

Appendix B: LCCA

The LCCA is a tool to compare several scenarios (options) over 40 years. It is a way to find the best balance between the capital value, the GHG emissions and the operating costs. There are numerous costs associated with acquiring, operating, and maintaining a building or building system. Building-related costs usually fall into the following categories:

- Initial Costs - Purchase, Acquisition, Construction Costs
- Energy Costs and other operating costs over 40 years
- Costs for equipment that has to be replaced with the 40-year life-cycle
- Residual Values - Resale or Salvage Values or Disposal Costs
- Finance Charges - (e.g., contract costs for ESPCs)
- Non-Monetary Benefits or Costs

It also includes a shadow carbon price of \$300 per tons equivalent CO₂ over 40 years.

The goal consists in setting 4 scenarios and calculate their LCCA value:

- Baseline
- Neutral
- Maximum
- Optimized (also called Hybrid)

Baseline: This scenario is calculated, based on retrofitting to 25% better than NBCC 2020 energy targets requirements. The baseline cannot be considered for construction phase.

Neutral cost: This scenario should be determined thanks to an iterative process by modifying the Baseline with a bundle of practically applicable ECMs (Energy Conservation Measures). It should achieve GHG emissions reductions but without any NPV (Net Present Value) variation compared to the Baseline:

$$NPV = \$LCCA40(Neutral) - \$LCCA40(Baseline) = \$0$$

Maximum: The scenario aims at achieving the maximum of GHG emissions reduction compared to the Baseline. It is based on the Baseline and a bundle of the most GHG reduction efficient ECMs that can be practically implemented for the retrofit. The NPV is not a priority for this scenario:

$$NPV = \$LCCA40(Maximum) - \$LCCA40(Baseline)$$

Optimized: It is an iterative calculation. In this scenario, you are supposed to implement the most cost vs. GHG-reduction efficiency ECMs. It is based on the Baseline and a bundle of the most cost vs. GHG-reduction efficient ECMs (\$/ton reduced). The NPV should be optimized.

$$NPV = \$LCCA40(Optimized) - \$LCCA40(Baseline)$$

The LCCA40 calculation includes several factors to be included into the 40 years calculation:

- The \$300 Carbon shadow price will remain constant over 40 years
- The inflation rate will vary over 40 years.
- The escalation rate will vary over 40 years.

- The discount rate will vary over 40 years.
- The GHG emissions factors excepted, for electricity, will remain constant over 40 years.
- The GHG emissions factor for electricity will vary over 40 years.

The factors and rates values and forecast will be provided by Parks Canada representative. If the scope of the forecast does not cover the whole 40 years of calculation, it will be assumed the missing factors and rates will remain constant, based on the last known value.

All GHG calculations should be based on the National Inventory Report 1990-2019: Green House Gas and Sinks in Canada (ECCC, 2021)

The LCCA report should include a table comparing the NPV value with comment:

Scenario	1: Baseline Costing	2: Cost Neutral GHG Reduction (over 40 years inc. carbon price)	3: Maximum GHG Reduction	4: Optimized GHG Reduction
<i>Recommended Option</i>	N	(Y/N)	(Y/N)	(Y/N)
<i>Modelled TEDI</i>				
<i>Annual GHG Emissions</i>				
<i>Capital Cost</i>				
<i>Energy Costs</i>				
<i>40 Year Life-cycle cost</i>				
<i>Incremental NPV compared to baseline</i>	N/A			
<i>Percentage increase in Life-cycle Cost</i>	N/A			
<i>Advantages</i>				
<i>Disadvantages</i>				

1.1.1.1 ECMs:

To set the different scenarios, ECMs should be determined.

Each measure is defined by:

- Its class D or C cost estimate (including the removal cost of existing assemblies)
- Its GHG emissions reduction impact
- Its efficiency rate GHG emission reduction vs cost estimate (GH)

There are two kinds of measures:

- Building envelope improvement (Wall assembly)

- Offsetting measure (PV array for example). Offsetting measures cannot be considered for Scenario 2.

1.1.1.2 Modelling:

To carry out the LCCA calculations, the consultant will have to make an energy modelling of each building, using an ASHRAE 140 certified software. The goal is to identify the operating costs of the building thanks to the energy breakdown.

First, the consultant will set the modelling of the baseline. Based on that, the next 3 scenarios should be calculated, by adding a bundle ECMs.

As outcomes and for each scenario, the consultant will release:

TEDI	kWh/m ² /yr
MEUI	kWh/m ² /yr
TEUI	kWh/m ² /yr
GHGI	tonséq.CO ₂ /yr
Energy breakdown	See the next table

Energy Breakdown table:

Loads breakdown	Scenario Name	
	kWh consumption	Energy source
Heating		
Cooling		
DWH		
Indoor lighting		
Outdoor lighting if available		
Fans		
Pumps		
Plug loads		
Other loads		
TOTAL kWh		

To calculate the operating cost related to energy, Parks Canada representative will provide the average energy rate over 40 years.

1.1.2 Deliverable

The consultant will have to provide a report including:

- A baseline design of the buildings, based on the NBCC or NECB energy requirements (In your case, it is NBCC Part 9 section 36).
- ECMs description to setup the 3 other scenarios, including the description, the class D or C cost estimate (excluding removal), the GHG reduction and the efficiency ratio (GHG reduction per dollar spent). All the ECMs should be listed in a table including the previous description and sorted as:
 - Building improvement
 - Wall assemblies
 - Slab assemblies
 - Roof assemblies
 - Other building part assemblies
 - Openings (Glazing, windows, doors..., SHGC, Uw...)
 - Envelope airtightness
 - Cooling system efficiency
 - Heating system efficiency
 - DWH
 - Lighting efficiency and control
 - BAS
 - Offsetting measures
- A table that compares the NPV of the different scenarios.
- A cost estimate class D or C (including removal of existing assemblies) report of the ECMs with assumption and methodology
- A comprehensive cost estimate class C of the selected scenario including the removal costs.
- Financial or/and technical justifications if Netzero could not be reached.

Guidelines and directives

- The Greening Government Strategy
- Treasury Board - Real Property Guidance
- Treasury Board - Real Property GHG Life-Cycle Cost Analysis (GHG LCCA) Guidance
- PSPC - GHG Options Analysis Methodology – Feb 10th 2022
- National Inventory Report 1990-2019 : Green House Gas and Sinks in Canada (ECCC, 2021)
- PSPC/ECCC Emission Factor Projections from 2020 to 2040