Peel Region

NET ZERO EMISSIONS BUILDING RETROFIT STANDARD

1 A New Corporate Building Retrofit Standard for Peel

1.1 Background

In 2019, Peel Region declared a climate emergency and approved their 2020-2030 *Climate Change Master Plan* (CCMP). The plan outlines their commitments to reduce corporate *greenhouse gas* (GHG) emissions to 45% below 2010 levels by 2030 and to better prepare services, operations, and infrastructure to handle the impact of increased extreme weather.

As buildings represent about 40% of Peel Region's corporate emissions, Peel committed to develop a 'Corporate Net Zero Emissions (NZE) Retrofit Building Standard' for their existing regional buildings and facilities. Such a standard would be the first of its kind for Existing Buildings.

Peel Region recognizes that the implementation of such a standard is fundamental to meeting the current interim corporate emissions reduction target of 45% by 2030 and the longer-term ambition of achieving net zero emissions, as well as to demonstrating leadership in climate action commensurate with the Region's declaration of a climate emergency. The standard also represents an important opportunity to increase the Region's safety and resilience in the face of climate change, reduce operational and maintenance costs, increase staff and occupant health and wellbeing, and support the economic growth of the region.

The NZE Building Retrofit Standard, hereafter referred to as 'the Standard', sets out requirements to ensure all retrofits of regional buildings and facilities align with a transition to achieve net zero carbon emissions and follow a "Standardized" approach.

Table 1: Federal, Provincial and Regional Climate Change Targets

	Climate Change Target
Government of Canada	• 17% reduction in GHG emissions below 2005 levels by 2020 • 30% reduction in GHG emissions below 2005 levels by 2030
Province of Ontario	• 30% reduction in GHG emissions below 2005 levels by 2030
Peel Region	• 45% reduction in GHG emissions below 2010 levels by 2030 • 80% reduction in GHG emissions by 2050

1.2 Developing the Standard

The development of the Standard was led by a consultant team and Peel's *Office for Climate Change and Energy Management* (OCCEM) with input from a Corporate NZE Building Retrofit

Standard Working Group and direction and final decision-making provided by a Steering Committee. Working Group members included staff from across multiple regional departments such as Public Works, Regional Housing, Peel Housing Corporation, Long-term Care, Paramedics and Real Property Asset Management. Steering Group members represented senior leadership within Peel Region.

In alignment with Peel Region's Net Zero Emissions New Construction Standard, the following key principles were identified as appropriate to guide the development of this standard:

1. **Emission Reductions:** Ensure GHG emission reductions are achieved. A clear priority for Peel Region is to achieve reductions of 45% by 2030 relative to 2010 levels and set the buildings on a path t o carbon neutrality by 2050.
2. **Feasibility:** Consider the business case and the cost of complying with the standard. This includes lifetime costs through construction, operation, and maintenance, as well as co-benefits and their public value.
3. **Resilience:** Support the development of a safe, secure, and connected community, one that is resilient to extreme weather events, is resource efficient and has increased energy security.
4. **Social Equity:** Explore opportunities to incorporate social and equity metrics in support of vulnerable people. This includes affordable housing, reduced chronic homelessness, and enhanced support and services for seniors, including long-term care facilities.
5. **Economic Prosperity:** Explore opportunities to enhance support and services for employment and provide employment opportunities. This can in turn address the inability to afford the cost of living and promote regional economic prosperity.
6. **Relevance:** Address the most common building archetypes in the Region's diverse portfolio for the largest reach. It should also consider recent case studies, the impacts of COVID-19 and recent supply chain issues.
7. **Implementation:** Provide a framework that is easily understood and actionable, rather than just providing aspirational targets.
8. **Alignment:** Integrate with the Region's governance structure and existing processes for the project selection, design, and construction of public buildings. It must also align with existing and upcoming policies and legislation.
9. **Transparency:** Ensure transparency and accountability to increase public trust and quality. This will include the monitoring and verification of building performance in use to ensure buildings perform at the levels specified through the design process.

For more details on the analysis completed during the development of the Standard, refer to Peel Region's Building Retrofit Report.

1.3 Applying the Standard

The NZE Building Retrofit Standard applies to all existing regional buildings and facilities that are scheduled for retrofit interventions. Note, all regional buildings and facilities scheduled for a major renovation would fall under the NZE New Construction Standard as outlined in Figure 1.

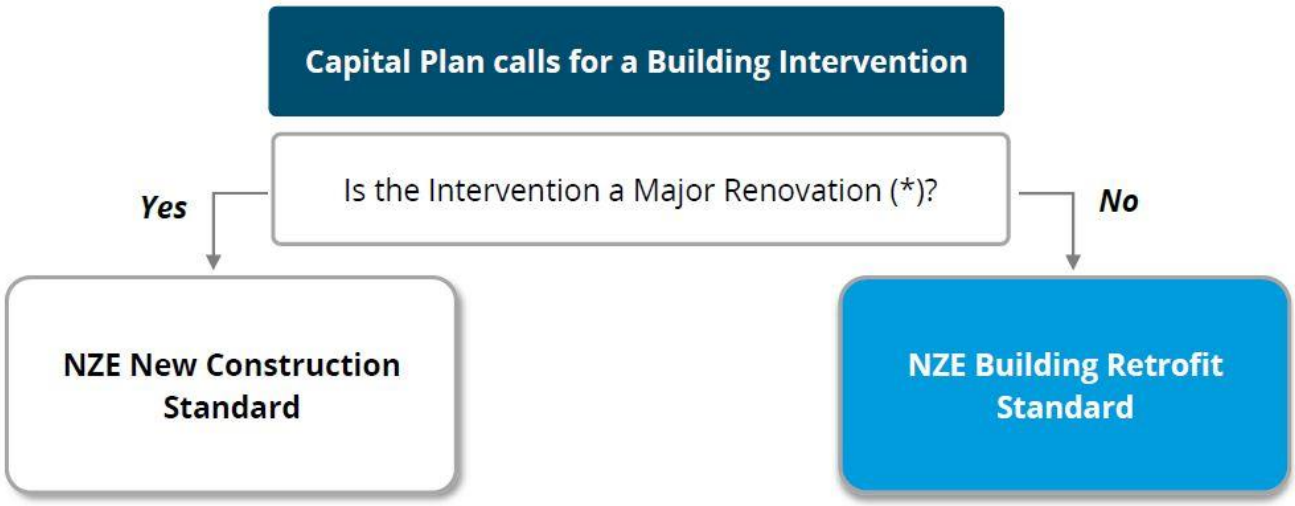


Figure 1: Applying the Standards

(*) Major renovation *refers to any HVAC&R, envelope, and/or interior renovations that require a new certificate of occupancy and/or prevent normal building operations from occurring while they are in process. Proposed changes of use to the building are also considered major renovations.*

2 Requirements for Building Retrofits

2.1 Overview and Structure

The goal of the NZE Retrofit Building Standard is to help transition Peel's existing building portfolio to Net Zero Emissions in a consistent and streamlined manner that balances carbon performance and cost efficiency.

Under this premise, the structure of the Standard was developed to meet the following objectives:

1. To develop default NZE retrofit solutions to streamline the most common interventions. These correspond to the five core archetypes identified, under typical building conditions (Compliance Path 1): Multi-Unit Residential Buildings, Townhouses, Police Stations/Offices, Paramedic Stations and Light Industrial Buildings.
2. To provide design teams with the flexibility to identify and select an alternative solution that provides superior financial and/or emission reduction performance compared to the default (Compliance Paths 2 and 4).
3. To define a process that leverages analysis results from previous project experience to reduce analysis required by design teams (Compliance Path 3).
4. To define a consistent methodology for options analysis that can be used to:
    a. Identify the most cost-effective system to fully decarbonize heating and DHW systems for buildings where a default system has not yet been identified. (Compliance Path 5)
    b. Identify the level of efficiency that balances carbon performance and cost efficiency. (Compliance Path 6)

The NZE Building Retrofit Standard is structured into six Compliance Paths as outlined in Figure 2. The structure follows a flow chart, where the first two questions are informed by the project type and identify whether the project can use default solutions via Compliance Path 1 (Prescriptive Default Solutions) or Compliance Path 3 (Decarbonization Database). The Standard structure allows the flexibility to explore an alternative solution than the default solution identified in Compliance Path 1 or 3 that may provide superior financial/GHG performance, via Compliance Path 2 and 4 respectively. The Standard outlines the standardized methodology for completing this analysis to ensure a consistent approach and decision-making process.

The last question in the flowchart identifies whether the project team is exploring interventions related to the heating and/or DHW system or efficiency measures for buildings where there is no default solution. No combustion in heating and DHW systems is a requirement in the standard, therefore, Compliance Path 5 describes the methodology that project teams must use to identify the most cost-effective systems to fully decarbonize

the heating and DHW systems. In contrast, the Standard only requires the implementation of efficiency measures (such as envelope and heat recovery requirements) that meet a minimum performance of cost efficiency. Compliance Path 6 describes the methodology that design teams must use to assess and identify cost-effective energy efficiency measures.

The Standard includes the following Compliance Paths:

- Compliance Path 1 – Prescriptive – Default Solutions
- Compliance Path 2 - Prescriptive - Option Analysis
- Compliance Path 3 – Non-Prescriptive – Decarbonization Database
- Compliance Path 4 – Non-Prescriptive – Options Analysis Reference Project
- Compliance Path 5 – Non-Prescriptive – Options Analysis Heating/DHW
- Compliance Path 6 – Non-Prescriptive – Option Analysis Energy Efficiency

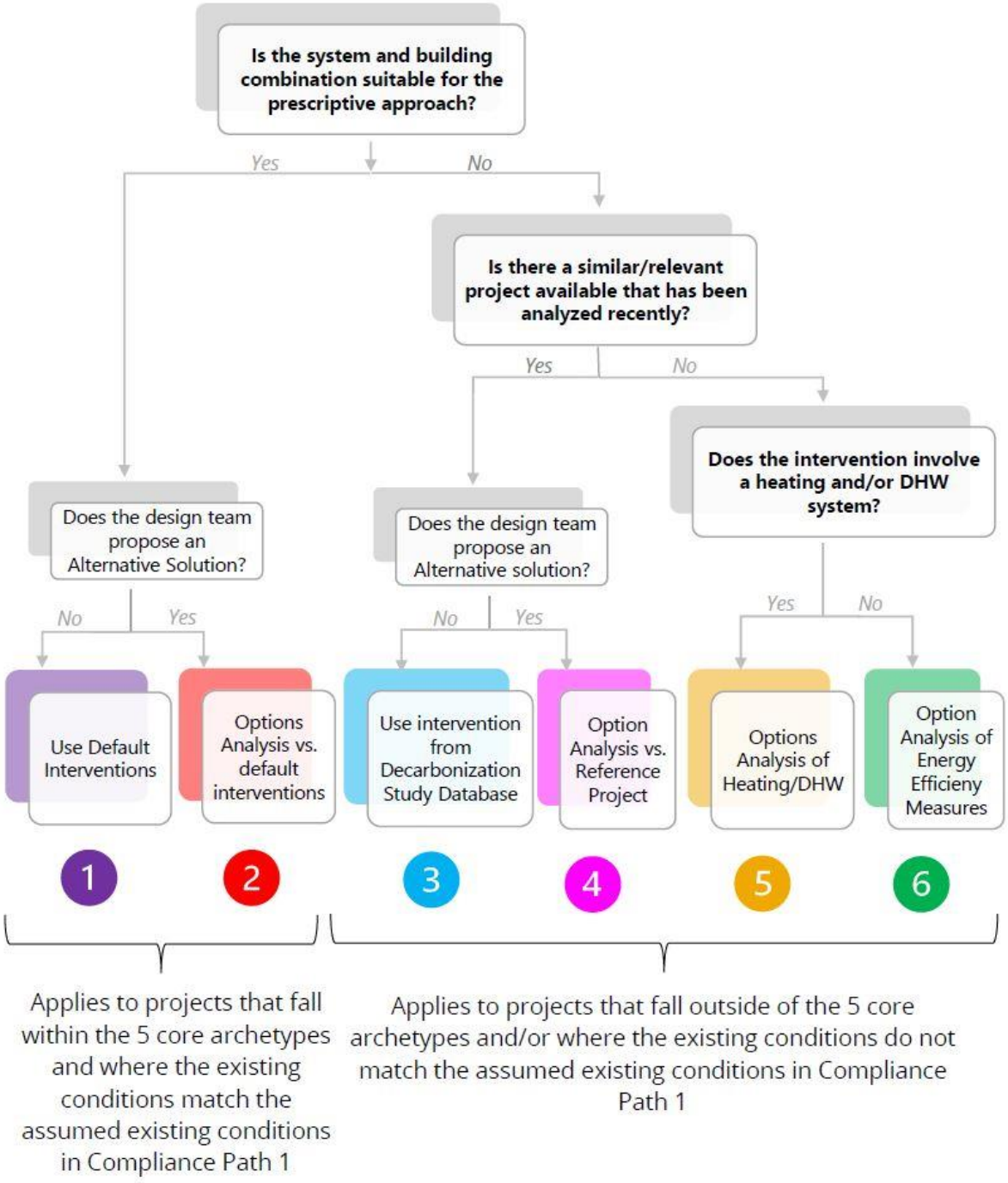


Figure 2: NZE Retrofit Standard Compliance Paths.

The following sections run through each Compliance Path, detailing the intent of the path, when it applies, how to apply it and an example.

2.2 Mandatory Requirements and Additional Considerations

2.2.1 Mandatory Requirements

The following requirements are required to be met by all systems, regardless of the compliance path.

1. Mechanical systems must be sized using future weather design conditions, refer to Table 2, below.

   Table 2: Brampton, Mississauga and Caledon Future Weather Design Values

Brampton	Design Temperature (°C)			
	January (NBCC 2015) (Dry Bulb Temperature)		July 2.5% (GWL_{2001}: 1.5)	
	2.5%	1.0%	Dry	Wet
Brampton	-19	-21	32	25
Mississauga	-18	-20	32	25
Caledon *	-21	-23	31	25

**climatedata.ca and the DVE do not provide future design values for Caledon. The provided future design values are specific for Orangeville, the closest location to Caledon that design values are provided.*

   The above design values have been informed by *climatedata.ca* and the *Pacific Climate Impacts Consortium's Design Value Explorer* (DVE). The following thresholds categorize the design data:

   NBCC 2015 design values as per the National Building Code of Canada 2015

   GWL_{2001}:1.5 is provided for the design of short to medium-term components (e.g. 10 to 30 years, such as HVAC plants, fenestration).

2. HVAC systems must use refrigerants that do not exceed the GWP limits indicated in section 4.2 of the CaGBC Zero Carbon Design Standard[1].

2.2.2 Additional Climate Resilience Considerations

To enhance building resilience against climate-related risks, project teams need to consider climate related hazards including warming climate and extreme heat events, cold snaps, extreme snowfall events, ice storms flooding, wildfires, strong wind events, and droughts, regardless of compliance path. Suggested climate resilience measures that should be considered include, but are not limited to:

[1] https://www.cagbc.org/wp-content/uploads/2024/07/CAGBC_Zero_Carbon_Building%E2%80%93Design_Standard_v4.pdf

- Ensure air handling equipment can accommodate HEPA or active carbon filters to mitigate indoor exposure to outdoor gaseous contaminants during poor air quality events, such as wildfire smoke
- Design mechanical HVAC systems to allow for upgrades that account for changing climate conditions, such as extra space, pipe, coil and/or ductwork allotment
- Locate/mount equipment so that it avoids damage from snow loads and falling trees/debris from strong wind events
- Use exterior mechanical and electrical equipment rated for high wind speeds
- Relocate critical systems and key electrical infrastructure above the Flood Construction Level (FCL)
- Upgrade drainage systems to accommodate extreme rainfall volumes and Intensity-Duration-Frequency (IDF) curves projected for the end of the building's design service life, as well as meltwater from extreme snowfall events and ice storms
- Install features to protect rooftop equipment from flooding due to intense rainfall events, such as isolator curbs and overflow scuppers
- Ensure backup power systems are sized to account for increases in electrical demand and ensuring that there is adequate backup power
- Incorporate fire resistant materials into building envelope, including roof, cladding, and fenestration

2.3 Compliance Path 1: Prescriptive – Default Solutions

2.3.1 Intent

To provide a consistent and streamlined approach (default solutions) to retrofit interventions for the five core archetypes identified. This Compliance Path does not require any analysis to be completed by the project team.

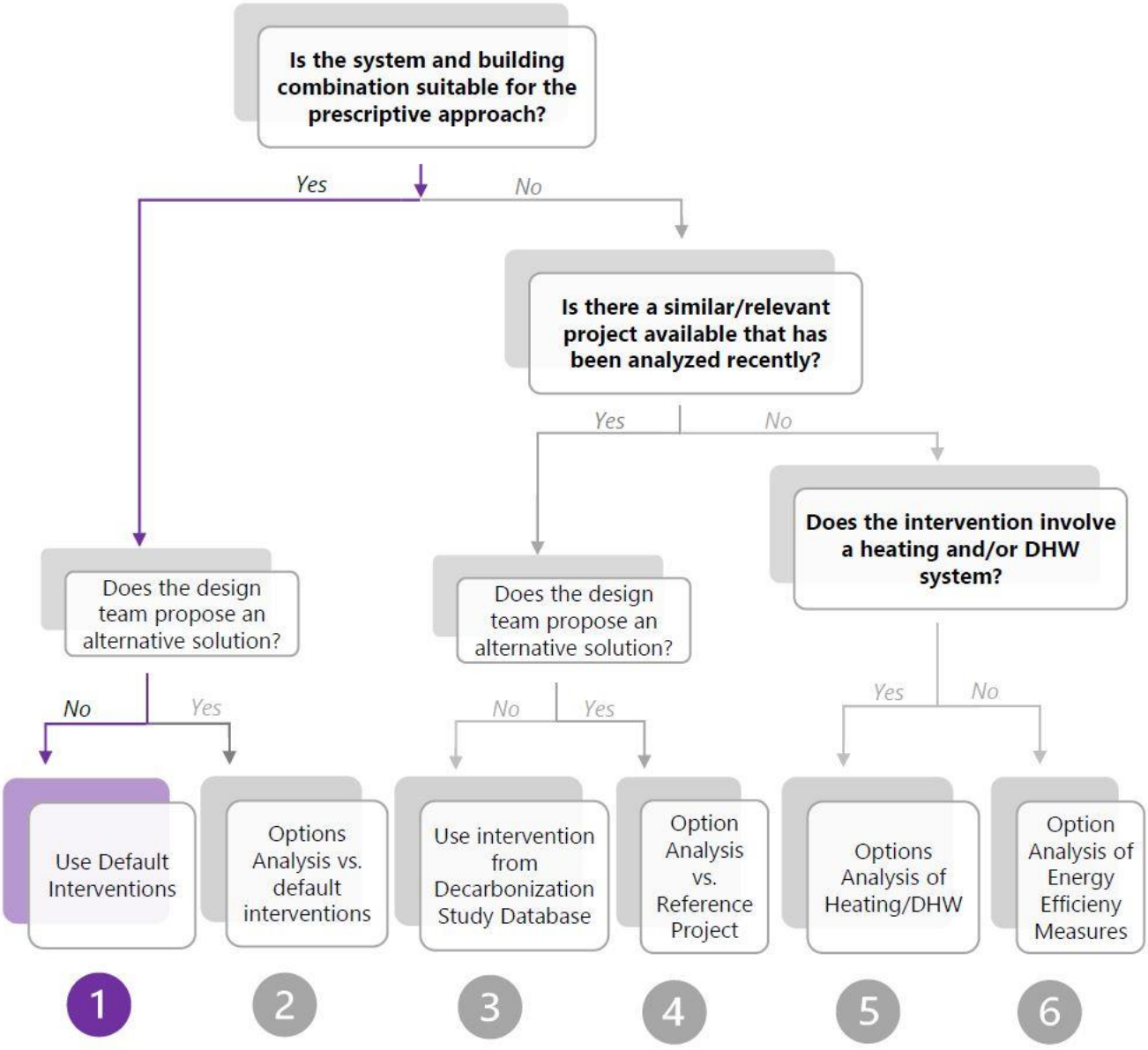


Figure 3: NZE Retrofit Standard – Prescriptive Compliance Path

2.3.2 Application

The ***Prescriptive Compliance Path 1*** applies to projects that fall under the following criteria:

- The building archetype is one of the following:
  - Multi-family unit residential building
  - Townhouse
  - Office or Police Station
  - Paramedic Station
  - Light Industrial building
- The intervention is related to a non-HVAC element **or**
- The intervention is related to the HVAC system and the existing system is equal to the existing HVAC system listed in Table 3 to Table 9 for the specific Archetype.

2.3.3 Approach

The project team will complete the initial questionnaire in the (*NZE BR) LCCCA (cost and carbon) Tool*. If the tool indicates Compliance Path 1 as the appropriate Compliance Path for the project the project team will review the default solutions listed in the tool and below in Table 3 to Table 9.

If eligible the project team may proceed with designing and implementing the default solution(s) for the scheduled intervention.

Design teams are encouraged to think critically and consider switching to Compliance Path 2 if the default intervention in the tables is not suitable for the specific building/project, from a technical or financial perspective.

2.3.4 Example: Prescriptive Compliance Path

Example Project: Replacement of natural gas boiler at MURB
Default Solution (per Table 2)
Replace existing boiler with Cold-Climate Ductless Mini-Split, sized for heating and cooling demands in-suite for each unit.

2.3.5 Prescriptive Compliance Path – Default Solutions

The following tables outline the default prescriptive solutions for each archetype by building element:

Table 3: Prescriptive Solutions for MURBS

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solution
Wall	• Masonry/Metal Panel cladding, block and strapping with insulation interior.	• Improve air sealing by replacing sealant around windows, locally repair cladding and flashings.
Roof	• 4" of insulation	• Roof, re-roofed with 4" of continuous Insulation – refer to Peel Region's Roofing Standard.
Windows/Doors		• Replace punched windows and balcony doors with market products that are compliant with the latest NECB requirements.
HVAC Plant	• Non-condensing NG Boiler	• Cold-Climate Ductless Mini-Split, sized for heating and cooling demands in-suite for each unit. [Every unit has its own residential ductless mini-split]*
HVAC Distribution System	• Hydronic Baseboards	
DHW System	• Centralized, Standard efficiency gas-fired DHWT	• CO_2 DHW heat pump system**
Ventilation	• Standard efficiency, constant volume central MUA (NG) serving pressurized corridor system and ventilation load	• Heat pump-based, constant volume central make-up air unit (MUA) serving pressurized corridor system and ventilation load

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solution
Lighting		• Lighting design compliant with the latest NECB requirements
Mechanical equipment		• Efficiencies of all mechanical and auxiliary equipment compliant with the latest NECB requirements

* Design teams should consider PTAC/PTHP systems, providing both heating and cooling, as a potential alternative.

**Design teams should consider running an options analysis for electric resistor DHW heater, as the design is highly dependent on the DHW demand assumptions and therefore this design solution may be shown to be cost-effective for the specific project.

Table 4: Prescriptive Solutions for MURBS

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solution
Wall	• Masonry/Metal Panel cladding, block and strapping with insulation interior.	• Improve air sealing by replacing sealant around windows, locally repair cladding and flashings.
Roof	• 4" of insulation	• Roof, re-roofed with 4" of continuous Insulation.
Windows/Doors		• Replace punched windows and balcony doors with market products that are compliant with the latest NECB requirements.
HVAC Plant		

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solution
HVAC Distribution System	• Electric Baseboards	• Cold-Climate Ductless Mini-Split, sized for heating and cooling demands in-suite for each unit. [Every unit has its own residential ductless mini-split]*
DHW System	• Centralized, Standard efficiency gas-fired DHWT	• CO_2 DHW heat pump system**
Ventilation	• Standard efficiency, constant volume central MUA (NG) serving pressurized corridor system and ventilation load	• Heat pump-based, constant volume central make-up air unit (MUA) serving pressurized corridor system and ventilation load
Lighting		• Lighting design compliant with the latest NECB requirements
Mechanical equipment		• Efficiencies of all mechanical and auxiliary equipment compliant with the latest NECB requirements

* Design teams should consider PTAC/PTHP systems, providing both heating and cooling, as a potential alternative.

**Design teams should consider running an options analysis for electric resistor DHW heater, as the design is highly dependent on the DHW demand assumptions and therefore this design solution may be shown to be cost-effective for the specific project.

Table 5: Prescriptive Solutions for MURBS

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solution
Wall	• Masonry/Metal Panel cladding, block and strapping with insulation interior.	• Improve air sealing by replacing sealant around windows, locally repair cladding and flashings.
Roof	• 4" of insulation	• Roof, re-roofed with 4" of continuous Insulation.
Windows/Doors		• Replace punched windows and balcony doors with market products that are compliant with the latest NECB requirements.
HVAC Plant	• Standard efficiency gas fired boiler • Rooftop mounted air-cooled chiller	• Replace existing plant (natural gas boiler and chiller) with a central Air Source Heat Pump based plant providing both heating and cooling, with an electric boiler support/top up*
HVAC Distribution System	• Two-pipe fan coil system	• Replace existing FCUs with either two or four-pipe FCUs sized to work with low temperature hot water loop systems*
DHW System	• Centralized, Standard efficiency gas-fired DHWT	• CO_2 DHW heat pump system**
Ventilation	• Standard efficiency, constant volume central MUA (NG) serving pressurized corridor system and ventilation load	• Heat pump-based, constant volume central make-up air unit (MUA) serving pressurized corridor system and ventilation load

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solution
Lighting		• Lighting design compliant with the latest NECB requirements
Mechanical equipment		• Efficiencies of all mechanical and auxiliary equipment compliant with the latest NECB requirements

* If existing FCUs are sized for low hot water loop temperatures, the electric boiler support/top might not be necessary.
If both the plant components and the HVAC distribution system (FCUs) are due for replacement at the same time, design teams should consider exploring switching to non-hydronic decentralized options (e.g., mini-split systems) as a potentially cost-effective alternative.

**Design teams should consider running an options analysis for electric resistor DHW heater, as the design is highly dependent on the DHW demand assumptions and therefore this design solution may be shown to be cost-effective for the specific project.

Table 6: Prescriptive Solutions for Townhouses

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solutions
Wall	• Wood frame, brick/vinyl/wood siding, insulation between 2x4 wood studs	• Improve air sealing by replacing sealant around windows*
Roof	• Gabel, Hip/Valley, Mansard, Insulation blown in ceiling joist space	• Replace asphalt shingles, improve sealing in attic when an existing air barrier already exists.*

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solutions
Windows/Doors		• Replace with market products that are compliant with the latest NECB requirements.
HVAC Plant	• Gas Fired Furnace	• Central Cold Climate Ducted Air Source Heat Pump (ASHP) with auxiliary backup.**
DHW System	• Distributed, standard efficiency gas-fired DHWT	• DHW, Distributed Electric DHWT
Ventilation	• Operable windows – assume no mechanical ventilation	• Operable windows – assume no mechanical ventilation
Lighting		• Lighting design compliant with the latest NECB requirements
Mechanical equipment		• Efficiencies of all mechanical and auxiliary equipment compliant with the latest NECB requirements

* Design teams should consider running an options analysis for envelope interventions that add insulation, such as:

- Wall: Re-cladding or overclad, add 4” of continuous exterior insulation.
- Roof: Replace asphalt shingles, improve sealing, and add blown-in roof insulation (roof/batten).

** Design teams should consider running an options analysis for a cold climate mini-split unit, sized for heating and cooling, as depending on the specific geometry of the Townhouse this solution may be more cost-effective.

Table 7: Prescriptive Solutions for Office/Police Station

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solutions
Wall	• Brick veneer with 4" of insulation	• Localized repairs/air sealing at glazing transitions. • Interior retrofit – new interior steel stud wall c/w +3.5" of insulation.
Roof	• Cast in place concrete roof deck, conventional single/multi-ply roof membrane. Average 3-4" of polyiso insulation	• Replace existing membrane, improve air sealing at mechanical units and penetrations.
Windows/Doors		• Replace with market products that are compliant with the latest NECB requirements.
HVAC Plant	• Central natural gas boiler • Central chiller	• Electric Boiler and New Chiller*
HVAC Distribution System	• VAV with reheat (hydronic)	• Renewal of VAV and reheat
DHW System	• Natural gas DHW Boiler	• Electric DHWT
Ventilation	• Mixed-air VAV system	• Mixed-air VAV system
Lighting		• Lighting design compliant with the latest NECB requirements
Mechanical equipment		• Efficiencies of all mechanical and auxiliary equipment compliant with the latest NECB requirements

* An air source heat-pump based (ASHP) solution was shown to not be cost-effective in the analysis that informed the default solution, as the existing system was considered to be a high-temperature hot water (HTHW) system serving a VAV system, and a change to a heat pump based system would trigger a transition to a lower temperature regime, which in turn would require a complete reconfiguration of the HVAC system. This strongly penalized the ASHP intervention in terms of financial performance.

If the existing office building has a low-temperature hot water (LTHW) heating system or there is a plan to transition to a LTHW heating system with distributed heating/cooling terminal units (e.g., fan coils), design teams should consider running an option analysis for central Air Source Heat Pump (ASHP) plant sized for both heating and cooling (4-pipe system).

Table 8: Prescriptive Solutions for Paramedic Station

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solutions
Wall	• Brick/CMU cladding cavity wall c/w SPF insulation, and block or 6" Steel stud backup (fibreglass filled b/t studs)	• Improve air sealing by replacing sealant around windows/transitions.
Roof	• Steel or composite roof deck, conventional single/multi-ply roof membrane	• Replace/restore existing membrane, improve air sealing at mechanical units' penetrations
Windows/Doors		• Replace with market products that are compliant with the latest NECB requirements. • Replace overhead doors with R5 insulated metal doors. • Improve air sealing by replacing sealant around windows/doors, weatherstripping of overhead/swing doors.

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solutions
HVAC Plant	• Natural gas furnace • Air conditioning split system	• Cold-Climate Mini-split Unit**
HVAC Distribution System		
Ventilation	• Residential ERV	• Renew ERV
Garage HVAC System	• Dedicated Exhaust fans and natural gas-fired MAU. • Perimeter heating via gas-fired radiant tube heaters. • No cooling	• DOAS system with heat recovery, heat pump heating coil with back up electric radiant heaters
DHW System	• Electric DHW heater	• Electric DHW heater
Lighting		• Lighting design compliant with the latest NECB requirements
Mechanical equipment		• Efficiencies of all mechanical and auxiliary equipment compliant with the latest NECB requirements

** Design teams should consider running an options analysis for a centralized air source heat pump (ASHP), sized for heating and cooling, as depending on the specific geometry of the paramedic station this solution may be more cost-effective. The mini-split solution offers the benefit of better controllability for multi-zone spaces.

Energy uses in light industrial buildings vary widely depending on the specific process loads and ventilation/exhaust rates. The analysis that informed the default solutions assumed a “pumping station” with a very large internal process load (the water distribution pump) and a low ventilation rate requirement (mechanical spaces, as per ASHRAE 62.1). A sensitivity analysis to higher ventilation/exhaust rates (recycling centres, as per ASHRAE 62.1) was performed to test the impact of high exhaust rates to the default solutions.

Table 9: Prescriptive Solutions for Light Industrial

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solutions
Wall	• Brick Cladding, concrete block, or metal-clad building with metal stud	• Improve air sealing by replacing sealant around windows
Roof	• Metal roof deck, flat or pitched	• Replace existing membrane, improve air sealing at mechanical units, penetrations.
Windows/Doors		• Replace overhead doors with R5 insulated metal doors. • Replace with market products that are compliant with the latest NECB requirements.
HVAC Plant	• Distributed NG fired Unit heaters, heated air curtains above bay doors. • No Cooling	• Distributed electric heating (Unit heaters, Infrared)
DHW System	• Electric DHW heaters	• Electric DHW heaters
Ventilation	• MAU and Exhaust fans, no heat recovery	• For buildings with low ventilation/exhaust requirements (e.g., pumping stations): ASHP Make-Up Air (MUA) system, no heat recovery* • For buildings with high ventilation/exhaust requirements (e.g., recycling centres): ASHP DOAS system (i.e., exhaust ducted back to the system) with heat recovery*
Lighting		• Lighting design compliant with the latest NECB requirements

Element	Existing Condition *(Review if capital plan intervention includes an HVAC retrofit)*	Default Solutions
Mechanical equipment		• Efficiencies of all mechanical and auxiliary equipment compliant with the latest NECB requirements

* The cost efficiency of the ventilation systems depends heavily on the ventilation load. Design teams are encouraged to consider and assess alternative configurations:
- electric resistor vs. heat pump heating coils.
- fully ducted dedicated outside air system (DOAS) with heat recovery vs. de-coupled make-up air (MUA) and exhaust.

2.4 Compliance Path 2: Prescriptive Options Analysis

2.4.1 Intent

To allow for flexibility in scenarios where an alternative solution provides superior financial/GHG performance than the listed default solution due to site-specific opportunities and/or constraints. This compliance path requires analysis to be completed by the project team.

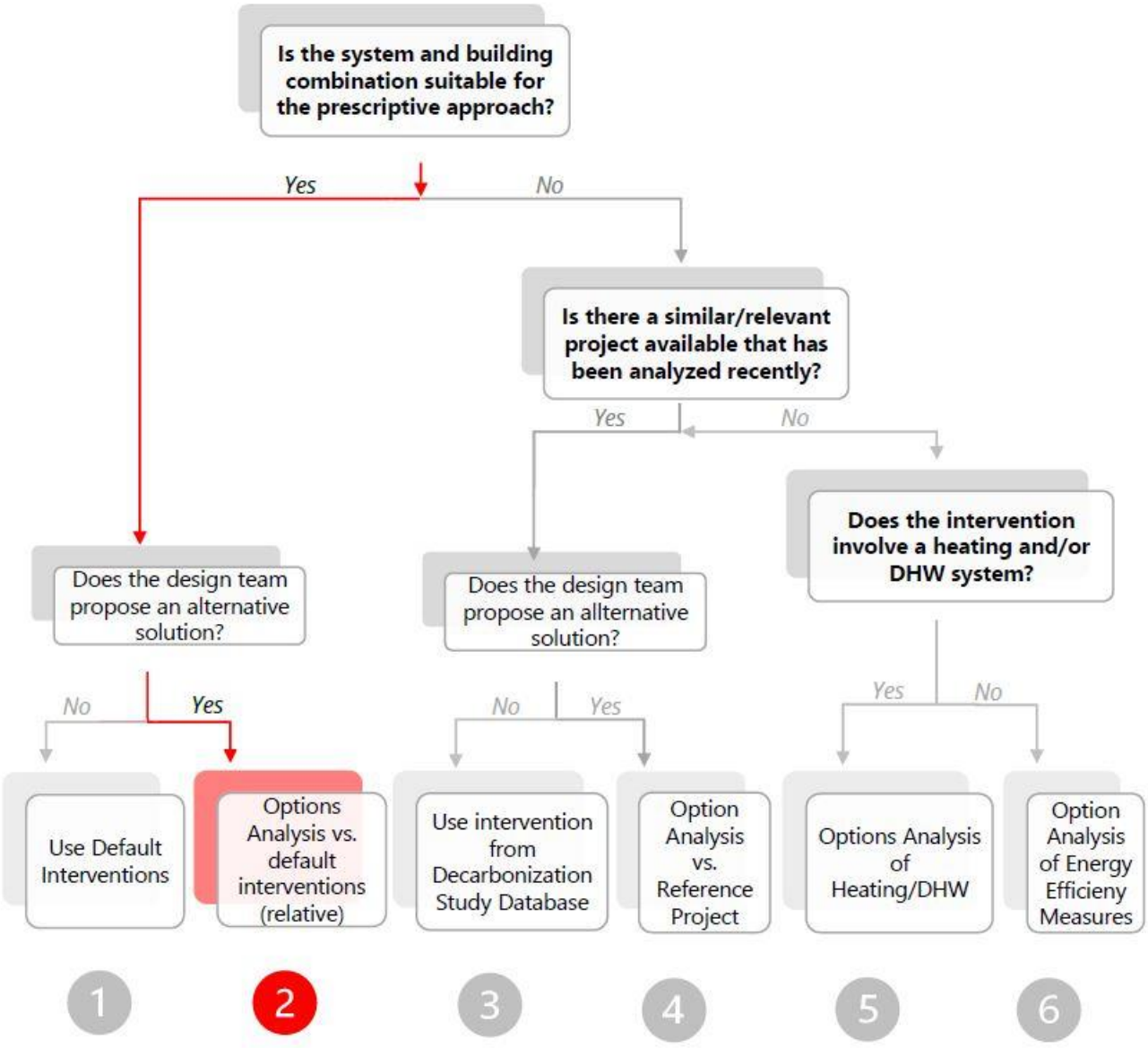


Figure 4: Options Analysis Compliance Path

2.4.2 Application

The *Prescriptive Options Analysis Compliance Path* applies to projects that fall under the following criteria:

- The building archetype is one of the following:
  - Multi-family unit residential building
  - Townhouse
  - Office or Police Station
  - Paramedic Station
  - Light Industrial building
- The intervention is related to a non-HVAC system/element **or**
- The intervention is related to the HVAC system and the existing system is equal to that listed in Table 3 to Table 9 for the specific archetype.
- The design team wishes to propose an alternative solution to the default listed in Table 3 to Table 9.

2.4.3 Approach

Project teams are to develop a comparative analysis of the proposed alternative solution against the default solution listed in Compliance Path 1 of the Standard. The project team are to use the *(NZE BR) LCCCA (cost and carbon) Tool* to complete the analysis.

The project team are to present the results of the comparative analysis to Peel Region Project Manager, noting any qualitative considerations alongside the quantitative results.

Peel Region project manager will select the solution based on the results of the comparative analysis.

The project will be added to the decarbonization database (Compliance Path 3).

2.4.4 Example: Options Analysis Compliance Path

Example Project: Replacement of natural gas boiler and HVAC distribution system at an Office Building	
Default Solution (Compliance Path 1)	***Alternative Solution***
Replace the existing boiler with an electric boiler. Replace HVAC distribution (VAV reheat) (Existing chiller in-situ)	Replace the existing boiler with a Cold Climate Air Source heat pump system. Replace the HVAC distribution system (LTHW FCUs). *Change in HVAC configuration already planned in the capital plan.*
Deliverables for each solution	

Comparative analysis including quantitative and qualitative results as per the LCCA Methodology

Quantitative Results *(Indicative results presented for illustrative purposes only)*

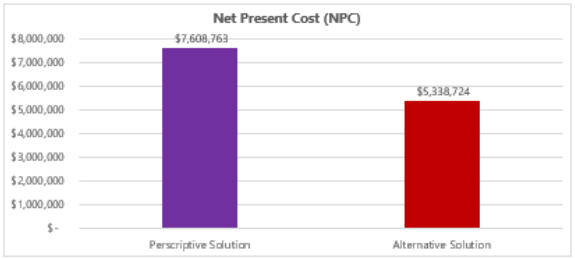
Compliance Path 2: Option Analysis Results

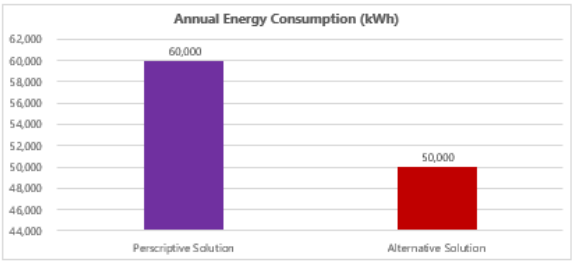
Table 1: Project Information - Reference Only

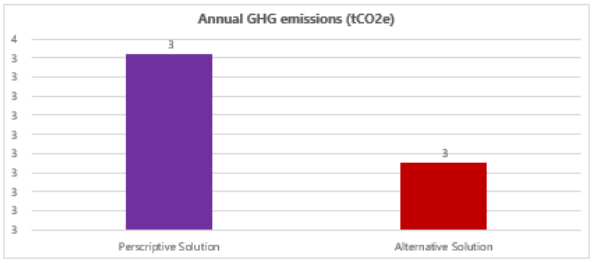
Project Archetype	Office/Police Station
Intervention (Type)	HVAC
Intervention (Detail)	HVAC Plant
Project Year (Construction)	2025

Table 2: LCCA Results

Metric	BAP (Replacement like-for-similar)	Perscriptive Solution	Alternative Solution
Net Present Cost (NPC)	$ 4,590,703	$ 7,608,763	$ 5,338,724
First Capital Costs	$ 2,797,000	$ 3,000,000	$ 2,000,000
Annual Energy Consumption (kWh) Year 1	75,727	60,000	50,000
Annual GHG emissions (tCO2e) Year 1	12	3	3
Energy Abatement Cost ($/kWh)	n/a	$ 4.68	$ 0.71







Analysis results demonstrate a better life cycle cost and GHG performance for the alternative solution: air source heat pump system. Other qualitative considerations were presented:

- Technical considerations:
  - Both systems involve well-established technologies (low risk)
  - Alternative solution results in a lower peak electrical draw and therefore avoids the need for an electrical upgrade.
- Spatial considerations: both systems are viable in terms of physical space requirements.

Implementation: both systems have a similar construction schedule and impact on operations.

2.5 Compliance Path 3: Non-Prescriptive - Decarbonization Database

2.5.1 Intent

To leverage analysis results from previous project experience to reduce analysis required for projects that do not have default solutions identified in Compliance Path 1. This Compliance Path does not require any analysis to be completed by the project team. The analysis completed for projects following Paths 2, 5 and 6 will be added to a "decarbonization database" as reference projects.

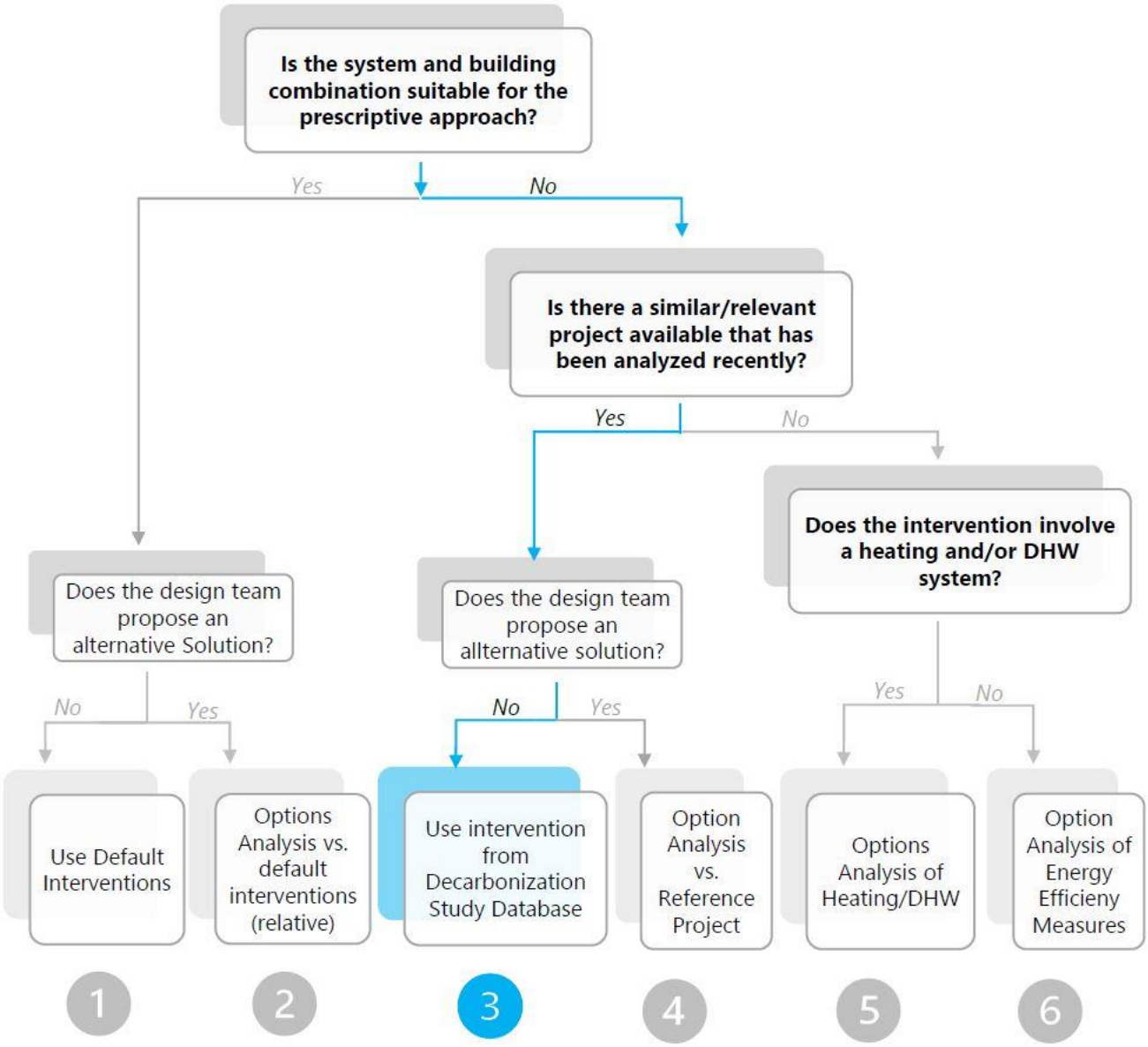


Figure 5: Decarbonization Database Compliance Path

2.5.2 Application

The *Decarbonization Database Compliance Path* applies to projects where:

- The project archetype is not within the five core archetypes identified in the Standard.
- OR the project archetype is listed within the five core archetypes, however, the scheduled intervention is related to the HVAC system, and the existing HVAC system does not align with that listed in Table 3 to Table 9 for the specific Archetype.
- **And** there is a similar project available that has been analyzed recently within the decarbonization database.

A similar project is defined as one that aligns with:

- The project archetype
- The intervention type
- The scale of the project
- Similar site conditions

2.5.3 Approach

The RoP project manager will review the decarbonization database to see if there is a project match. If there is no match, the project team will be directed to Compliance Path 5 or 6, depending on whether the project involves the heating/DHW system or energy efficiency measures.

If the project has a match in the decarbonization database, the proposed solution will be shared with the project team for review.

Design teams are encouraged to think critically and consider switching to Compliance Path 4 if the intervention in the decarbonization database is not suitable for the specific building/project, from a technical or financial perspective.

2.5.4 Example

Example Project: Replacement of Standard efficiency, constant volume central Make-Up Air Unit (Natural Gas) in a museum
Decarbonization Database
Reference project "Museum" (completed 2024) – Note this is not a real RoP project. • The project archetype is not within the five core archetypes • The RoP project manager identifies there is a recent "similar" project within the decarbonization database that has the same project archetype, intervention type, scale of the project and similar conditions. This project "Museum" is selected as the reference project. • The proposed solution included in the reference project was: ○ *Heat pump-based, constant volume central make-up air unit (MUA)* • The project team critically reviews the solution outlined in the reference project ("Museum") and confirms this is suitable for the project in question from a technical and financial perspective. The project team confirm no alternative solutions will be explored and choose to proceed with the recommended solution identified in the reference project ('Museum").

2.6 Compliance Path 4: Non-Prescriptive - Options Analysis vs. Reference Project

2.6.1 Intent

To allow for flexibility in scenarios where an alternative solution compared to the solution identified in the reference project (within the decarbonization database) may make more sense due to site-specific opportunities and/or constraints. This Compliance Path requires analysis to be completed by the project team.

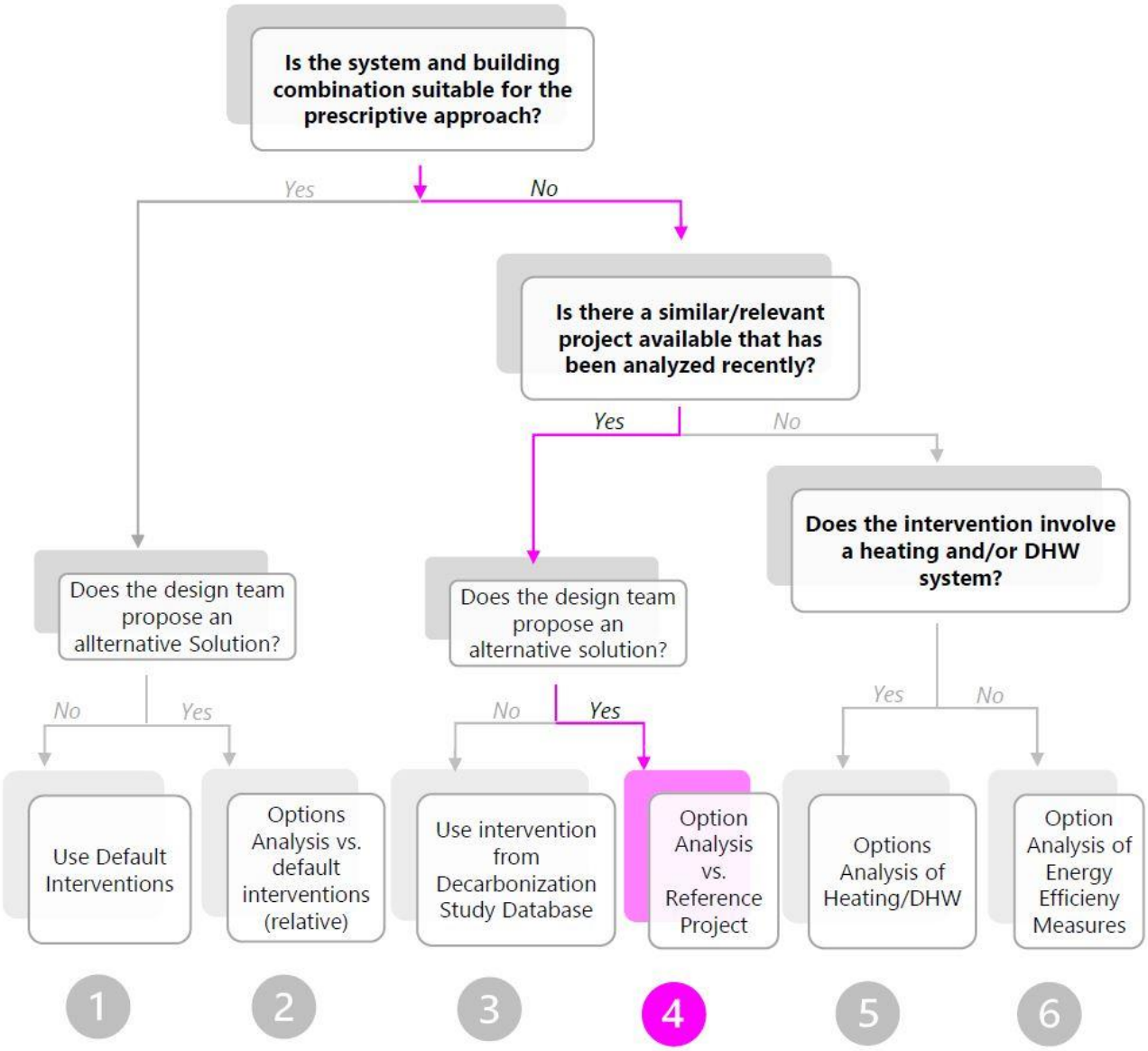


Figure 6: Option Analysis vs. Reference Project Compliance Path

2.6.2 Application

The *Option Analysis vs. Reference Project Compliance Path* applies to projects where:

- The project is not suitable for the prescriptive approach.
    - i.e. Either the project archetype is not within the five core archetypes **or** the project archetype is listed within the five core archetypes, however, the scheduled intervention is related to the HVAC system, and the existing HVAC system does not align with that listed in Table 3 to Table 9 for the specific Archetype.
- **And** there is a similar project available that has been analyzed recently.
- **And** the project team have proposed an alternative solution to the identified solution(s) in the reference project(s) (decarbonization database).

2.6.3 Approach

The RoP project manager will review the decarbonization database to see if there is a project match. If there is no match, the project team will be directed to Compliance Path 5 or 6, depending on whether the project involves the heating/DHW system or energy efficiency measures. If the project has a match in the decarbonization database, the proposed solution will be shared with the project team for review.

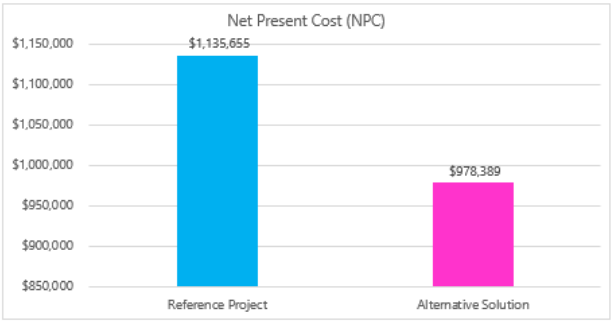
Design teams are encouraged to think critically and identify potential solutions that are more suitable than the proposed alternative from the decarbonization database.

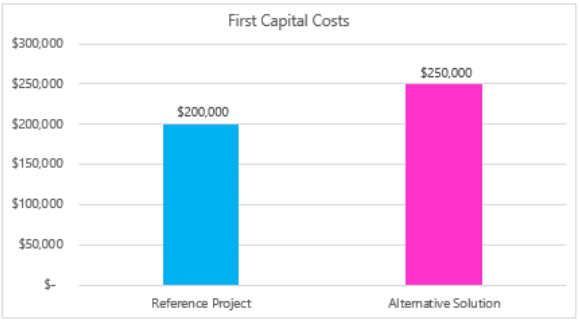
The project team are to use the *(NZE BR) LCCCA (cost and carbon) Tool* to complete the analysis of the reference solution and alternative solution proposed. The project team are to present the results of the comparative analysis to Peel Region Project Manager, noting any qualitative considerations alongside the quantitative results.

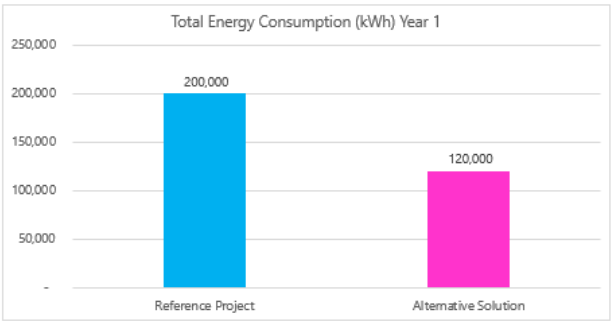
Peel Region project manager will select the solution based on the results of the comparative analysis.

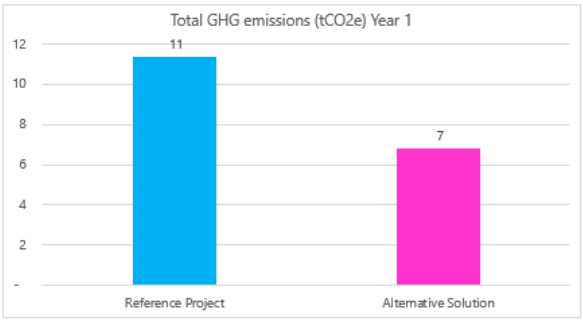
The project will be added to the decarbonization database (Compliance Path 3).

2.6.4 Example

<table>
<tr><th colspan="2">Example Project: Replacement of MAU at a Museum</th></tr>
<tr><th>Reference Project (Decarbonization Database)</th><th>Alternative Solution</th></tr>
<tr><td>Electric Resistance, constant volume central make-up air unit (MUA)</td><td>Heat pump-based, constant volume central make-up air unit (MUA)</td></tr>
<tr><td colspan="2">Results (Illustrative results only)</td></tr>
<tr><td colspan="2">
Compliance Path 4: Reference Project Solution vs. Alternative Solution
Table 1: LCCA Results
<table>
<tr><th>Metric</th><th>Reference Project</th><th>Alternative Solution</th></tr>
<tr><td>Net Present Cost (NPC)</td><td>$ 1,135,655</td><td>$ 978,389</td></tr>
<tr><td>First Capital Costs</td><td>$ 200,000</td><td>$ 250,000</td></tr>
<tr><td>Total Energy Consumption (kWh) Year 1</td><td>200,000</td><td>120,000</td></tr>
<tr><td>Total GHG emissions (tCO2e) Year 1</td><td>11</td><td>7</td></tr>
</table>








</td></tr>
<tr><td colspan="2">

Analysis results demonstrate a better financial performance for the alternative solution. Other qualitative considerations were presented:
Technical considerations:

Both systems involve well-established technologies (low-risk)
Alternative solution results in a lower peak electrical draw (higher efficiency) and therefore avoids the need for an electrical upgrade.

Spatial considerations: both systems are viable in terms of physical space requirements.
Implementation: both solutions have similar implementation timelines and disruption to the site.

</td></tr>
</table>

2.7 Compliance Path 5: Non-Prescriptive - Options Analysis of Heating/DHW

2.7.1 Intent

To identify the most cost-effective system to fully fuel-switch heating and DHW systems in buildings where a default solution has not been identified. This compliance path does require analysis to be completed by the project team.

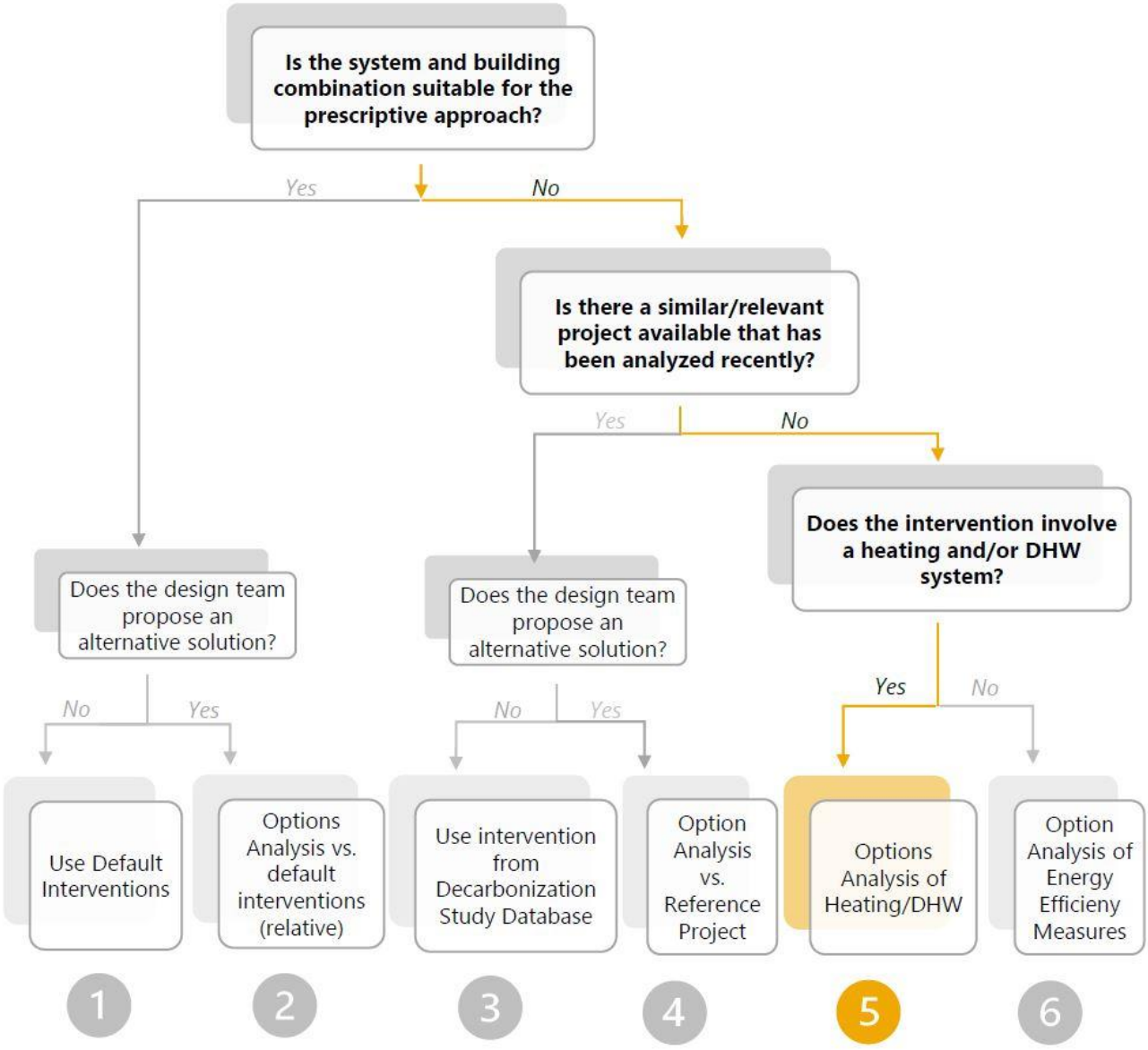


Figure 7: Option Analysis of Heating/DHW Compliance Path

2.7.2 Application

The *Non-Prescriptive - Options Analysis of Heating/DHW Compliance Path* applies to projects where:

- The project is not suitable for the prescriptive approach.
    - i.e. Either the project archetype is not within the five core archetypes **or** the project archetype is listed within the five core archetypes, however, the scheduled intervention is related to the HVAC system, and the existing HVAC system does not align with that listed in Table 3 to Table 9 for the specific Archetype.
- **And** there is not a reference project (i.e. similar project) available in the decarbonization database that has been analyzed recently.
- **And** the intervention involves a heating and/or a DHW system.

2.7.3 Approach

Project teams are to develop a comparative analysis of 3 all-electric solutions, at least one of the three solutions must include a heat pump design solution.

The project team are to use the *(NZE BR) LCCCA (cost and carbon) Tool* to complete the analysis. The project team are to present the results of the comparative analysis to Peel Region Project Manager, noting any qualitative considerations alongside the quantitative results.

Peel Region project manager will select the solution based on the results of the comparative analysis.

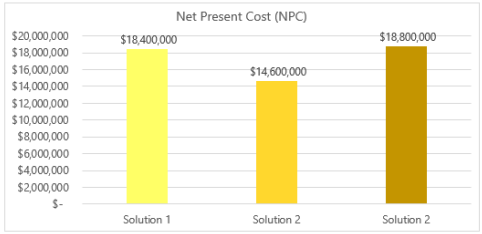
The project will be added to the decarbonization database (Compliance Path 3).

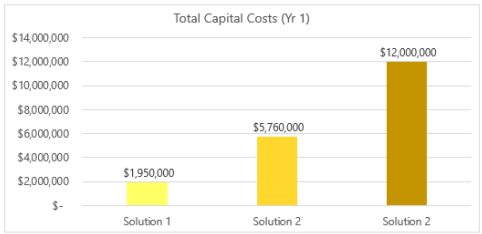
2.7.4 Example

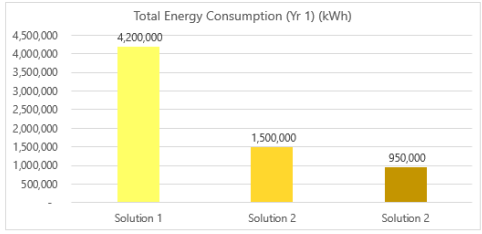
Example Project: Replacing a Natural Gas Boiler in a Child Care Centre		
Option 1	**Option 2**	**Option 3**
Electric Boiler (no cooling)	Air Source Heat Pump system for heating and cooling	Geo-exchange system for heating and cooling
Deliverables for each solution		
Comparative analysis including quantitative and qualitative results as per the LCCA Methodology		
Quantitative Results *(Indicative results presented for illustrative purposes only)*		

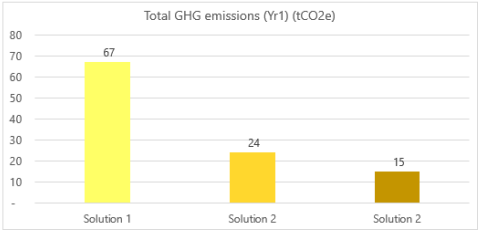
Compliance Path 5: Options Analysis of Heating/DHW System

Metric	Solution 1	Solution 2	Solution 2
Net Present Cost (NPC)	$ 18,400,000	$ 14,600,000	$ 18,800,000
Total Capital Costs (Yr 1)	$ 1,950,000	$ 5,760,000	$ 12,000,000
Total Energy Consumption (Yr 1) (kWh)	4,200,000	1,500,000	950,000
Total GHG emissions (Yr1) (tCO2e)	67	24	15









- Analysis results demonstrate a better financial performance for Option 2.
- Project team present the results of the analysis, including both quantitative and qualitative considerations.

- The RoP Project manager makes a strategic decision on which solution should be taken forward in the design.

2.8 Path 6: Non-Prescriptive - Options Analysis of Energy Efficiency Measures

2.8.1 Intent

To identify the level of efficiency that balances carbon performance with cost efficiency in buildings where a default solution has not been identified. This Compliance Path requires analysis to be completed by the project team.

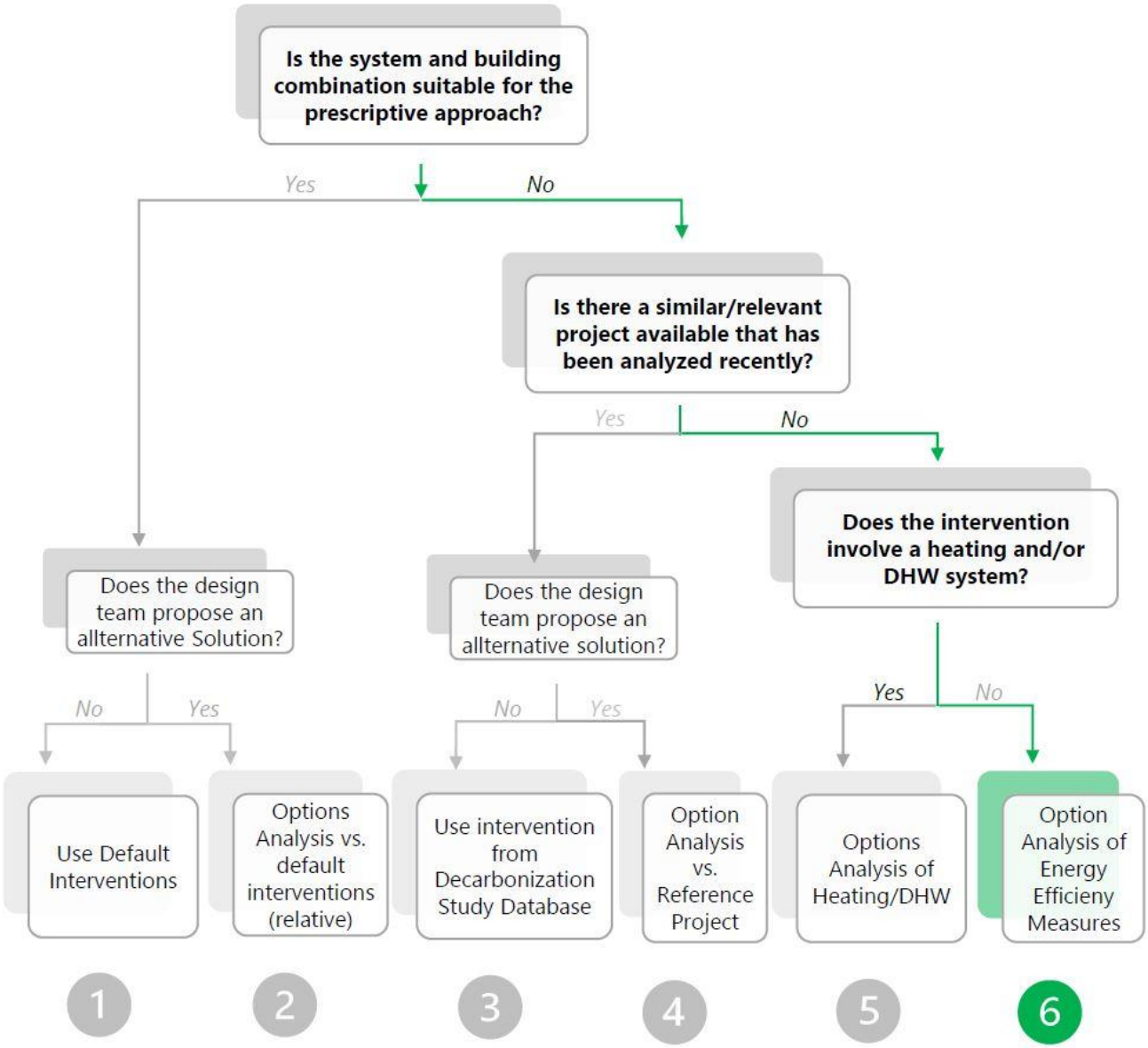


Figure 8: Option Analysis of Heating/DHW Compliance Path

2.8.2 Application

The *Non-Prescriptive - Options Analysis of Energy Efficiency Measures Compliance Path* applies to projects where:

- The project is not suitable for the prescriptive approach.
    - i.e. Either the project archetype is not within the five core archetypes **or** the project archetype is listed within the five core archetypes, however, the scheduled intervention is related to the HVAC system, and the existing HVAC system does not align with that listed in Table 3 to Table 9 for the specific Archetype.
- **And** there isn't a reference project (i.e. similar project) available in the decarbonization database that has been analyzed recently.
- **And** the intervention does not involve the heating and/or DHW system.

2.8.3 Approach

Project teams are to develop a comparative analysis of 3 solutions for the following performance tiers:

- "Good" – Like for similar. This solution corresponds to the intervention as described in the capital plan. It is to be used as the baseline, "Business-As-Planned" (BAP) scenario for comparison.
- "Better" – Tier 2 performance, superior to the intervention in the capital plan.
- "Best" – Tier 3 performance, "best in class / highest efficiency" intervention.

If the existing heating and/or DHW system is not already a primary electric system, assume the BAP is a heating and/or DHW with a COP of 2 for the analysis.

The project team are to use the *(NZE BR) LCCCA (cost and carbon) Tool* to complete the analysis. The project team are to present the results of the comparative analysis to Peel Region Project Manager, noting any qualitative considerations alongside the quantitative results.

The LCCA analysis for the "better" and the "best" tiers will report metrics "incremental capital cost ($/m2)" and "energy abatement cost ($/kWh)" relative to the "Good" performance tier.

Peel Region project manager will select the solution based on the results of the comparative analysis.

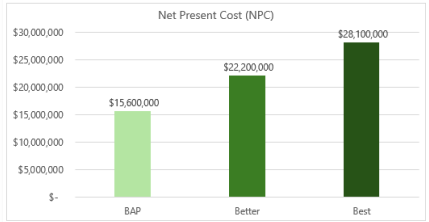
The project will be added to the decarbonization database (Compliance Path 3).

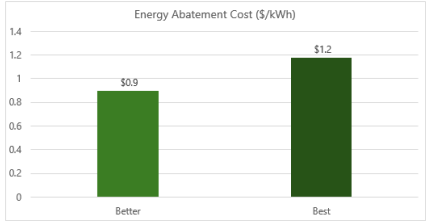
2.8.4 Example

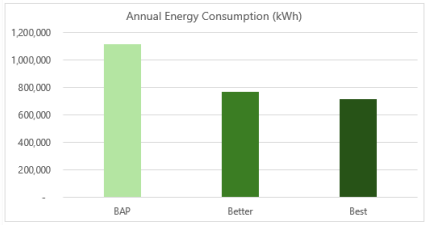
Example Project: Window replacement in a Child Care Centre		
Good (BAP)	***Better***	***Best***
NECB minimum requirements - Thermally broken Alum framed, double glazed, argon filled (U-0.45, SHGC-0.45)	Thermally broken, Alum framed, double glazed, low e- on E/W/S facing, argon filled with fixed/awning or casement operable section (U-0.35, SHGC-0.3)	Triple glazed, argon filled fibreglass framed windows, low e-coating (U-0.17, SHGC-0.25)
Deliverables for each solution		
Comparative analysis including quantitative and qualitative results as per the LCCA Methodology		
Quantitative Results *(Indicative results presented for illustrative purposes only)*		

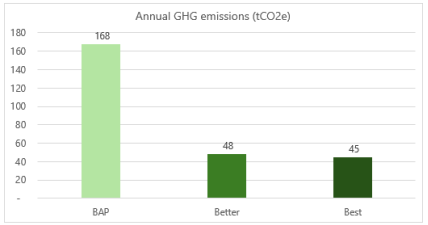
Compliance Path Six: Options Analysis of Energy Efficiency Measures

Metric	BAP	Better	Best
Net Present Cost (NPC)	$ 15,600,000	$ 22,200,000	$ 28,100,000
First Capital Costs	$ 5,610,000	$ 8,300,000	$ 10,500,000
Annual Energy Consumption (kWh)	1,115,604	767,377	715,445
Annual GHG emissions (tCO2e)	168	48	45
Energy Abatement Cost ($/kWh)		$ 0.9	$ 1.2









- Analysis results demonstrate that additional levels of efficiency “Better” and “Best” Scenario present energy and emission savings but are not cost-effective in terms of energy abatement cost ($/kWh).
- Project team present the results of the analysis, including both quantitative and qualitative considerations.

- The RoP Project manager makes a strategic decision on which solution should be taken forward in the design.

3 Energy Modelling Guidelines

When completing the Option Analysis in Compliance Paths 2, 4, 5 and 6 the project teams should use the energy modelling guidelines outlined in Table 10. Design teams should refer to the latest Energy Modelling Guidelines from the CaGBC[2] generally, however, as this Standard pertains to New Construction, design teams should follow the modifications outlined in Table 7.

Table 10: Energy Modelling Guidelines

Element	Energy Modelling Approach
General guidance: Modelling Guideline	CaGBC Modelling Guidelines
Occupancy Schedules	As per project information and if not available as per the latest NECB
Internal gains	As per project information and if not available as per the latest NECB
DHW load	As per project information and if not available as per the latest NECB (referencing project occupancy)
Infiltration	Unless air leakage testing (blower door testing) is conducted to verify alternate values, the following infiltration assumptions must be used. • Baseline for MURBs, Townhouses and Light Industrial buildings: 0.52 l/s/m^2 at 5Pa[3] • Baseline for Police/Office buildings and Paramedic Stations: 0.35 l/s/m^2 at 5Pa[4] • 20% reduction as a result of window replacements • 30% reduction as a result of comprehensive envelope upgrade (windows and walls)
Envelope performance	Calculate overall envelope performance as per section 2.2 of the CaGBC Energy Modelling Guidelines. Overall thermal transmittance must account for thermal bridging (repetitive structural members and linear and point

[2]CaGBC (2017). https://www.cagbc.org/news-resources/technical-documents/energy-modelling-guidelines-2/
[3] ASHARE. (2009). Leaky Buildings
[4] Sustainable Buildings Canada. (2016). Accounting for infiltration in Savings by Design Energy Models.

	transmittances) as well as de-rated performance of insulation materials over time. The modelling report must document the analysis process and the assumptions.
Weather file	Future shifted weather file. Toronto Pearson Intl AP. Scenario RCP8.5. Time Period 2020s. https://services.pacificclimate.org/wx-files/api/files/1213/content

4 (NZE BR) LCCCA (Cost and Carbon) Tool

To support design teams in implementing the Standard, an Excel-based tool, the (NZE BR) LCCCA (cost and carbon) Tool, has been developed to ensure consistency with regards to analysis and outputs across projects. The tool includes an initial questionnaire for design teams to complete at project initiation. Based on the specific project information, the tool indicates the appropriate Compliance Path and provides instructions for next steps. Compliance path 1 to 6 are included within the tool.

For Compliance Paths 2, 4, 5 and 6 an option analysis is required, including a Life Cycle Cost Assessment (LCCA). The tool runs the LCCA for each option and displays the results in a dashboard with guidance on how to interpret the results. Financial assumptions used in the LCCA are detailed in Appendix A – Financial Assumptions, and will be periodically updated by Peel. To complete the LCCA, design teams must provide:

Annual utility consumption for each option analysed, as derived from energy models.

First costs and replacement costs for the specified intervention(s)

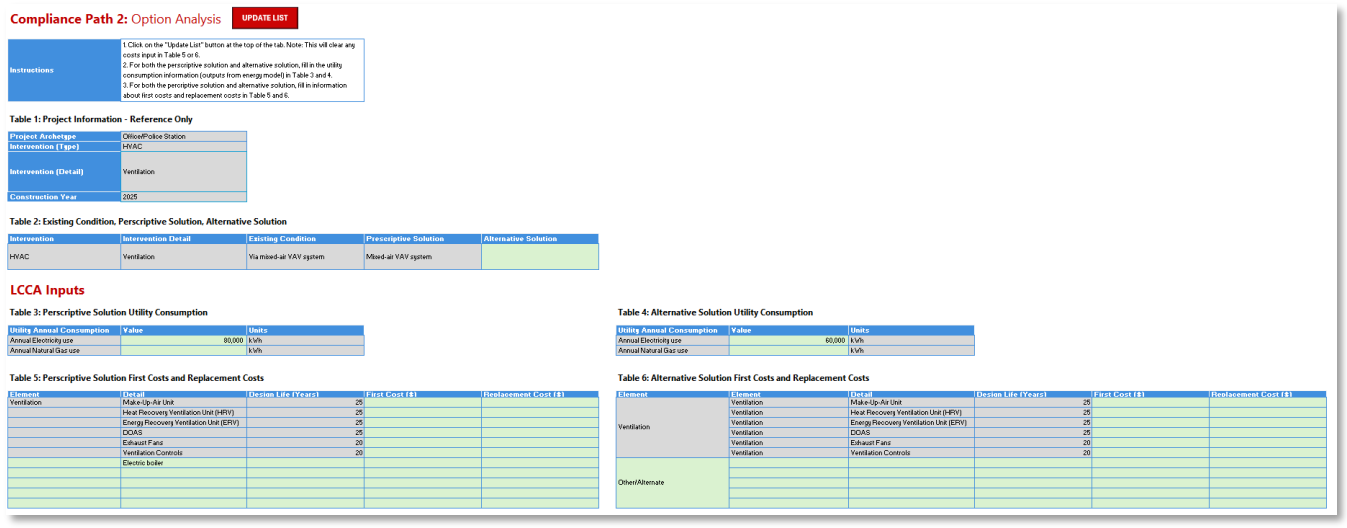


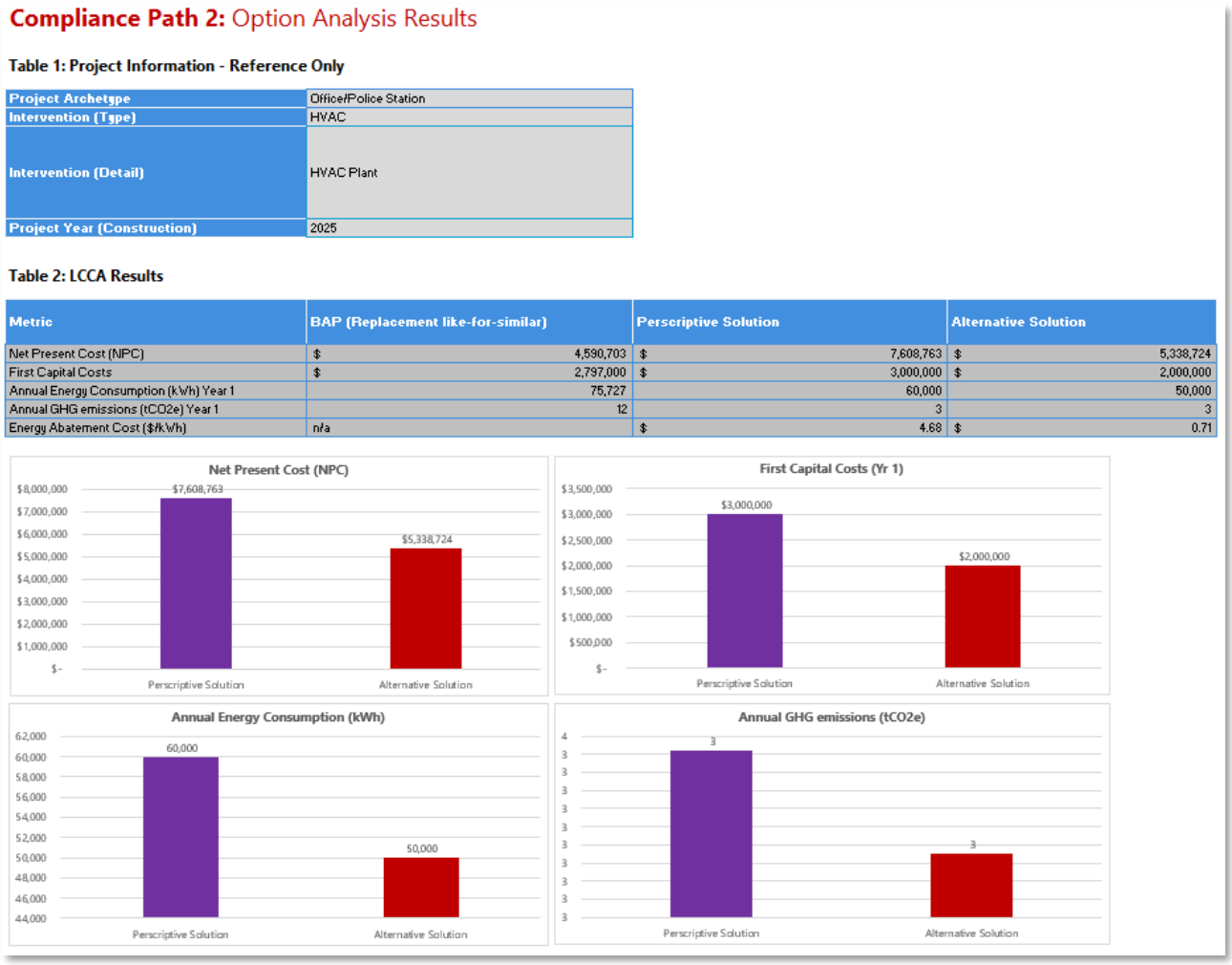
Figure 9: Example Input tab for Compliance Path 2

4.1 Reporting Requirements

4.1.1 Compliance Path 2

Analysis is required for Compliance Path 2. The following metrics are presented in the tool output dashboard and used to assess the comparative performance of the prescriptive solution (Compliance Path 1) and the alternative solution explored. The tool estimates the financial performance of the Business-As-Planned (replacement like for similar) scenario also as reference for the project team.

- Net Present Cost over the analysis period
- First Capital Costs
- Annual Total Energy Consumption (kWh) on implementation of the intervention
- Annual GHG emissions (tCO2e) on implementation of the intervention
- Estimated Energy Abatement Cost ($/kWh) compared to the BAP (replacement like for similar)



Compliance Path 2: Option Analysis Results

Table 1: Project Information - Reference Only

Project Archetype	Office/Police Station
Intervention (Type)	HVAC
Intervention (Detail)	HVAC Plant
Project Year (Construction)	2025

Table 2: LCCA Results

Metric	BAP (Replacement like-for-similar)	Perscriptive Solution	Alternative Solution
Net Present Cost (NPC)	$ 4,590,703	$ 7,608,763	$ 5,338,724
First Capital Costs	$ 2,797,000	$ 3,000,000	$ 2,000,000
Annual Energy Consumption (kWh) Year 1	75,727	60,000	50,000
Annual GHG emissions (tCO2e) Year 1	12	3	3
Energy Abatement Cost ($/kWh)	n/a	$ 4.68	$ 0.71

Figure 10: Output Dashboard for Compliance Path 2

4.1.2 Compliance Path 4

Analysis is required for Compliance Path 4. The following metrics are presented in the tool output dashboard and used to assess the comparative performance of the Reference solution (Compliance Path 3) and the alternative solution explored.

- Net Present Cost over the analysis period
- First Capital Costs
- Annual Total Energy Consumption (kWh) on implementation of the intervention

- Annual GHG emissions (tCO2e) on implementation of the intervention

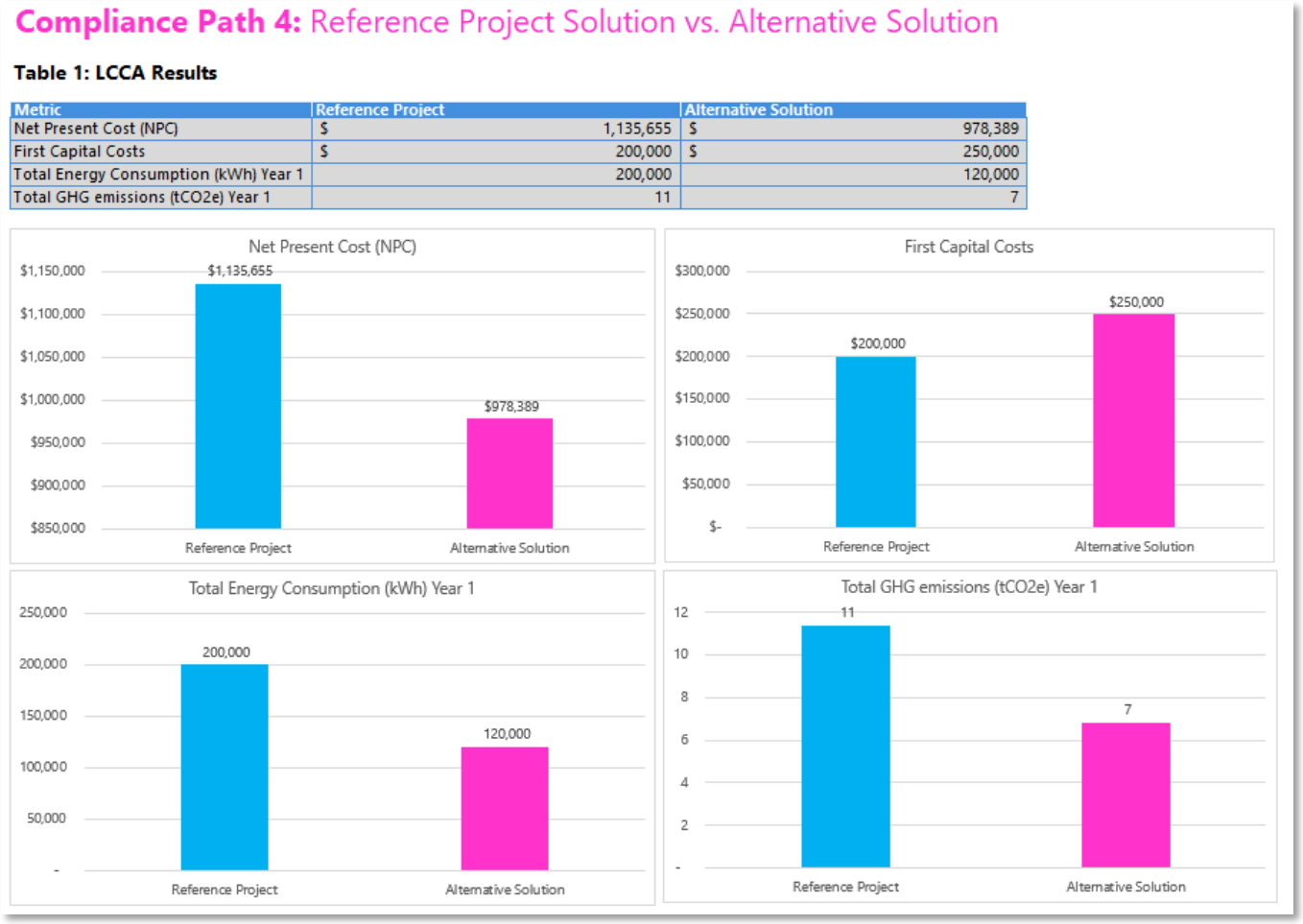


Figure 11: Output Dashboard for Compliance Path 2

4.1.3 Compliance Path 5

Analysis is required for Compliance Paths 5. The following metrics are presented in the tool output dashboard and used to assess the comparative performance of the options.

- Net Present Cost over the analysis period
- First Capital Costs
- Annual Total Energy Consumption (kWh) on implementation of the intervention
- Annual GHG emissions (tCO2e) on implementation of the intervention

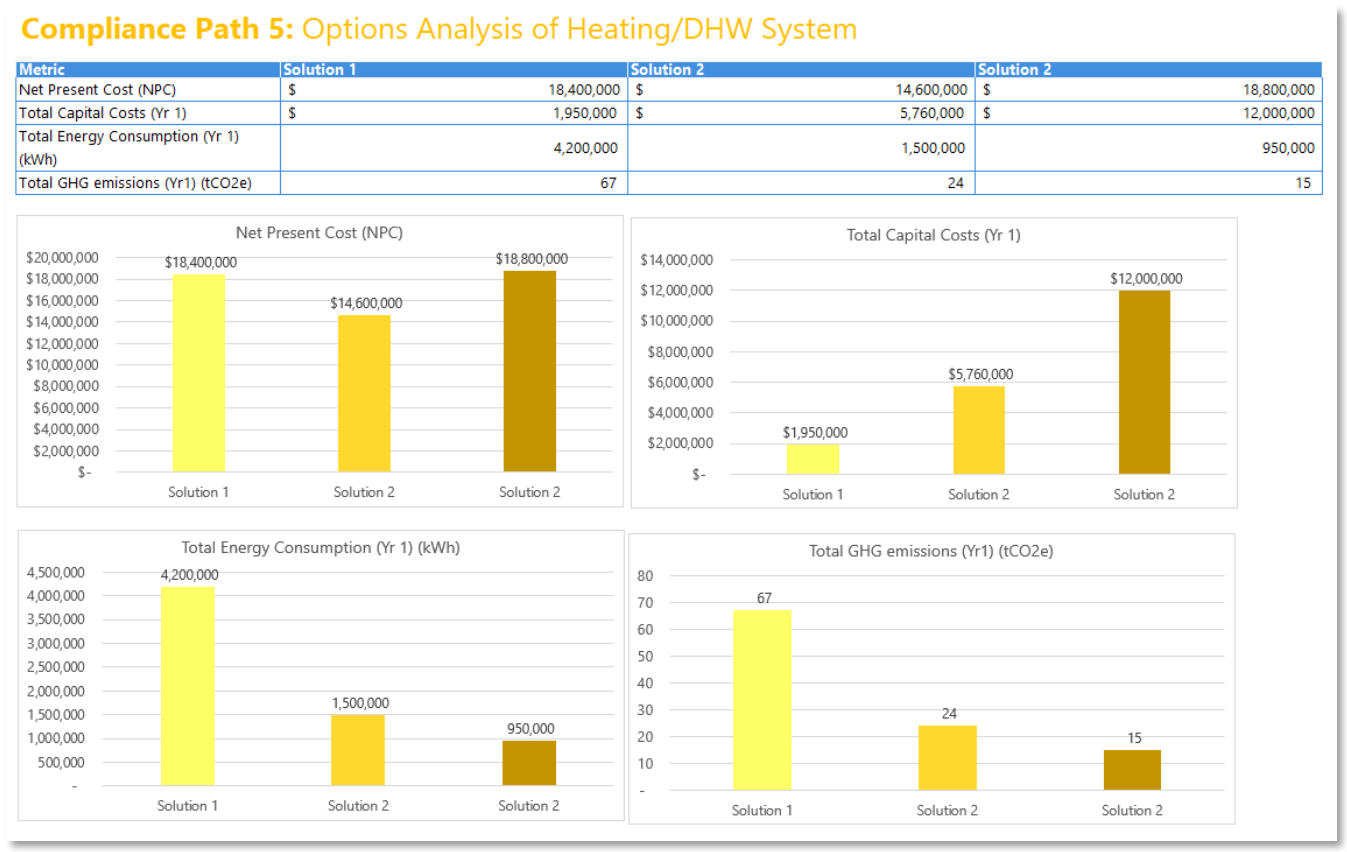


Figure 12: Output Dashboard for Compliance Path 5

4.1.4 Compliance Path 6

Analysis is required for Compliance Paths 6. The following metrics are presented in the tool output dashboard and used to assess the comparative performance of the options.

- Net Present Cost over the analysis period
- First Capital Costs
- Annual Total Energy Consumption (kWh) on implementation of the intervention
- Annual GHG emissions (tCO2e) on implementation of the intervention
- Energy Abatement Cost ($/kWh) compared to the Good (BAP) Solution
    - Incremental NPC compared to the Good (BAP) Solution divided by
    - Incremental total energy consumed compared to the Good (BAP) over the analysis period.

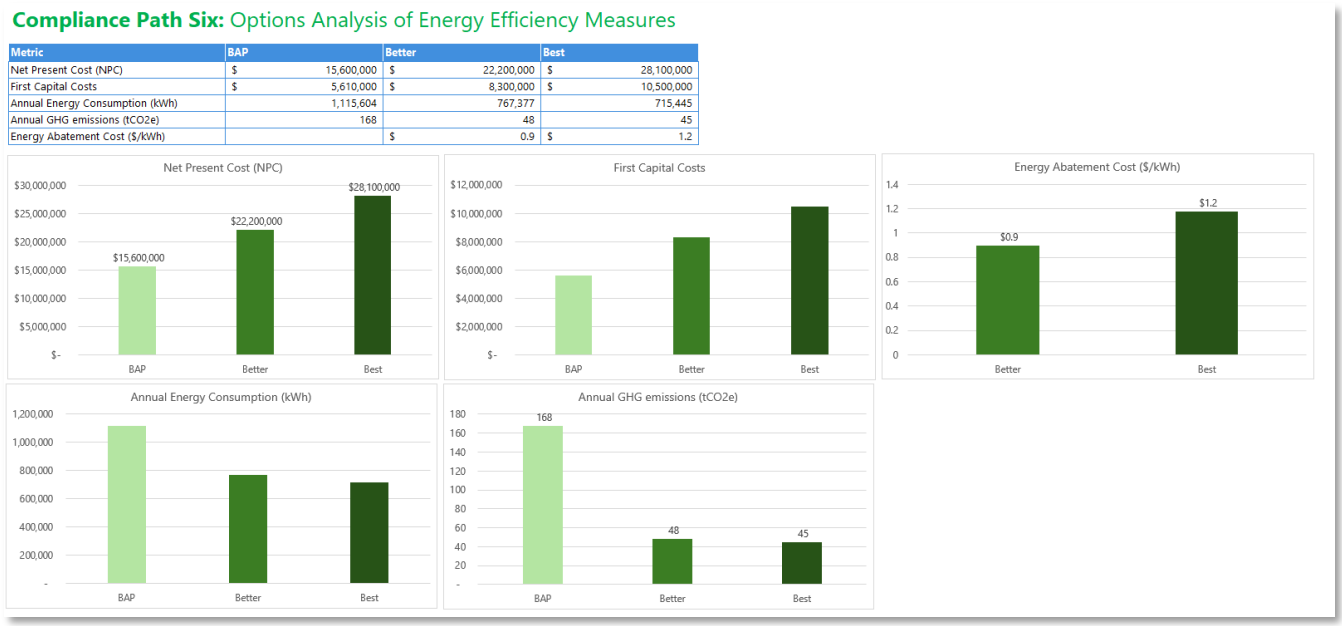


Figure 13: Reporting Requirements for Compliance Path 6

Appendix A – Financial Assumptions

Table 11: Assumed design life for equipment[5]

Element	Design life (Years)
Air Conditioning (A/C) Unit	15
Air Handling Unit	20
Air Source Heat Pump	15
Baseboard	30
Boiler	30
Chiller	23
Cooling Tower	20
Demand Controlled Ventilation (DCV)	15
DHW Boiler	30
DHW CO2 Heat Pump	15
DHW Electric Water Heater	15
DHW Tank	30
Dedicated Outside Air System (DOAS)	25
Electric Boiler	15
Energy Recovery Ventilation (ERV)	25
Exhaust Fans	20
Fans	20
Fan Coil Unit (FCU)	20
Furnace	18
Heat Exchanger	24
Heat Pump Make-Up Air Unit (HP MUA)	25
Heat Recovery Ventilation (HRV)	25
Mini Split	15
Make-Up Air (MUA) Unit	25
Pump	20
Roof	25

[5] ASHRAE. 2024. ASHRAE Equipment Life Expectancy Chart where equipment listed.

Element	Design life (Years)
Radiant Tube Heater (rad tube heater)	25
Electric Radiant Tube Heater	10
Unit Heater	13
Variable Air Volume (VAV)	20
Wall	25
Window	25

Appendix B – Glossary

Carbon Offset: A credit for reductions in greenhouse gas emissions that occur somewhere else and that can be purchased to compensate for the emissions of a company or project. High quality carbon offsets include third party verification of emissions reductions as well as additionality, longevity, and leakage criteria.

Commissioning: A systematic process that documents and verifies that all systems and components of a building are designed, installed, tested, operated and maintained according to operational requirements.

Compliance Path: A designated approach within the Standard that a project must meet to ensure compliance.

Embodied Carbon: Carbon emissions associated with materials and construction processes throughout the whole life cycle of a building.

Energy Modelling: The process of simulating a buildings energy performance using a 3D computational model.

Greenhouse Gases (GHGs): Gases that absorb and emit radiant energy within the thermal infrared range. The accumulation of greenhouse gases in the atmosphere causes the greenhouse effect and contribute to planetary warming and climate change.

HVAC: Heating, Ventilation, Air Conditioning

Life Cycle Cost Assessment (LCCA): A financial analysis to evaluate the total costs of a project over the analysis period. LCCA is a method to assess comparative cost-effectiveness of projects.

Major Renovation refers to any HVAC&R, envelope, and/or interior renovations that require a new certificate of occupancy and/or prevent normal building operations from occurring while they are in process. Proposed changes of use to the building are also considered major renovations.

Net Zero Emissions (NZE): Refer to Zero Carbon Balance

New Construction refers to site preparation for, and construction of, entirely new structures and/or significant extensions to existing structures whether or not the site was previously occupied.

Operational Carbon: The emissions associated with the energy used to operate a building.

Renewable Energy: A source of energy that is replenished through natural process or using sustainable management policies such that it is not depleted at current levels of consumption. Examples include solar and wind energy used for power generation and

solar energy used for heating. Air-source and ground-source (geo-exchange) heat pump systems do not constitute renewable energy systems.

Resilience: The ability and flexibility to maintain critical building operations and functions, in response to climate change and an increase in extreme weather events.

Zero Carbon Balance: When the net emissions associated with embodied carbon, operational carbon and avoided emissions are zero or less over the life of a building.

Zero Carbon Building (ZCB): A highly energy-efficient building that produces onsite, or procures, carbon-free renewable energy [or high-quality carbon offsets] in an amount sufficient to offset the annual carbon emissions associated with building operation.