Disclaimer

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The estimates and recommendations are intended for illustrative purposes only. All calculations and estimates are based on various assumptions that may or may not be accurate in any particular circumstance, and users of the report rely on them at their own risk.
Executive Summary

The Province of British Columbia has issued a request for emission offsets (RFEO) to seek vendors of greenhouse gas (GHG) emissions reductions that can be monetized on a scale of 5,000 tonnes of carbon dioxide equivalent (CO₂e) or more per project, per year, to meet BC’s legislated carbon neutral government commitment. GHG offset projects in the building sector face numerous market barriers despite the fact that many energy efficiency and emission reduction measures are cost-effective due to long-term energy bill savings. This report is designed to explore potential opportunities for the creation of offset projects in the building sector.

Between February and March, 2015, the authors identified and assessed four distinct types of offset opportunities for buildings. Of the four, three were considered viable:

→ Energy upgrades for commercial buildings
→ Fuel oil conversion in houses
→ Energy upgrades for multi-unit residential buildings

Preparing this report involved the following steps:

1) Clarifying the size and types of buildings influenced by prospective GHG offset proponents.

2) Estimating the energy savings and costs associated with emission reduction measures under scenarios that look at variables such as level of reductions, types of buildings, and geographic locations.

3) Ascertaining, through interviews with key potential proponents, the level of GHG offset subsidy needed to achieve emission reductions by addressing market barriers.

4) Determining the province-wide potential for GHG offset projects in terms of number of houses or floor area of commercial and multi-unit residential buildings.

5) Accounting for GHG offset validation, verification, and other “transaction” costs required for compliance with the Emission Offset Regulation (EOR).

6) Estimating cost per tonne of CO₂e emission reductions and payback periods.

7) Reviewing alignment with the portfolio objectives for the BC government’s RFEO and the EOR.

The results of the analysis for each project opportunity are outlined below.

Opportunity #1: Energy Upgrades for Commercial Buildings

This opportunity is based on making use of existing infrastructure for tracking and verifying energy use through the Building Owners and Managers Association’s (BOMA) BESt program, an environmental sustainability and energy management certification program for existing buildings in Canada. BOMA BESt has approximately 220 buildings registered in BC and requires certification with an independent verification service provider every three years.
→ Quantification

→ One potential method of quantifying offsets is a performance standard baseline with standard normalization factors that could be applied to ongoing energy consumption data. Energy data could be collected by the proponent’s data tracking systems (e.g., BOMA BESt data collection) or by using tools such as the ENERGY STAR® Portfolio Manager to measure annual emissions against performance standards. Historic performance could be an alternative method for determining the baseline against which incremental reductions would be calculated.

→ A standard baseline could be informed by provincial data consolidation through the Tract and Neighbourhood Data Modelling (TaNDM) project to identify appropriate groupings and normalization factors. Because of considerable variation between building design and other factors that influence energy consumption, developing acceptable, conservative performance standards by class, building characteristics, location, and other factors would take significant up-front effort and costs. One or more performance standards or specified approaches to establishing valid historic baselines could be designated by the BC Government, thereby reducing individual offset project validation costs. Only the Program of Activities (PoA) project plan would need to be validated, and ongoing verification could be simplified.

→ Regulatory Analysis (EOR compliance):

→ Ownership – The utility customer could be a landlord, property manager or tenant – and the ownership of offsets needs to be formally transferred to the proponent.

→ Project Justification – Other market barriers such as the focus of the building owner, split incentives, potential inability to monetize benefits at the time of sale, and high discount rates on capital investments are pervasive and greatly reduce the viability of implementing energy retrofit projects. This report also evaluates financial obstacles associated with these projects. It finds that retrofits that would achieve a 50% GHG emissions reduction face clear economic barriers to project adoption, in addition to other market barriers, and retrofits that would achieve a 25% emissions reduction may also face market barriers.

→ Verification – Project proponents might be able to use a single independent verifier to achieve both BOMA BESt certification and offset verification requirements under the BC Emission Offsets Regulation (EOR) to reduce transaction costs. This is dependent on expanding the scope of the current BOMA BC-contracted verifier for BOMA BESt to verify emission reductions below the baseline under the offset PoA, in concert with an ISO 14065-accredited offset verification body.

→ Proponent Capacity: To ensure cost-effectiveness, offset project proponents would need to aggregate a large number of buildings (~200) under a PoA. A proponent would be required to administer the PoA, including aggregating buildings into the program at different points of time over the life of the project.

→ GHG Offset Potential: 11,000 to 16,000 tonnes of CO₂e per year, after achieving full participation. Within the context of a 10-year validation/crediting period, some buildings may not achieve 10 full years of emissions reductions due to the time lag
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between the start of the validated PoA and the implementation of the emission reduction activity for specific buildings. If desired by the proponent and government, a second validation period could be initiated to ensure that the entire pool of buildings would be eligible to receive offset payments for 10 years.

→ Estimated GHG Offset Costs (including project management, validation and verification): $33/tonne for a 25% reduction and $70/tonne for a 50% reduction over historic GHG emissions.

Opportunity #2: Fuel Oil Conversion in Houses

This opportunity is based on the Home Energy Rebate Offer (HERO) program administered by BC Hydro and FortisBC, with a potential expansion to include oil-heated houses. Oil-to-electric conversion is economically attractive to homeowners.

→ Quantification
  → A performance standard baseline with standard normalization factors such as climate zone, size, type of house, and occupancy, verified by HERO energy advisors.

→ Regulatory Analysis (EOR compliance):
  → Ownership – The individual homeowners need to transfer offset ownership to the project proponent.
  → Project Justification – This is a challenging prospect given the strong economic drivers for fuel switching from oil to natural gas/electricity, coupled with pressure from insurance companies to change uncertified oil tanks and existing fuel switching incentive programs administered by FortisBC (oil-to-gas conversions) and the Innovative Clean Energy (ICE) Fund (oil-to-electric conversions). However, the project is justifiable for houses that have updated oil tanks (i.e., those who would not need to switch for house insurance). Furthermore, a shortened 5-year offset payment period could be used to reduce the risk that a business-as-usual fuel switch would have occurred part way through the standard 10-year validation/crediting period, undermining the project justification.
  → Verification – Ongoing monitoring of individual houses would be avoided, monitoring each home would be cost-prohibitive and generally impractical; rather, emission reductions would be established based on deemed savings for replacing an oil furnace with a heat pump.

→ Proponent Capacity: An electric utility could have the capacity to administer an offset project. An alternative proponent is the contractor who is administering the ICE Fund incentive.

→ GHG Offset Potential: 62,000 tonnes CO₂e per year for this project opportunity in BC, after achieving full participation.

→ Estimated Emission Offset Costs (including project management, validation, and verification): $26/tonne CO₂e.
Opportunity #3: Energy Upgrades for Multi–Unit Residential Buildings

This opportunity is based on encouraging energy/emissions upgrades at the time of residential building renewals that occur at the time of replacing major building components such as windows, boilers, roofs and cladding. The GHG offsets will help address prevalent market barriers, despite the strong economic rationale for upgrades.

→ Quantification
  
  → One potential option for quantification is to use a performance baseline with standard normalization factors that could be applied to ongoing energy consumption data using tools such as the ENERGY STAR Portfolio Manager. Given the need for a large number of buildings (400+) to be aggregated, a performance standard baseline or a specified approach to establishing a valid historic baseline could be adopted. A standard baseline could be informed by provincial data consolidation through the TaNDM project to identify appropriate groupings by specified characteristics and normalization factors. One or more performance standards or specified approaches to establishing valid historic baselines could be designated by the BC Government, thereby reducing project validation costs. The performance standards would also be based on the condition and anticipated replacement of major energy–consuming components. Only the PoA project plan would need to be validated, and ongoing verification would be simplified.

→ Regulatory Analysis (EOR compliance):
  
  → Ownership – The utility customer could be a landlord, condo owner, strata corporation, property manager, or tenant—and the ownership of offsets needs to be formally transferred to the proponent.
  
  → Project Justification – Other market barriers such as building owner focus, split incentives, potential inability to monetize benefits at time of sale, and high discount rates on capital investments are pervasive and greatly reduce the implementation of energy retrofit projects. The study also evaluated financial obstacles faced by these projects. It found that retrofits that would achieve a 50% emissions reduction face clear economic barriers to project adoption in addition to other market barriers. Those targeting a 25% reduction face market barriers.
  
  → Verification – The project proponent could collect normalized energy consumption data through tools such as ENERGY STAR Portfolio Manager for all participating buildings and relate that to the validated performance standard baseline to calculate emissions reductions, which could then be verified.

→ Proponent Capacity: Pre–existing staffing in–place and interest by BC Non–Profit Housing Association (BCNPHA). Landlord BC and the Condominium Home Owners Association are also potential proponents.

→ Estimated GHG Offset Potential: 17,000 – 26,000 tonnes CO₂e per year, after achieving participation of 10% of the potential pool of participants. Within the context of a 10 year validation/crediting period, some buildings may not achieve 10 full years of offsets due to the time lag between the start of the validated program of activities and the emission reduction activity for specific buildings. Similar to opportunity #1, if desired by the proponent and government, a second validation period could be
Executive Summary (continued)...

initiated to ensure that the entire pool of buildings would be eligible to receive offsets payments for 10 years.

→ Estimated Emission Offset Development Costs (including project management, validation and verification): $29/tonne of CO₂e for a 25% reduction and $30/tonne of CO₂e for a 50% reduction over baseline.

Other Benefits

The proposed offset opportunities provide significant co-benefits, namely:

→ Reduced building energy costs and improved housing affordability and business competitiveness.

→ Improved building occupant comfort and health due to reduced drafts, cold spots, mould, and increased fresh air intake with heat and energy recovery ventilators.

→ Improved building durability.

→ Potential for increased building resale value.

→ Significant BC-based jobs, particularly in the cleantech industry that provide a wide-range of products, services and design solutions.

Recommended Next Steps

Based on the analysis conducted and presented in this paper, the following three steps are recommended to enable GHG offset providers to develop project that align with the noted opportunities, or others in the buildings sector.

→ Consider developing performance standard protocols to define the emission baselines for key sectors. This could be informed by full implementation of the TaNDM project, as it would provide high-quality information on energy use and emission intensity by building type and region.

→ Pilot the use of performance standards for individual buildings. Revise the protocols to reflect lessons learned.

→ Release revised protocols and designate them as compliant with the appropriate Emission Offset Regulation, if appropriate.

These recommendations may stimulate investment in emissions reductions in buildings and monetizing GHG offsets in a manner that is aligned with the stated objectives of the Ministry of Environment under the RFEO.
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1 Background

1.1 Carbon Neutral Government and Emission Offsets Regulation

British Columbia has shown leadership in climate action through its commitment to carbon neutrality. The Greenhouse Gas Reduction Targets Act requires the Province of BC and other public sector organizations to measure their respective greenhouse gas (GHG) emissions, to pursue actions to reduce GHG emissions, to report their emissions, and then to annually net the remaining emissions to zero through the purchase of BC–based emission offsets.

The Emission Offsets Regulation (EOR) provides the framework for offsetting emissions to achieve carbon neutrality, supplementing extensive efforts to directly reduce emissions from energy consumption in buildings, vehicles, business travel, and waste (paper diversion). The BC Green Building Protocol provides a template for developing offset projects from buildings.

1.2 Request for Emission Offsets and Portfolio Objectives

The Province of British Columbia has issued a request for emission offsets to seek vendors of GHG offsets on a scale of 5,000 tonnes CO₂e per year per project/program or more to meet BC’s legislated carbon neutral government commitment.

1.2.1 Strategic Portfolio Objectives

The request for emission offsets lists four strategic portfolio objectives, namely:

1) Prioritize low–cost projects that demonstrate and achieve the greatest value.

2) Address key provincial emission reduction challenges in the industrial sectors.

3) Build clean community infrastructure, including green buildings.

4) Achieve key government objectives, aligned with the BC Climate Action Plan, the Technology Strategy, and/or the BC Jobs Plan, including:

   → Advancing clean technology (new or novel technology that delivers functionally equivalent goods or services while reducing greenhouse gas emissions relative to industry common practice).

   → Transforming BC to a green economy (e.g., renewable energy, green building, clean transportation, water management, waste and pollution control, and land and resource management).

1.2.2 Market Barriers

Offset project development in the building sector faces numerous market barriers, despite the fact that some energy efficiency and emission reduction measures are cost–effective over the long term. These include, but are not limited to:

→ Split incentives between building owners and occupants, depending on who pays the energy bills. When occupants pay energy bills, the owner doesn't have an incentive to
invest in energy efficiency upgrades. Furthermore, occupants are generally not willing to pay for emission reduction upgrades if the length of their tenancy is unknown.

- Lack of information on comparative energy performance of similar buildings (e.g., office, apartment, condominium, retail), translating to a lack of valuation of energy performance in the pricing of real estate (for sale, lease).
- Lack of general awareness of comprehensive emission reduction options among building owners and managers.
- Short-term financial perspective on building upgrade investments translating into high discounting of future benefits and a reduced willingness to invest capital.
- The cost of energy efficiency upgrades leading to emission reductions is borne at the time of construction, whereas financial benefits in energy savings accrue over time.
- Limited service industry capacity to deliver energy efficiency and emission reduction technologies outside the Lower Mainland and southern Vancouver Island (with some exceptions).
- Lack of understanding of the long-term (e.g., 20 to 50 years) financial impact of building design and upgrades with unknown future environmental externalities and emissions pricing, particularly in the context of the legislated target of an 80% reduction in emissions by 2050.

This report is designed to explore effective approaches to offset project development in the buildings sector.

1.3 Sources of Emissions from Buildings

Direct emissions from buildings in the residential, commercial, institutional, and manufacturing sectors were 11 megatonnes of CO₂e in 2012, representing about 18% of BC’s total emissions (Ministry of Environment, 2012). (This excludes emissions from electricity generation, which are relatively small due to BC’s hydroelectric-dominated grid. In some urban areas such as the City of Vancouver, these sectors produce the majority of emissions (54%) (Government of B.C., 2010). Figure 1.1 highlights the proportion of emissions from various building subsectors, excluding manufacturing (Natural Resources Canada, 2015). This research project aims to identify opportunities for reducing emissions in the four largest categories: single detached houses (42%), offices (13%), apartments (9%), and retail (6%).
Figure 1.1 British Columbia Greenhouse Gas Emissions from Buildings by Sector
2 Research Framework

2.1 General Approach
This research project is based on a three-pronged approach:

1) Identify types of emission reduction opportunities and potential proponents that are in a position to aggregate emission reductions across multiple buildings and capable of generating greater than 5,000 tonnes of CO2e per year. In total, four broad types of opportunities were identified, including three outlined in this report and the fourth in Appendix 1.

2) Prepare an inventory of the identified emission reduction opportunity types, taking into consideration the magnitude of the building stock they influence.

3) Assess potential offset opportunities based on benefits and costs of emission reductions, compliance with the EOR, and perspectives of key stakeholders.

This final report includes the following three components:

→ A summary of leading emission offset opportunities
→ A companion spreadsheet with analysis of benefits and costs of opportunities
→ A preliminary timeline for implementation

We consider the three opportunities contained in this report to have potential, whereas a fourth, local, government-led opportunity (Appendix 1) was not included due to substantive barriers regarding offset ownership, aggregation, influence over building owners and high anticipated GHG offset validation and verification costs.

2.2 Research Questions
This project aims to address the following research questions:

→ Are offsets a cost-effective incentive to reduce GHG emissions in buildings?
→ Which building sectors and sources of emissions have the greatest potential for emission reductions?
→ Who are the prospective offset project proponents?
→ What types of emission reduction measures (ERMs) are technically feasible?
→ What are the benefits and costs of the ERMs, with and without offsets?
→ What are the options for a Program of Activities (PoA) to achieve the emission reductions?
→ What are the projected emission reductions when a PoA is aggregated across multiple buildings?
→ What are the perspectives of key stakeholders on these offset project opportunities?
→ What are the quantification and measurement options for emissions reduction projects in buildings?
What are the validation and verification requirements for compliance with the applicable regulations?

What are the potential market transformation benefits to BC’s clean technology industrial sector?

2.3 Methodology

Preparing this report involved the following steps:

1) Clarifying the size and types of buildings influenced by prospective proponents

2) Estimating the energy savings associated with emission reduction measures under scenarios that look at variables such as level of reductions, types of buildings, and geographic locations

3) Ascertainning, through interviews with key potential proponents, the level of offset subsidy needed to achieve emission reductions by addressing market barriers

4) Determining the province-wide potential for offset projects in terms of number of houses or floor area of commercial and multi-unit residential buildings

5) Accounting for offset validation, verification, and other transaction costs required for compliance with the EOR

6) Estimating cost per tonne of CO2e emission reductions and payback periods

7) Reviewing alignment with the Province’s Request for Emission Offsets portfolio objectives

This report provides the following project background information:

- Building-specific metrics
  - Baseline emissions
  - Potential emission reductions
  - Estimated cost for emission reductions: Capital $/m² and Life Cycle $/tonne CO2e as well as a discounted payback period
  - Offset value

- Building stock potential

- Provincial emission reduction potential
  - Emission reduction measure costs
  - Offset project costs
  - Validation
  - Verification
  - $/tonne CO2e average

- Types of clean technology companies that could benefit from increased offset development in the building sector
2.4 Data Sources

The key building stock data sources are:


- BC Assessment database to determine the number of buildings over 100,000 ft² within the sub-sectors that participate in the BOMA BESI certification program.

- Utility studies on end-use consumption for various sectors of commercial buildings. These are statistical studies that show the average consumption for space heating, water heating, lighting, plug loads, etc., of various market segments (office, retail, multi-unit residential buildings).

- British Columbia Building Performance Study (2014).


- NRCan national energy use database for provincial energy performance by building type.


For a complete list of sources see the bibliography in section 8.2.
3 Offset Opportunity #1 – Energy Upgrades for Commercial Buildings

3.1 Prospective Proponents

One or more of the following proponents could be in a position to develop an Offset Project Information Document (PID):

→ Building Owners and Managers Association of BC (BOMA BC)
→ Canada Green Building Council (Leadership for Energy and Environmental Design – LEED for New Construction or Existing Buildings)
→ Private offset project aggregators

3.2 Project Background

Commercial buildings present a range of opportunities for enhancing energy efficiency. However, they have generally been challenging to incorporate into offset projects because aside from the largest buildings and most aggressive efficiency measures, an individual building-by-building approach results in relatively modest reductions that are not cost-effective to convert into offsets. Nonetheless, given the overall size of the sector, significant gains in emission reduction volume would be achieved if buildings are grouped together, and the associated economies of scale associated with GHG monitoring, quantification, reporting and verification (MQRV) could help make generation of offsets more cost-effective.

Organizations such as the Building Owners and Managers Association of BC (BOMA BC) and BOMA Canada present a further opportunity with programs such as the BOMA BES certification program that currently has about 220 buildings registered in BC as of February 2015 in the following geographic locations:

→ Capital Region → Kamloops
→ Courtenay → Metro Vancouver
→ Cranbrook → Nanaimo
→ Fraser Valley → Prince Rupert

Under BES Certification Levels 2, 3, and 4, program participants are required to track and report their energy use intensity (EUI), which could be translated to GHG emissions, because the fuel mix (e.g., electric, gas, steam, district energy) is also provided. The average EUI is published for each building type in BC, including:

→ Office → Open air retail
→ Light industrial → Multi-unit residential buildings (MURBs)
→ Enclosed shopping centres

Program participants are required to re-certify every three years, enabling a comparison between periods. Importantly—since these buildings are already undergoing a
certification process by independent professionals, with associated data monitoring every three years—much of the data likely needed to quantify GHG offsets is already being gathered and evaluated, including data that might also prove useful for developing performance standards, as discussed in the next section.

As illustrated in Table 3.2, there are a number of building sizes enrolled in BOMA BEST, but the average building size is approximately 100,000 sq ft or larger.

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<td>Smallest sq ft</td>
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<td>----------------</td>
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<tr>
<td>Open Air Retail</td>
</tr>
<tr>
<td>Office</td>
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<tr>
<td>Industrial</td>
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<tr>
<td>Enclosed Shopping Centre</td>
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3.3 Program of Activities – Energy Efficiency and Fuel Switching

Programs of Activity (PoAs) involve the aggregation of many different individual project locations of a similar type into a single offset project, with new locations being able to be added to the project over time as they are identified and reduction activities undertaken. Such approaches enable standardization of monitoring, quantification, reporting across all individual locations, and permit validation and verification (MQRV) of the PoA as a whole, rather than conducting separate MQRV for each individual project location (at significant extra cost). Development of a PoA for this offset project opportunity could enable the aggregation of 150 to 200 buildings (gradually identified and incorporated into the project over a specified initial period (e.g., three years) during a 10-year validation/crediting period. The PoA could be revalidated prior to the end of the 10-year period to enable late entrants to generate at least 10 years of emission reduction offsets from when they entered the program.

The scope of participating buildings could include the same five segments covered within the BOMA BEST program, namely office, light industrial, enclosed shopping centres, open–air retail, and multi–unit residential buildings. Note that office and retail represent the largest source of commercial building emissions in BC (refer to Figure 1.1). Buildings fully occupied by BC public sector organizations and Climate Action Charter signatories would be excluded because they do not qualify under the EOR (because they are already required to reduce emissions under the province’s carbon-neutral commitment). Note that BOMA BEST also includes public health care facilities, although these would be excluded from an offset project due to the Carbon Neutral Government legislation that retires all associated emissions reductions such that they can’t be monetized and sold.

To minimize transaction costs per unit of emission reduction, the PoA could focus on larger properties of over 100,000 sq ft with one or multiple buildings, focusing initially on BOMA BEST participants and major new construction projects.
The building owner would undertake a deep energy retrofit, including one or more of the following ERMs that would reduce natural gas consumption by at least 25%:

→ Building envelope thermal improvement (reduced thermal losses with new windows, wall, roof, and foundation insulation, reduced thermal bridging)
→ Building envelope airtightness improvement, measured through whole-building airtightness testing
→ Natural gas boiler, water heater, make-up air unit replacement
→ Renewable energy use for space and water heating such as renewable natural gas (subject to clarification of offset ownership), solar hot water, district energy, geoxchange
→ Retro-commissioning and improved building energy system controls and management
→ Increased occupant engagement in behavioral conservation measures through metering, social marketing, and other approaches.

New buildings that are designed and constructed to enhanced energy efficiency levels and that are using low or zero-carbon fuels would also be eligible to participate, using the BC Building Code or a related performance benchmark as the baseline. Eligibility criteria would align with the selected baseline and validation protocols, as noted below. The schedule for this project would be as follows:

→ **Year 0:** The PoA is designed and the offset project is validated by an ISO 14065–accredited third party (validation body). It is likely that some initial participant buildings would be included at this stage.

→ **Years 1 to 3:** The project proponent continues securing participant buildings for aggregation. Baseline data (ideally leveraging a performance standard, see below) are confirmed via BOMA BESt (or equivalent) independent verification body. Previously certified buildings could be exempted from this step if data are already available. This does not constitute verification of offsets.

→ **Years 1 to 6:** Deep energy retrofits are completed for existing buildings. New construction buildings demonstrate energy performance in operations. Buildings obtain required BOMA BESt (or equivalent) recertification every three years to verify post-retrofit EUI. The goal is to achieve 10 years of emission reductions from the completion date of the retrofits, in some cases entering a second validation/crediting period. The latest entrants will complete 2 stages of BOMA BESt certification over a 6-year period.

→ **Years 1 to 10:** Operation of upgraded buildings achieves emission reductions. Buildings have been recertified periodically under BOMA BESt (or equivalent). An accredited verification body completes first assurance verification of emission

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1 Electricity savings would not be the focus of a GHG offset program given the low grid emissions factor in BC.

2 Emission reductions from the purchase of renewable energy accrue to the gas meter owner that is displacing natural gas emissions. In conversation with FortisBC, the gas utility does not require transfer of ownership in return for incentives.
reductions to create saleable carbon offsets at some point during this period and then conducts repeat verifications at the desired frequency. Offset payments are generated according to PoA guidelines.

→ **Year 10:** The PoA is revalidated for a second 10-year crediting/validation period. The goal is to enable each individual building to generate 10 years of emission reduction offsets from the date of the retrofit during the first validation/crediting period and into the second. The initial emission reduction report for the project would be submitted. It is recognized that revalidation carries some risk, as baseline and project justification considerations may have change since the date of the initial validation, which may reduce the volume of offsets that can be generated during a second validation period.

### 3.4 Quantification and Measurement

Given that this project opportunity could involve a wide range of different ERMs, with fewer or greater numbers of ERMs being applied in any given building, a whole-building approach to quantifying emission reductions would be taken (Option B from the BC Green Building protocol, Version 1.0).

The PoA would be built around registration with the national BOMA BESst program (or other program), with the Program of Activities being administered by BOMA BC, including engaging the services of an independent verifier that would verify the EUI and other details necessary both for evaluation under the certification program and for generating GHG offsets.

#### 3.4.1 Baseline Approach

Where a large number of buildings are involved, especially where the buildings individually have a relatively small area (low square footage), a cost-effective approach to determining baseline emissions is required. This report has identified two potential approaches:

→ **A weather-normalized historic baseline**

→ **A performance standard calculated on the basis of established emissions intensity for each class and use of building** (e.g., tonnes CO2e / m² / year).

The advantage of the historic baseline approach is its custom applicability to each individual building and the standard practice of collecting energy data for the planning and evaluation of proposed energy retrofits, easily extended to calculating CO2e emissions for an offset project. The challenge in using the historic baseline approach is that each individual building would have a unique baseline that would need to be separately justified and validated.

The advantage of the performance standard approach is that the program of activities could be validated once using a conservative baseline that is aligned with project justification objectives. Furthermore, verification of emission reductions is easily demonstrated for individual buildings that simply need to be less carbon intensive than the established performance intensity level.

Since there can be considerable variation between building designs and complexity in factors that influence energy consumption in buildings, developing acceptable,
conservative performance standards would likely require the development of performance standard intensities for various building classes as well as additional factors such as climate zone (Zone 6 in British Columbia), size category, age, window-to-wall ratio and heating, ventilation, and air-conditioning (HVAC) system typology. While development of a comprehensive set of baseline performance standards would increase the up-front cost of starting a project/PoA, it may also serve to reduce costs over the life of the project. An ideal approach would be to develop a set of BC-wide performance standards that would apply to all GHG offset projects for buildings and could be added to the BC Green Building Protocol. This approach could help spread costs among various project activities and would ensure that a standardized approach is used across all building projects.

The alternative—a building-specific approach—would likely require the use of historic building data coupled with consideration of the serviceable life of any existing building systems that would need upgrading in the absence of a GHG offset project. There may also need to be building-specific assessments of barriers to implementing the ERMs to satisfy the BC EOR’s project justification requirements. Each project would require validation on a building-by-building basis.

To set valid baselines, it would also be important to account for key factors external to the ERMs, such as how weather—e.g., heating degree days (HDDs)—and occupancy levels can affect baseline energy consumption.

Both the performance standard and building-specific approaches would require some adjustment of annual baseline emissions to account for these factors. For example, if using a performance standard, the actual occupancy rate in each year for a given building would likely need to be used to update the performance standard to better reflect what would have occurred in that year in the absence of the project (less occupancy typically results in less energy use in both the baseline and project scenario).

The Ministry of Environment has embarked on a building energy benchmarking initiative called TaNDM (Tract and Neighbourhood Data Modelling) that could provide the necessary data to develop a performance standard for various building types. TaNDM aims to combine BC Assessment, FortisBC, and BC Hydro datasets for all buildings in BC to establish energy use intensity. These data could be normalized for climate conditions and categorized by building type for use in the development of offset projects. Data privacy could be protected by reporting aggregated information by building type and climate zone (Zone 5 in British Columbia).

3.4.2 Measurement Approach

Assuming a performance standard baseline approach is used but excluding data needed to initially establish the performance standards, key parameters to be measured on a building-specific basis include:

- Baseline energy use and emissions:
  - Building area m² (assessed only once at the beginning of the project, unless there is a building expansion)
  - Local weather (e.g., HDDs, etc., taken from official weather data)
  - Other data potentially needed (e.g., occupancy, etc.) to adjust the baseline emissions intensity each year based on factors external to the ERMs
→ Project energy use and emissions:
  → Quantities of each type of energy used by the building based on utility meter readings/bills
  → Confirmation that any replaced equipment, if applicable, is not resold or reused to ensure emissions do not increase outside the project

Where the buildings in question are already part of an existing environmental performance certification process (e.g., BOMA BEST), most of the information noted above would already have been collected.

Furthermore, in many cases these data are collected through a consistent tool such as the ENERGY STAR Portfolio Manager that already provides energy data normalization around key factors that affect energy consumption and GHG emissions.

3.4.3 Alignment with Protocol

The approach of a performance standard baseline with measured data for post-retrofit emissions aligns with the requirements of the BC Green Building Protocol.

3.5 Emission Reduction Potential and Financial Analysis

The tables below outline the emission reduction potential that could be achieved by current BOMA BEST participants. Given that some of those buildings house public sector organization offices, full realization of this potential would require new construction, and/or new (private sector) entrants to the BOMA BEST program. This level of emission reductions is very conservative relative to the province–wide potential for commercial buildings, given that BOMA BEST participants represent only 3% of the total commercial floor space area in BC. (Source: NRCan 2011 National Energy Use Database).

Table 3.3 outlines the estimated impacts of offsets per square meter of floor space for the Lower Mainland and Vancouver Island regions. These estimates are based on the actual energy consumption of buildings in the BOMA BEST program and the average electricity and natural gas fuel mix for the commercial sector based on the 2014 BOMA BEST Energy and Environment Report.

RDH estimated the incremental capital costs necessary to achieve the two targeted emission reductions based on research for BC Hydro for office building upgrades for new construction. While existing building retrofit costs can differ from new construction, these estimates are reasonable if applied at the time of existing building renewal. The emission reduction measures were as follows:

→ The 25% scenario was focused primarily on building enclosure measures (added insulation, window replacements, and reduced air leakage) that could be undertaken in conjunction with a seismic or durability upgrade;

→ The 50% scenario focused on measures such as additional mechanical system upgrades of new HVAC systems, fan–coils with dedicated outdoor air system (DOAS), energy recovery ventilators, and demand–controlled ventilation. This is a fuel switching measure from gas to electricity for space heating.

The cost per tonne of CO₂e emission reduction was calculated for both capital cost scenarios, assuming a 10-year offset validation/crediting period and estimating the value
of discounted energy savings over 15 years. The targeted offset value was set at 15% of the incremental capital cost, aligned with many utility demand-side management program rebate levels\(^3\). This is intended to represent the sweet spot for a subsidy whereby consumers make emission reduction investments that they would not otherwise make. Further sensitivity analysis on this and other factors could be completed with the spreadsheet provided by RDH.

The simple payback periods were calculated, with and without the offset payment. The results illustrate that the 25% emission reduction scenario is cost-effective without an offset, demonstrating negative costs (positive financial benefits) and 5–9 year paybacks (without offsets). However, as noted earlier, nonmarket barriers such as barriers to adopting new technologies are prevalent and the offset could be considered justifiable.

**TABLE 3.3 – EMISSION REDUCTION AND OFFSET POTENTIAL PER M2 FLOOR AREA – COASTAL REGIONS**

<table>
<thead>
<tr>
<th>Sub-Measure</th>
<th>Baseline Emissions</th>
<th>Emission Reduction</th>
<th>Capital Cost - Low</th>
<th>Capital Cost - High</th>
<th>$/Tonne (Net of Benefits) - Low</th>
<th>$/Tonne (Net of Benefits) - High</th>
<th>Target Offset Value</th>
<th>Payback Period w/o Offsets</th>
<th>Payback Period with Offsets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Mainland and southern Vancouver Island (Climate Zone 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office - 25% gas reduction</td>
<td>16.2</td>
<td>3.5</td>
<td>$3.00</td>
<td>$5.00</td>
<td>$86.24</td>
<td>$29.45</td>
<td>$17.04</td>
<td>6.43</td>
<td>5.47</td>
</tr>
<tr>
<td>Office - 50% gas reduction</td>
<td>16.2</td>
<td>7.0</td>
<td>$13.00</td>
<td>$17.00</td>
<td>$13.14</td>
<td>$353.87</td>
<td>$53.24</td>
<td>20.11</td>
<td>17.09</td>
</tr>
<tr>
<td>Industrial - 25% gas reduction</td>
<td>15.2</td>
<td>4.9</td>
<td>$3.00</td>
<td>$5.00</td>
<td>$110.72</td>
<td>$70.25</td>
<td>$12.14</td>
<td>4.59</td>
<td>3.93</td>
</tr>
<tr>
<td>Industrial - 50% gas reduction</td>
<td>15.2</td>
<td>7.6</td>
<td>$3.00</td>
<td>$5.00</td>
<td>$312.58</td>
<td>$157.50</td>
<td>$40.05</td>
<td>18.33</td>
<td>15.75</td>
</tr>
<tr>
<td>Retail - 25% gas reduction</td>
<td>12.2</td>
<td>2.5</td>
<td>$3.00</td>
<td>$5.00</td>
<td>$53.12</td>
<td>$25.74</td>
<td>$23.66</td>
<td>8.94</td>
<td>7.60</td>
</tr>
<tr>
<td>Retail - 50% gas reduction</td>
<td>12.2</td>
<td>5.1</td>
<td>$3.00</td>
<td>$5.00</td>
<td>$84.89</td>
<td>$358.09</td>
<td>$56.64</td>
<td>27.93</td>
<td>23.74</td>
</tr>
<tr>
<td>TOTAL (25%)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>TOTAL (50%)</td>
<td></td>
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</tbody>
</table>

Under the 50% reduction scenario, the costs exceed benefits for some sectors, illustrating a need for offset payments. For the office sector, the payback period declines from 20 years to 17 years with a $54/tonne offset, valued at 15% of the incremental capital costs.

Table 3.4 outlines the baseline emissions and reductions for office, industrial, and retail buildings in Terrace, BC, using a multiplier for HDDs in Terrace, BC, relative to actual buildings in the south coast (outside of major urban areas). Office buildings have lower baseline emissions and reductions, but industrial and retail buildings have larger emission reductions per square meter of floor area.

**TABLE 3.4 – EMISSION REDUCTION AND OFFSET POTENTIAL PER M2 FLOOR AREA – INTERIOR BC**

<table>
<thead>
<tr>
<th>Sub-Measure</th>
<th>Baseline Emissions</th>
<th>Emission Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior (Based on Terrace HDDs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office - 25% gas reduction</td>
<td>14.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Office - 50% gas reduction</td>
<td>14.7</td>
<td>6.4</td>
</tr>
<tr>
<td>Industrial - 25% gas reduction</td>
<td>21.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Industrial - 50% gas reduction</td>
<td>21.2</td>
<td>10.6</td>
</tr>
<tr>
<td>Retail - 25% gas reduction</td>
<td>16.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Retail - 50% gas reduction</td>
<td>16.9</td>
<td>7.1</td>
</tr>
</tbody>
</table>

\(^3\) For example, the FortisBC Efficient Boiler Program provides an incentive of $9/MJU for condensing boilers. Based on RDH costing data, this incentive represents between 17% and 26% of the incremental costs.
Table 3.5 outlines the province-wide potential for emission reductions, assuming the equivalent of 100% participation of existing BOMA BESi participants. In fact, to achieve the required 5,000 tonnes of annual CO₂e reductions, at least half of the current BOMA BESi participants would need to undertake deep energy retrofits achieving a 25% reduction in emissions.

It is assumed that new entrants into the program (or similar programs), along with new construction projects, would occur as a result of the offset project, yielding reductions of approximately 10,900 tonnes CO₂e after the full suite of buildings have implemented retrofits to achieve emission reductions.

**TABLE 3.5 – PROVINCE-WIDE EMISSION REDUCTION POTENTIAL**

<table>
<thead>
<tr>
<th>Opportunity Sub-Measure</th>
<th>Building Stock Potential</th>
<th>Technical Potential</th>
<th>Targetted Offset</th>
<th>Number of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m² potential</td>
<td>tonnes/year</td>
<td>tonnes/year</td>
<td># of buildings or floor area</td>
</tr>
<tr>
<td>Deep Energy Retrofits of BOMA BESi Buildings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office - 25% gas reduction</td>
<td>1,756,054</td>
<td>96,650</td>
<td>741</td>
<td>6,527</td>
</tr>
<tr>
<td>Office - 50% gas reduction</td>
<td>1,317,011</td>
<td>72,458</td>
<td>556</td>
<td>9,791</td>
</tr>
<tr>
<td>Industrial - 25% gas reduction</td>
<td>269,290</td>
<td>-</td>
<td>-</td>
<td>1,331</td>
</tr>
<tr>
<td>Industrial - 50% gas reduction</td>
<td>201,968</td>
<td>-</td>
<td>-</td>
<td>1,544</td>
</tr>
<tr>
<td>Retail - 25% gas reduction</td>
<td>880,403</td>
<td>270,155</td>
<td>29,900</td>
<td>3,023</td>
</tr>
<tr>
<td>Retail - 50% gas reduction</td>
<td>660,302</td>
<td>202,616</td>
<td>22,425</td>
<td>4,535</td>
</tr>
<tr>
<td>TOTAL (25%)</td>
<td>2,905,707</td>
<td>366,765</td>
<td>30,641</td>
<td>10,881</td>
</tr>
<tr>
<td>TOTAL (50%)</td>
<td>2,179,280</td>
<td>275,074</td>
<td>22,981</td>
<td>15,870</td>
</tr>
</tbody>
</table>

The total floor area sought under the 25% reduction scenario is 3.3 million square metres, or about 330 large commercial buildings. This would require a concerted effort by the offset proponent to identify buildings that are undertaking renewals for seismic, structural, or aesthetic purposes or for change of occupancy, as emission reduction opportunities are more easily addressed at the time of building renewal.

A review of building permits for the City of Vancouver illustrates that a large number of buildings undertake construction activities on an annual basis (average of 2011, 2012, and 2013 data):

- 1,065 Business and Personal Services
- 387 Mercantile
- 367 Assembly
- 175 Industrial
- 41 Institutional
- 1,994 Buildings Total (excluding institutional)

There were 5,240 commercial and institutional properties in Vancouver based on the 2008 BC Assessment database; and thus, the rate of construction among the building stock would appear to be very high (> 30%), noting that some of those 1,994 permits might involve the same building twice in a year. Each time a building takes out a permit for construction, an opportunity is created to upsell energy efficiency and emission reductions.

Table 3.6 illustrates the estimated costs to the proponent of managing the overall offset project and validation and verification costs by accredited companies. It is assumed that a 0.25 full-time equivalent (FTE) position is required for four years to market the offset.

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4 A large building is defined as 10,000 square metres or greater.
project to prospective participants and to oversee the project validation and first offset verification in Year 4. Validation costs are estimated to be relatively low ($20,000) due to the pre-existence of the BOMA BEST program that includes third-party verification. Accredited offsets verification is assumed to be 50% of validation for the first period (Year 4) and slightly less for the second and third periods (Years 7 and 10).

The average cost for an offset is about $33/tonne of CO₂e for the 25% reduction scenario with all costs included.

**TABLE 3.6 – OFFSET OPPORTUNITY TOTAL COSTS**

<table>
<thead>
<tr>
<th>Project Management Cost</th>
<th>Validation Cost</th>
<th>Verification Cost</th>
<th>Average Offset Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$/year</td>
<td>$</td>
<td>$</td>
<td>$/tonne</td>
</tr>
<tr>
<td>$</td>
<td>25,000</td>
<td>20,000</td>
<td>26,000</td>
</tr>
<tr>
<td>25% reduction scenario</td>
<td>$</td>
<td></td>
<td>33.42</td>
</tr>
<tr>
<td>50% reduction scenario</td>
<td>$</td>
<td></td>
<td>69.58</td>
</tr>
</tbody>
</table>

### 3.6 Stakeholder Perspectives

See Appendix 3 for a comprehensive list of stakeholders who were consulted on this opportunity, namely:

→ BC Ministry of Energy and Mines, Energy Efficiency Branch
→ Building Owners and Managers Association of BC
→ City of Vancouver – Sustainability Group
→ FortisBC
→ Ledcor

The stakeholders were optimistic about the potential for aggregating commercial buildings to achieve emission reductions and offsets. The pre-existence of the BOMA BEST program provides one opportunity for aggregation, including associated data collection and review processes that, even if needing to be modified to conform to BC EOR requirements, should result in considerable savings versus starting from scratch.

With full-time staff focussed on energy efficiency and co-funding from BC Hydro, BOMA BC has existing capacity to design and manage an offset program. Additional offset project administration costs could be supported through offset sales. BOMA BC would require the services of one or more consultants for developing the project plan and supporting PoA validation and offset verification.

Other proponents such as the Canada Green Building Council—with their LEED for Existing Buildings—or private offset firms could also be viable offset providers. A number of FortisBC programs are in place that would support emission reductions in this sector, namely:
→ Commercial Custom Design Program – Retrofit Projects
→ Efficient Boiler Program
→ Efficient Commercial Water Heater Program
→ Foodservice Incentive Program

The offset project plan should speak to the pervasive market barriers preventing access to the FortisBC program. The 25% emission reduction offset scenario assumes elimination of those barriers and participation in programs such as the Efficient Boiler Program.

3.7 Key Regulatory Requirements

Appendix 2 highlights the key regulatory requirements for offsets. The following outlines key considerations for the EOR requirements that need further clarity for each opportunity.

3.7.1 Ownership

As with all offset projects, project proponents must ensure that they have clear ownership of the emission reductions from which they hope to generate GHG offsets. Transfer of ownership from one entity to another may involve a commercial agreement that returns some value to the entity that is assigning their ownership rights.

The following potential ownership-related items may require attention:

→ Building Owner vs. Manager – If a building is owned by one entity but managed by another under contract, ownership of the offsets would need to be clearly established particularly where energy bills are paid by the manager. Further market research on this issue is warranted.

→ Tenant Reductions – If a project involves the implementation of ERMs by tenants and where those tenants have direct control over energy consumption (e.g., the tenant owns the equipment that consumes the energy, tenants are sub-metered and pay the utility bill directly, etc.) then tenants would need to assign ownership of reductions to the building owner/manager. This could be a particular issue in properties that contain very large tenants that are often billed directly by a utility (e.g., shopping malls with large flagship tenants).

→ Program of Activities – All building owners/managers would need to assign ownership rights to the offsets to the entity that provides overall management of the PoA.

3.7.2 Project Justification – Other Regulations

There are no regulatory requirements that explicitly require emission reductions for existing buildings. In some cases, when the BC Building Code or Vancouver Building Bylaw energy standards are triggered for major construction projects, energy and emission reductions occur. However, the measures considered in this report enable greater savings/reductions than represented in the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standards.
3.7.3 Project Justification – Market

The BOMA BEST program has been in place since 2006 (formerly known as “BOMA Go-Green”). There are 255 participants in BC at the time of writing this report, and 73 of them have been in the program long enough (> 4 years) to be recertified. The remaining participants are still within their initial 3-year certification period. Energy efficiency is a relatively minor component to the BOMA BEST Certification Program so barriers still exist for program participants to engage in deep energy retrofits. Only one FortisBC program is in place to support deep retrofits, but that program does not include fuel switching from natural gas to electricity, envisioned in this study as an option for offsets.

The persistent market barriers preventing deep energy retrofits include the following:

→ Building owner focus is generally not on energy efficiency. Issues such as occupancy rates, building maintenance, and property acquisition and divestiture tend to be top priorities. A real but difficult-to-quantify market barrier is the lack of focus on energy retrofits, despite strong financial rationale for pursuing them.

→ There are split incentives between landlords, property managers, and tenants of commercial buildings. The benefits of deep energy retrofits generally accrue to an individual tenant with a utility meter or to the tenants as a collective who each sign a triple-net-lease with the landlord that includes an allocation of energy costs. However, the capital investment is generally made by the landlord in the case of capital improvements or the property manager in the case of energy management systems.

→ Furthermore, the real estate industry generally does not monetize high-energy performance within the lease price (rent or building purchase price. Other factors such as location and amenities command a higher value. However, recent evidence from the United States is showing higher rents, lower vacancies, and higher building sales prices for ENERGY STAR-certified buildings (with a Portfolio Manager score over 75). Note that ENERGY STAR certification is not available in Canada, although it is possible to generate a score in Canada for five building types (food retail, hospitals, medical offices, K–12 schools, and offices) at the time of this report writing.

→ Many commercial buildings are owned by pension funds, but those purchases and associated follow-up investments are considered over multiple-year timeframes within the context of a capital asset management plan. Currently, energy performance is not commonly considered in the context of such plans. In other words, energy data are not evaluated or tracked to relate to capital investment decisions.

Offsets can help alleviate barriers as follows:

→ Providing human resource support from the offset proponent (e.g., BOMA BC) to support BOMA BEST participants to consider building energy (and emissions) performance within the context of capital asset planning and renewals.

→ Providing a small subsidy to support implementation of ERMs (i.e., financial incentive of 15% of incremental capital costs).

3.7.4 Validation

Validation would proceed as per normal for a PoA, but with the following additional considerations, given the project opportunity and quantification approach:
→ Baseline validation would focus on assessing the validity of the performance standards for different building classes and factors (if a performance standard approach is employed).

→ If an historic baseline approach is used, the validator would be expected to validate the general baseline quantification methods proposed as well as validate that those methods were applied appropriately to assess the baselines for all project locations being added at the start of the PoA.

→ The validator would be expected to confirm the eligibility of all project locations being added at the start of the PoA. It is hoped that this validation would be able to leverage information gathered and verified as part of certification to existing programs like BOMA BEST.

3.7.5 Verification

As previously noted, the suggested quantification approaches would generate verifiable data and should lead to verifiable GHG offsets. Various verification frequencies could be employed, depending on the volumes (and associated revenues) of offsets generated each year vs. associated reporting and verification costs. Where volumes are large enough, annual verification could be conducted. However, where volumes are smaller (or where project participants do not mind waiting longer to receive offset revenues), less frequent verification could be conducted, for instance every 3 to 4 years, in alignment with the BOMA BEST recertification. Furthermore, individual buildings will enter the PoA over the first 3 to 4 years, emission reductions will occur in the subsequent 3 years and verification of offsets could be as late as Year 7 of the validation/crediting period. As noted earlier, the goal is to facilitate 10 years of emission reduction offsets for each building, spanning over two separate validation/crediting periods.

One implication of verifying less frequently, however, is that a given building might join a PoA and start undertaking a range of ERMs shortly after the last verification and would then need to wait until the next verification in order to have its eligibility formally verified and credits generated.

The risk of not having the building or individual ERMs accepted into the program could be managed through the adoption of high-quality selection procedures that would ensure that only eligible buildings are added and that all data monitoring and quality assurance procedures are followed.

Where the buildings are already part of an existing environmental/energy certification program (e.g., BOMA BEST, LEED-EB), it is also hoped that the GHG offset verifier would be able to coordinate with the certification program auditors to minimize the incremental cost of the GHG verification. For example, the environmental program certification auditors could potentially be treated as technical experts on the ISO 14065-accredited GHG verification team so that their data assessments could apply to both programs.
4 Offset Opportunity #2 – Fuel Oil Conversion in Houses

4.1 Prospective Proponents

One or more of the following potential proponents could potentially develop a fuel oil conversion offset project:

→ BC Hydro
→ FortisBC
→ ICE Fund fuel switching program administrator

4.2 Project Background

The Home Energy Rebate Offer (HERO) is an energy efficiency funding program available to BC Hydro and FortisBC residential customers with separate meters across British Columbia, including single-family dwellings, duplexes, row homes, town houses, and mobile homes on a permanent foundation. Energy efficiency measures under this program are limited to those that reduce use of electricity and natural gas heating. However, there were an estimated 912,010 tonnes of CO₂ emissions from oil-fired space and water heating in BC in 2010 (Government of B.C., 2010) across 70,000 households (Natural Resources Canada, 2015). A large proportion of oil-heated houses are on Vancouver Island due to the late introduction of natural gas (in 1991) as compared to the rest of the province. In fact, there are 13,000 oil-heated houses in the Capital Regional District alone (Capital Regional District Staff 2015). These houses are not eligible for HERO rebates pertaining to space heating. Oil combustion produces approximately 40% more GHGs than natural gas, and switching to electricity eliminates all direct emissions and has minimal indirect emissions due to BC’s hydroelectric-dominated electricity grid.

In September 2015, the BC Ministry of Energy and Mines announced a fuel switching incentive program for 300 houses to replace oil heating with electric heat pumps through the Innovative Clean Energy (ICE) Fund. The value of the ICE Fund incentive is up to $1,700.

FortisBC offers its own rebate (called Switch ‘n’ Shrink) for fuel switching from oil to natural gas. FortisBC representatives confirmed that the program achieves full participation every year and is limited by the preallocated budget. FortisBC is targeting fuel switching of 850 houses from oil to natural gas (95% efficient furnaces) every year. Their market research indicates 12,500 houses on Vancouver Island are within 100 metres of a natural gas pipeline, which leaves substantial room for additional fuel switching.

4.3 Program of Activities – Fuel Switching

A PoA for residential fuel switching could be prepared by one of the aforementioned proponents to enable aggregation of approximately 7,000 houses with entry points within a specified period (e.g., 5 years) during the 10-year validation period. Each individual house would only require the equivalent of 5 years of offset revenues.
The PoA would incentivize fuel switching from oil–fired space heating to electric heat pumps. This latter technology is currently incentivized under HERO for electric space heating houses, including customers of BC Hydro province–wide and electricity customers of FortisBC in the Okanagan and West Kootenay regions.

To minimize transaction costs associated with offset project development per unit of emission reduction, the PoA could focus on houses that have sizable space heating requirements that rely on an oil furnace or boiler, with eligibility criteria that specify the size and age of house. These will tend to be single–family and duplex houses. Eligibility would also be limited to owner–occupied houses and landlords who provide heating to tenants.

If the proponent is one of the utilities such as BC Hydro, it could expand upon the HERO eligibility criteria to include fuel oil as a primary heating type (currently the requirement is to demonstrate electricity consumption of over 10,000 kWh).

To provide offset project justification, eligibility would be limited to houses with a certified oil tank that has at least 5 years of remaining life at the time of the retrofit. This would avoid free riders who would replace their furnace regardless, due to home insurance requirements. Oil tanks older than 20 to 25 years must be replaced, as well as those without a Canadian Standards Association or an Underwriters Laboratories of Canada label indicating the manufacturing date. Existing oil furnaces and water heaters of those in the program would need to be decommissioned to prevent project leakage through resale of used equipment.

Validation/verification could be supported by Certified Energy Advisors (CEA) under the HERO program under the supervision of an accredited third–party organization. CEAs could confirm the historic consumption of oil, verify the remaining life of the oil tank, oversee the decommissioning of the oil furnace/tank, and verify the installation of the high–efficiency heating equipment. The estimated cost for CEAs is $350/house, based on their costs under HERO. Eligibility criteria would align with the selected baseline and validation protocols, as described in Section 4.4.

Following the completion of the ICE Fund incentive program (300 houses)—which offered a higher rebate—the schedule for this opportunity would be as follows:

1. Year 0: Proponent is confirmed, PoA is designed, baseline data necessary to apply performance standard is collected, and project plan is validated.

2. Years 1 to 5: The proponent seeks participation of approximately 6,500 houses that are not eligible for HERO incentives and have installed heat pumps to replace oil–fired furnaces and boilers. The confirmation of pre–retrofit energy bills (illustrating baseline oil consumption), installation of heat pumps, and removal of oil heating (enabling emission reductions) will be completed by a CEA (~$350/house, paid by the proponent, not the homeowner) under the supervision of an ISO 14065–accredited organization. The timing of verification of offsets is dependent on the PoA, although a general goal would be to provide an offset payment shortly after installation of equipment. As such, annual verification may be desirable. Following confirmation of oil heating replacement, an offset payment of $800 is provided to the homeowner for electric conversions, matching the current incentive provided to HERO participants.

3. Year 10: At the end of the 10–year validation/crediting period, all houses have completed an oil heating replacement and have achieved 5 years of emission...
reductions, with verification of offsets and payment occurring up-front. The final emission reduction report for the project has been submitted.

4.4 Quantification and Measurement

Given the focus on a specific emission reduction measure (ERM)—replacing fuel oil heating with electric heating—a retrofit isolation approach to quantifying emission reductions would be taken (Ministry of Environment). The retrofit isolation approach differs from a whole-building approach in that only the impacts from one specific ERM (in this case changing heating source from oil to electric) are examined—i.e., these impacts are isolated from any broader changes that might be occurring at a whole-building level due to various other factors.

4.4.1 Baseline Approach

Because this project is applied to individual residential homes that individually have very small GHG emission reductions per year, a performance standard approach would be advisable in order to reduce verification costs at a building-specific level. Historic performance could be an alternative method.

Performance standard emission levels would be established for residential oil home heating on a tonnes CO₂e/m²/year basis, assuming oil heating in the baseline. Different performance standard intensities would be required for different home vintage years and other characteristics that could affect the total heating demand. In each case, a conservative baseline intensity would be established, essentially representing the lowest starting emissions rate for a typical house in that category. It is also expected that the performance standard intensities would be developed using a reference (typical) heating degree day (HDD) value so that baseline emissions each year for a given building could be determined based on the typical HDD in each year. HDD estimates could be developed for geographic regions of BC as per the BC Building Code.

4.4.2 Measurement Approach

Assuming a performance standard baseline approach is used, but excluding data needed to initially establish the performance standards, key parameters to be measured on a building-specific basis include):

- Baseline energy use and emissions:
  - Building area m² or other relevant home characteristics (assessed only once when the new heating system is installed)
  - Local weather (e.g., HDDs, etc.) – based on BC Building Code reference

- Project energy use and emissions:
  - Ongoing monitoring of individual homes would be avoided. Instead, the rated efficiency of the new heating system—coupled with the baseline energy consumption for each home (based on the performance standard)—would be used to estimate the amount of energy (electricity and/or natural gas) that each home would consume as a result of the fuel switch.
As part of installation, there would be a requirement that the old furnace and oil tank be removed and appropriately disposed of—but not resold—to ensure emissions do not occur elsewhere.

4.4.3 Alignment with Protocol

The approach aligns with the requirements of the BC Green Building Protocol. The BC Fuel Switching Protocol could also be used.

4.5 Emission Reduction Potential and Financial Analysis

Table 4.1 outlines the estimated impact of offsets per participating house, representing a provincial average. The baseline oil consumption across all communities was provided by Community Energy Emissions Inventory (CEEI-2010). A portion of this consumption could be for water heating, but if homeowners change their furnace, they would also likely change their water heater to electricity. The oil furnace conversion efficiency was assumed to be 70%. The efficiency of the electric heat pump was 250% (COP 2.5) based on the experience of the authors. This was used to estimate electricity emissions (note that the EOR states electricity emissions are zero, but this analysis assumes an emissions factor of 10.08 t/GWh as per the 2014 BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions). The difference is explained by the 2007 Energy Plan that states that electricity emissions will be net zero after 2016 (Government of British Columbia, 2015).

The financial cost per tonne of emission reduction was calculated for both capital cost scenarios, assuming 5–years of offset payments and including the value of 15 years of net energy savings following the fuel switch. The net costs are negative, meaning that the benefits exceed costs. The payback period is 3 years.

In order to estimate this opportunity, a simplified benefit–cost analysis was completed—considering only the rebate value and CEA cost—totalling $1,150 per house rather than estimating incremental capital costs and life cycle benefits.

TABLE 4.1 – EMISSION REDUCTION AND OFFSET POTENTIAL PER HOUSE (VANCOUVER ISLAND)

<table>
<thead>
<tr>
<th>Baseline Emissions</th>
<th>Emission Reduction</th>
<th>Capital Cost - Low</th>
<th>Capital Cost - High</th>
<th>$/Tonne (Net of Benefits) - Low</th>
<th>$/Tonne (Net of Benefits) - High</th>
<th>Target Offset Value</th>
<th>Payback Period w/o Offsets</th>
<th>Payback Period with Offsets</th>
</tr>
</thead>
<tbody>
<tr>
<td>tonnes/house</td>
<td>$/house - full cap cost</td>
<td>$6,000</td>
<td>$10,000</td>
<td>$</td>
<td>$</td>
<td>0.30% of total capital cost</td>
<td>23.69</td>
<td>3.32</td>
</tr>
<tr>
<td>9.2</td>
<td>8.9</td>
<td>$6,000</td>
<td>$10,000</td>
<td>$829</td>
<td>$739</td>
<td>23.69</td>
<td>3.32</td>
<td>2.99</td>
</tr>
</tbody>
</table>

Table 4.2 outlines the province-wide potential for emission reductions. As noted earlier, over 70,000 households in 2011 were served by oil space heating. The program aims to seek additional houses that were not covered by the following two programs:

→ FortisBC: 850/year x 10 years from 2012 to the offset end date of 2022 = 8,500.

→ ICE Fund = 300 houses.

As discussed in Section 4.3, houses with oil tanks older than 15 years or with a remaining life of less than 5 years would be excluded from this opportunity. As such, a conservative target for this opportunity is 10% of households (~7,000), with an emphasis on single-family houses that account for the largest emissions (to be specified in the PoA design, aligned with the performance standard baseline).
TABLE 4.2 – PROVINCE-WIDE EMISSION REDUCTION POTENTIAL

<table>
<thead>
<tr>
<th>Building Stock Potential</th>
<th>Technical Potential</th>
<th>Targetted Offset</th>
<th>Number of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC</td>
<td>tonnes/year</td>
<td>tonnes/year</td>
<td># of buildings or floor area</td>
</tr>
<tr>
<td>Achievable:</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70,300</td>
<td>623,070</td>
<td>62,307</td>
<td>7,030</td>
</tr>
</tbody>
</table>

Table 4.3 illustrates the estimated costs for validation and verification by accredited companies. Due to the performance standard approach, this project has the lowest validation and verification cost of all three offset opportunities outlined in this report. As such, the validation is estimated to cost $20,000 and verification is 50% of validation cost.

It is assumed that program costs are included in the utility HERO program, but if part-time staffing were required ($25,000 per year for four years), then the average offset cost would be $26/tonne CO₂e.

TABLE 4.3 – OFFSET OPPORTUNITY TOTAL COSTS

<table>
<thead>
<tr>
<th>Project Management Cost</th>
<th>Validation Cost</th>
<th>Verification Cost</th>
<th>Average Offset Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$/year</td>
<td>$</td>
<td>$</td>
<td>$/tonne</td>
</tr>
<tr>
<td>$ 25,000</td>
<td>$ 20,000</td>
<td>$ 10,000</td>
<td>$ 25.78</td>
</tr>
</tbody>
</table>

4.6 Stakeholder Perspectives

See Appendix 3 for a comprehensive list of stakeholders who were consulted on this opportunity, namely:

→ BC Hydro
→ BC Ministry of Energy and Mines Energy Efficiency Branch
→ FortisBC

The stakeholders were not optimistic about the potential for offset projects for a number of reasons.

First, there is the issue of project justification given the strong market trend toward oil conversion, which is stimulated in part by home insurance requirements (see Section 4.7.3 for more details).

Second, there are already two existing programs through the Ministry of Energy and Mines (MEM) and FortisBC, with the latter targeting conversions to natural gas. The MEM program that targets 300 houses will fully retire the emissions reductions, making monetization of offsets impossible. The FortisBC program requires a 95% efficient furnace, beyond the 92% regulatory requirement under the Energy Efficiency Act. As such, there is little opportunity for additional emission reductions through offsets.
4.7 Key Regulatory Requirements

4.7.1 Ownership

Ownership issues are theoretically straightforward with this project opportunity. The owner of each home would be required to assign ownership of reductions to the PoA coordinating entity. That said, it is possible that some owners may be unwilling to assign ownership, depending on their motivation for switching from oil to electricity (e.g., some homeowners may wish to claim their own emissions reduction).

4.7.2 Project Justification – Other Regulations

There are no direct requirements to switch from oil to other fuels, albeit there are some bylaws (e.g., Capital Regional District) pertaining to safe oil tank usage and decommissioning. While this may cause some homeowners to fuel switch, many will opt for a simple oil tank replacement, thus still producing greenhouse gas emissions and leaving open the opportunity for offsets.

4.7.3 Project Justification – Market

As noted in the stakeholder perspective section, there are two programs currently targeting the conversion of oil heating. More importantly, stakeholders indicated a very strong market trend away from oil heating, partly driven by insurance company requirements for oil tank labelling and decommissioning after 20 to 25 years. This often drives homeowners to fuel switch, in which case offsets cannot be generated. However, there are circumstances where the homeowner chooses to invest $1,200 for a replacement oil tank rather than invest $5,000+ to install a natural gas furnace (less the $1,000 FortisBC Switch ‘n’ Shrink rebate) or $6,000+ for a heat pump. Thus, market barriers are still prevalent.

Despite the strong financial incentive to convert oil heating, the capital costs of converting to electric or natural gas heating are high and thus, many households retain their original heating system. Thus, the offset project is assumed to be justifiable in terms of additionality and the requirements of the EOR.

4.7.4 Validation

Validation would proceed as per normal for a PoA, but with the following additional considerations given the project opportunity and quantification approach:

→ Baseline validation would focus on assessing the validity of the baseline performance standards and deemed savings factors attributable to project heating systems. This would be similar to Opportunity #1 described previously and would also benefit from development of a set of BC-wide performance standards to further reduce cost.

→ The validator would be expected to confirm the eligibility of all project locations added at the start of the PoA. It is expected that this validation would rely heavily on data gathered by qualified installers and/or any oversight of the program that would be provided by funding utilities, with some spot checking as needed to provide assurance to a reasonable level.
4.7.5 Verification

Given that no data is expected to be monitored on an ongoing basis during the project, the complexity of verification should be reduced. Focus would be on confirming that correct emission reduction calculations have been performed, including adjusting baselines as appropriate for independent variables such as HDDs, size of house, vintage, etc. As a PoA, verification would also involve confirming the eligibility of any new locations added to the project since validation or previous verification (in a manner equivalent to the validation). The verification data would be collected by a CEA shortly after oil tank replacement, with a goal of providing the incentive payment to the homeowner in a timely fashion. As such, the verification would need to occur on an annual basis, enabling release of payment.

Alternatively, verification costs could be reduced if the PoA provides deemed savings with the inclusion of certain data collected by the third party CEA under the supervision of the ISO 14067–accredited verification body. In this case, verification could occur at the end of the emission reduction period, including random audits of the CEA data collection—potentially discounting the overall savings.
5 Offset Opportunity #3 – Energy Upgrades for Multi-Unit Residential Buildings

5.1 Prospective Proponents

One or more of the following proponents could develop an offset project:

→ BC Non-Profit Housing Association (BCNPHA)
→ Landlord BC
→ Condominium Home Owners Association (CHOA) of BC
→ Private offset aggregators

5.2 Project Background

Multi-unit residential buildings (MURBs) house approximately 565,000 households in BC; 31% of the total (NRCAN, 2011 data). A large, untapped emission reduction potential exists in MURBs, due to the lack of comprehensive support programs by utilities and governments. Smaller housing types benefit from comprehensive programs such as HERO (refer to Offset Opportunity #2) and the Energy Conservation Assistance Program (ECAP) for low-income households. Very large buildings benefit from programs such as FortisBC’s Commercial Custom Design Program – Retrofit Projects and the New Construction Program (for major renovations). A large proportion of MURBs are not covered under these programs.

MURBs consist of three building types, namely:

→ Mid- to high-rise MURBs (steel-frame)
→ Low-rise MURBs (wood frame)
→ Town houses

There are at least three types of MURB ownership structures:

1. Low-income rentals and co-ops
2. Market rentals
3. Condominiums with strata corporations

The BC Non-Profit Housing Association (BCNPHA) represents over 500 nonprofit housing societies and businesses. The Co-Op Housing Federation of BC (CHFBC) represents housing co-ops. Collectively, about 800 housing providers, mostly nonprofits and co-ops, subsidize over 90,000 households in 200 communities across BC (BC Housing, 2015) over and above BC Housing’s directly managed portfolio of 6,000 residential units. Buildings are owned by the housing providers as a portfolio, making them suitable for aggregation. For example, the Baptist Housing Society has 3,000 residential units in 14 communities across the province. These include First Nations off-reserve housing. BCNPHA has 2 to 3 staff members who focus on energy efficiency, subsidized by energy utilities. The association conducted an inventory of energy consumption among their members and
energy efficiency opportunities and thus have an understanding of the emission reduction potential in their sector. Table 5.1 highlights the energy use intensity from samples of BCNPHA members (not the entire sector).

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Energy Use Intensity (from a sample of 217 buildings)</th>
<th>Percentage of Total Housing Stock (from a sample of 1,096 buildings)</th>
<th>Average Emissions per building (from a sample of 217 buildings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apartment</td>
<td>377 kWh/m²</td>
<td>45%</td>
<td>198 Tonnes CO2e per building</td>
</tr>
<tr>
<td>Single-Family Dwelling</td>
<td>362 kWh/m²</td>
<td>25%</td>
<td>16 Tonnes CO2e per building</td>
</tr>
<tr>
<td>Single Attached</td>
<td>153 kWh/m²</td>
<td>21%</td>
<td>46 Tonnes CO2e per building</td>
</tr>
<tr>
<td>Mixed Type</td>
<td>313 kWh/m²</td>
<td>8%</td>
<td>36 Tonnes CO2e per building</td>
</tr>
</tbody>
</table>

Currently, the BCNPHA conducts free on-site energy audits, assistance for developing business cases for energy efficiency and navigating and securing incentives, and coaching on building capital projects. They have a broad geographic base of service, noted in Table 5.2.

<table>
<thead>
<tr>
<th>Region</th>
<th>% of Total Societies that are BCNPHA Members</th>
<th>Number of Residential Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vancouver</td>
<td>23%</td>
<td>18,000</td>
</tr>
<tr>
<td>Lower Mainland</td>
<td>20%</td>
<td>13,500</td>
</tr>
<tr>
<td>Vancouver Island</td>
<td>19%</td>
<td>9,500</td>
</tr>
<tr>
<td>Okanagan</td>
<td>14%</td>
<td>7,000</td>
</tr>
<tr>
<td>Northern BC</td>
<td>10%</td>
<td>4,000</td>
</tr>
<tr>
<td>Kootenays</td>
<td>8%</td>
<td>4,000</td>
</tr>
<tr>
<td>Fraser Valley</td>
<td>6%</td>
<td>3,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td>59,000</td>
</tr>
</tbody>
</table>

The BC First Nations Energy and Mining Council (FNEMC) employs a full time Community Energy Program Specialist to facilitate opportunities for energy efficiency and community energy systems. Because the total number of emission reductions from First Nations housing is anticipated to be small, it is not likely feasible to develop an offset project solely focused on First Nations housing. However, one of the other organizations, such as BCNPHA, could include eligibility for First Nations housing. One of the best opportunities
for emission reductions in houses is in communities that use diesel-fired electricity (e.g.,
Masset, Anahim Lake, Bella Coola, Kwadacha, Tsay Key, and others).

Landlord BC represents property owners who provide rental housing at market rates. In
the City of Vancouver, an estimated 46 landlords own 60% of the market rental units,
illustrating the opportunity for aggregation. Furthermore, approximately 60% of
Vancouverites live in rentals.

The Condominium Home Owners Association (CHOA) of BC represents strata corporations
that own and manage condominiums. While these are individually owned, property
managers often service hundreds and thousands of residential units across multiple
buildings. In the City of Vancouver, 8 property managers manage virtually all stratified
MURBs. Province-wide, CHOA membership includes the following number of strata
councils with over 25 residential units:

- Lower Mainland: 2,489
- Vancouver Island: 424
- Northern BC: 75
- Kootenays: 89
- Other Interior: 455
- TOTAL: 3,532 Strata Councils

In 2012, the BC Homeowner Protection Office (BC HPO) conducted a major energy
benchmarking study for 39 mid- and high-rise condominium buildings, with resultant
energy use intensities illustrated in Figure 5.1 (Source: RDH Building Engineering study
Energy Consumption and Conservation in Mid- and High-Rise Residential Buildings in
British Columbia prepared for the HPO). That same year, BC HPO conducted a deep energy
efficiency retrofit demonstration project for a 37-unit, 13-storey building in Vancouver,
resulting in a 20% reduction in energy use (RDH Building Engineering, 2013). Figure 5.1
illustrates the building’s energy use intensity before (red) and after (green) the building
retrofit, compared to a cohort of similar buildings.

![Figure 5.1 British Columbia Greenhouse Gas Emissions from Buildings by Sector](image)

It is worth noting that the average energy use intensity of apartments from the BCNPHA
sample and study (377 kWh/m²) is 77% higher than the average consumption of the 39
condominiums reviewed in the aforementioned study (213 kWh/m²). This may lead to a
conclusion that nonprofit housing has larger potential savings, with a caveat that the studies had different scopes and methodologies and thus may not be directly comparable. Further analysis on the market and psychological drivers for energy efficiency is warranted to explain the differences between rental and owner-occupied buildings. This could include a review of the correlation between energy metering and billing methods and energy consumption (there is an incentive to conserve energy for those occupants who pay for their actual consumption, rather than a fixed share of overall building consumption).

5.3 Program of Activities – Energy Efficiency and Fuel Switching

A PoA could be developed by one of the aforementioned proponents to enable aggregation of 400+ buildings and entry within a specified period (e.g., 3 to 5 years) during a 10-year validation/crediting period. The PoA could be re-verified prior to the end of the 10-year validation/crediting period to enable late entrants (i.e., entering in Years 3 to 5) to generate at least 10 years of emission reduction offsets.

The PoA eligibility criteria could include the following building types and segments:

→ High-rise, mid-rise, and low-rise multi-unit residential buildings, including large town house clusters

→ Condominiums, market and nonprofit rentals, coops, First Nations housing on/off reserve

→ Ownership and/or management of groups of buildings by strata corporations, wide-reaching property managers, nonprofit societies, First Nations and co-op housing umbrella organizations (BC First Nations Energy and Mining Council, Co-op Housing Federation of BC)

→ Existing buildings and new construction

To minimize transaction costs per unit of remission reduction, the PoA could focus on larger properties of over 50,000 sq ft, with one or multiple buildings. It is noted that in the City of Vancouver, properties of that scale (726 in total) represent only 13% of all properties (5,700) but represent 53% of the square footage and the majority of residential units (BC Assessment, 2013) (City of Vancouver Staff 2015).

Under this PoA individual building owners would undertake a deep energy retrofit, including one or more of the following emission reduction measures (ERMs) that would reduce natural gas consumption by at least 25% (electricity savings would not be the focus of a GHG offset program given the low grid emissions factor in BC):

→ Building envelope thermal improvement (reduced thermal losses) through the installation of new windows; wall, roof, and foundation insulation; and reduced thermal bridging

→ Building envelope airtightness improvement, confirmed through whole-building airtightness testing

→ Replacement of the natural gas boiler, water heater, and make-up air unit

→ Use of renewable energy for space and water heating, such as renewable natural gas, solar hot water, district energy, and geoxchange systems
→ Retro-commissioning and improved building energy system controls and management
→ Increased occupant engagement in conservation through metering, social marketing, and other approaches.

New buildings that are designed and constructed to enhanced energy efficiency levels and that use low or zero-carbon fuels would also be eligible to participate, using the BC Building Code as the baseline.

This would complement the proposed Offset Opportunity #1 where the focus is on commercial buildings.

Offset revenues could help cover part of the incremental capital cost of high-efficiency building components and equipment, along with the dedicated services of a third-party staff person or contractor who could help the owners identify the best emissions reduction opportunities and arrange financing, among other roles. This coach role has been piloted by the BC Non-Profit Housing Association via the Green Landlord project that included 23 buildings.

Eligibility criteria would align with the selected baseline and validation protocols, as noted in Section 5.4.

The schedule for this project would be as follows:
→ Year 0: PoA is designed, PoA is validated by an accredited third party.
→ Years 0 to 4: Offset proponent seeks participant buildings for aggregation.
→ Years 1 to 5: Deep energy retrofits are completed to facilitate real emission reductions (or operation begins in newly constructed energy-efficient buildings), with ongoing data monitoring by the building managers and/or energy consultant.
→ Year 5 or 6: All emission reductions are completed and post-retrofit data are collected. Accredited organization completes first verification of reductions and offsets by reviewing data from building managers and/or a consultant who tracks ongoing energy performance within the parameters set by the validated PoA. The first offset payment is generated. The goal is to monetize 10 years of GHG offsets over two validation/crediting periods.
→ Years 1 to 15: Building management practices are in place to maintain emission reductions and collect data. Verification of data can occur on a schedule aligned with offset payments: annually or less frequently.
→ Year 9 or 10: PoA revalidated to allow for a 10-year crediting period from the date of the retrofit. The initial emission reduction report for the project would be submitted. It is recognized that revalidation carries some risk, as baseline and project justification considerations may have change since the date of the initial validation, which may reduce the volume of offsets that can be generated during a second validation period.

5.4 Quantification and Measurement

Given that this offset option could involve a wide range of different ERMs, with fewer or greater numbers of ERMs being applied in any given building, a whole-building approach
to quantifying emission reductions would be the best option (Option B from the BC Green Building protocol).

5.4.1 Baseline Approach

The approach would be the same as for Offset Opportunity #1.

A valid historic baseline could be developed by building owners. This historic baseline could also be useful for the cost-benefit evaluation of energy upgrades. The performance baseline approach could include several building subtypes and normalization factors to allow the highest-emitting buildings to receive credit.

Alternatively, a building-specific baseline could be applied based on a common methodology for data collection and normalization (e.g., ENERGY STAR Portfolio Manager), coupled with completed depreciation reports, as required by the Strata Properties Act, including information provided by a third-party on building asset replacement (e.g., boiler life), thus lowering the cost for baseline validation.

5.4.2 Measurement Approach

The approach would be the same as for Offset Opportunity #1 except that there is no expectation that buildings would be part of an existing environmental certification program.

In addition, the strata depreciation reports could be used to provide additional evidence of the conditions of major building assets that affect GHG emissions and alignment with a particular performance baseline.

5.4.3 Alignment with Protocol

The approach aligns with the requirements of the BC Green Building Protocol.

5.5 Emission Reduction Potential and Financial Analysis

The tables below outline emission reduction potential and financial analysis based on two references:

➢ Homeowner Protection Office (HPO), 2012. Energy Consumption and Conservation in Mid- and High-Rise Residential Buildings in British Columbia. RDH completed the analysis for this study based on 39 buildings in southwest BC.


Table 5.1 outlines the estimated impact of offsets per square metre of floor space for the Lower Mainland and Vancouver Island regions. These estimates are based on the actual energy consumption of buildings from the aforementioned HPO study.

RDH estimated the incremental capital costs needed to achieve the two targeted natural gas emission reductions of 25% and 50%, based on research for BC Hydro for apartment building upgrades beyond the BC Building Code standard ASHRAE 90.1-2010 (for new construction). A range of costs is provided (minimum and maximum). While existing building costs can vary from new construction, these estimates are reasonable if applied
at the time of existing building renewal, whereby the ASHRAE standard would apply. The emission reduction measures were as follows:

→ The 25% scenario was focused primarily on reducing the gas–fired, make–up air unit-conditioned air volume in the common area spaces (5% savings) and the installation of an energy recovery ventilator (ERV) connected to that make–up air unit (23% savings).

→ The 50% scenario included the items above, plus condensing gas boilers (8% savings), increased building airtightness from building enclosure upgrades (4% savings) and low–flow hot water faucets (8% savings) as well as energy management practices to support the maintenance of savings.

The financial cost per tonne of emission reduction was calculated for both capital cost scenarios, assuming a 10–year offset validation/crediting period and including the value of 15 years of energy savings. The targeted offset cost was set at 10% of the incremental capital cost of ERMs, aligned with many utility demand–side management program rebate levels. This is lower than the targeted incentive for Opportunity #1, partly on the basis of stakeholder consultations that highlighted the importance of providing independent, professional advice to building owners, reflected in the project management costs in Table 5.5 ($50,000 per year for 4 years). The simple payback periods were calculated, with and without the offset payment.

### TABLE 5.3 – EMISSION REDUCTION AND OFFSET POTENTIAL PER M2 FLOOR AREA – COASTAL REGIONS

<table>
<thead>
<tr>
<th>Sub-Measure</th>
<th>Baseline Emissions</th>
<th>Emission Reduction</th>
<th>Capital Cost - Low</th>
<th>Capital Cost - High</th>
<th>$/Tonne (Net of Benefits) - Low</th>
<th>$/Tonne (Net of Benefits) - High</th>
<th>Target Offset Value</th>
<th>Payback Period w/o Offsets</th>
<th>Payback Period with Offsets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Mainland and southern Vancouver Island (Climate Zone 4)</td>
<td>kg/m2</td>
<td>kg/m2</td>
<td>$/m2</td>
<td>$/m2</td>
<td>$/tonne</td>
<td>$/tonne</td>
<td>years</td>
<td>years</td>
<td>10% of incremental capital cost</td>
</tr>
<tr>
<td>Low-rise - 25% gas reduction</td>
<td>21.0</td>
<td>5.0</td>
<td>$4.00</td>
<td>$7.00</td>
<td>$91.36</td>
<td>$31.31</td>
<td>$11.01</td>
<td>6.24</td>
<td>5.61</td>
</tr>
<tr>
<td>Low-rise - 50% gas reduction</td>
<td>21.0</td>
<td>10.0</td>
<td>$13.00</td>
<td>$23.00</td>
<td>$41.32</td>
<td>$58.76</td>
<td>$18.01</td>
<td>10.21</td>
<td>9.19</td>
</tr>
<tr>
<td>High-rise - 25% gas reduction</td>
<td>21.0</td>
<td>5.0</td>
<td>$4.00</td>
<td>$7.00</td>
<td>$91.36</td>
<td>$31.31</td>
<td>$11.01</td>
<td>6.24</td>
<td>5.61</td>
</tr>
<tr>
<td>High-rise - 50% gas reduction</td>
<td>21.0</td>
<td>10.0</td>
<td>$13.00</td>
<td>$23.00</td>
<td>$41.32</td>
<td>$58.76</td>
<td>$18.01</td>
<td>10.21</td>
<td>9.19</td>
</tr>
<tr>
<td>Townhouses - 25% reduction</td>
<td>21.0</td>
<td>5.0</td>
<td>$4.00</td>
<td>$7.00</td>
<td>$91.36</td>
<td>$31.31</td>
<td>$11.01</td>
<td>6.24</td>
<td>5.61</td>
</tr>
<tr>
<td>Townhouses - 50% reduction</td>
<td>21.0</td>
<td>10.0</td>
<td>$13.00</td>
<td>$23.00</td>
<td>$41.32</td>
<td>$58.76</td>
<td>$18.01</td>
<td>10.21</td>
<td>9.19</td>
</tr>
<tr>
<td>Total (25%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.01</td>
<td>5.61</td>
<td>5.61</td>
</tr>
<tr>
<td>Total (50%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18.01</td>
<td>9.19</td>
<td>9.19</td>
</tr>
</tbody>
</table>

The results illustrate that the 25% emission reduction scenario is cost–effective without an offset using a social discount rate (6% real). However, as noted earlier, market barriers are prevalent, preventing current market uptake outside of government and/or utility–supported demonstration projects. Furthermore, many consumers apply a higher discount rate to their investments on the order of 20%

Under the 50% reduction scenario, the costs exceed benefits for the “high” capital cost scenario, illustrating a need for monetizing offsets to break even.

Table 5.4 outlines the province–wide potential for emission reductions, based on a query of the BC Assessment database (2013) for all buildings in these segments. The total technical potential for MURB reductions is in the hundreds of thousands of annual tonnes of CO₂e. The targeted offset potential is set at 10% of the building stock for the 25% emission reduction measures. This represents 4 million square metres of floor area, which could be covered by about 450 small buildings with 30 residential units, 90 large buildings with 100 units and 2,500 town house buildings (6 residential units each).
TABLE 5.4 – PROVINCE-WIDE EMISSION REDUCTION POTENTIAL

<table>
<thead>
<tr>
<th>Building Stock Potential</th>
<th>Technical Potential</th>
<th>Targetted Offset</th>
<th>Number of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>75% can achieve 50% savings</td>
<td>Achievable: 10%</td>
<td></td>
</tr>
<tr>
<td>Lower Mainland Vancouver Island</td>
<td>10,170,847</td>
<td>716,900</td>
<td>2,722,847</td>
</tr>
<tr>
<td></td>
<td>7,628,135</td>
<td>537,675</td>
<td>2,042,136</td>
</tr>
<tr>
<td></td>
<td>8,632,939</td>
<td>80,136</td>
<td>259,125</td>
</tr>
<tr>
<td></td>
<td>6,474,701</td>
<td>60,102</td>
<td>219,844</td>
</tr>
<tr>
<td></td>
<td>14,084,422</td>
<td>968,501</td>
<td>2,756,826</td>
</tr>
<tr>
<td></td>
<td>10,563,316</td>
<td>726,376</td>
<td>2,067,620</td>
</tr>
<tr>
<td></td>
<td>32,888,204</td>
<td>1,765,37</td>
<td>5,772,799</td>
</tr>
<tr>
<td></td>
<td>24,666,153</td>
<td>1,324,152</td>
<td>4,325,599</td>
</tr>
</tbody>
</table>

For the estimate, it is also assumed that only 75% of the buildings could achieve the larger 50% emission reduction due to technical limitations.

To achieve the targeted level, a concerted effort by the offset proponent is required to identify buildings that are undertaking renewals for seismic, structural, and aesthetic purposes, as ERMs are more cost-effective at the time of renewals. Each time a building takes out a permit for construction, an opportunity is created to upsell energy efficiency and emission reductions.

A review of building permits for one city (Vancouver, BC) illustrates that about 100 MURBs undertake construction activities on an annual basis (average of 2011, 2012, and 2013 data):

- Apartments of 3 storeys or less: 27 permits
- Apartments over 3 storeys: 14 permits
- Others (including mixed used): 56 permits
- TOTAL (excluding institutional): 98 permits

Compared to the targeted number of similar buildings in Table 5.2 (540 buildings), it would take about 6 years of building permits to achieve an equivalent number of buildings in Vancouver alone. Given that about 30% of provincial apartments are in Vancouver (Natural Resources Canada, 2015) the PoA would need to attract approximately one-third to one-half of the building owners/managers seeking permits in order to meet this target.

Table 5.5 illustrates the estimated costs to the proponent of managing the overall offset project, including validation and verification costs. It is assumed that a half-time position ($50,000 per year) is required for 4 years to market the offset project to prospective participants and to oversee the project validation and the first verification period. This project would have a higher validation cost than the other opportunities outlined in this report due to the lack of an established certification program (such as BOMA BEST). As such, the validation is estimated to cost $30,000 and verification is 50% of validation for the first period and slightly less for the second and third verification periods.

The average cost for an offset is about $30/tonne CO₂e for both the 25% and 50% reduction scenarios.
TABLE 5.5 – OFFSET OPPORTUNITY TOTAL COSTS

<table>
<thead>
<tr>
<th>Project Management Cost</th>
<th>Validation Cost</th>
<th>Verification Cost</th>
<th>Average Offset Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$/year</td>
<td>$</td>
<td>$</td>
<td>$/tonne</td>
</tr>
<tr>
<td>$ 50,000</td>
<td>$ 30,000</td>
<td>$ 39,000</td>
<td></td>
</tr>
<tr>
<td>25% reduction scenario</td>
<td></td>
<td></td>
<td>$ 28.80</td>
</tr>
<tr>
<td>50% reduction scenario</td>
<td>$</td>
<td></td>
<td>$ 29.87</td>
</tr>
</tbody>
</table>

5.6 Stakeholder Perspectives

See Appendix 3 for a comprehensive list of stakeholders who were consulted on this opportunity, namely:

→ A private sector energy efficiency service provider and contractor for Landlord BC
→ BC Non-Profit Housing Association (BCNPHA)
→ BC First Nations Energy and Mining Council (FNEMC)
→ BC Ministry of Energy and Mines (MEM)
→ City of Vancouver
→ Condominium Home Owners Association (CHOA) of BC
→ FortisBC

The stakeholders were generally optimistic on the potential for aggregating larger MURB buildings to achieve emission reductions and generate offsets. All agreed on the value of using energy use intensities with normalized data to define the building baseline and emission reduction cases.

A number of FortisBC programs are in place that would support emission reductions in this sector, namely:

→ Commercial Custom Design Program – Retrofit Projects
→ Efficient Boiler Program
→ Efficient Commercial Water Heater Program

However, all stakeholders, including FortisBC, articulated that emission reductions are not occurring under current market conditions, due to a lack of access to capital (for nonprofits especially) and a lack of time among housing/MURB owners to consider building improvements. The BC Non-Profit Housing Association felt that the targeted level of offset price would meet the hurdle rate necessary for investment and that current incentives such as the FortisBC Efficient Boiler program is insufficient alone to motivate investment. The FNEMC pointed out that—despite 100% funding for upgrades—uptake in the ECAP is very low due to lack of time, illustrating the need for staffing support in order to facilitate emission reductions.
One stakeholder was skeptical of the ability to identify the targeted number of buildings prior to the first verification date, and indicated the importance of having an extended verification period beyond the standard 10 years. Furthermore, this stakeholder expressed an opinion that offsets are not required—rather funding for capacity-building should be the focus. The author of this report is of the opinion that the private sector will mobilize to build such capacity if an offset market develops.

The most promising potential offset proponent is the BC Non-Profit Housing Association, with over 5 years of staffing and human resources dedicated to energy and emission reductions. However, strata MURBs represent a larger proportion of the housing stock and thus the Condominium Home Owners Association of BC’s recent entry into this sector could position them to become an offset provider.

One stakeholder expressed a view that the most suitable offset proponent would be a professional organization that is already active in the offset market.

5.7 Key Regulatory Requirements

5.7.1 Ownership

Similar to Offset Opportunity #1, MURBs share ownership issues that would need to be considered and addressed:

→ Building Owner vs. Manager – If a building is owned by one entity but managed by another under contract, ownership of the offsets would need to be clearly established.

→ Tenant Reductions – If a project involves the implementation of ERMs by tenants and where those tenants have direct control over energy consumption (e.g., tenants are sub-metered and pay the utility bill directly, etc.), then tenants would need to assign ownership of reductions to the building owner/manager. However, in most MURBs this is less of a concern because it is relatively unlikely that individual tenants would have their own gas-fired water or space heating within their units, and reduction in electricity consumption (more likely to be sub-metered) would not be a basis for offset generation.

→ PoA – All building owners/managers would need to assign ownership rights to the offsets to the entity that provides overall management of the PoA.

5.7.2 Project Justification – Other Regulations

There are no regulations that require upgrades of MURBs that lead to emission reductions outside of major reconstruction activities. The Vancouver Building Bylaw provisions for existing buildings exempt MURBs undertaking voluntary building enclosure repairs.

5.7.3 Project Justification – Market

Refer to the description of barriers for Offset Opportunity #1. The market barriers to emission reductions vary by ownership type, depending on the divergence between who owns the building and who pays the energy bills.
5.7.4 Validation

Validation should be similar to Offset Opportunity #1 (refer to Section 3.7.3). However, because it is assumed that no existing environmental certification program is in place, the project will not benefit from associated potential validation cost savings during the certification process.

5.7.5 Verification

Verification should be similar to Offset Opportunity #1. However, because it is assumed that no existing environmental certification program is in place, activity data such as energy consumption would need to be supplied by the building managers and/or consultants and reviewed by the ISO 14065–accredited validation body. The audit risk would likely be viewed as higher due to greater chance of data quality issues as compared to buildings participating in an existing certification program. Furthermore, the depreciation reports for condominiums could be provided as additional evidence to make the case for incremental emission reductions (e.g., if the depreciation report indicates that the service life of upgraded building components and equipment exceeds the 10-year offset validation period and thus replacement was incremental to the baseline).
6 Cleantech Industry Benefits

In 2011, the BC provincial government released its economic strategy, the “Canada Starts Here: BC Jobs Plan”. The BC Jobs Plan was established with the intent to accelerate the province’s job creation potential by leveraging its strengths in key industries, as well as by capitalizing on the strengths of its skilled and knowledge-based workers.

The BC government has identified the clean technology sector as a priority industry with a high potential for growth and job creation. British Columbia is recognized as a leader in “green” economic investment and clean technology research, development, and innovation, and its clean technology sector is currently one of the most vibrant in North America (KPMG, 2012).

Research by GLOBE Advisors found that BC’s green building and energy efficiency sector has an extensive value chain with some of the highest potential for new investment and local job creation in BC’s green economy, including in the areas of construction and renovation; building material and energy-efficient product/technology design and manufacturing; and energy management. In 2012, the products, materials, and clean technology segment of green building in BC, which includes firms that produce wood-based products, energy-efficient technologies, and other energy-efficient construction materials, accounted for approximately $977 million in GDP and 9,200 direct full-time equivalent (FTE) jobs in BC (KPMG, 2012).

There is a range of companies that are active within the sub-sectors of BC’s green building technology and energy efficiency services value chain. These include (but are not limited to) manufacturers and suppliers involved with:

- **HVAC/Heating:** High-efficiency gas furnaces and boilers, heat and energy recovery ventilators (HRVs and ERVs), variable refrigerant flow (VRF) systems and heat pumps, heat exchangers, and geo-exchange and hydronic systems.

- **Building Envelope:** double and triple-glazed windows, energy-efficient doors, insulation, cladding/siding, and other structural components.

- **Lighting, Controls, and Building Automation:** Light-Emitting Diodes (LEDs) and other energy-efficient lighting systems, controls, building automation systems, sensors, monitoring software and applications, and occupant engagement solutions.

- **Energy Efficiency Services:** Architects, designers, engineers, energy advisors/auditors, building envelope specialists, energy modellers, financiers, equipment suppliers and retailers, and a variety of trades workers/contractors (carpenters, heating technicians, electricians, plumbers, equipment installers, and more).

BC’s policy and regulatory environment has been a driver for growing BC’s green building/energy efficiency industry and related clean technology sector. Specific policies and related initiatives include the **Energy Efficiency Act, Clean Energy Act, Greenhouse Gas Reduction Targets Act**, the Climate Action Plan, Energy Plan, revenue neutral carbon tax, carbon neutral government, as well as the evolving BC Building Code (updated in 2014) and Energy-Efficient Buildings Strategy.
BC’s Emission Offsets Regulation (EOR) and the BC Green Buildings Protocol have the potential to support the transition to a green economy in BC by enabling the use of carbon offsets as a tool to help overcome financial barriers on certain emission reduction measures (ERMs). In doing so, an opportunity exists to support the growth of BC companies active in providing related energy-efficient and renewable energy products, equipment, and services.

The opportunities for building offsets to support BC’s clean technology and energy efficiency service sectors vary by both building and project opportunity. A brief overview of the types of companies (including the products, technologies, and services they offer) that may benefit from energy and carbon reduction projects is provided below by activity.

### 6.1 Commercial, Retail, and Light Industrial Building Retrofits

The energy load profile for both the commercial and light industrial sectors are not as predictable as that of the residential sector with the operations within the buildings (heating as well as plug loads, etc.) having a large impact. As such, retrofit activities must consider a broader range of potential ERMs. Energy service providers in this space will often focus on a process that involves three steps:

1. Reduce energy waste by focusing on ERMs through existing systems.
2. Implement efficiency equipment upgrades such as replacing HVAC equipment, heat recovery, lighting upgrades, and control systems.
3. Address the supply-side through renewable energy solutions such as biomass, solar, or geo-exchange.

In the HVAC space, a trend exists toward the integration of high-efficiency boilers, heat exchangers/heat and energy recovery ventilation systems (HRVs and ERVs), and variable refrigerant flow (VRF) systems (heat pumps) that in some cases are replacing gas-fired rooftop units. While this equipment is increasingly produced in North America as opposed to Europe and Asia, only some systems and related components are manufactured in BC, namely high-efficiency boilers and ERVs. Design, installation, and maintenance services, however, are readily available and would be impacted positively as offset projects are developed.

Energy-efficient lighting (e.g., LEDs), electronic sensors, and controls are additional technology components that would be positively impacted by accelerated retrofit and upgrade activities in BC. While LED lighting is sourced primarily from North America and more recently from Asia, sensors and controls are a particular strength of BC’s clean technology industry.

### 6.2 Oil Conversion to Natural Gas/Electric Heating

Homeowners are more motivated to invest in switching to a new technology if costs are competitive and/or energy prices make the business case appealing. Conversations with contractors as part of BC’s Home Performance Industry Study suggested that end-of-life was the most common time for homeowners to upgrade their heating equipment (GLOBE Advisors, 2013). As such, offsets tied to a rebate program, such as the HERO program currently being offered by utilities in BC, may provide an accelerated way to replace oil–
powered furnaces with high-efficiency natural gas furnaces/boilers or electricity-power heat pumps or heat and energy recovery systems (ERVs, or HRVs). This in turn could support the market for BC’s residential heating contractors and the related value chain.

Heat pump technology is advancing quickly and ductless heat pumps could be installed in place of oil furnaces with the potential for considerable energy savings and comfort benefits. Various forms (air-to-air, air-to-water, ground source, etc.) are entering the market and coefficients of performance values are improving. The air-to-air heat pump is the most common heat pump technology for residential retrofits as these systems can be connected into existing forced-air systems.

Switching to heat pumps, geo-exchange systems, and hydronics may increase the need for more piping insulation and related services to support this transition. Oil conversion to electric heating can lead to opportunities for improving mechanical insulation systems in the residential sector in BC and generate related revenues to suppliers and service companies. Controls and thermostats for home energy management systems could again be integrated into the service offerings of heating contractors involved in these conversion projects.

In terms of the relevant services, scaling up an oil conversion program would have a direct impact on both contractors and energy advisors in the province. Contractors and equipment installers potentially play the most important influencer role in the heating conversion process. Contractors are responsible for undertaking the renovation and energy efficiency upgrades for property owners and are often the go-to source for information by homeowners. In 2012, there were approximately 3,570 plumbing, heating, and air-conditioning contractor businesses in BC (GLOBE Advisors, 2013) (GLOBE Advisors, 2013). A very large percentage of these businesses are sole-proprietors or businesses employing fewer than five staff.

In order to access bonus rebates through the existing Home Energy Rebate Offer (HERO) program, homeowners must undertake an energy audit on their house, performed by an NRCan Certified Energy Advisor (CEA). CEAs conduct home energy performance audits in order to educate property owners and assist them in identifying opportunities for improving energy efficiency. In 2012, there were approximately 150 certified energy advisors in BC (Natural Resources Canada, 2015), but this has declined significantly since the government-supported LiveSmart BC: Efficiency Incentive Program ended.

6.3 Multi–Unit Residential Building (MURB) Retrofits

The energy and GHG emissions profile for MURBs is primarily from heating and, as such, the focus related to equipment, technology, and services is predominantly on HVAC and building envelope upgrades.

HVAC systems and technologies in the MURB retrofit space are similar to the commercial and light industrial retrofit projects described above. Energy and heat recovery are large opportunity areas for MURBs, with BC companies active in this space.

On the building envelope side, MURBs that still have windows with single-pane glazing show particular promise for deep energy savings and GHG emission reductions. These buildings are prevalent in the Lower Mainland. Many of these MURBs also have cast-serve concrete slabs that act as thermal bridges from the inside of the building to the outside environment and present ideal opportunities for upgrades.
A MURB envelope retrofit case study worth considering is the Belmont Project in Vancouver (SAB Magazine, 2013). The envelope repair included an energy efficiency upgrade that replaced the existing aluminum windows with Cascadia’s triple-glazed fibreglass windows, combined with low-conductivity cladding attachments and rockwool insulation to overclad cast-in-place concrete that was exposed on the building. As a result, space heating costs dropped from $17,000/year to $3,000/year without the need for any mechanical upgrades. The windows were the biggest part of the energy/GHG emissions savings as they represented the largest source of thermal loss from the building envelope.

This project and its related ERMs were particularly cost-effective because the envelope retrofit was required due to water damage. The project demonstrated that going to a triple-glazed fiberglass window instead of double-glazed aluminum can make a huge difference in terms of the energy savings and GHG reductions for a relatively minimal additional cost. As a result of the energy savings, the project won the Beyond Green Award from the National Institute of Building Sciences in Washington, DC.

There are also opportunities for integrating home energy management systems such as controls, thermostats, and occupant engagement software as part of MURB upgrade projects. A current initiative in the MURB space includes a private-public partnership project with BC Housing to undertake deep retrofits of 13 social housing single-room occupancy buildings in Vancouver’s downtown eastside. This pilot project includes renovations and a deep retrofit of the building envelope, including windows (BC Housing, 2015).

6.4 Market Transformation

Market transformation is an ongoing process, an evolution shaped by a range of factors that include population demographics, psychographics and behavioural considerations, building type and ownership structure, and the availability of cost-effective products and services. The financial element, including payback periods and access to capital can present some of the largest barriers to market transformation.

As mentioned earlier in this section, BC is a province where the payback period on low-carbon/electric-power products and equipment can be long and unattractive as power rates continue to increase and natural gas rates remain at historic lows.

In addition, split incentives, where owners are not able to recoup the costs of their energy efficiency upgrades and the savings are passed on to the tenants/renters, create additional hurdles for moving forward on certain types of projects.

Regulatory efforts such as advancing and revising BC’s Building Code and municipal rezoning policies, as well as financial mechanisms such as BC’s carbon tax and offset market can help to overcome some of these hurdles.

In Toronto, for example, the re-zoning policy is performance-based, encouraging the adoption of energy-saving technologies such as ERVs and high-efficiency windows. It has also resulted in a shift, whereby local developers in the MURBs space have moved toward using decentralized HVAC systems, leading to condo owners controlling the heating and cooling systems in their own units with subsequent energy efficiency improvements. It has also led to a growth in market activity for BC-based clean technology and design companies supplying the Ontario market.
In terms of generating offsets to support market transformation in the energy-efficient building and retrofit space, it is important to consider flexible, creative, and open-minded approaches that allow for a wide variety of business models and ERMs. Additional revenue potential from deep energy retrofit projects is also possible; for example, by decreasing the size of existing equipment in favour of more compact energy-efficient technology, it may be possible to open up new retail or tenant rental space for building owners/property managers.

There are also opportunities to bundle these financial mechanisms with platforms and tools to increase the reliability and cost-effectiveness.

It may also be possible to broaden the scope beyond retrofits alone to include renovations and additions—a time when building owners typically consider more holistic, planned changes. For example, adding an additional energy-efficient storey onto a building could help pay for the upgrades while at the same time potentially generating offsets.

In summary, building sector offset projects have the potential to make a positive impact on BC’s clean technology and green building services industries. The overall benefits, however, will depend on the ability to scale up projects and bundle ERMs, as well as the development of a strategic approach to offset project design that considers industry strengths and capabilities in BC.
7 Key Findings

7.1 Summary of Overall Findings

Between February and March, 2015, four distinct offset opportunities were identified by RDH and the Delphi Group. Three of these opportunities were considered viable within the context of the research framework (refer to Section 2):

→ Energy upgrades for commercial buildings
→ Fuel oil conversion in houses
→ Energy upgrades for multi-unit residential buildings

During a preliminary screening of the analysis methodology, one opportunity was not pursued further because it was not deemed to be a viable opportunity for carbon offset generation (see Appendix 1).

7.1.1 Opportunity #1: Energy Upgrades for Commercial Buildings

This opportunity is based on making use of existing infrastructure for tracking and verifying energy use through the Building Owners and Managers Association’s (BOMA) BEST program, an environmental sustainability and energy management certification program for existing buildings in Canada. BOMA BEST has approximately 220 buildings registered in BC and requires certification with an independent verification service provider every three years.

→ Quantification

→ One potential method of quantifying offsets is a performance standard baseline with standard normalization factors that could be applied to ongoing energy consumption data. Energy data could be collected by the proponent’s data tracking systems (e.g., BOMA BEST data collection) or by using tools such as the ENERGY STAR® Portfolio Manager to measure annual emissions against performance standards. Historic performance could be an alternative method for determining the baseline against which incremental reductions would be calculated.

→ A standard baseline could be informed by provincial data consolidation through the Tract and Neighbourhood Data Modelling (TaNDM) project to identify appropriate groupings and normalization factors. Because of considerable variation between building design and other factors that influence energy consumption, developing acceptable, conservative performance standards by class, building characteristics, location, and other factors would take significant up-front effort and costs. One or more performance standards or specified approaches to establishing valid historic baselines could be designated by the BC Government, thereby reducing individual offset project validation costs. Only the Program of Activities (PoA) project plan would need to be validated, and ongoing verification could be simplified.

→ Regulatory Analysis (EOR compliance):
Ownership – The utility customer could be a landlord, property manager or tenant – and the ownership of offsets needs to be formally transferred to the proponent.

Project Justification – Other market barriers such as the focus of the building owner, split incentives, potential inability to monetize benefits at the time of sale, and high discount rates on capital investments are pervasive and greatly reduce the viability of implementing energy retrofit projects. This report also evaluates financial obstacles associated with these projects. It finds that retrofits that would achieve a 50% GHG emissions reduction face clear economic barriers to project adoption, in addition to other market barriers, and retrofits that would achieve a 25% emissions reduction may also face market barriers.

Verification – Project proponents might be able to use a single independent verifier to achieve both BOMA BESt certification and offset verification requirements under the BC Emission Offsets Regulation (EOR) to reduce transaction costs. This is dependent on expanding the scope of the current BOMA BC-contracted verifier for BOMA BESt to verify emission reductions below the baseline under the offset PoA, in concert with an ISO 14065–accredited offset verification body.

Proponent Capacity: To ensure cost-effectiveness, offset project proponents would need to aggregate a large number of buildings (~200) under a PoA. A proponent would be required to administer the PoA, including aggregating buildings into the program at different points of time over the life of the project.

GHG Offset Potential: 11,000 to 16,000 tonnes of CO₂e per year, after achieving full participation. Within the context of a 10-year validation/crediting period, some buildings may not achieve 10 full years of emissions reductions due to the time lag between the start of the validated PoA and the implementation of the emission reduction activity for specific buildings. If desired by the proponent and government, a second validation period could be initiated to ensure that the entire pool of buildings would be eligible to receive offset payments for 10 years.

Estimated GHG Offset Costs (including project management, validation and verification): $33/tonne for a 25% reduction and $70/tonne for a 50% reduction over historic GHG emissions.

7.1.2 Opportunity #2: Fuel Oil Conversion in Houses

This opportunity is based on the Home Energy Rebate Offer (HERO) program administered by BC Hydro and FortisBC, with a potential expansion to include oil-heated houses. Oil-to-electric conversion is economically attractive to homeowners.

Quantification

A performance standard baseline with standard normalization factors such as climate zone, size, type of house, and occupancy, verified by HERO energy advisors.

Regulatory Analysis (EOR compliance):

Ownership – The individual homeowners need to transfer offset ownership to the project proponent.
→ Project Justification – This is a challenging prospect given the strong economic drivers for fuel switching from oil to natural gas/electricity, coupled with pressure from insurance companies to change uncertified oil tanks and existing fuel switching incentive programs administered by FortisBC (oil-to-gas conversions) and the Innovative Clean Energy (ICE) Fund (oil-to-electric conversions). However, the project is justifiable for houses that have updated oil tanks (i.e., those who would not need to switch for house insurance). Furthermore, a shortened 5-year offset payment period could be used to reduce the risk that a business-as-usual fuel switch would have occurred part way through the standard 10-year validation/crediting period, undermining the project justification.

→ Verification – Ongoing monitoring of individual houses would be avoided, monitoring each home would be cost-prohibitive and generally impractical; rather, emission reductions would be established based on deemed savings for replacing an oil furnace with a heat pump.

→ Proponent Capacity: An electric utility could have the capacity to administer an offset project. An alternative proponent is the contractor who is administering the ICE Fund incentive.

→ GHG Offset Potential: 62,000 tonnes CO₂e per year for this project opportunity in BC, after achieving full participation.

→ Estimated Emission Offset Costs (including project management, validation, and verification): $26/tonne CO₂e.

7.1.3 Opportunity #3: Energy Upgrades for Multi–Unit Residential Buildings

This opportunity is based on encouraging energy/emissions upgrades at the time of residential building renewals that occur at the time of replacing major building components such as windows, boilers, roofs and cladding. The GHG offsets will help address prevalent market barriers, despite the strong economic rationale for upgrades.

→ Quantification

→ One potential option for quantification is to use a performance baseline with standard normalization factors that could be applied to ongoing energy consumption data using tools such as the ENERGY STAR Portfolio Manager. Given the need for a large number of buildings (400+) to be aggregated, a performance standard baseline or a specified approach to establishing a valid historic baseline could be adopted. A standard baseline could be informed by provincial data consolidation through the TaNDM project to identify appropriate groupings by specified characteristics and normalization factors. One or more performance standards or specified approaches to establishing valid historic baselines could be designated by the BC Government, thereby reducing project validation costs. The performance standards would also be based on the condition and anticipated replacement of major energy-consuming components. Only the PoA project plan would need to be validated, and ongoing verification would be simplified.

→ Regulatory Analysis (EOR compliance):
Ownership – The utility customer could be a landlord, condo owner, strata corporation, property manager, or tenant—and the ownership of offsets needs to be formally transferred to the proponent.

Project Justification – Other market barriers such as building owner focus, split incentives, potential inability to monetize benefits at time of sale, and high discount rates on capital investments are pervasive and greatly reduce the implementation of energy retrofit projects. The study also evaluated financial obstacles faced by these projects. It found that retrofits that would achieve a 50% emissions reduction face clear economic barriers to project adoption in addition to other market barriers. Those targeting a 25% reduction face market barriers.

Verification – The project proponent could collect normalized energy consumption data through tools such as ENERGY STAR Portfolio Manager for all participating buildings and relate that to the validated performance standard baseline to calculate emissions reductions, which could then be verified.

Proponent Capacity: Pre-existing staffing in-place and interest by BC Non-Profit Housing Association (BCNPHA). Landlord BC and the Condominium Home Owners Association are also potential proponents.

Estimated GHG Offset Potential: 17,000 – 26,000 tonnes CO2e per year, after achieving participation of 10% of the potential pool of participants. Within the context of a 10 year validation/crediting period, some buildings may not achieve 10 full years of offsets due to the time lag between the start of the validated program of activities and the emission reduction activity for specific buildings. Similar to opportunity #1, if desired by the proponent and government, a second validation period could be initiated to ensure that the entire pool of buildings would be eligible to receive offsets payments for 10 years.

Estimated Emission Offset Development Costs (including project management, validation and verification): $29/tonne of CO2e for a 25% reduction and $30/tonne of CO2e for a 50% reduction over baseline.

7.2 Summary of Analysis

Table 7.1 outlines the full extent of the analysis conducted on GHG offset opportunities for buildings.
<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Sub-Measure</th>
<th>Baseline Emissions</th>
<th>Emission Reduction</th>
<th>Capital Cost - Low</th>
<th>Capital Cost - High</th>
<th>$/Tonne (Net of Benefits) - Low</th>
<th>$/Tonne (Net of Benefits) - High</th>
<th>Target Offset Value</th>
<th>Payback Period w/o Offsets</th>
<th>Payback Period with Offsets</th>
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<td>Fuel Oil Heating conversions</td>
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<td>Number of Buildings</td>
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<td>Verification Cost</td>
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</table>

| 2  | Fuel Oil Heating conversions      | Single Family House - heat pump | Achievable: 10%         | 70,300              | 623,070           | 15,870             | 454            | $25,000        | $20,000          | $10,000             |
|    |                                     | TOTAL (50%)        |                          | 1,765,537            | 1,324,152         | 259,696             | 25,970         | $25,000        | $20,000          | $10,000             |

| 3  | Deep Energy Retrofits of MURBs    | Low-rise - 25% gas reduction | 10,170,847                 | 716,900             | 2,722,847         | 54,395             | 454            | $50,000        | $30,000          | $39,000             |
|    |                                     | Low-rise - 50% gas reduction | 7,628,135                  | 537,675             | 2,042,136         | 81,593             | 340            | $50,000        | $30,000          | $39,000             |
|    |                                     | High-rise - 25% gas reduction | 8,632,935                 | 80,136              | 293,125           | 43,531             | 90             | $50,000        | $30,000          | $39,000             |
|    |                                     | High-rise - 50% gas reduction | 6,474,701                 | 60,102              | 219,844           | 65,296             | 68             | $50,000        | $30,000          | $39,000             |
|    |                                     | Townhouses - 25% reduction | 14,084,422                 | 968,501             | 2,756,826         | 75,205             | 210            | $35,000        | $25,000          | $30,000             |
|    |                                     | Townhouses - 50% reduction | 10,563,316                 | 726,376             | 2,067,620         | 112,807            | 1,855          | $25,000        | $20,000          | $25,000             |
|    |                                     | TOTAL (25%)        |                          | 32,888,204           | 1,765,537         | 5,772,799           | 210            | $50,000        | $30,000          | $39,000             |
|    |                                     | TOTAL (50%)        |                          | 24,666,153           | 1,324,152         | 4,329,599           | 259,696        | $25,000        | $20,000          | $25,970             |

0.059260 m²/ft²

**Cost-Effectiveness Legend**
- Cost-effective < $20/tonne
- Potentially cost-effective with other portfolio objectives (cleantech, etc)
- Marginally cost-effective
- Not cost-effective
7.3 Other Benefits

The proposed offset opportunities provide significant co-benefits, namely:

- Reduced building energy costs and improved housing affordability and business competitiveness.
- Improved building occupant comfort and health due to reduced drafts, cold spots, and mould and increased fresh air intake (with HRVs/ERVs).
- Improved building durability.
- Potential for increased building resale value.
- Significant BC-based jobs as noted in the cleantech industry impacts.

7.4 Recommended Next Steps

Based on the analysis conducted and presented in this paper, the following three steps are recommended to enable GHG offset providers to develop project that align with the noted opportunities, or others in the buildings sector.

- Consider developing performance standard protocols to define the emission baselines for key sectors (e.g., office, shopping centre, different sizes and occupancy types for multi-unit residential buildings, oil heating of houses). This could be informed by full implementation of the TaNDM project, as it would provide high-quality information on energy use and emission intensity by building type and region. In some cases, deemed calculated measures could be established for specific technologies in specific building applications, for example, the oil-to-heat pump conversion for a specific house type and climate zone.
- Pilot the use of performance standards for individual buildings on a cost-recovery basis. Revise the protocols to reflect lessons learned.
- Release revised protocols and designate them as compliant with the appropriate regulation.

These recommendations may stimulate investment in emissions reductions in buildings and monetizing GHG offsets in a manner that is aligned with the stated objectives of the Ministry of Environment under the Request for Emissions Offsets.

Andrew Pape-Salmon, P.Eng., MRM
Associate, Senior Specialist - Energy
apapesalmon@rdh.com
RDH Building Engineering Ltd.

Stephan Wehr, P.Eng.
Vice President
swehr@delphi.ca
The Delphi Group
8 Appendices

8.1 Appendix 1: Offset Opportunity #4 – Local Government CEEP Implementation for New and Existing Buildings

This section provides a summary of a fourth offset opportunity that could be advanced by local governments. It was decided that it would not be analyzed in detail due to substantial barriers regarding offset ownership, aggregation, influence over building owners and high anticipated validation and verification costs.

8.1.1 Prospective Proponents

→ BC Municipalities
→ BC Regional Districts

8.1.2 Description

Dozens of local governments across the Province have completed Community Energy and Emissions Plans (CEEP) in response to Local Government Act and Community Charter requirements for inclusion of GHG reduction plans in their official community plans and Climate Action Charter goals surrounding community (non-corporate) emissions. The figure below illustrates that the Victoria CEEP has a goal to reduce emissions in existing buildings by 31,000 tonnes CO₂e by 2020 through a number of measures. Local governments currently have relatively few tools with which to influence emissions reductions for existing buildings and frequently rely on partnerships with organizations that have resources and/or influence. In the case of the Victoria CEEP, these include (Victoria CEEP, 2012, pg. 81):

→ Developing innovative financing for building retrofit projects.
→ Developing programs and incentives.
→ Increasing the use of high-efficiency systems.
→ Using market mechanisms as a tool to increase energy efficiency (audits and labelling).
→ Increasing awareness.

The aforementioned tools do not rely on regulations or existing programs and activities and therefore are potentially compatible with the requirements for GHG offsets.
Through emission reduction programs, local governments could aggregate reductions of multiple building segments, offering an incentive for deep emission reductions (30%+) in concert with completion of annual building energy benchmarking. Medium and large buildings could use ENERGY STAR Portfolio Manager and/or ASHRAE Building Energy Quotient tools, which collect actual energy consumption data and normalize them for common variables such as climate conditions and occupancy (currently only for office, retail, and warehouse spaces in Canada). For houses, the EnerGuide Rating System could be used for tracking energy performance before and after the reduction measures. These tools are compatible with the emission quantifying methods set out in the BC Green Buildings Protocol. Some municipalities might apply the emission reductions from their programs against their Climate Action Charter targets; if the breadth and depth of reductions is expanded, offsets could also be generated.

A project could include the following components:

→ The baseline for energy use intensity could be defined by the CEEP analysis.

→ Targeted emission reductions would be aligned with best-case CEEP-estimated benefits of local government programs, although offset payments would not be based on this.

→ As a requirement, energy benchmarking data would be required for a minimum of 3 years pre–retrofit to determine the baseline (this could be readily assembled based on historic energy bills). This would align with the BC Green Building Protocol historic benchmark baseline approach.

→ A second offset payment would be made after the retrofit is complete, illustrating an investment in physical improvements. The proponent or verification body could commission random independent audits of 10% of the buildings to verify achievement of emission reductions prior to release of payment.

→ Subsequent offset payments would be made for each year of emission reductions falling below the sector-wide benchmark (representing the common performance or the historic emissions, whichever is lower). This enables a conservative estimate of reductions.
Local governments with CEEPs or equivalent studies (e.g., Vancouver Greenest City Action Plan and Energy Retrofit Strategy for Existing Buildings) would be candidates for proponents or partners, including:

1. Metro Vancouver (based on Surrey or other CEEP)
2. Vancouver (based on Greenest City Action Plan and Energy Retrofit Strategy for Existing Buildings)
3. Capital Regional District (based on Victoria CEEP)
4. Central Okanagan Regional District (based on Kelowna Community Climate Action Plan and/or other southern interior CEEP)
5. Peace River Regional District (based on Fort St John CEEP, Dawson Creek CEEP and/or other northern interior CEEP)

CEEPs also set emission reduction targets to influence new construction, for example, the City of Victoria’s target of 10,000 to 13,000 tonnes CO₂e by 2020. Victoria’s plan includes reliance on existing regulations such as the BC Building Code along with voluntary adoption of programs such as LEED and high-efficiency heating systems. However, there might be circumstances where additional reductions could be achieved with higher standards such as zero-emission-construction. An offset could be determined at the time of building permit and the payment could be linked to verifying compliance through commissioning (a requirement for LEED and Passive House) prior to occupancy. Additional requirements, such as annual benchmarking and reporting, could provide further evidence of achievement of zero-emission goals. The baseline would be BC Building Code minimum energy standards or published “stretch” requirements such as 22% more efficient than the BC Building Code standard, as is the case with the City of Vancouver.

8.1.3 Data Sources

The key building stock data sources are:

- BC Assessment database to determine the number of buildings inside the jurisdiction of each participating local government.
- Local government specific data surveys on buildings (e.g., CEEPs).

The key energy performance data sources are:

- Local government specific data surveys on buildings (e.g., CEEPs).
- BC Hydro studies on the energy performance of new construction (apartments and offices).
- BC Hydro and FortisBC energy end-use studies for the relevant subsectors.
- NRCan National Energy Use Database, which provides information on province-wide energy performance by building type.
- Seattle Energy Benchmarking report (January 2014), which provides information on the spread of energy performance by relevant subsector.
8.1.4 Emission Reduction Cost–Benefit Analysis Methodology

This methodology assumes a change in the emissions intensity from historic benchmarking data to future documented levels.

- Clarify the size and types of buildings within the influence of the 5 sample local governments through BC Assessment data. Determine appropriate groupings of building types by proponent.

- Estimate the energy savings from the CEEP s and other sources:
  - For existing buildings, use a targeted reduction for a deep energy retrofit.
  - For new buildings, align with zero–emissions standards.

- Determine the incentives required to achieve the incremental emission reductions:
  - For existing buildings, offset value needed to address barriers to:
    1. Completing benchmarking
    2. Upgrading buildings through retrofits
    3. Maintaining savings, post–retrofit
  - For new buildings, the incremental costs to achieve zero–emission construction through fuel switching and energy efficiency.

- Overlay offset validation and verification costs required for compliance with the EOR.

- Estimate $ per tonne CO₂e required to overcome barriers to emission reduction project implementation for each of the 5 proponents.

- Conduct a review of adherence with the Request for Emission Offsets (RFEO) portfolio objectives such as advancing cleantech goals. Significant co–benefits could justify a higher offset price.

8.1.5 Offset Validation and Verification Analysis Methodology

- For existing buildings, the building energy benchmarking for multiple years before and after the emission reductions provides the basis for an historical benchmark based baseline approach (in the BC Green Building Protocol).

- For new construction, a comparison–based baseline approach (in the GBP) would be used, using studies of energy and emission performance of new buildings constructed under the BC Building Code and published city rezoning or density–bonus standards such as those in the Cities of Vancouver and North Vancouver.

8.1.6 Project Viability

Local Governments have committed to reducing their GHG emissions under the Local Government Act and Community Charter. The sale of these carbon offsets would require the local governments to include these sold emissions in their footprints to avoid issues around double counting. As a result, this opportunity was not deemed to be viable as local governments would not be able to claim the environmental benefits from their initiatives.
8.2 Appendix 2: Overview of Regulatory Requirements

Offset projects must meet 7 key project criteria under the EOR as described in the table below. It is likely that the projects in the building sector are able to meet many of these criteria. Those that will require additional consideration are as follows, highlighted under each opportunity (Sections 3 through 5):

- Ownership
- Project Justification
- Quantifiable
- Verifiable

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<th>CRITERIA DESCRIPTION</th>
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<td>A GHG reduction must occur from controlled sources, sinks, or reservoirs and occur within the provincial borders of BC.</td>
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<td>The GHG reduction project must have started commercial operations no earlier than November 29, 2007.</td>
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<td></td>
<td>Only reductions of one or more of the six main types of GHGs(^5) are eligible and they must be quantified according to their carbon dioxide equivalent (CO(_2)e) global warming potential (GWP).</td>
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<tr>
<td><strong>Real</strong></td>
<td>The project must provide a technical description of how the project will achieve a GHG reduction.</td>
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<tr>
<td></td>
<td>The project must select a baseline scenario that will result in a conservative estimate of the GHG reduction.</td>
</tr>
<tr>
<td><strong>Quantifiable</strong></td>
<td>The project proponent must identify an appropriate protocol, determine how measurements and monitoring can be conducted, and estimate the reduction opportunity for the project.</td>
</tr>
<tr>
<td><strong>Justifiable</strong></td>
<td>The project must be distinct from its baseline scenario and face financial, technological, or other obstacles, and the incentive of the GHG reduction potentially being recognized as an offset must overcome or partially overcome those obstacles. Project proponents must be able to justify these claims.</td>
</tr>
<tr>
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<td>Project proponents must consider existing or proposed regulatory requirements and incentives when selecting a baseline scenario.</td>
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\(^5\) Carbon Dioxide, Methane, Nitrous Oxide, Hydrofluorocarbons, Sulphur Hexafluoride and Petrofluorocarbons
| Verifiable | Project plans must be validated and project reports must be verified by independent third-party assurance providers, pursuant to the qualifications identified in and requirements set out under the Regulation. |
| Counted Once | A GHG reduction can only be recognized as an offset if it is not recognized under any other GHG reduction program. |
| Clear Ownership | The project proponent must, with respect to the GHG reductions to be achieved by carrying out the project, have a defensible claim of ownership. |
8.3 Appendix 3: List of Stakeholders Referenced

- Building Owners and Managers Association of BC (BOMA BC)
- BC Hydro
- FortisBC
- BC Ministry of Energy and Mines
- BC Non-Profit Housing Association (BCNPHA)
- BC First Nations Energy and Mining Council
- Condominium Home Owners Association (CHOA) of BC
- City of Surrey
- City of Vancouver
- City of Victoria
- City of Kelowna
- City of Dawson Creek
- City of Terrace
- Landlord BC
- Renewal Funds
8.4 Appendix 4: Bibliography of Sources

Listed in order of appearance in the body of the report:


