Evaluating Sustainable Design Alternatives in the Nuclear Industry

Ontario Association for Impact Assessment

October 2022

Challenge

- Satisfy Canada's *Greening Government Strategy*
- Increase certainty around Factors to be Considered in an Impact Assessment (under the modernized *Impact Assessment Act*)

Challenge

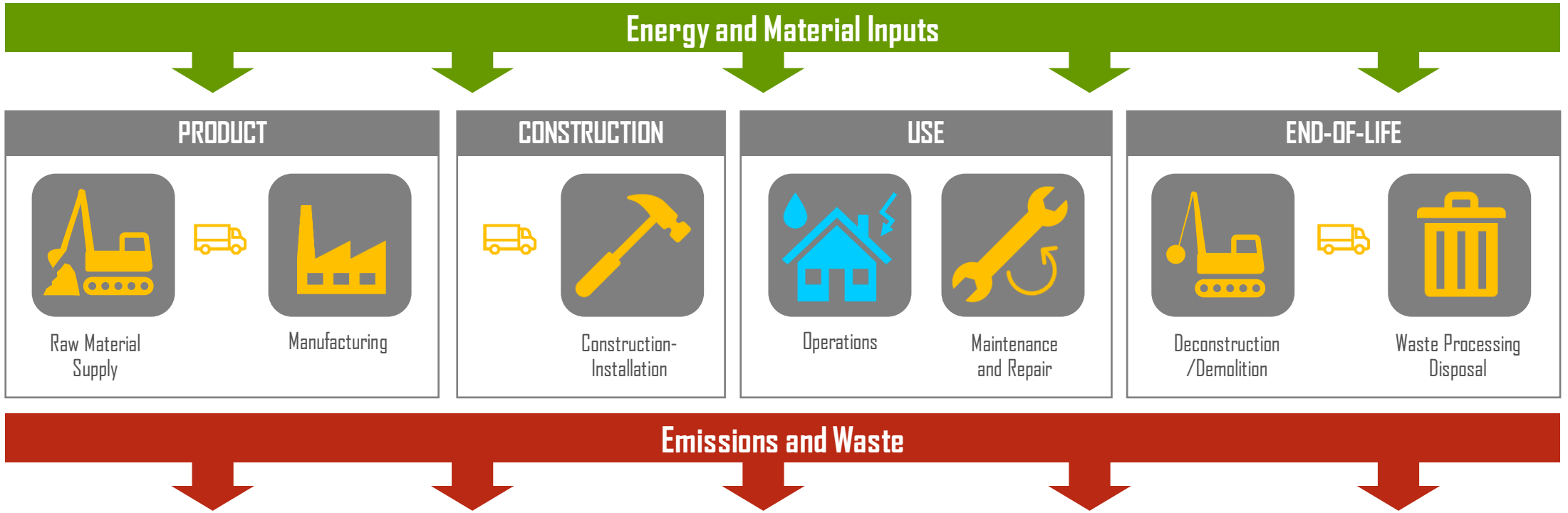
Adaptation
&
Mitigation

- What do we need to consider?
- How do we measure it?
- When to consider it?
- How do we tailor our analysis to consider the stage of design?

HATCH

Life Cycle Thinking

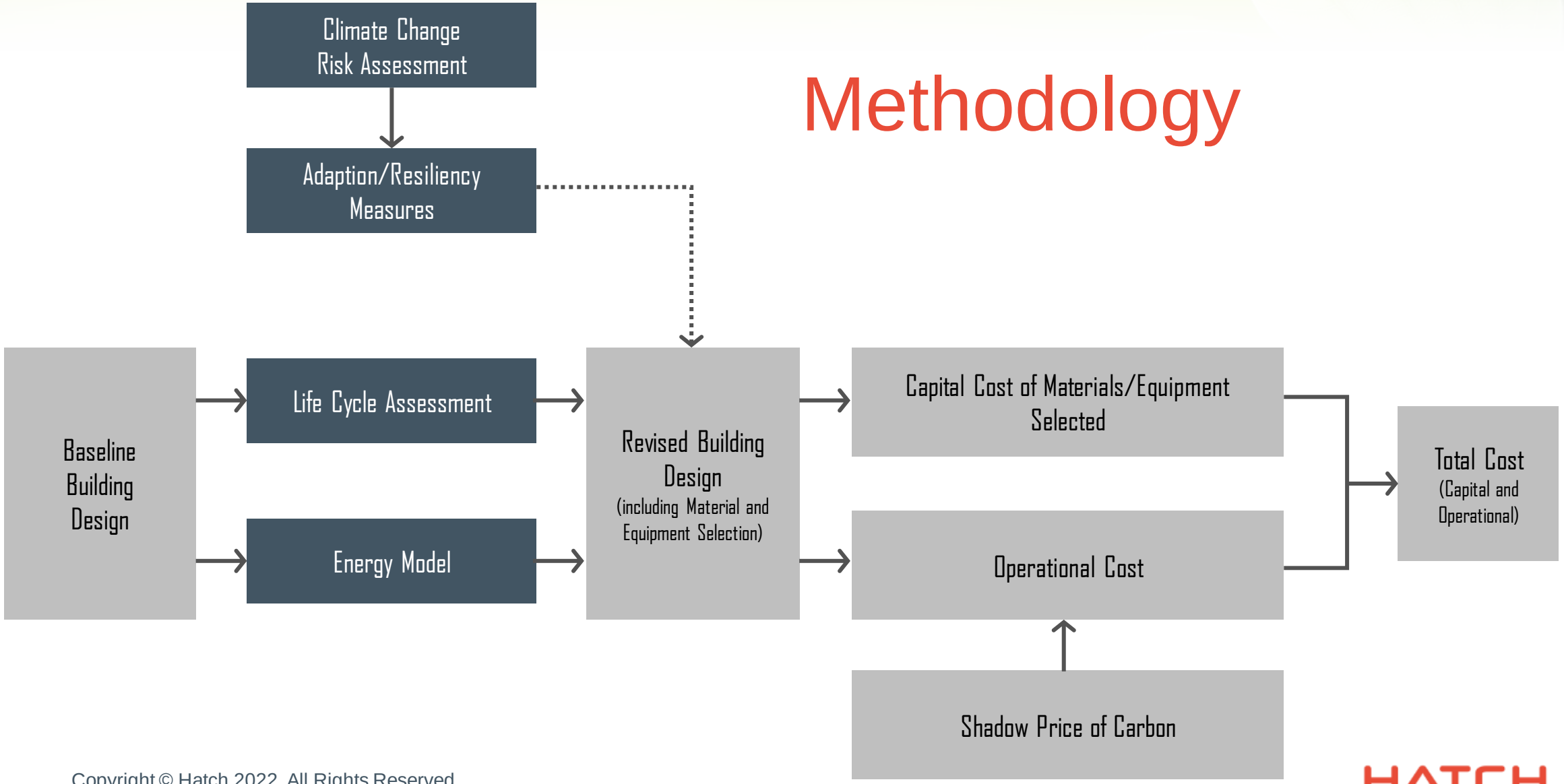
A framework that aims at accounting the impacts throughout the entire life cycle.



- Embodied Carbon (Life Cycle Assessment)
- Operational Carbon (Energy Modelling)

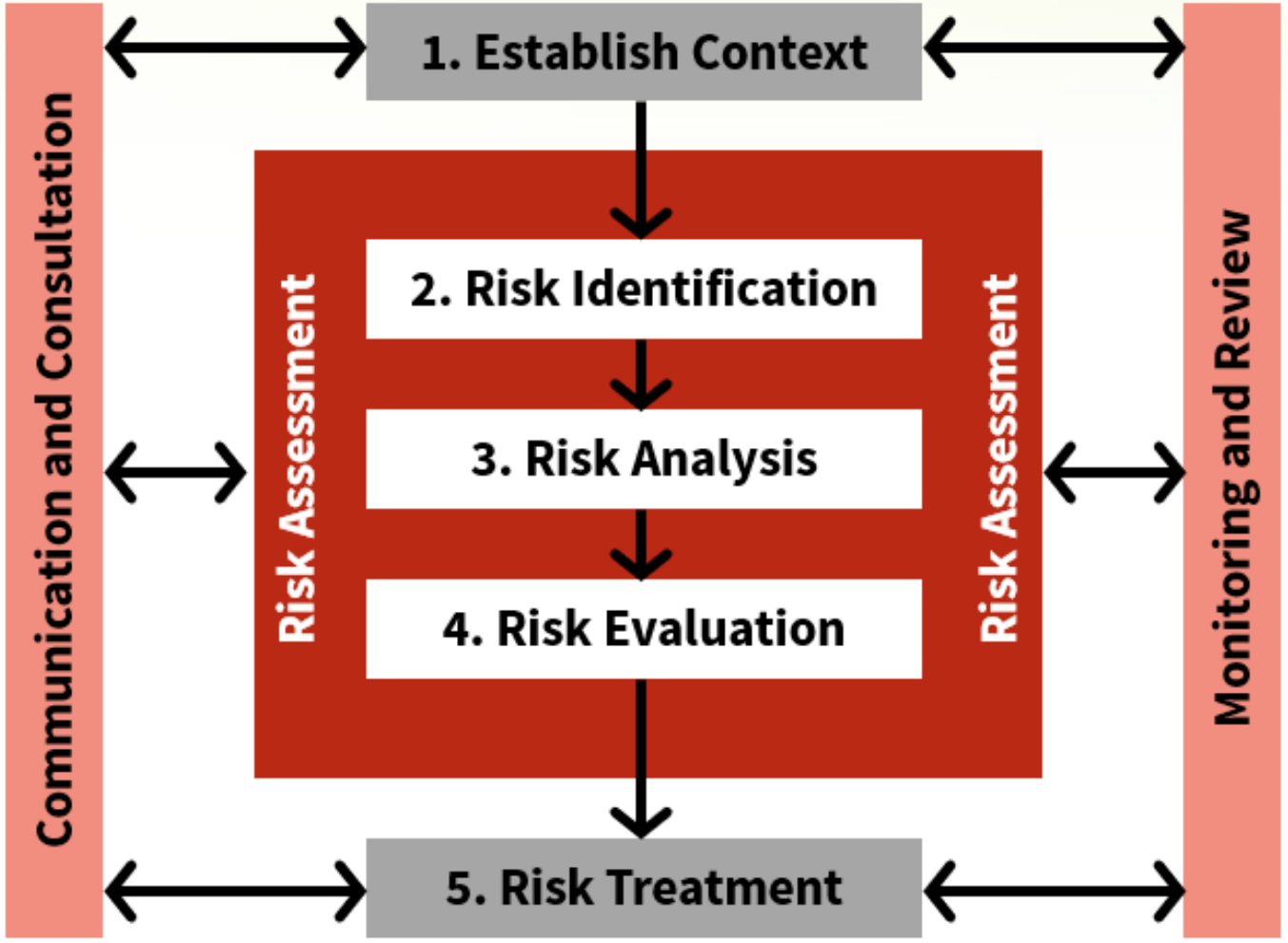
HATCH

Methodology



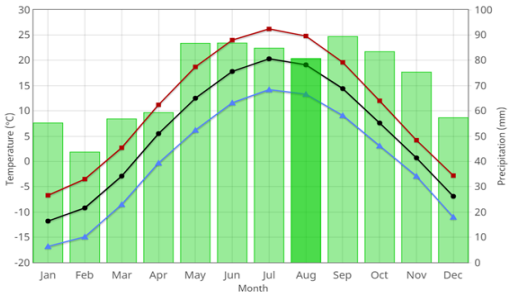
HATCH

Climate Change Risk Assessment



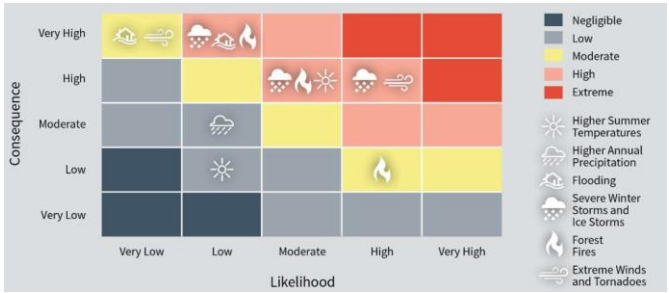
HATCH

Climate Change Risk Assessment



Establish context

- Review all relevant available climate datasets to characterize the baseline and future climate.
- Emphasis on climate variables contained within the National Building Code



Risk Assessment

- Identify, analyze and evaluate the risks
- Interactions between climate variables and infrastructure components.
- Assess likelihood and severity of predicted impacts.

Risk Treatment

- Identification and assessment of potential adaptation measures

HATCH

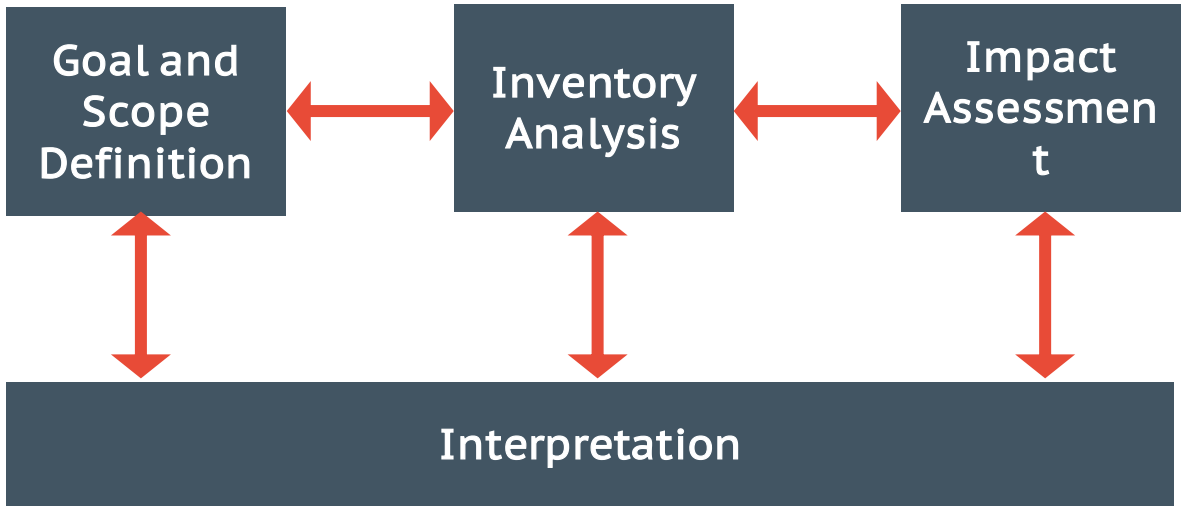
Risk Treatment Opportunities

Climate Parameter	Identified Risk	Possible Adaptation Measures
Extreme Winter/Ice Storms	Damage to roof	Sloped roof to reduce snow loads
Forest Fires	Damage to building and health	Restoration of wetlands in surrounding areas
Higher Summer Temperatures	Increase demand for cooling	Vegetated/cool roof (if feasible) and reduction of solar glare through windows
Flooding	Failure of roof drainage system and flooding within building	Position and elevation of building

HATCH

Life Cycle Assessment

- Methodology to evaluate environmental impacts over the entire life cycle
- ISO Standards
  - ISO 14040 Principles and Framework
  - ISO 14044 Requirements and Guidelines



Life cycle assessment framework based on ISO 14044

HATCH

Life Cycle Assessment

Goal and Scope definition

- Quantify embodied carbon emissions through the entire life cycle
- Including all envelope and structural elements
- 50 years lifetime

Element	Materials	QTY (kg)	Sourcing	Transport
Foundation	Concrete, 35 Mpa	400,032	40 km	lorry >32t
Walls	Autoclaved aerated concrete block	445	183 km	lorry>32t
	Roll formed steel cladding	12,087	550 km	lorry 16-32t
Columns	Concrete, 35 Mpa	131,399	40 km	lorry >32t
	Hot-Rolled Structural Sections	239,507	480 km	lorry >32t
Walls	Gypsum Board	53,881	183 km	lorry 16-32t
	Curtain wall	118,980	480 km	lorry >32t
Floors	Concrete, 35 Mpa	5,361,841	40 km	lorry >32t
Footings	Concrete, 35 Mpa	1,217,574	40 km	lorry >32t
Roofs	Concrete, 35 Mpa	1,436,504	40 km	lorry >32t

Inventory Analysis

- Estimate of material quantities, including replacement, based on Material take offs (MTO)
- Sourcing of materials
- End of Life assumptions

Impact Assessment

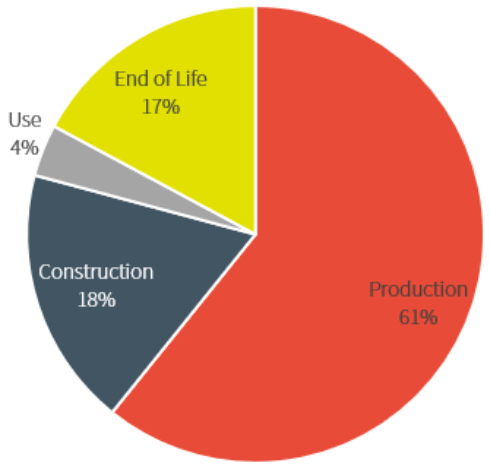
- Estimate of environmental impacts for each materials and processes
- LCI Databases / LCA Tool

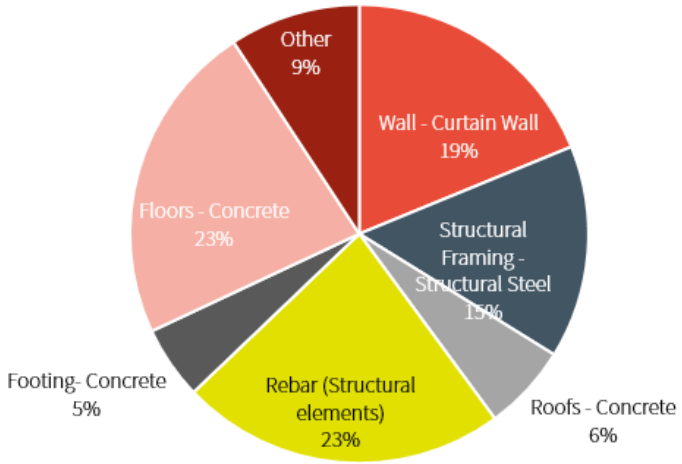
HATCH

Life Cycle Assessment Interpretation

Contribution Analysis

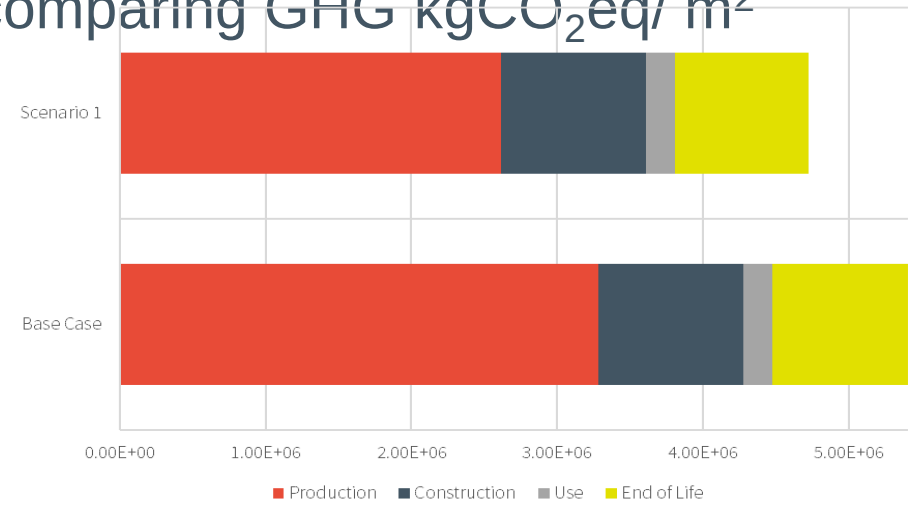
- Life Cycle Stages
- Material





Scenario Analysis

- Replacement of materials to consider a mass timber structure (12.6% reduction)
- Evaluation of alternative by comparing GHG $kgCO_2eq/ m^2$



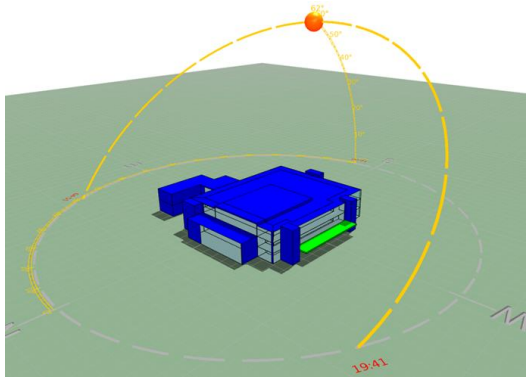
HATCH

Energy Modelling Process

Building design and functionality used to develop baseline EM

Alternative identification based on design stages, including:

- *Structural/Siting Modelling*
  - *Building geometry and orientation*
  - *Window-to-wall ratio*
  - *Thermal performance of the envelope and structure*
- *Heating & Cooling (HVAC) Systems Modelling*
- *Usage Modelling*
  - *Lighting & energy use controls*
  - *Service water heating systems*



Evaluate alternatives

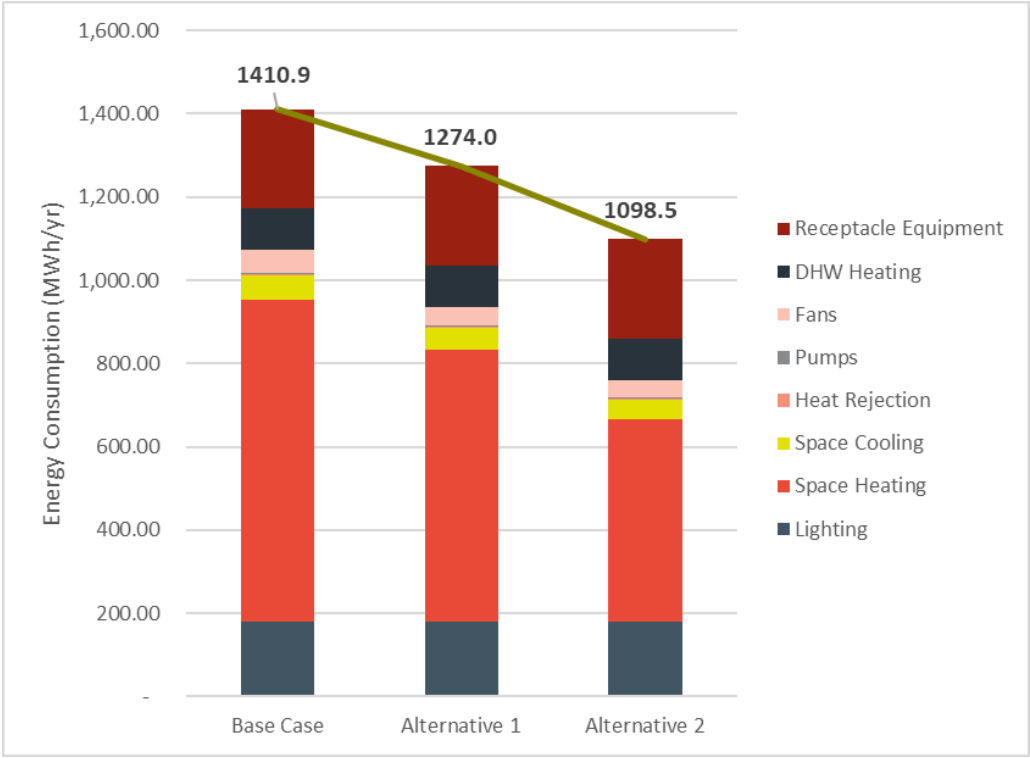
Standards and guidelines include:

- *National Energy Code of Canada*
- *ASHRAE Standard 209-2018 Energy Simulated Aided Design for Buildings Except Low-Rise Residential Buildings*
- *Canada Green Building Council Zero Carbon Building Standards*

HATCH

Evaluation of Alternatives

- Comparison of Alternatives to Consider:
  - Energy Model outputs, including:
    - Thermal Energy Demand Intensity (TEDI)
    - Total Energy Use Intensity (TEUI)
    - Greenhouse Gas Intensity (GHGI)
  - Client Preferences
  - Maintainability
  - Costs, including:
    - CAPEX & Future Maintenance
    - Energy Costs
    - Shadow Price of Carbon

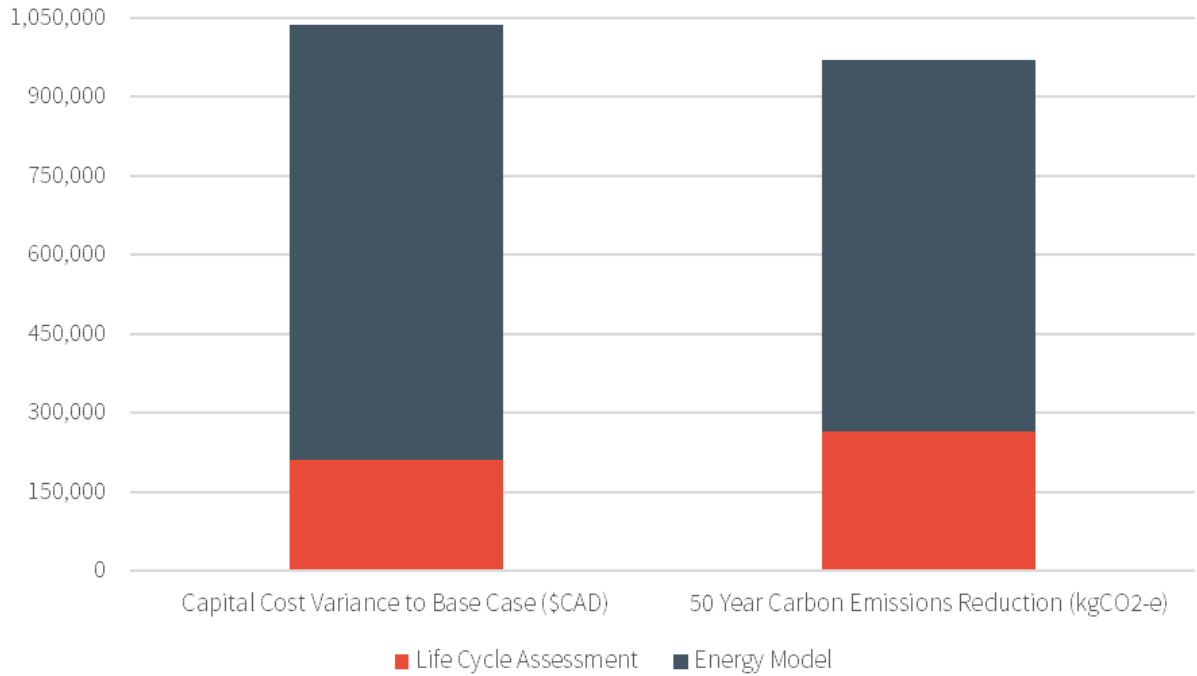


Energy Consumers

HATCH

Mitigation Summary

- Some recommended design changes based on Life Cycle Assessment and Energy Model Results:
  - Increased R-value of insultation
  - Utilization of triple-glazed windows
  - Concrete specifications (Portland Limestone Cement vs Portland cement)
  - Exterior Siding materials (Steel vs Aluminum)
  - Window frame material (Aluminum vs Plastic)
- Identified required steps for future net zero transition.



HATCH

Conclusions

- Early involvement in the design process is beneficial to permit maximum influence of sustainability features in the design, though involvement in any stage is possible.
- Adaptation and Mitigation must be considered concurrently, with inputs from design team, sustainability practitioners, and owner, to ensure that recommendations are feasible and practical.
- Quantifying the effect of design changes (which may be generally accepted as improvements in a qualitative manner) allows for clear demonstration of cost- and impact-benefit over the life of a project and can increase certainty in the Impact Assessment process.

HATCH

Thank you

For more information,
please visit www.hatch.com

Kathleen Vukovics
Ontario Regional Director,
Environmental Services
Email: kathleen.vukovics@hatch.com

Mimi Ginger Wilde, P. Eng.
Senior Engineer, Nuclear
Email: mimi.wilde@hatch.com

Catalina Gonzalez, P. Eng.
Environmental Specialist
Email: gonzalezc@hatch.com