Ensuring social and affordable housing is part of a just and equitable transition to a low carbon future

BUILDING THE BUSINESS CASE FOR RETROFITS, BRIEF 2: Financing Solutions

May 2023

This project has received funding from:

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Acknowledgements:
This project benefited from the invaluable contributions of Stefanie Drozda and Mike Mellross [Alberta Ecotrust], Cam McDonald [Right at Home Housing Society], Hazel Navarozza and Joanne Cabrera [Civida], Jonathan Lay and Nick Lilley [Home Ed], Councillor Anne Stevenson, Barbara Daly, Lisa Dockman, Andrea Soler and Lauren Hall [City of Edmonton], Mike Krokis and Faisal Husain [3D Energy], Matt Zipchen, Tim Stoate and Beata Domanska [Efficiency Capital].

1 INTRODUCTION

Achieving the ambitious greenhouse gas (GHG) emission reductions stated in Edmonton's Community Energy Transition Strategy and Calgary's Climate Strategy will require transformative and rapid change across all sources of emissions. Both cities have committed to net-zero emissions by mid-century. Residential buildings are a significant emission source, accounting for 18% and 32% of community-wide emissions in Edmonton and Calgary, respectively. These buildings also have a service life of 40-80 years. Attaining the cities' targets in the next 30 years will thus require deep energy and GHG saving retrofits (upgrades) to most existing residential buildings.

Yet, progress has been doggedly slow—especially in the social and affordable housing sector where an assortment of unique barriers limits the uptake of retrofits. Two critical barriers are that the business case is poorly understood and challenging for decision-makers to justify, compounded by a lack of awareness of available funding support and financing options. The presence of these and other barriers means individuals and families in subsidized housing will have limited opportunities to benefit from access to low-carbon goods and services, improved housing and the enhanced quality of life offered by decarbonization. For Edmonton's and Calgary's transition to be considered "just, equitable and inclusive"—a guiding principle of both cities' Strategies—all residents must have fair access to these opportunities.

Failure to include the social and affordable housing sector in the transition to a low-carbon future is not an option. The 2,950 social and affordable housing buildings in Edmonton and Calgary generate about 200,000 tonnes of carbon dioxide equivalent (t CO_2e) per year—that is a lot of potential emission reductions to leave on the table. Furthermore, tenants of these buildings will almost certainly be part of Edmonton's and Calgary's "energy poor"—households who are unable to maintain adequate energy services at a reasonable cost. Energy poverty is a form of material deprivation that can result in financial stress, cold homes and poor health, the need to cut other basic expenditures, lower educational attainment, social isolation and risk-taking behaviours, as well as less tangible non-material deprivation, like loss of dignity. Retrofitting deep energy savings into social and affordable housing buildings will help reduce energy poverty in the sector, giving rise to a range of important social and economic benefits.

For the purpose of this Brief, a deep retrofit is a multi-measure retrofit project that achieves at least a 25% reduction in current levels of energy consumption.[1]

Deep retrofit ≥ 25% energy savings

[1] This level of savings was chosen as it is the minimum level of energy savings required to be eligible for FCM's Sustainable Affordable Housing, Retrofit Capital Projects funding initiative (see www.greenmunicipalfund.ca/sustainable-affordable-housing). Other resources view energy savings of *at least* 40% as defining a deep retrofit. Indeed, the Canada Greener Affordable Housing (CGAH) program defines a deep energy retrofit as delivering a 70% reduction in pre-retrofit energy consumption.

1.1 Project goal

The project is intended to:

1. Prove and demystify the business case for deep energy retrofits of buildings typical of the social and affordable housing sector; and
2. Introduce financing options and funding support and show how housing providers can improve the business case for action.

This Brief is focused on the second barrier; a companion Brief focuses on the first barrier. By addressing these two critical barriers to the uptake of deep energy and GHG saving retrofits, it is hoped that these Briefs will support and inform dialogue between decision-makers in the social and affordable sector and providers of funding and financing support to kick-start and accelerate retrofits across the sector's inventory of buildings.

The content of both Briefs is based on detailed energy and financial assessments of four case study buildings in Edmonton (managed by HomeEd, Right at Home Housing Society and CIVIDA) and a workshop (held on Thursday, November 10th, 2022) to explore financing options, attended by other social and affordable housing providers, policymakers, and interested stakeholders from the green building industry, non-profits, and sources of financial support.

2 THE OPPORTUNITY

Demand for social and affordable housing increasingly exceeds available supply. A major obstacle to addressing the housing shortfall is that it takes too long to get new units to market. One way to help meet growing demand is to focus on restoring, retrofitting, or reusing existing buildings that may otherwise be repurposed or demolished—thereby extending their useful service life. About 8-10% of subsidized housing units in Edmonton and Calgary are in need of major repairs.[2] Renewing an existing building structure for continued use is less expensive than new construction, and generally more sustainable. Importantly, capital renewal projects also provide an opportunity to overlay deep energy and GHG saving upgrades on top of planned refurbishments. This improves the cost-effectiveness and business case for the upgrades since the building envelope, and mechanical and electrical systems are already being rehabilitated. In essence, only the incremental cost of the energy and GHG saving measures beyond business-as-usual upgrades count as 'new' capital expenditures. Furthermore, a very high percentage of the existing social and affordable housing inventory in both cities was constructed prior to the adoption of the 2011 National Energy Code of Canada for Buildings in Alberta and are thus considerably more energy intensive than newer construction. This means there is plenty of scope for improving the energy efficiency of these buildings

> *"Our typical buildings are either row townhouses or walk-up apartments built around 1980. That's true of the other non-profit housing providers in Edmonton. They're all 40+ years old."*
>
> Housing provider in Edmonton

[2] Statistics Canada, 2022, Table 98-10-0247-01, core housing need by tenure including presence of mortgage payments and subsidized housing.

and generating material utility cost savings for both housing providers and tenants alike. The majority of tenants pay at least one utility bill: "*Tenants pay for power, but we pay for heat and water*" (a comment typical of housing providers in Edmonton)[3]. Housing providers will simultaneously benefit from lower maintenance costs, increased valuations for owned properties, and enhanced resilience to energy price volatility and extreme weather impacts.

More broadly, deep energy saving retrofits of the social and affordable housing inventory have the potential to generate significant triple bottom line benefits—including the health and well-being of tenants, the local economy, and climate change mitigation. Analysis of actions to address energy poverty in Edmonton, for example, has shown that for each 10% reduction in the average energy bill of an energy poor household, the number of energy poor households in the city would decline by nearly 2%. That equates to 360-915 fewer households experiencing the adverse impacts of energy poverty outlined above.[4]

The main social, economic and environmental benefits of deep energy and GHG saving retrofits to social and affordable housing buildings are listed in Figure 1. The figure also shows the relative significance assigned to each benefit stream by participants at the project workshop. In the view of participants, the most significant benefits relate to the utility bill savings that would accrue to both the housing providers and those tenants that paid bills. The importance of the former cannot be overstated as a potential source of funding for retrofits of buildings in the sector. For some housing providers, borrowing is a viable option to fund retrofits, but only if the savings they accrue exceed the costs of servicing the debt. Other housing providers—for whom borrowing is not currently an option—are willing to use their cash reserves to fund retrofits; but to pay for deep retrofits they must build-up these reserves over multiple years through operational cost savings. This of course serves as a barrier to the rapid adoption of deep retrofits by some housing providers.

> "*If our savings, on a month-to-month basis, are more than our debt servicing, then the* [retrofit] *project makes sense. That is the framing we look at.*"
>
> "*…whatever savings I get I put into reserve funds and then build that up for major, deep energy retrofits.*"
>
> Housing providers in Calgary and Edmonton

[3] Though, in some cases, the tenant does not have any utility bills in their name or is directly responsible for all utility bills.

[4] Assumes a household is 'energy poor' if its energy cost burden exceeds 6% or 10% of after-tax income, implying about 50,765 and 19,840 households in Edmonton, respectively, are experiencing energy poverty (as per the Energy Poverty and Equity Explorer accessible at www.energypoverty.ca).

Figure 1: Key social, economic and environmental benefits of deep energy and GHG saving retrofits of social and affordable housing stock

Description of benefits	Most significant benefits
Reduced utility bills for housing provider	25%
Reduced maintenance costs for housing provider	9%
Extended useful service life of property	2%
Increased property value	0%
Avoided capital rehabilitation / renewal investments in future years	2%
Reduced utility bills, improved affordability and more disposable income for tenants	21%
Improved thermal comfort, physical and mental health, safety and wellbeing of tenants	11%
Reduced risk of tenant going into arrears	0%
Increased resilience to energy price volatility / shocks and carbon price escalation	7%
Increased resilience of building to extreme weather impacts and climate change	5%
Inclusive energy transition—reduced inequality and disparities in community	5%
Reduced community greenhouse gas (GHG) emissions	11%
Local employment and growth opportunities for green building sector	4%

Note: the percentages and bars represent the relative frequency of participant votes for their two most significant benefits

3 THE CHALLENGES

Given the wealth of potential benefits from retrofitting deep energy and GHG savings into the social and affordable housing stock, why has the uptake of retrofits been stubbornly slow? The reality is—housing providers face many challenges when it comes to pursing deep retrofits to reduce energy consumption and GHG emissions. The main barriers are listed in Figure 2. The relative significance assigned to each barrier by participants at the project workshop is also displayed. The most important challenges relate to the scarcity of available capital and competing needs for that pool of limited funds. Capital renewal of social and affordable housing buildings is frequently done to very tight budgets with no scope to include energy or GHG savings measures beyond minimum code requirements, despite the potential for larger

> *"…most of our funding is to ensure the buildings we have don't fall down."*
>
> *"…for money to come out of our reserves, it's not going to be used for* [energy] *efficiency, it's going to be used to keep our buildings going."*
>
> *"All of our buildings are 50-55 years old and they're all reaching the end of life … the primary goal* [of our real estate strategy] *is to extend the life of an asset to the best of our ability with the funding that we have."*
>
> Housing providers in Calgary and Edmonton

operating cost savings. As one housing provider in Edmonton put it: "*Like most non-profits* […] *we have too much to do and not enough dollars to do it*." Relatedly, while housing providers are interested in reducing their GHG emissions and environmental stewardship generally, it does not motivate or influence business decisions. Dollars influence business decisions in the sector with emissions savings viewed as a co-benefit: "*oh, by the way*, [the project] *will also reduce GHG emissions*" (comment from a housing provider).

Housing providers are also challenged by knowledge and capacity gaps with respect to both (1) planning and coordinating the retrofits and (2) the available options to finance the required capital expenditures and existing restrictions on access to finance—in particular, restrictions on taking on (more) debt. One housing provider commented: "*the direction from our executive team and Board is that they currently do not want to take on any more debt*." Though not all social and affordable housing providers face borrowing limits or prohibitions; one provider in Edmonton with little debt against their portfolio uses debt financing to fund capital projects, which include energy saving retrofits.

Only a handful of workshop participants identified misaligned incentives as a key barrier to implementing deep energy retrofits. However, for some housing providers, they are the most important hurdle to overcome. When debt servicing of loans to pay for deep retrofits must be covered by utility bill savings, but the savings accrue partially or wholly to tenants because they pay the bills, the result was described by one housing provider in Edmonton as "*great for our tenants*" but "*our biggest problem*" to pursuing deep retrofits. Relatedly, the ownership of the property can be a significant hurdle. Within a housing provider's portfolio of properties, some will be owned, while many are only managed for the City of Edmonton (or City of Calgary) or the province. Several housing providers commented that while the cities are open to investing in deep energy saving retrofits, the province is not; "*The ones we manage for the province, we cannot do anything, there's zero opportunity*."

As stated above, the goal of this Brief and the companion Brief (focused more on highlighting the costs and benefits of deep retrofits) is to help social and affordable housing providers in Edmonton and Calgary overcome these challenges. If they can be successfully addressed, the scale of the opportunity for operational cost savings, GHG emission reductions and economic co-benefits is significant (see Box 1). Importantly for the transition to a low carbon future, failing to take advantage of the opportunity presented by routine capital renewal projects—i.e., to cost-effectively embed deep energy and GHG saving measures into the projects—risks locking in higher carbon footprints in the building stock for another 30-40 years, given the expected service life of building systems.

Box 1: The opportunity at-scale in Calgary and Edmonton

To illustrate the potential impacts from scaling-up this project, the costs and benefits of rolling out the case study findings to all of Calgary and Edmonton have been simulated—assuming 6-7% of the nearly 2,945 row townhouse and walk-up apartment (social and affordable) properties in both cities are retrofitted annually between 2023-2050 to achieve the "economic potential" for energy and GHG emission savings identified at the four case study properties. The resultant impacts are listed below:

- Total incremental **investment costs** = **$227 million** (2022 dollars) or $8.1 million per year, on average.
- **Lifetime energy savings** = **23 PJ** or 0.5 PJ per year, on average. This is equivalent to a 28% reduction in baseline energy consumption over the period 2023-2050.
- **Lifetime utility bill savings** = **$439 million** (2022 dollars) or $8.8 million per year, on average.
- **Lifetime GHG emissions savings** = **1,347,730 t CO_2e** or 26,955 t CO_2e per year, on average. This is equivalent to a 27% reduction in baseline GHG emissions over the period 2023-2050.

This level of investment each year would directly and indirectly contribute **$3-4 million** to **household incomes**, support roughly **35-40 full-time jobs**, and contribute **$6-7 million** to provincial **GDP** annually through 2050.

Figure 2: Key barriers to deep energy and GHG saving retrofits of social and affordable housing stock

Description of barriers	Most significant barriers
Limited understanding of the full business case—energy saving measures and their costs, utility savings potential, and non-energy co-benefits	7%
Poor knowledge of options to finance the initial capital investment at little or no up-front cost and overcome financing restrictions—like debt covenants imposed by existing lien holders that place limits on taking on more debt	23%
Retrofits offer longer paybacks and lower rates of return compared with alternative (uses of capital) investments	2%
Competing priorities for the limited available capital—like deferred maintenance or acquisition of new properties	25%
Uncertainty around the length of ownership of the property given the long lifespan of energy saving measures	0%
Concern that the estimated utility bill savings will not be realized (performance risk)	2%
Uncertainty relating to project costs, and concern for cost overruns, delays in completing projects and risks to building operations	0%
Limited understanding and capacity to manage and plan retrofits—coordinate with multiple organizations offering retrofit assessments, design and installation, and incentives and financing and their application processes	14%
Properties first require costly rehabilitation (construction upgrades) to enable the retrofit of energy saving measures	7%
Misaligned interests—depending on ownership, savings on operational expenses do not flow to decision-makers of capital investments, such as energy saving retrofits	2%
Misaligned interests—housing provider pays none or only a portion of the utility bill and thus has limited incentive to invest in retrofits to save energy	7%
Insufficient available capital	16%

Note: the percentages and bars represent the relative frequency of participant votes for their two most significant challenges

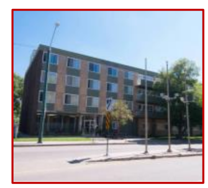
4 THE COSTS AND BENEFITS OF DEEP RETROFITS

To demonstrate and demystify the financial case for deep energy retrofits for social and affordable housing providers in Edmonton and Calgary, four case study buildings in Edmonton were identified in tandem with project partners (Civida, HomeEd and Right at Home) for detailed energy and financial assessments.

4.1 The case study buildings

The four case study buildings are presented in Table 1. They were selected to be representative of buildings in the sector. In 2020, about 55% of the social and affordable housing buildings in Alberta were semi-detached, row townhouses like Rundle Heights II and Woodvale Court, accounting for about 38% of available dwelling units.[5] Apartments like Lexington Manor with fewer than 5-storeys accounted for 9% of buildings (37% of dwelling units) in the province, with a further 2% of buildings (and 20% of dwelling units) comprising apartments with five or more storeys, as typified by Renfrew Arms.[6]

Table 1: Description of case study buildings

	Rundle Heights II	Woodvale Court	Renfrew Arms	Lexington Manor
				
Housing provider	Civida	Right at Home	Civida	Home Ed
Number of units	97	46	65 + parkades	40 + parkade
Types of units	2-, 3-, 4- & 5-bed	2- & 3-bed	1-bed	Studio, 1- &2-bed
Approximate floor area	12,420 m^2	5,980 m^2	4,890 m^2	2,790 m^2
Construction period	Circa 1970	Circa 1981	Circa 1981	Circa 2000

To develop an understanding of each building's current energy performance as well as energy and GHG saving opportunities, an energy assessment (sometimes called an "energy audit") was performed at each property. Further details of these assessments are provided in Brief 1. The assessments established the baseline energy performance (in both physical units and dollars) for each case study building (summarized in Table 2). Estimated GHG emissions and intensity in 2022 are also shown in Table 2.

[5] Statistics Canada, 2022, Table 46-10-0001-01, Inventory of publicly owned social and affordable housing assets, Alberta.

[6] Single detached houses could not be accommodated within the scope of the project; accounting for about 34% of buildings and 5% of dwelling units in Alberta.

4.2 The identified energy and GHG saving opportunities

The energy assessments identified multiple energy saving measures for each case study property. A whole building approach was adopted with efficiency improvements identified for the following building systems: space heating equipment and schedules, domestic hot water equipment, ventilation equipment, building envelope (i.e., walls, foundation, roof, windows, doors), interior and exterior lighting, electrical equipment (e.g., dryers) and hot water end-use equipment (e.g., faucets, toilets). The full list of identified energy saving measures for the row townhouse complexes (Rundle Heights II and Woodvale Court) and the apartment blocks (Renfrew Arms and Lexington Manor) are provided in Table 3 and Table 4, respectively.

Table 2: Baseline energy performance of case study buildings in 2022

	Rundle Heights II	Woodvale Court	Renfrew Arms	Lexington Manor
Electricity use	1,844 GJ	860 GJ	1,580 GJ	607 GJ
Natural gas use	8,512 GJ	5,739 GJ	5,736 GJ	2,936 GJ
Energy use intensity (EUI)	0.83 GJ / m^2	1.10 GJ / m^2	1.48 GJ / m^2	1.27 GJ / m^2
Electricity bill	$46,540	$23,595	$47,085	$33,900
Natural gas bill	$122,170	$30,480	$45,235	$20,775
Energy bill	$168,710	$54,075	$92,320	$54,675
GHG emissions	715 t CO_2e	427 t CO_2e	521 t CO_2e	242 t CO_2e
GHG emission intensity	0.06 t CO_2e / m^2	0.07 t CO_2e / m^2	0.11 t CO_2e / m^2	0.09 t CO_2e / m^2

Note: GJ = Gigajoule = 278 kWh (Kilowatt hours)

The energy assessments identified some equipment that was defective or nearing or past the end of its useful service life—for example, the windows and many domestic hot water heaters at both Rundle Heights II and Woodvale Court. In these cases, two sets of measures were identified: new equipment compliant with minimum code and upgraded equipment that is more energy efficient than minimum code. This distinction is important when it comes to the analysis of retrofit benefits and costs, since the installed costs of the required windows and domestic hot water heaters would in principle need to be incurred in the near future to maintain the properties in a state of good repair. As a result, when calculating Net Present Values as part of the business case analysis (discussed in Section 5), the total installed costs of the minimum code equipment is treated as a monetary benefit (i.e., as a CAPEX saving). Planning deep retrofits to coincide with major capital rehabilitation projects at buildings as part of standard asset management—such as replacing windows, siding, roofs, boilers, etc. at the end of their useful service life—provides opportunities to upgrade the energy performance of building systems at a lower incremental cost.

In addition to energy saving measures, the assessments identified opportunities to install solar photovoltaic (PV) systems on each building. The size of the systems varies considerably depending on the area of suitable roof space at each site—ranging from 25 panels at Renfrew Arms (with an installed capacity of 14 kilowatts) to 821 panels at Rundle Heights II (with an installed capacity of 443 kilowatts).

4.3 Analysis of retrofit costs and benefits

The primary motivation for housing providers in the sector to invest in deep retrofits is reduced utility bills concomitantly with extending the life of the property. Below, a summary of retrofit costs and utility bill savings is presented separately for each case study building. Only results for the full "economic potential" at each property are shown as a basis for simulating the impacts of different financing options in Section 5; additional results can be found in the companion Brief 1 [Benefits and Costs]. In Brief 1, the economic potential for deep retrofits at a property was defined to include only measures that collectively provided the operator with a positive cumulative Net Present Value (NPV).

When viewing the summarized results below, note that all values are measured in 2022 dollars. Furthermore, to account for uncertainty regarding anticipated savings, it is assumed that only 90% of savings estimated by the energy assessments are realized. To reflect the GHG emissions intensity of electricity delivered to end-users, estimated GHG savings are based on the 'consumption-intensity' of the provincial grid, as opposed to the 'generation-intensity'. The latter reflects the GHG emissions intensity of electricity delivered to the grid only, failing to capture losses associated with transmission and distribution from generating sites to end-users.

Table 3: Energy conservation measures and renewable energy measures identified for the row townhouse complexes

Measure ID	Building	Short description	Detailed description
ECM-1	RH	Low-cost measures	Door seals & sweeps, pipe insulation & DHW tank blankets, Low-flow aerators, furnace pipe
ECM-2	RH	Low-flow water fixtures	Low-flow washroom facets, low-flow kitchen faucets, dual-flow toilets
ECM-3	RH	Smart thermostats and HRV controls	Smart thermostats set back to 16C for unoccupied hours (2,920) plus addition of HRV controls
ECM-4	RH	Lighting upgrade	Replacement of all interior and exterior non-LED fixtures with LEDs (lighting load reduction = 0.6 Watts / m2)
ECM-5a	RH	DHW heater upgrade (above min. code)	Replace 50% existing storage DWHs at end of life with condensing tankless DWHs (EF from 59% to 93%)
ECM-5b	RH	DHW heater upgrade (min. code)	Replace 50% existing storage DWHs at end of life with storage type heater (EF from 59% to 67%)
ECM-6a	RH	Window upgrade (above min. code)	Replace existing windows at end of life with triple-pane, argon-filled, low-e windows (RSI from 0.222 to 0.621)
ECM-6b	RH	Window upgrade (min. code)	Replace existing windows at end of life with min. code double-pane, argon filled, low-e (RSI from 0.222 to 0.505)
ECM-7	RH	Exterior wall insulation upgrade	Install Extruded Polystyrene (XPS) insulation with thermal insulation (increase RSI from 1.76 to 4.05)
ECM-8	RH	Foundation walls, headers & rims insulation	Seal cracks, increase R-value of headers and rims to at least 20, increase R-value of foundation walls from 2.4 to 15
ECM-9	RH	Upgrade doors	Replace all existing exterior doors (R-2) with fiberglass doors (R-5)
REM-1	RH	Install solar PV system	Install grid-connected PV system comprising 821 x 540 W panels (cap. = 443.3 kW)
ECM-1	WC	Low-cost measures	Door seals & sweeps, pipe insulation & DHW tank blankets, Low-flow fixtures, furnace pipe
ECM-2	WC	Low-flow water fixtures	Low-flow washroom facets, Low-flow kitchen faucets
ECM-3	WC	Smart thermostats	Smart thermostats set back to 16C for unoccupied hours (2,920) plus addition of HRV controls
ECM-4	WC	Lighting upgrade	Replacement of all interior and exterior non-LED fixtures with LEDs (lighting load reduction = 3.02 Watts / m2)
ECM-5a	WC	DHW heater upgrade (above min. code)	Replace 50% existing storage DWHs at end of life with condensing tankless DWHs (EF from 57% to 93%)
ECM-5b	WC	DHW heater upgrade (min. code)	Replace 50% existing storage DWHs at end of life with storage type heater (EF from 57% to 67%)
ECM-6a	WC	Window upgrade (above min. code)	Replace existing windows at end of life with triple-pane, argon-filled, low-e windows (RSI from 0.383 to 0.592)
ECM-6b	WC	Window upgrade (min. code)	Replace existing windows at end of life with min. code double-pane, argon filled, low-e (RSI from 0.383 to 0.490)
ECM-7	WC	Exterior wall insulation upgrade	Install Extruded Polystyrene (XPS) insulation with thermal insulation (increase RSI from 1.76 to 3.87)
ECM-8	WC	Foundation walls, headers & rims insulation	Seal cracks, increase R-value of headers and rims to at least 20, increase R-value of foundation walls from 2.4 to 15
ECM-9	WC	Roof insulation upgrade	Blown-in cellulose insulation with thermal resistance of RSI-3.6 per mm (increase RSI from 4.23 to 8.81)
ECM-10	WC	Upgrade doors	Replace existing doors with doors that are rated R-5 or better (increase RSI from 0.383 to 1.23)
REM-1	WC	Install solar PV system	Install grid-connected PV system comprising 273 x 455 W panels (cap. = 124.2kW)

Notes: RH = Rundle Heights II; WC = Woodvale Court; DWH = domestic hot water; HRV = heat recovery ventilator; kW = kilowatt; R-value and RSI are both measures of thermal resistance (the higher the resistance value, the slower the rate of heat transfer through the insulating material; EF = efficiency factor (an EF of 80% means that 80% of the energy that is being used to heat your water is effectively converted into heat).

Table 4: Energy conservation measures and renewable energy measures identified for the apartment blocks

Measure ID	Building	Short description	Detailed description
ECM-1	RA	Low-cost measures	Door seals & sweeps, pipe insulation & DHW tank blankets, increase operational efficiency of supply fans, adjust AC unit temperature in mechanical room
ECM-2	RA	Smart thermostats	Smart thermostats set back to 16C for unoccupied hours (2,920) plus addition of HRV controls
ECM-3	RA	Lighting upgrade	Replacement of all non-LED fixtures with LEDs (lighting load reduction in suites, common areas & parkade = 4.2, 5.5 and 1.2 Watts / m^2, respectively)
ECM-4	RA	Heat transfer fluid additive	Installation of a heat transfer fluid enhancer for all water/glycol-based heating fluids
ECM-5a	RA	Window upgrade (above min. code)	Replace existing windows at end of life with triple-pane, argon-filled, low-e windows (RSI from 0.284 to 0.621)
ECM-5b	RA	Window upgrade (min. code)	Replace existing windows at end of life with min. code double-pane, argon filled, low-e (RSI from 0.284 to 0.505)
ECM-6	RA	Clothes Dryer Upgrade	5 existing electric dryers replaced with natural gas models (used for a combined 4 hours per day)
ECM-7	RA	Energy Recovery Wheel	Installation of one 11,000 cubic feet per minute Energy Recovery Wheel (ERW) for the ventilation system, plus 25 m of required ducting
REM-1	RA	Install solar PV system	Install grid-connected PV system comprising 25 x 550 W panels (cap. = 13.75 kW)
ECM-1	LM	Low-cost measures	Door seals & sweeps (30 m), low-flow aerators (40 devices)
ECM-2	LM	Smart thermostats	Smart thermostats set back to 16C for unoccupied hours (2,920) plus addition of HRV controls
ECM-3	LM	Heat transfer fluid additive	Installation of a heat transfer fluid enhancer for all water/glycol-based heating fluids
ECM-4	LM	Vestibule window upgrade	Replace existing vestibule windows with triple-pane, argon-filled, low-e windows (RSI from 0.159 to 1.031)
ECM-5a	LM	Near condensing boilers (AFUE 88%)	Replace the 2 existing boilers with 2 new near-condensing boilers (capacity = 246 kW, AFUE increase from 64.4% to 88%)
ECM-5b	LM	New min. code boilers (AFUE 80%)	Replace the 2 existing boilers with 2 new non-condensing (min. code) boilers (capacity = 246 kW, AFUE increase from 64.4% to 80%)
ECM-6	LM	Clothes dryer upgrade	Replace the 1 existing electric dryer with natural gas model (used for 40 loads per week)
REM-1	LM	Install solar PV system	Install grid-connected PV system comprising 88 panels with capacity = 36.8 kW

Notes: RA = Renfrew Arms; LM = Lexington Manor; DWH = domestic hot water; HRV = heat recovery ventilator; kW = kilowatt; R-value and RSI are both measures of thermal resistance (the higher the resistance value, the slower the rate of heat transfer through the insulating material; EF = efficiency factor (an EF of 80% means that 80% of the energy that is being used to heat your water is effectively converted into heat); AFUE = Annual Fuel Utilization Efficiency (an AFUE of 90% means that 90% of the energy in the boiler's fuel source becomes heat).

Box 2: Net Present Value and Profitability Index decision criteria

Net Present Value (NPV)—a form of lifecycle cost analysis—is an indictor of a retrofit's economic merits. In contrast to other performance indicators like simple payback, not only does NPV consider all cash flows over the useful life of a retrofit project, but it also accounts for the time value of money. A project's cash flows include the purchase and installation costs of equipment, energy and water cost savings, and all other costs and benefits, such as reduced O&M costs and any avoided planned capital rehabilitation expenditures. Using the housing provider's chosen discount rate, all cash flows are expressed as present values—i.e., in comparable dollars today when decisions are made. A positive NPV indicates a retrofit project's present value cash inflows (the benefits) exceed the present value of its cash outflows (the costs) over the term of the analysis (typically, the expected useful service life of the measures). Simply put, a project with a positive NPV is profitable. In contrast, a negative NPV indicates the project is unprofitable.

To ration capital efficiently across multiple worthy projects with positive NPVs the Profitability Index (PI) can be used. The PI is equal to 1 + (NPV ÷ initial capital expenditure). In the context of deep retrofits, PI thus provides a metric of the operational cost savings per unit of investment. The higher the PI, the more attractive the project—and rationed capital should first be allocated to projects with the highest PI so that savings are maximized for a given level of capital expenditure.

4.3.1 Retrofit project value: Rundle Heights II

The economic potential for energy and GHG emission savings at Rundle Heights are, respectively, a 58% reduction in baseline annual energy consumption and a 60% reduction in baseline annual emissions (see Table 5). To realize the economic potential of the property an investment of $1,927,585 is required, producing annual utility savings of $113,120 over the functional life of the installed measures.

Note that the energy and GHG saving measures listed in Table 5 (and in the summary tables for the other three case study buildings) have been rank-ordered according to their estimated Profitability Index (PI). The measures towards the top of the table are relatively more profitable.

4.3.2 Retrofit project value: Woodvale Court

The economic potential for energy and GHG emission savings at Woodvale Court are, respectively, a 41% reduction in baseline annual energy consumption and a 43% reduction in baseline annual emissions (see Table 6). To realize the economic potential of the property an investment of $713,830 is required, producing annual utility savings of $43,275 over the functional life of the installed measures.

4.3.3 Retrofit project value: Renfrew Arms

The economic potential for energy and GHG emission savings at the Renfrew Arms are, respectively, a 20% reduction in baseline annual energy consumption and a 22% reduction in baseline annual emissions (see Table 7). To realize the economic potential of the property, an investment of $170,875 is required, producing annual utility savings of $22,690 over the functional life of the installed measures.

Table 5: Economic potential for deep retrofits at Rundle Heights II

Measure ID	Measure description	Cumulative reduction in baseline energy use	Cumulative annual average utility bill savings	Cumulative investment costs	Cumulative reduction in baseline annual GHG emissions
		%	$ per year	$	%
ECM-1	Low-cost measures	8%	13,964	38,480	6%
ECM-8	Foundation walls, headers & rims insulation	21%	27,279	139,180	18%
ECM-4	Lighting upgrade	22%	28,613	142,580	19%
ECM-2	Low-flow water fixtures	31%	51,273	297,880	23%
ECM-3	Smart thermostats and HRV controls	32%	59,410	378,390	29%
REM-1	Install solar PV system	46%	102,752	1,375,815	50%
ECM-5a	DHW heater upgrade (above min. code)	51%	108,027	1,553,415	55%
ECM-7	Exterior wall insulation upgrade	**58%**	**113,120**	**1,927,585**	**60%**

4.3.4 Retrofit project value: Lexington Manor

The economic potential for energy and GHG emission savings at the Lexington Manor are, respectively, a 30% reduction in baseline annual energy consumption and a 27% reduction in baseline annual emissions (see Table 8). To realize the economic potential of the property an investment of $186,920 is required producing annual utility savings of $17,220 over the functional life of the installed measures.

Table 6: Economic potential for deep retrofits at Woodvale Court

Measure ID	Measure description	Cumulative reduction in baseline energy use	Cumulative annual average utility bill savings	Cumulative investment costs	Cumulative reduction in baseline annual GHG emissions
		%	$ per year	$	%
ECM-1	Low-cost measures	7%	6,158	13,850	5%
ECM-2	Low-flow water fixtures	9%	14,686	62,610	9%
ECM-8	Foundation walls, headers & rims insulation	18%	18,534	100,140	16%
ECM-4	Lighting upgrade	22%	22,144	129,480	19%
ECM-3	Smart thermostats	22%	23,645	146,280	22%
REM-1	Install solar PV system	30%	38,384	450,580	34%
ECM-9	Roof insulation upgrade	34%	38,916	477,480	34%
ECM-5a	DHW heater upgrade (above min. code)	36%	41,335	562,580	40%
ECM-7	Exterior wall insulation upgrade	**41%**	**43,275**	**713,830**	**43%**

Table 7: Economic potential for deep retrofits at Renfrew Arms

Measure ID	Measure description	Cumulative reduction in baseline energy use	Cumulative annual average utility bill savings	Cumulative investment costs	Cumulative reduction in baseline annual GHG emissions
		%	$ per year	$	%
ECM-1	Low-cost measures	2.8%	1,683	1,040	2%
ECM-6	Clothes dryer upgrade	3%	6,742	13,540	6%
ECM-7	Energy Recovery Wheel	9%	10,326	41,290	10%
ECM-4	Heat transfer fluid additive	11%	11,616	46,790	12%
ECM-3	Lighting upgrade	14%	18,105	104,340	17%
ECM-2	Smart thermostats	19%	21,276	136,500	21%
REM-1	Install solar PV system	**20%**	**22,691**	**170,875**	**22%**

Table 8: Economic potential for deep retrofits at Lexington Manor

Measure ID	Measure description	Cumulative reduction in baseline energy use	Cumulative annual average utility bill savings	Cumulative investment costs	Cumulative reduction in baseline annual GHG emissions
		%	$ per year	$	%
ECM-1	Low-cost measures	1.8%	1,570	1,380	1.4%
ECM-6	Clothes dryer upgrade	2%	2,857	3,880	2%
ECM-2	Smart thermostats	9%	5,140	22,330	8%
REM-1	Install solar PV system	13%	12,352	112,490	15%
ECM-3	Heat transfer fluid additive	16%	12,943	115,290	16%
ECM-5a	Near condensing boilers (AFUE 88%)	29%	17,132	176,840	27.0%
ECM-4	Vestibule window upgrade	**30%**	**17,222**	**186,920**	**27.2%**

5 FINANCING OPTIONS

> *"Like most non-profits [...] we have too much to do and not enough dollars to do it."*
>
> Housing provider in Edmonton

Across the case study buildings, the investment needed to achieve the economic potential for energy savings ranged from $713,830 to $1,927,585 for the row townhouses and from $170,875 to $186,920 for the walk-up apartments. Despite the potential large operational cost savings offered by these investments, scarcity of available capital and competing needs for that capital is a significant hurdle to pursuing deep energy and GHG saving retrofits of the social and affordable housing stock (recall Section 3). Fortunately, there are several financing solutions available to support deep energy retrofits of buildings in the sector by overcoming the upfront investment costs. A key conclusion from this project, however, is that there is no "one size fits all" approach.

5.1 Financing options and attributes

There are essentially four viable financing tools to help social and affordable housing providers cover the initial capital costs of deep retrofits, as well as address several of the other challenges identified in Section 3:[7]

1. Traditional secured loans;
2. Soft loans;
3. Clean Energy Improvement Program; and
4. Energy Service Agreements.

Below, each of these tools is described briefly with respect to a number of key attributes that housing providers identified as important to consider when evaluating the appropriateness of financing options for their organization (described in Table 9).

Table 9: Key attributes of financing tools for deep retrofits

Repayment vehicle
Refers to the mechanism through which the source of capital (like a financial institution or municipality) recovers their investment from the housing provider (e.g., monthly loan payments, property taxes, service fees). Closely related to the repayment vehicle is how repayment is secured—i.e., what does the capital provider require as collateral to ensure their money is repaid, like the property or the energy saving equipment.
Preferential financing terms
Refers to whether the financing tool enables access to a below market interest rate (cost of capital), longer-term financing (e.g., 10-year or more term), or both. This can also include forgivable loans where housing providers, for example, do not have to pay back all or a portion of the outstanding balance provided certain conditions are met. Deep energy and GHG emission saving retrofits—with longer payback periods and lower rates of return compared with alternative uses of capital—are not well suited for short- to medium-term financing with repayment terms typically less than 10 years.

[7] Note that two prominent energy efficiency financing solutions used elsewhere in North America—utility on-bill financing and on-bill repayment—are not considered in this Brief as they are currently not available in Alberta.

Various types of "credit enhancements" can be used to encourage capital providers to offer preferential terms to housing providers (see Box 3).

Covers all initial capital expenditures

Refers to whether the funds provided are sufficient to cover all or only a portion of the required capital investment. For example, FCM's Capital Project: Retrofit of Sustainable Affordable Housing offers financing for up to 80% of total eligible project costs.[8] The Canada Greener Affordable Housing program will finance 100% of total eligible project costs but caps the total expenditure at $170,000 per dwelling unit.[9] Depending on the level of financing support offered by any single financing tool, it may be necessary to stack solutions (see below).

> "*Anything above and beyond* [standard building renewal projects] *requires a significant amount of external capital. Affordable housing is a money losing business. Most people that do not work in this space have very little appreciation of how much that is true. So, if we don't have someone else giving us the money* [for deep energy retrofits], *we don't do that kind of work."*
>
> Housing provider in Edmonton

Transferability

Refers to whether a housing provider can transfer the obligation to repay any outstanding loan balance or service fees to new ownership should a property be sold. Many energy and GHG emission saving measures have expected useful lives well over 15 years. Given the long lifespan of these measures, the transferability of repayment obligations is important to address uncertainty relating to the length of ownership and recovery of the initial investment through lifetime operational cost savings.

Accounting treatment

Refers to whether the repayment vehicle has the potential to be treated as an operating expense, rather than debt, and thus does not impact the housing provider's capital balance sheet, preserving the organizations' borrowing capacity for other core investments. The accounting treatment of the repayment vehicle is important for those housing providers that face borrowing restrictions.

> "*the direction from our executive team and Board is that they currently do not want to take on any more debt*."
>
> "*…we do not borrow against our assets. Our ability to borrow is high, but that's a shift in mentality we need to get comfortable with.*"
>
> "*…yes, the accounting treatment of the financing is quite important*."
>
> Housing providers in Calgary and Edmonton

Work along side existing financing obligations

In some cases, the use of a particular financing tool may be limited by existing financial obligations or circumstances. For example, a highly leveraged property or portfolio, or a housing provider with poor

[8] See https://greenmunicipalfund.ca/funding/capital-project-retrofit-sustainable-affordable-housing.

[9] See https://www.cmhc-schl.gc.ca/en/professionals/project-funding-and-mortgage-financing/funding-programs/all-funding-programs/canada-greener-affordable-housing-program/-/media/a159d706323a4a23a1c041045abd44f5.ashx.

credit, may face borrowing limits or be offered unattractive terms. Existing mortgage lenders may limit access to the Clean Energy Improvement Program or at least complicate the approvals process.

Provides security against underperformance

There are several risks associated with deep energy and GHG emission saving retrofit projects—most notably, whether the anticipated energy savings and return on investment are actually realized (performance risk) and uncertainty over the length of ownership of a property (see "transferability" above). Some financing solutions offer security or insurance against performance risk, linking repayment to actual, verified savings.

Bundled turn-key service

Refers to whether the financing tool is amenable to one organization or consortium providing turn-key project delivery (development, funding/financing, construction, monitoring and maintenance). Deep energy and GHG emission saving retrofit projects can be a complex and daunting undertaking for housing providers—both in terms of coordinating and managing multiple contractors to execute the upgrade, as well as obtaining reliable information on the costs and performance of saving measures, available financing and funding, and navigating the application process.

Stackable with grants, other financing options

Refers to whether it is possible to combine (or "stack") the financing tool with other tools and funding supports, like grants or rebates. This enables housing providers to fund large retrofit projects when one single financing tool is not sufficient or appropriate for case at hand. It also allows housing providers to scale projects to the portfolio level, as well as improve financing terms.

> *"If you get a loan from them, it comes with a matching grant. The rates are higher, may be 5-6% now, but with the grant attached to it, the effective rate is lower and more attractive."*
>
> "[to be net zero ready] *any stackable financing is important."*
>
> Housing providers in Edmonton

Project performance requirements/criteria

For some tools, eligibility or the level of financial support offered may require the retrofit project to achieve specified triple bottom line thresholds—e.g., 25% or more energy or GHG savings. For example, for projects to be eligible for financial support from the Canada Greener Affordable Housing (CGAH) program they must target a 70% reduction in pre-retrofit energy consumption.

When investigating potential financing solutions, it is important to understand their requirements and eligibility criteria and work towards ensuring the planned retrofit project meets or exceeds them from the outset.

Applicability to subsidized housing sector

Refers to the extent the financing tool is currently used by housing providers in the sector and their level of familiarity with the tool.

Box 3: Credit enhancements

Credit enhancements encompass a variety of provisions that reduce the risk of extending credit to a borrower (so-called 'credit risk'). In the context of this Brief, they are anything that closes the gap between the terms under which an investor or financial institution is willing to lend money and the terms under which a housing provider is willing to borrow money. Credit enhancements can be instrumental in terms of:

- Encouraging lenders to finance unfamiliar products, like deep retrofits where the revenue stream is essentially energy cost savings and not a tangible product.
- Encouraging lenders to provide more attractive financing terms, by absorbing or sharing some of the credit risk.
- Convincing lenders to relax their underwriting criteria and lend to housing providers that they otherwise would not, again by absorbing or sharing some of the credit risk.

The main forms of credit enhancement—typically funded by government—include:

- Loan loss reserves (LLRs) – funds are set aside (reserved) by the government to help pay for potential losses if housing providers default on their loan. The pool of money set aside typically covers a share of the first losses on individual loans (say, 80%-90% of first losses) with the total reserve capped as a fixed percentage of the total loan portfolio.
- Loan guarantee – is similar to an LLR, except it does not require money to be set aside nor is it capped as a percentage of the total loan portfolio principle. All potential losses of the loan portfolio are covered. An agreement is signed between the government and the lender guaranteeing all losses will be covered in the event of a loan default.
- Interest rate buy-down – government directly subsidizes the interest rate offered by a lender to a housing provider, thereby reducing financing costs and making the loan more affordable/attractive. Typically, a lump sum is paid upfront to a lender equal to the present value of the difference in interest costs between the subsidized rate and the commercial rate over the term of the loan.

Credit enhancements can support a range of financing tools and are particularly well suited to leveraging public money to mobilize private investment in deep energy and GHG emission saving retrofits.

5.1.1.1 Traditional secured loan

A traditional secured loan is the familiar loan provided by a retail lender (banks, credit unions or trust companies), whereby the lender advances the borrower a sum of money in exchange for a legal claim against the borrower's assets (e.g., a housing provider's property or portfolio of properties). The property serves as collateral for the loan (principal, interest and other financing charges); if the housing provider defaults on payments, the lender can convert the property to cash to ensure the loan is repaid. Interest rates and repayment terms on secured loans are generally more favourable than unsecured loans—though still less favourable than soft loans (below). In contrast to some of the other financing tools, the repayment of the loan is not linked to the anticipated or actual energy savings.

Key attributes of financing option:	
Repayment vehicle	Periodic (typically monthly) loan payments
Preferential terms: lower cost of capital	Not typically, though housing providers owned by the cities were accessing rates of 2.1%-4.1% per year
Preferential terms: longer terms (≥10 years)	Not typically, though housing providers owned by the cities were accessing loan terms of 10 years with 40-year amortization periods
Covers all initial capital expenditures	Yes, can cover 100% of project costs
Transferability	No, obligation to repay loan stays with borrower
Accounting treatment	Debt obligation on balance sheet
Work alongside existing financing obligations	Possible, with challenges
Provides security against underperformance	No
Bundled turn-key service	No
Stackable with grants, other financing options	Yes
Project performance requirements/criteria	No
Applicability to subsidized housing sector	Well established

5.1.1.2 Soft loan

Soft loans—also known as preferential or concessional loans—work in much the same way as secured loans described above. Except, the financing terms on soft loans tend to be more favourable and affordable, with no or below market interest rates and longer repayment terms (≥10 years) and amortization periods (e.g., 40-50 years). Soft loans are typically provided by government or quasi-public institutions like the Federation of Canadian Municipalities (FCM) or the Canada Mortgage and Housing Corporation (CMHC) to support the achievement of specific policy goals.[10] Government can also use credit enhancements to encourage retail lenders to offer soft loans for deep retrofits in the sector.

Key attributes of financing option:	
Repayment vehicle	Periodic (typically monthly) loan payments
Preferential terms: lower cost of capital	Yes
Preferential terms: longer terms (≥10 years)	Yes
Covers all initial capital expenditures	No, typically capped at a % of eligible project costs or as total project cost
Transferability	No, obligation to repay loan stays with borrower
Accounting treatment	Debt obligation on balance sheet
Work alongside existing financing obligations	Possible, with challenges
Provides security against underperformance	No
Bundled turn-key service	No
Stackable with grants, other financing options	Yes
Project performance requirements/criteria	Yes, eligibility typically requires a specified reduction in pre-retrofit energy or GHG emissions
Applicability to subsidized housing sector	Well established

[10] Links to the energy and GHG emission savings financing programs offered by these organizations for affordable housing are provided at the bottom of page 16.

5.1.1.3 Clean Energy Improvement Program

The Clean Energy Improvement Program (CEIP) is a new financing tool in Alberta that enables residential and commercial property owners to pay for the upfront investment costs of energy and GHG emission saving retrofits. Both the City of Edmonton[11] and the City of Calgary[12] have active programs, though at the time of writing certain multi-family properties and federal, provincial and municipally owned properties are ineligible. Unlike a traditional secured loan, repayment is facilitated by a Clean Energy Improvement Tax added to a property's tax bill. Because tax-liens are senior to outstanding mortgage debt, they are considered very secure. Furthermore, since the repayment obligation is attached to the property and not the borrower, it can be transferred to a new owner at the time of sale. As a result of these attributes, the CEIP can offer favourable interest rates and loan terms. But because of its senior-lien position, to be eligible for CEIP, the property owner must obtain prior consent from their mortgage lender, where relevant.

Key attributes of financing option:

Repayment vehicle	Additional charge on property tax bill
Preferential terms: lower cost of capital	Yes, annual interest rates offered by Calgary's and Edmonton's CEIP are in the range of 2.95%-3.50%
Preferential terms: longer terms (≥10 years)	Yes, terms equivalent to the expected useful life of installed equipment or up to 20 years
Covers all initial capital expenditures	Yes, but the total annual repayment is limited by the property's annual property tax payment, which will indirectly cap the total project value
Transferability	Yes, possible for obligation to repay loan to remain with the property after sale
Accounting treatment	Off-balance sheet (non-debt) operating expense
Work alongside existing financing obligations	Possible, with challenges
Provides security against underperformance	No
Bundled turn-key service	No, but list of approved contractors and eligible projects are provided
Stackable with grants, other financing options	Yes
Project performance requirements/criteria	No
Applicability to subsidized housing sector	Possible in principle, but unproven in practice

[11] See https://www.edmonton.ca/city_government/environmental_stewardship/clean-energy-improvement-program-ceip.

[12] See https://www.calgary.ca/environment/climate/clean-energy-improvement-program.html.

5.1.1.4 Energy Service Agreement

Under an Energy Service Agreement (ESA) a third party develops retrofit projects, manages their implementation and operation, and arranges and provides capital to pay for the projects.[13] In effect, a turn-key retrofit project is delivered. The housing provider negotiates and signs a contract with the third party and agrees to pay them either a fixed or floating fee for a portion of the verified energy savings received over the duration of the contract; a portion of the savings during this period resides with the housing provider resulting in an immediate reduction in operational costs. Over the contract period the third party retains ownership of the installed equipment. At the end of the contract ownership passes to the housing provider. ESAs typically have higher transaction costs as the third party provider needs to be confident performance risks are fully understood and managed, which requires greater due diligence compared to the other financing tools. Consequently, ESAs work best for large retrofit projects. Uncertainty over energy savings is addressed through covenants in the contracts, energy savings insurance products or both.

Key attributes of financing option:

Repayment vehicle	**Service fee paid from utility bill savings**
Preferential terms: lower cost of capital	**No, expected return to service provider entails higher transaction costs to cover greater due diligence / insurance against performance risk and costs of delivering bundled service**
Preferential terms: longer terms (≥10 years)	**Service contracts can be up to 10 years**
Covers all initial capital expenditures	**Yes, can do**
Transferability	**Possible, but challenging**
Accounting treatment	**Possible to structure such that repayments are considered off-balance sheet (non-debt) operating expense**
Work alongside existing financing obligations	**Yes**
Provides security against underperformance	**Yes, repayments made from verified savings and can be guaranteed using specialized insurance**
Bundled turn-key service	**Yes**
Stackable with grants, other financing options	**Yes**
Project performance requirements/criteria	**No**
Applicability to subsidized housing sector	**Well established**

[13] An example includes The Atmospheric Fund's Energy Saving Performance Agreement offered by Efficiency Capital (see https://taf.ca/publications/espa-brochure/ or https://efficiencycap.com/).

5.2 Evaluation of financing options on retrofit project economics

To highlight the impact of different financing solutions on project economics, several financing scenarios were simulated for funding the upfront investment required to achieve the identified economic potential at Lexington Manor (presented in Section 4.3). Descriptions of the financing solutions considered are listed below:

Scenario	Description
Self-financing	✓ 100% of the required upfront investment is paid from the housing providers cash reserves ✓ 90% of the projected energy savings are achieved
Secured loan	✓ 100% of the required upfront investment is borrowed from retail lender ✓ Financing terms: monthly payments over 7 years at 4.1%
Secured loan + grant	✓ 75% of the required upfront investment is borrowed from retail lender ✓ Financing terms: monthly payments over 7 years at 4.1% ✓ Remaining 25% of investment is covered by a grant
Soft loan	✓ 100% of the required upfront investment is borrowed from government or quasi-public institution ✓ Financing terms: monthly payments over 20 years at 2.1%
CEIP	✓ 100% of the required upfront investment is borrowed from government ✓ Financing terms: monthly payments over 20 years at 3.2% (2.95%-3.50%)
CEIP + grant	✓ 75% of the required upfront investment is borrowed from government ✓ Remaining 25% of investment is covered by a grant ✓ Financing terms: monthly payments over 20 years at 3.2% (2.95%-3.50%)
Soft loan + grant	✓ 75% of the required upfront investment is borrowed from government or quasi-public institution ✓ Financing terms: monthly payments over 20 years at 2.1% ✓ Remaining 25% of investment is covered by a grant
Soft loan + grant + self-financing	✓ 55% of the required upfront investment is borrowed from government or quasi-public institution ✓ Financing terms: monthly payments over 20 years at 2.1% ✓ 25% of investment is covered by a grant ✓ Remaining 20% of investment is self-financed from cash reserves

ESA + self-financing	✓ 50% of required upfront investment is financed under the ESA ✓ Remaining 50% of required upfront investment is self-financed from cash reserves ✓ ESA contract term is 10 years with an expected return of 8% ✓ 80% of the savings are taken to pay the ESA over the contract term
ESA + secured loan	✓ 50% of required upfront investment is financed under the ESA ✓ Remaining 50% of required upfront investment is borrowed from retail lender ✓ ESA contract term is 10 years with an expected return of 8% ✓ 80% of the savings are taken to pay the ESA over the contract term ✓ Financing terms: monthly payments over 7 years at 4.1%
ESA + soft loan	✓ 50% of required upfront investment is financed under the ESA ✓ Remaining 50% of required upfront investment is borrowed from government or quasi-public institution ✓ ESA contract term is 10 years with an expected return of 8% ✓ 80% of the savings are taken to pay the ESA over the contract term ✓ Financing terms: monthly payments over 20 years at 2.1%
ESA + soft loan + grant	✓ 50% of required upfront investment is financed under the ESA ✓ 25% of required upfront investment is borrowed from government or quasi-public institution ✓ 25% of investment is covered by a grant ✓ ESA contract term is 10 years with an expected return of 8% ✓ 80% of the savings are taken to pay the ESA over the contract term ✓ Financing terms: monthly payments over 20 years at 2.1%

For all financing scenarios, a real annual discount rate of 2.96% is used for the NPV calculations.[14] The discount rate represents either the housing provider's "hurdle rate" (minimum acceptable rate of return on investments) or its cost of borrowing or cost of capital.

Additionally, the following two non-energy benefits (or "co-benefits") are included in the NPV calculations to illustrate the importance of capturing these additional benefits when forming the business case for deep retrofits:

1. **Maintenance cost savings**. Retrofits are expected to reduce the need for replacements through the installation of long-lived equipment, reduce the frequency of inspections, reduce the need for repairs, reduce the need for staff to respond to tenant complaints, all of which will reduce

[14] This rate corresponds to a nominal annual discount rate of 5.0%, deflated using the annual average CPI (all-items) growth rate over the last 20 years in Edmonton (1.98% per year).

routine maintenance costs. For the purpose of the scenario analysis, maintenance cost savings are assumed to conservatively amount to 3% of expected annual utility bill savings.[15]

2. **Avoided capital expenditures**. Capital expenditures required under business-as-usual (such as the replacement of deficient windows or domestic water heaters nearing end of life) are treated as avoided replacement costs in the scenario analysis, since these expenditures are no longer incurred. Instead, the installed costs of the alternative, higher efficiency equipment are incurred. In the case of Lexington Manor, an expenditure of $49,420 is assumed to be avoided in the first year of the retrofit project as it would have been necessary to replace the two existing boilers with two new non-condensing (min. code) boilers under business-as-usual.

The total investment requirement to realize the economic potential for energy and GHG emission savings at Lexington Manor is $186,918. The annual average utility bill savings over the expected useful life of all installed measures are $17,222. The results of the financing scenario analysis are presented in Table 10; the corresponding estimated cash flows are provided at Appendix A.

Table 10: Summary of impact of financing scenarios on project economics

Financing scenario	Without non-energy benefits		With non-energy benefits	
	NPV	Discounted payback (years)	NPV	Discounted payback (years)
Self-financing	$105,845	12-13	$163,870	8-9
Secured loan	$95,135	13-14	$153,160	9-10
Secured loan + grant	$144,545	9-10	$202,565	<1
Soft loan	$116,685	<1	$174,705	<1
CEIP	$98,050	<1	$156,075	<1
CEIP + grant	$146,730	<1	$204,755	<1
Soft loan + grant	$160,705	<1	$218,425	<1
Soft loan + grant + self-financing	$158,535	3-4	$216,560	<1
ESA + self-financing	$79,230	15-16	$137,250	10-11
ESA + secured loan	$73,940	15-16	$131,965	11-12
ESA + soft loan	$84,580	12-13	$142,605	<1
ESA + soft loan + grant	$128,050	<1	$186,070	<1

Note: The discounted payback period is the number of years it takes for the upfront investment costs of the retrofit project to equal to discounted value of expected cash flows—i.e., for the investment to break even. It is calculated as the number of years it takes for the cumulative net present value of the project to equal zero.

[15] TAF, 2020, The Case for Deep Retrofits, The Atmospheric Fund (TAF), Toronto, ON.

Several conclusions can be drawn from the results in Table 10:

- Not unexpectedly, combining any of the financing solutions with grants improves retrofit project economics. The beneficial impact of grants is nonetheless smaller when coupled with the soft loan than with the more expensive secured loan or ESA—at least based on the assumed financing costs and terms.
- The soft loan as defined represents the preferred financing solution, solely in terms of the expected NPV. The simulated CEIP offers slightly higher financing costs to the simulated soft loan and thus does not perform as well, but it would help the housing provider avoid potential challenges presented by the on-balance sheet accounting treatment of the loan or related restrictions arising from existing financing obligations.
- If the housing provider's hurdle rate or opportunity cost of capital is relatively low, self-financing the retrofit project from cash reserves may offer higher NPVs than secured loans or an ESA.
- Purely in terms of NPV, the ESA performs least well compared to the other financial tools—primarily due to the high transaction costs reflected in the 8% expected rate of return for the service provider. However, the lower NPV must be considered in tandem with other advantages offered by the tool, including the provision of a bundled turn-key project delivery system and its off-balance sheet accounting treatment. If the housing provider wishes to take advantage of these attributes of an ESA, then it is advisable to combine it with a soft loan, a grant, or both.
- The importance of including non-energy benefits when developing a business case for deep retrofits is also clearly evident from the difference in estimated NPVs in Table 10, irrespective of the financing solution used.

While financing retrofit projects using soft loans improves the business case, it is evident from some of the quotes throughout the Brief that debt-financing is a tough sell to decision-makers for some housing providers in the sector. Though being able to stack the loans with grants certainly makes for a stronger case—and may be sufficient to shift the mindset of some Boards. CEIP sidesteps the challenges presented by debt-financing by providing an off-balance sheet solution. However, its attractiveness as an option to entice wholesale deep retrofits by housing providers not owned by the cities (who can access relatively low rates from retail lenders) depends on the interest rate offered. Furthermore, the extent to which CEIP is a viable option for much of the social and affordable housing inventory in Edmonton and Calgary is not known—both with respect to eligibility under current terms and conditions and the level of property tax paid on individual properties, if at all. By way of example, as one housing provider stated: "*For city properties, we don't pay the city portion of the property tax, but we do pay the provincial portion. For the provincial properties, we don't pay anything. This precludes 50% of our properties.*" This will indirectly cap the size of projects that can be funded via CEIP, which may necessitate stacking with other funding options to deliver deep retrofits.

Notwithstanding the relative project economics of the ESA simulated, it does provide a bundled ("one-stop-shop") delivery system and off-balance sheet solution for deep retrofit projects. Nevertheless, several housing providers said they do not require a full bundled service, as they have some of the required expertise in-house. Housing providers are also very sensitive to the disruption and inconvenience deep retrofits may entail for their tenants, and as a consequence, would look to retain project management responsibilities.

"In terms of expertise, we have certain levels of it (technical, project implementation side). The monitoring and reporting, we'd always need someone else outside of the organization to do."

"I think we'd do it ourselves, pay ourselves a fee to do that."

"Where we need the most help is in the creation of the business case. We don't have the in-house capacity to do any of that. We do have project managers once it's underway. That would be the extent of our involvement; coordination on-site between contractors and tenants."

"We have concerns about tenant relationships […] *because we are not moving tenants out. We don't have other places for them to go. Tenants stay in units while we work around them. Managing the process is something we're touchy about."*

Housing providers in Calgary and Edmonton

A key obstacle to taking on repayment obligations to fund deep retrofits expressed by all housing providers is how utilities are structured. Across the portfolio of properties owned and managed by a housing provider, the full spectrum of payment arrangements is possible—from tenants directly paying all utilities, to paying solely electricity, to paying a flat fee for all utilities to the housing provider, to receiving fixed payments from outside agencies who place tenants with the housing provider. For some housing providers—who must cover financing costs from utility bill savings—the structure of utility payments is hugely problematic as the savings do not accrue in full to the provider. "*Solving that problem is the barrier to me*" (comment from a housing provider). A suggested solution is for grants to cover the proportion of retrofit investment costs that cannot be recovered through utility bill savings that accrue to the housing provider.

When it comes to designing financial and funding supports, eligibility criteria—like a threshold level of pre-retrofit energy or GHG emissions saved—should acknowledge the importance the sector places on reducing operational (utility) cost savings concomitantly with extending the useful life of properties relative to reducing GHG emissions. While the importance of the latter is important, it is essentially viewed as a co-benefit: "*oh, by the way*, [the project] *will also reduce GHG emissions*" (comment from a housing provider).

Overall, it is reasonable to conclude that there is no “one size fits all” approach for the social and affordable housing sector. Financing and funding supports must be flexible so they can be adapted to suit the needs of individual housing providers, which vary from one organization to another, and in particular between the city-owned Home Ed and Calgary Housing Corporation and other housing providers.

6 APPENDIX A: CASH FLOW SUMMARIES OF THE DIFFERENT FINANCING SCENARIOS

Financing scenario for Lexington Manor: self-financing

Year	Investment costs	Annual utility bill savings	Non-energy benefits (NEBs)		Net annual cash flows	
			Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$186,918	$17,222	$517	$49,240	-$169,696	-$119,940
2	$0	$17,222	$517	$0	$17,222	$17,739
3	$0	$17,222	$517	$0	$17,222	$17,739
4	$0	$17,222	$517	$0	$17,222	$17,739
5	$0	$17,222	$517	$0	$17,222	$17,739
6	$0	$17,222	$517	$0	$17,222	$17,739
7	$0	$17,222	$517	$0	$17,222	$17,739
8	$0	$17,222	$517	$0	$17,222	$17,739
9	$0	$17,222	$517	$0	$17,222	$17,739
10	$0	$17,222	$517	$0	$17,222	$17,739
11	$0	$17,222	$517	$0	$17,222	$17,739
12	$0	$17,222	$517	$0	$17,222	$17,739
13	$0	$17,222	$517	$0	$17,222	$17,739
14	$0	$17,222	$517	$0	$17,222	$17,739
15	$0	$17,222	$517	$0	$17,222	$17,739
16	$0	$17,222	$517	$0	$17,222	$17,739
17	$0	$17,222	$517	$0	$17,222	$17,739
18	$0	$17,222	$517	$0	$17,222	$17,739
19	$0	$17,222	$517	$0	$17,222	$17,739
20	$0	$17,222	$517	$0	$17,222	$17,739
21	$0	$17,222	$517	$0	$17,222	$17,739
22	$0	$17,222	$517	$0	$17,222	$17,739
23	$0	$17,222	$517	$0	$17,222	$17,739
24	$0	$0	$0	$0	$0	$0
25	$0	$0	$0	$0	$0	$0
Total	**$186,918**	**$396,107**	**$11,883**	**$49,240**	**$209,188**	**$270,311**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: secured loan

Year	Investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	Non-energy benefits (NEBs)		Net annual cash flows	
						Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$0	$23,538	$7,225	$30,763	$17,222	$517	$49,240	-$13,541	$36,216
2	$0	$24,522	$6,241	$30,763	$17,222	$517	$0	-$13,541	-$13,024
3	$0	$25,546	$5,217	$30,763	$17,222	$517	$0	-$13,541	-$13,024
4	$0	$26,613	$4,149	$30,763	$17,222	$517	$0	-$13,541	-$13,024
5	$0	$27,725	$3,038	$30,763	$17,222	$517	$0	-$13,541	-$13,024
6	$0	$28,884	$1,879	$30,763	$17,222	$517	$0	-$13,541	-$13,024
7	$0	$30,090	$672	$30,763	$17,222	$517	$0	-$13,541	-$13,024
8	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
9	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
10	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
11	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
12	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
13	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
14	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
15	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
16	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
17	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
18	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
19	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
20	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
21	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
Total	**$0**	**$186,918**	**$28,421**	**$215,339**	**$396,107**	**$11,883**	**$49,240**	**$180,767**	**$241,890**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: secured loan and grant

Year	Net investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	Non-energy benefits (NEBs)		Net annual cash flows	
						Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$0	$17,654	$5,418	$23,072	$17,222	$517	$49,240	-$5,850	$43,907
2	$0	$18,391	$4,681	$23,072	$17,222	$517	$0	-$5,850	-$5,333
3	$0	$19,160	$3,913	$23,072	$17,222	$517	$0	-$5,850	-$5,333
4	$0	$19,960	$3,112	$23,072	$17,222	$517	$0	-$5,850	-$5,333
5	$0	$20,794	$2,278	$23,072	$17,222	$517	$0	-$5,850	-$5,333
6	$0	$21,663	$1,409	$23,072	$17,222	$517	$0	-$5,850	-$5,333
7	$0	$22,568	$504	$23,072	$17,222	$517	$0	-$5,850	-$5,333
8	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
9	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
10	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
11	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
12	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
13	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
14	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
15	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
16	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
17	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
18	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
19	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
20	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
21	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
Total	**$0**	**$140,189**	**$21,316**	**$161,505**	**$396,107**	**$11,883**	**$49,240**	**$234,602**	**$295,725**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: soft loan

Year	Net investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	Non-energy benefits (NEBs)		Net annual cash flows	
						Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$0	$7,601	$3,852	$11,454	$17,222	$517	$49,240	$5,768	$55,525
2	$0	$7,762	$3,691	$11,454	$17,222	$517	$0	$5,768	$6,285
3	$0	$7,927	$3,527	$11,454	$17,222	$517	$0	$5,768	$6,285
4	$0	$8,095	$3,359	$11,454	$17,222	$517	$0	$5,768	$6,285
5	$0	$8,267	$3,187	$11,454	$17,222	$517	$0	$5,768	$6,285
6	$0	$8,442	$3,012	$11,454	$17,222	$517	$0	$5,768	$6,285
7	$0	$8,621	$2,833	$11,454	$17,222	$517	$0	$5,768	$6,285
8	$0	$8,804	$2,650	$11,454	$17,222	$517	$0	$5,768	$6,285
9	$0	$8,990	$2,463	$11,454	$17,222	$517	$0	$5,768	$6,285
10	$0	$9,181	$2,273	$11,454	$17,222	$517	$0	$5,768	$6,285
11	$0	$9,376	$2,078	$11,454	$17,222	$517	$0	$5,768	$6,285
12	$0	$9,575	$1,879	$11,454	$17,222	$517	$0	$5,768	$6,285
13	$0	$9,778	$1,676	$11,454	$17,222	$517	$0	$5,768	$6,285
14	$0	$9,985	$1,469	$11,454	$17,222	$517	$0	$5,768	$6,285
15	$0	$10,197	$1,257	$11,454	$17,222	$517	$0	$5,768	$6,285
16	$0	$10,413	$1,041	$11,454	$17,222	$517	$0	$5,768	$6,285
17	$0	$10,634	$820	$11,454	$17,222	$517	$0	$5,768	$6,285
18	$0	$10,859	$595	$11,454	$17,222	$517	$0	$5,768	$6,285
19	$0	$11,089	$364	$11,454	$17,222	$517	$0	$5,768	$6,285
20	$0	$11,324	$129	$11,454	$17,222	$517	$0	$5,768	$6,285
21	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
Total	**$0**	**$186,918**	**$42,154**	**$229,072**	**$396,107**	**$11,883**	**$49,240**	**$167,035**	**$228,158**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: soft loan and grant

Year	Net investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	Non-energy benefits (NEBs)		Net annual cash flows	
						Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$0	$5,701	$2,889	$8,590	$17,222	$517	$49,240	$8,632	$58,388
2	$0	$5,822	$2,768	$8,590	$17,222	$517	$0	$8,632	$9,148
3	$0	$5,945	$2,645	$8,590	$17,222	$517	$0	$8,632	$9,148
4	$0	$6,071	$2,519	$8,590	$17,222	$517	$0	$8,632	$9,148
5	$0	$6,200	$2,390	$8,590	$17,222	$517	$0	$8,632	$9,148
6	$0	$6,331	$2,259	$8,590	$17,222	$517	$0	$8,632	$9,148
7	$0	$6,466	$2,124	$8,590	$17,222	$517	$0	$8,632	$9,148
8	$0	$6,603	$1,987	$8,590	$17,222	$517	$0	$8,632	$9,148
9	$0	$6,743	$1,847	$8,590	$17,222	$517	$0	$8,632	$9,148
10	$0	$6,886	$1,704	$8,590	$17,222	$517	$0	$8,632	$9,148
11	$0	$7,032	$1,558	$8,590	$17,222	$517	$0	$8,632	$9,148
12	$0	$7,181	$1,409	$8,590	$17,222	$517	$0	$8,632	$9,148
13	$0	$7,333	$1,257	$8,590	$17,222	$517	$0	$8,632	$9,148
14	$0	$7,489	$1,102	$8,590	$17,222	$517	$0	$8,632	$9,148
15	$0	$7,647	$943	$8,590	$17,222	$517	$0	$8,632	$9,148
16	$0	$7,810	$781	$8,590	$17,222	$517	$0	$8,632	$9,148
17	$0	$7,975	$615	$8,590	$17,222	$517	$0	$8,632	$9,148
18	$0	$8,144	$446	$8,590	$17,222	$517	$0	$8,632	$9,148
19	$0	$8,317	$273	$8,590	$17,222	$517	$0	$8,632	$9,148
20	$0	$8,493	$97	$8,590	$17,222	$517	$0	$8,632	$9,148
21	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
Total	**$0**	**$140,189**	**$31,615**	**$171,804**	**$396,107**	**$11,883**	**$49,240**	**$224,303**	**$285,426**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: soft loan, grant and self-financing

Year	Net investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	Non-energy benefits (NEBs)		Net annual cash flows	
						Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$37,384	$4,181	$2,119	$6,299	$17,222	$517	$49,240	-$26,461	$23,296
2	$0	$4,269	$2,030	$6,299	$17,222	$517	$0	$10,923	$11,439
3	$0	$4,360	$1,940	$6,299	$17,222	$517	$0	$10,923	$11,439
4	$0	$4,452	$1,847	$6,299	$17,222	$517	$0	$10,923	$11,439
5	$0	$4,547	$1,753	$6,299	$17,222	$517	$0	$10,923	$11,439
6	$0	$4,643	$1,656	$6,299	$17,222	$517	$0	$10,923	$11,439
7	$0	$4,742	$1,558	$6,299	$17,222	$517	$0	$10,923	$11,439
8	$0	$4,842	$1,457	$6,299	$17,222	$517	$0	$10,923	$11,439
9	$0	$4,945	$1,355	$6,299	$17,222	$517	$0	$10,923	$11,439
10	$0	$5,050	$1,250	$6,299	$17,222	$517	$0	$10,923	$11,439
11	$0	$5,157	$1,143	$6,299	$17,222	$517	$0	$10,923	$11,439
12	$0	$5,266	$1,034	$6,299	$17,222	$517	$0	$10,923	$11,439
13	$0	$5,378	$922	$6,299	$17,222	$517	$0	$10,923	$11,439
14	$0	$5,492	$808	$6,299	$17,222	$517	$0	$10,923	$11,439
15	$0	$5,608	$691	$6,299	$17,222	$517	$0	$10,923	$11,439
16	$0	$5,727	$572	$6,299	$17,222	$517	$0	$10,923	$11,439
17	$0	$5,848	$451	$6,299	$17,222	$517	$0	$10,923	$11,439
18	$0	$5,972	$327	$6,299	$17,222	$517	$0	$10,923	$11,439
19	$0	$6,099	$200	$6,299	$17,222	$517	$0	$10,923	$11,439
20	$0	$6,228	$71	$6,299	$17,222	$517	$0	$10,923	$11,439
21	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$517	$0	$17,222	$17,739
Total	**$37,384**	**$102,805**	**$23,185**	**$125,990**	**$396,107**	**$11,883**	**$49,240**	**$232,733**	**$293,857**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: ESA and self-financing

Year	Net investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	ESA payments	Non-energy benefits (NEBs)		Net annual cash flows	
							Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$92,287	$0	$0	$0	$17,222	$13,778	$517	$49,240	-$88,843	-$39,086
2	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
3	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
4	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
5	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
6	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
7	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
8	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
9	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
10	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
11	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
12	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
13	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
14	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
15	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
16	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
17	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
18	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
19	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
20	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
21	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
Total	**$92,287**	**$0**	**$0**	**$0**	**$396,107**	**$137,776**	**$11,883**	**$49,240**	**$166,043**	**$227,166**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: ESA and secured loan

Year	Net investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	ESA payments	Non-energy benefits (NEBs)		Net annual cash flows	
							Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$0	$11,622	$3,567	$15,189	$17,222	$13,778	$517	$49,240	-$11,744	$38,013
2	$0	$12,107	$3,081	$15,189	$17,222	$13,778	$517	$0	-$11,744	-$11,227
3	$0	$12,613	$2,576	$15,189	$17,222	$13,778	$517	$0	-$11,744	-$11,227
4	$0	$13,140	$2,049	$15,189	$17,222	$13,778	$517	$0	-$11,744	-$11,227
5	$0	$13,689	$1,500	$15,189	$17,222	$13,778	$517	$0	-$11,744	-$11,227
6	$0	$14,261	$928	$15,189	$17,222	$13,778	$517	$0	-$11,744	-$11,227
7	$0	$14,857	$332	$15,189	$17,222	$13,778	$517	$0	-$11,744	-$11,227
8	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
9	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
10	$0	$0	$0	$0	$17,222	$13,778	$517	$0	$3,444	$3,961
11	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
12	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
13	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
14	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
15	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
16	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
17	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
18	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
19	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
20	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
21	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
Total	**$0**	**$92,287**	**$14,032**	**$106,320**	**$396,107**	**$137,776**	**$11,883**	**$49,240**	**$152,011**	**$213,134**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: ESA and soft loan

Year	Net investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	ESA payments	Non-energy benefits (NEBs)		Net annual cash flows	
							Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$0	$3,753	$1,902	$5,655	$17,222	$13,778	$517	$49,240	-$2,211	$47,546
2	$0	$3,833	$1,822	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
3	$0	$3,914	$1,741	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
4	$0	$3,997	$1,658	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
5	$0	$4,082	$1,573	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
6	$0	$4,168	$1,487	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
7	$0	$4,256	$1,399	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
8	$0	$4,347	$1,308	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
9	$0	$4,439	$1,216	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
10	$0	$4,533	$1,122	$5,655	$17,222	$13,778	$517	$0	-$2,211	-$1,694
11	$0	$4,629	$1,026	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
12	$0	$4,727	$928	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
13	$0	$4,827	$828	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
14	$0	$4,930	$725	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
15	$0	$5,034	$621	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
16	$0	$5,141	$514	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
17	$0	$5,250	$405	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
18	$0	$5,361	$294	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
19	$0	$5,475	$180	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
20	$0	$5,591	$64	$5,655	$17,222	$0	$517	$0	$11,567	$12,084
21	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
Total	**$0**	**$92,287**	**$20,813**	**$113,100**	**$396,107**	**$137,776**	**$11,883**	**$49,240**	**$145,230**	**$206,354**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure's share of total investment costs)

Financing scenario for Lexington Manor: ESA, soft loan and grant

Year	Net investment costs	Loan principle repaid	Cost of financing (interest payments)	Loan payment	Annual utility bill savings	ESA payments	Non-energy benefits (NEBs)		Net annual cash flows	
							Maintenance cost savings	Avoided capital expenditures	Without NEBs	With NEBs
1	$0	$1,876	$951	$2,827	$17,222	$13,778	$517	$49,240	$617	$50,374
2	$0	$1,916	$911	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
3	$0	$1,957	$871	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
4	$0	$1,998	$829	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
5	$0	$2,041	$787	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
6	$0	$2,084	$743	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
7	$0	$2,128	$699	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
8	$0	$2,173	$654	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
9	$0	$2,219	$608	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
10	$0	$2,266	$561	$2,827	$17,222	$13,778	$517	$0	$617	$1,134
11	$0	$2,315	$513	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
12	$0	$2,364	$464	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
13	$0	$2,414	$414	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
14	$0	$2,465	$363	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
15	$0	$2,517	$310	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
16	$0	$2,571	$257	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
17	$0	$2,625	$202	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
18	$0	$2,681	$147	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
19	$0	$2,738	$90	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
20	$0	$2,796	$32	$2,827	$17,222	$0	$517	$0	$14,395	$14,911
21	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
22	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
23	$0	$0	$0	$0	$17,222	$0	$517	$0	$17,222	$17,739
Total	**$0**	**$46,144**	**$10,406**	**$56,550**	**$396,107**	**$137,776**	**$11,883**	**$49,240**	**$201,780**	**$262,904**

Note: the weighted average expected useful life of the installed measures is 23 years (weighted by each measure’s share of total investment costs)

ALL ONE SKY FOUNDATION is a not-for-profit, charitable organization established to help vulnerable populations at the crossroads of energy and climate change. We do this through education, research and community-led programs, focusing our efforts on adaptation to climate change and energy poverty. Our vision is a society in which ALL people can afford the energy they require to live in warm, comfortable homes, in communities that are resilient and adaptive to a changing climate.

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