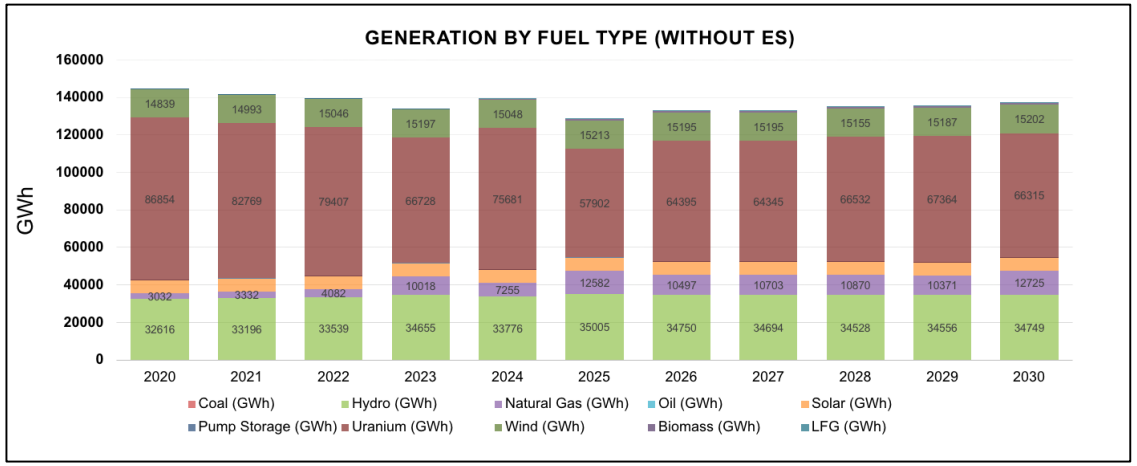
- Assess environmental and socio-economic metrics
- Assess GHG emissions at the grid level
- Compare life cycle GHG emissions of ES technologies

Pillar 1: Market Opportunity

Two-step recursive optimization







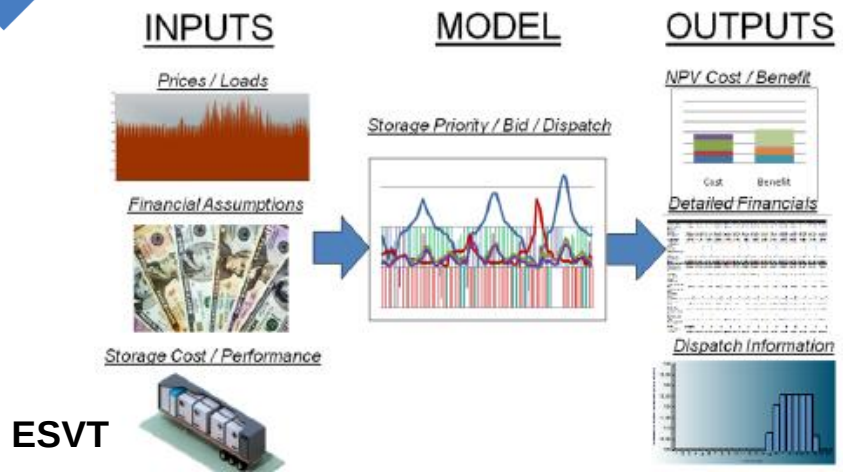
Pillar 2: Base Case + Global Adjustment (GA)

ES tech. screening and Cost-Benefit analysis

Inputs
- Use Pillar 1 inputs: Escalation of benefits, discount rate, electricity price escalation, average cost of electricity with ES, project life, inflation rate

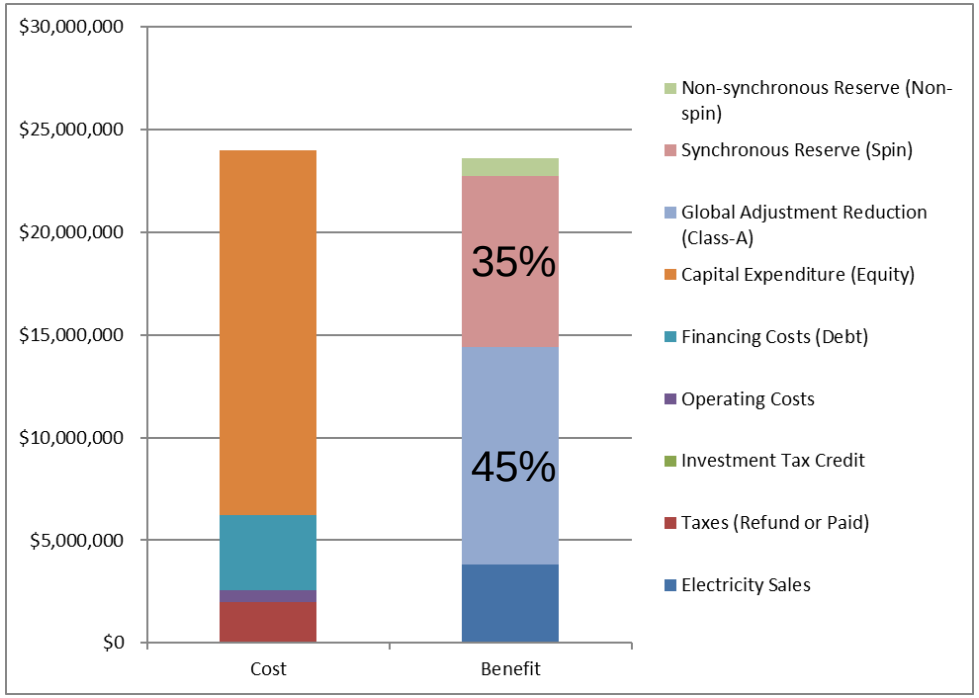
Stage 1
- Rank ES technology classes on a level playing field
- Pick top ES technologies that align with Pillar 1 results

Stage 2
- Detailed analysis at hourly resolution of specific project examples of top ES technologies from Stage 1
- Repeat that analysis across Use Cases



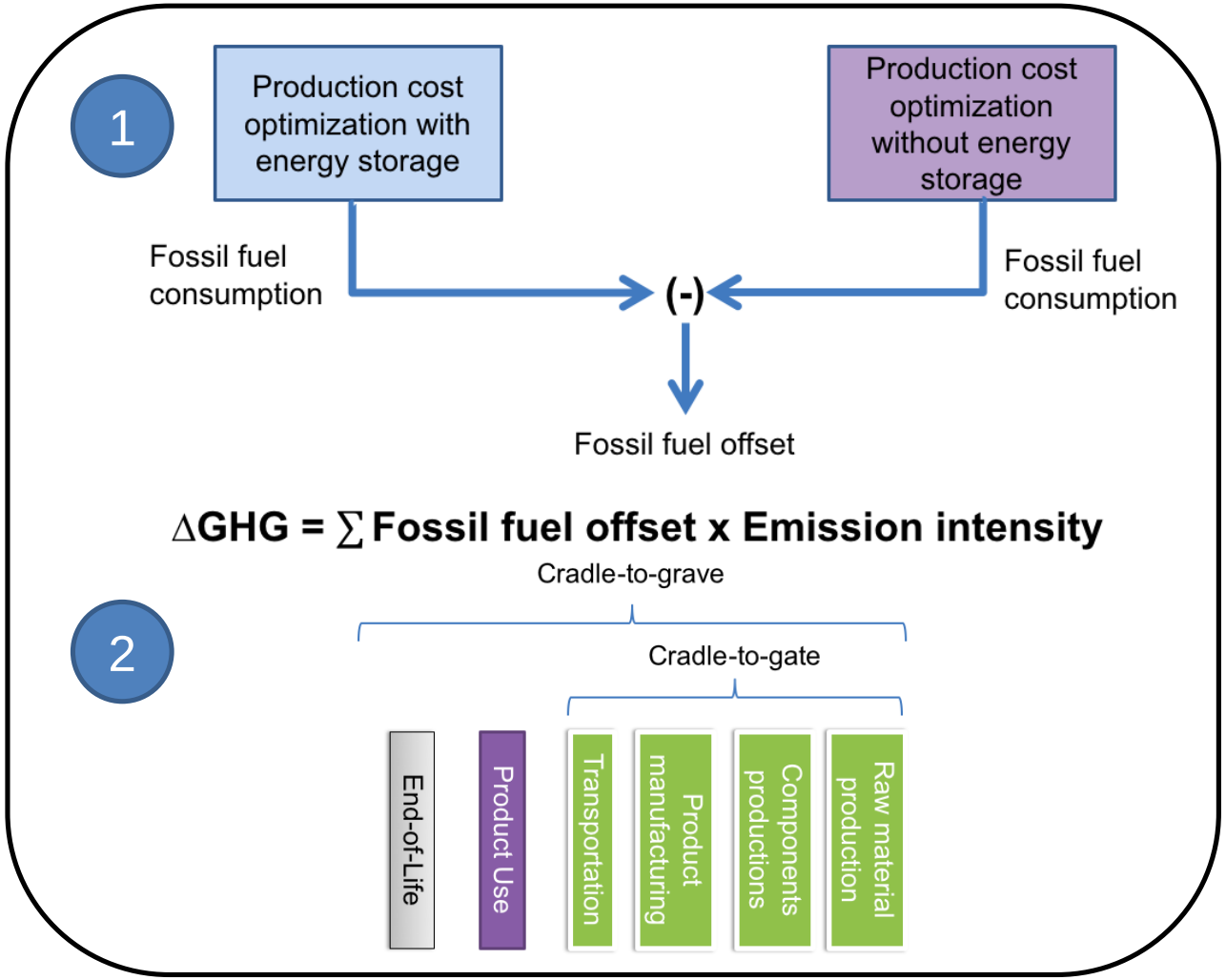
IPP-owned 10MW 2Hr LiB (15 yrs)

- Base case: B/C=0.61
- Global Adjustment largest contributor to the benefits
- **Break-even point by GA: B/C=0.98**
- Demand Response Reduction / Capacity Auction: B/C= 0.59-0.63



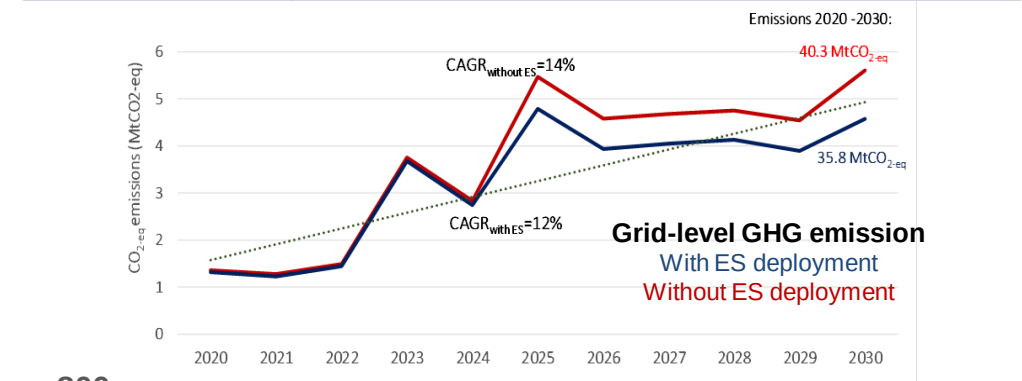
Pillar 3: Socio-economic Impact

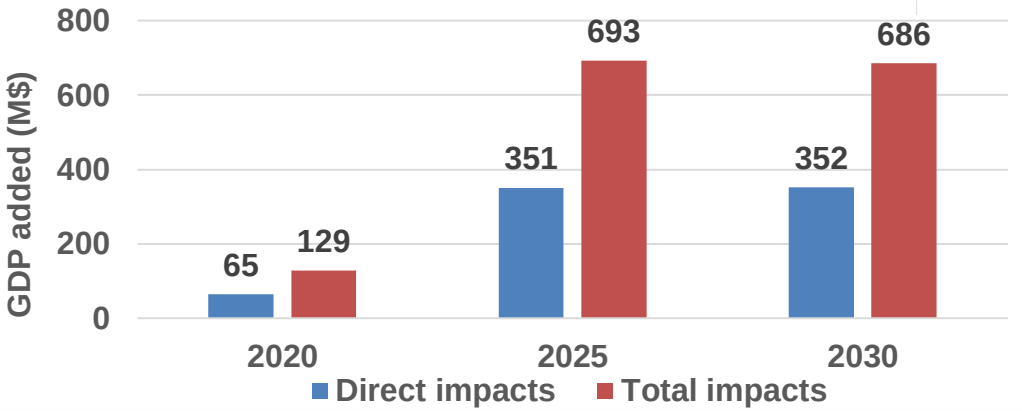
GHG emission and GDP



Grid-level GHG – LiB & RFBs

- GHG emissions reductions due to storage operation
- Nuclear **refurbishments** lead to increased reliance on NG, and **opportunities** for NG avoidance by ES
- **Reduce grid-level CO2-eq emissions by 11%** by 2030
- Total direct impact on **GDP** is at **768 $M** by 2030





Ontario Chapter – Key Findings

Key Findings in Pillar 1

- A **base-case** scenario, a **low-case** scenario, and a **high-case** scenario, each analyzed against a "**business-as-usual**" scenario in which ES was not built in the Ontario footprint.
  - Low Case - **745 MW** built resulting in **$50** million of gross lifetime benefits
  - Base Case – **2,636 MW** built resulting in **$200** million of gross lifetime benefits
  - High Case – **5,743 MW** built resulting in **$900** million of gross lifetime benefits
- The sensitivity analysis: **ES technology cost** impacts the amount of ES built.

Key Findings in Pillar 2

- First stage: from 19 generic ES technology classes simulated, greatest potential profit for **CAES-c, NaS, Li-ion**
- Second stage: down to a specific example of a **15** year **10MW** 2Hr **Li ion** battery simulated in three Use Cases
- Benefit-to-cost ratios **0.6** - **0.98**
- These results are likely a lower bound due to **current market participation** restrictions, **existing market** products

Key Findings in Pillar 3

- Energy storage deployment is estimated to increase Ontario's GDP by **$768M** and add **5,781** jobs.
- ES deployment would provide the incremental environmental benefit of reducing GHG emissions from the Ontario electricity system by **11%** by **2030** (a reduction of 4.5 $MtCO_{2\text{-eq}}$).
- GHG life cycle impacts of **Li-ion and VRF** battery systems are mostly due to the emissions during **manufacturing** (cradle-to-gate stage) of ES system components, specifically the battery pack and electrolyte production

THANK YOU

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