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UNIVERSITY OF TORONTO

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Decarbonization of Buildings in Canadian Cities: Using Property Assessed Clean Energy Financing to Attract Private Capital

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Abstract

This paper discusses property assessed clean energy (PACE) financing as an arrangement to support building decarbonization efforts in Canadian cities. PACE financing allows building owners to acquire debt financing for energy efficiency upgrades to their property, secured through a property tax lien on the building, and the debt is repaid through the property tax. The debt is bonded to the property and not the owner, and the property tax lien provides a collateralization feature that may support more favourable borrowing terms. This paper outlines and examines the three general approaches used to deliver PACE financing: government administered and financed; privately administered but government financed; and privately administered and financed. It further makes a recommendation for privately administered and financed programs to support the scaling up of PACE financing in Canada. Privately administered and financed programs can bring significant private capital to PACE programs while also reducing the public administrative burdens associated with program delivery. This paper then presents sustainability-linked debt as a funding tool to attract private capital to PACE programs. Sustainability-linked debt is debt that is linked to sustainability performance outcomes. The paper details the characteristics of sustainability-linked bonds (SLBs) and discusses how they could be used to attract impact investors by linking the greenhouse gas (GHG) emissions reductions from buildings to the return (coupon) rate of the SLBs. SLBs could be used by private PACE program providers to raise capital or by local government administered programs to acquire private capital to support PACE financing. In the latter case, the paper suggests that municipalities establish special purpose entities dedicated to PACE financing and capitalize these entities through SLB issuances.

Keywords: property assessed clean energy financing; PACE financing; sustainability-linked bonds; SLBs; building decarbonization; energy performance contracting; EPC; guaranteed savings; shared savings

JEL Codes: O10, Q01, Q50

Decarbonization of Buildings in Canadian Cities: Using Property Assessed Clean Energy Financing to Attract Private Capital

1. Introduction

Cities contribute a significant proportion of the world's greenhouse gas (GHG) emissions, with one estimate at approximately 70 percent (International Energy Agency 2021). Furthermore, urban populations comprise more than half the world's population, and are expected to increase to two-thirds by 2050 (URBANET 2016). These attributes place cities and urban regions at the centre of net-zero transformation, and as a result, policies to reduce global emissions must focus on urban emission sources and reduction capabilities. Major attention must be given to reducing emissions from buildings, which contribute the majority of emissions in most major global cities (Wei et al. 2021). Canadian cities face similar realities, contributing one-third of Canada's GHG emissions in 2018, of which buildings are a primary contributor (Winter 2022). In 2021, 74 percent of Canada's population lived in cities (Statistics Canada 2022). Table 1 lists the proportion of GHG emissions from buildings in some of Canada's major cities.

Table 1: GHG emissions from buildings in major Canadian cities

Canadian city	GHG emissions from buildings (% of total emissions)	GHG reporting year	GHG emissions from buildings ranked among emissions sources
Halifax, NS	72	2016	1st
Montréal, QC	28	2015	2nd
Ottawa, ON	46	2020	1st
Toronto, ON	58	2020	1st
Winnipeg, MB	30	2011	2nd
Edmonton, AB	38	2021	1st
Calgary, AB	57	2021	1st
Vancouver, BC	26	2015	2nd

Sources: Halifax Regional Municipality 2020; Halifax Regional Municipality 2023; City of Montréal 2020; City of Ottawa 2021; City of Toronto 2021b; City of Toronto 2023; City of Winnipeg 2018; City of Edmonton 2021; City of Calgary 2022; Metro Vancouver 2019.

The most notable observation from Table 1 is that GHG emissions from buildings in major Canadian cities tend to be the largest or second largest source of emissions, which follows the general trend across many global metropolises (Wei et al. 2021). Additionally, GHG emissions from buildings tend to make up relatively large portions of overall GHG emissions in these cities. Therefore, GHG mitigation plans for Canadian cities must have a dedicated strategy to reduce emissions from buildings. Many have pledged to substantially reduce their emissions by 2030, and further, to achieve net-zero emissions by 2050. Table 2 lists several major Canadian cities, their 2030 reduction targets (as a percentage relative to the year stated), and their net-zero pledges.

The cities' pledges are ambitious and will demand substantial policy and financing support. Considering the proportion of emissions from buildings for many of these cities, building decarbonization will occupy a significant role in the plans for these cities to reduce emissions and meet their targets for 2030 and 2040/2050. Further considering that the majority of buildings that will exist will have already been built (Kennedy and Frappe-Sénéclauze 2021; London Energy Transformation Initiative 2021), strategies will need to support energy efficiency building retrofits, which are building renovations that support more efficient energy use, and as a result, support GHG emissions reductions from buildings. A critical part of these strategies will be financing. In a 2021 study by the Pembina Institute, a cost of $20 billion per year between 2021 and 2040 was estimated to be needed to retrofit Canada's existing building stock for decarbonization (Kennedy and Frappe-Sénéclauze 2021). How will this financing be sourced? This study introduces and discusses property assessed clean energy (PACE) financing as one approach that can support the financing of energy efficiency building retrofits.

Table 2: 2030 emission reduction targets and net-zero pledges of major Canadian cities

Canadian city	2030 emission reduction target (% relative to year)	Net-zero emissions pledge (year)
Halifax, NS	75 (2016)	Yes (2050)
Montréal, QC	55 (1990)	Yes (2050)
Ottawa, ON	68 (2012)	Yes (2050)
Toronto, ON	45 (1990)	Yes (2040)
Winnipeg, MB	20 (2011)	No (80% reduction relative to 2011 levels)
Edmonton, AB	50 (2005)	Yes (2050)
Calgary, AB	60 (2005)	Yes (2050)
Vancouver, BC	45 (2010)	Yes (2050)

PACE financing is defined by a property tax lien that legally binds debt to the property and not the owner of the property (that is, the loan may remain with the property when sold). The debt is then serviced through the property tax bill. The fundamental advantage of this mechanism for energy efficiency financing is in the property tax lien, which provides a very secured collateralization arrangement that supports long-term financing. This may facilitate larger project costs with longer financing periods and lower financing costs. By supporting longer financing terms, PACE financing can also support an equitable energy efficiency transition by making energy efficiency financing more affordable. This makes PACE financing a valuable tool for cities that are striving to achieve GHG emissions reductions from buildings. This paper provides some suggestions for municipalities on how to design PACE financing programs.

This paper outlines and discusses the general approaches used to deliver energy efficiency building retrofits and shows how PACE financing can complement these approaches. It then describes the three general arrangements used to deliver PACE programs: government financed and administered; government financed and privately administered; and privately financed and administered. This paper makes a case for the latter (privately financed and administered), which can increase the scale of private finance for energy efficiency retrofits and reduce the dependence on public funds, identified as one of the barriers to building a green retrofit economy in Canada (Delphi Group 2022). Privately financed and administered PACE programs also reduce the administrative demands for municipalities in delivering and managing PACE programs. Instead, municipalities can focus on policy development and implementation to regulate private PACE programs.

To improve the quality of PACE financed energy efficiency retrofits, the paper suggests that municipalities establish a guaranteed savings requirement, which requires energy efficiency service providers to guarantee the estimated savings from building upgrades. This reduces potential risks for building owners and requires service providers to carry the performance risks.

This paper further discusses the use of sustainability-linked debt as an optimal funding instrument for funding PACE programs. Sustainability-linked debt is debt that is linked to sustainability performance. This paper outlines the characteristics of sustainability-linked bonds (SLBs) and discusses how they could be used to attract impact capital by linking GHG emissions reductions from buildings to the return (coupon) rate of the SLBs. SLBs could be used by private PACE program providers to raise capital or by local government administered programs to acquire private capital to support PACE financing. In the latter case, I argue that municipalities could establish special purpose entities dedicated to PACE financing and capitalize these entities with SLB issuances.

2. Approaches to Financing Energy Efficiency

Energy efficiency is characterized by a reduction in energy consumption to perform a given set of energy related activities (that is, using less energy to perform the same tasks). Energy efficiency can support GHG emissions reductions by decreasing the consumption of fossil fuel power sources, demands on electricity grids, and energy-related expenditure for households and firms. Various business models exist to support the delivery of energy

efficiency retrofits for building decarbonization, ranging from traditional unsecured and secured loans to more specialized financing arrangements designed specifically for energy efficiency delivery (Leventis et al. 2016). Table 3 provides a non-exhaustive list of various arrangements that finance energy efficiency retrofits for buildings.

Table 3: Energy efficiency financing arrangements

Energy efficiency financing models	Description	Advantages	Disadvantages
Unsecured and secured loans [1]	Traditional loans used to finance assets or services.	Borrower and lender familiarity. Simplified and faster loan processing.	Lending terms unfavourable (high interest rates, short repayment period). Building owner carries performance risk associated with energy efficiency service.
On-bill financing and repayment	Financing arrangement that legally binds energy efficiency loans to a building's utility meter; loan is repaid through the utility bill. For an on-bill financing arrangement, the utility company provides the loan. For an on-bill repayment arrangement, third-party lenders provide the loan.	Supports long-term financing arrangement (more affordable debt service).	Limited to customers serviced by utility company. Does not reduce performance risk of energy efficiency services.
Property assessed clean energy (PACE) financing	Financing arrangement that binds energy efficiency loans to the property. Loan is repaid through the property tax bill.	Supports long-term financing arrangement (more affordable debt service). Allows municipalities to directly address a primary source of emissions.	Does not reduce performance risk of energy efficiency services.
Energy performance contracts	Energy efficiency service delivery arrangement that mitigates performance risks for building owners. Cost savings from the energy efficiency upgrade offsets the costs associated with financing the upgrade.	Reduces performance risk for the customer.	More complicated and less familiar service delivery model. May not be suitable for smaller buildings that may not generate substantial energy cost reductions.

1. Unsecured loans are uncollateralized; secured loans are backed by collateral. Unsecured loans are highly dependent on the credit score of the borrower. Secured loans typically support lower interest rates, higher principal amounts, and longer repayment periods.

Energy efficiency upgrades can be financed by traditional loans, unsecured or secured, which involve the building owner and the lender. These arrangements have an advantage due to their familiarity to both borrower and lender, which may lead to a quicker and more simplified loan administration process. Traditional loans, however, can come with unfavourable conditions such as high interest rates and short repayment periods, which can make debt service burdensome. Additionally, building owners must take on the administrative costs associated with acquiring energy efficiency service providers, and further carry the performance risks associated with the upgrade. These are barriers to financing energy efficiency. The latter three arrangements in Table 3 are specifically designed to reduce some of these barriers.

On-bill financing and repayment and PACE financing are designed to support secured, long-term arrangements that can make energy efficiency financing more favourable for property owners and lenders. Both mechanisms legally bind loans to the building instead of the individual. On-billing binds debt to the utility meter with repayment through the utility bill, while PACE financing binds debt to the property with repayment through the property tax. PACE financing is also unique in that it provides local governments with a direct enabling mechanism to address emissions from buildings, which are a significant emissions source for many municipalities. That is, PACE financing allows municipal governments to provide a municipal solution to a municipal problem. While on-bill financing and repayment and PACE arrangements support more favourable financing terms for energy efficiency loans, they do not implicitly address the administrative costs or performance risks associated with energy efficiency upgrades. Energy performance contracting arrangements are designed to address these barriers.

Energy performance contracts (EPCs) describe a project delivery arrangement used to provide energy efficiency services for buildings. Energy efficiency investments, in general, are designed to reduce energy costs and use these reductions to deliver returns on investments. However, these energy cost reductions are often based on modelling estimations that sometimes do not materialize (Fowlie et al. 2018). EPCs mitigate this performance risk, designed so that cost savings from the energy efficiency upgrade will cover the costs associated with financing. Figure 1 depicts how energy cost savings transmit over an EPC project.

The EPC service provider first identifies sources of energy cost reduction and the upgrades required to realize the reductions. The service provider then performs the energy upgrade under an EPC agreement. There are several different ways that EPCs can be arranged. The two most common are guaranteed savings contracts and shared savings contracts (Shang et al. 2017). Figures 2 and 3 provide a depiction of each, and Table 4 compares their key features.

In a guaranteed savings agreement (Figure 2), the EPC service provider designs and implements the energy efficiency upgrade, and the customer provides financing. The service provider guarantees a predetermined level of estimated energy savings. If the guaranteed energy savings are not realized, the service provider compensates the building owner for the shortfall. The service provider takes on the full performance

Figure 1: Depiction of how energy cost savings transmit across an EPC project

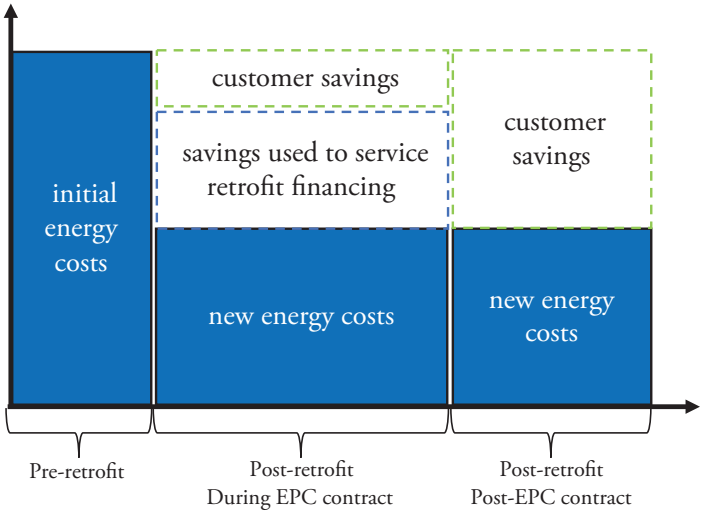
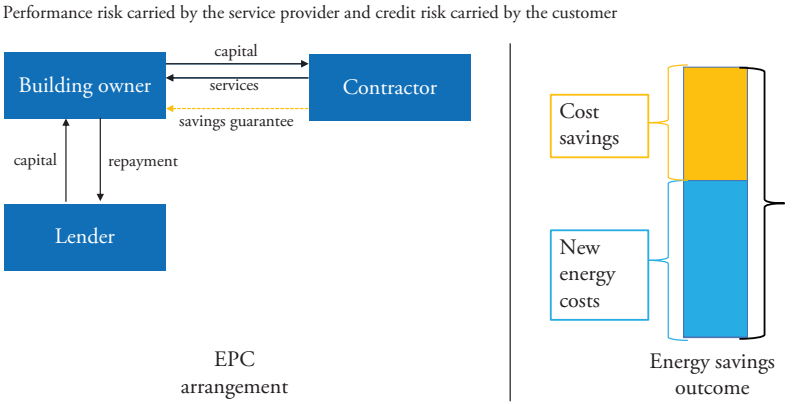


Figure 2: Depiction of a guaranteed savings EPC

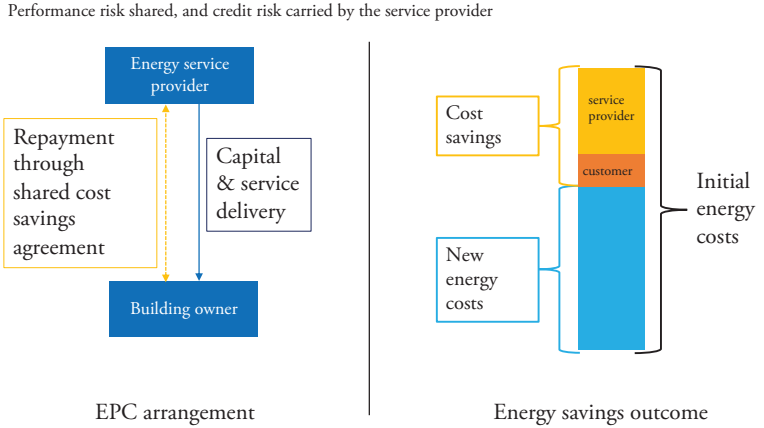


risk of the energy efficiency upgrade. That is, any unrealized energy savings from the upgrade is a cost to the service provider, and therefore, guaranteed savings arrangements transfer performance risk from the building owner to the service provider. The building owner, however, is responsible for sourcing and servicing the loan needed to finance

the upgrade, carrying the full credit risk. If the service provider is unable to fund the performance shortfall, the building owner will be left to service the loan without energy costs savings.

In a shared savings agreement (Figure 3), the EPC service provider designs, implements, and finances the energy efficiency upgrade. The expected energy savings are shared between the service provider and the building owner based on contractual arrangements until the service provider recovers the financial investment. If energy savings are not realized, the service provider does not recover service costs and the building owner does not receive energy cost savings. Performance risk is therefore shared between the service provider and the building owner. However, since the service provider finances the upgrade, the credit risk is now fully transferred to the service provider.

Figure 3: Depiction of a shared savings EPC



Guaranteed savings arrangements tend to be more common in developed EPC markets and shared savings arrangements tend to be more common at the emerging stages of EPC markets (International Energy Agency 2018; Liu et al. 2018). However, neither approach is superior to the other. The choice of arrangement depends on the suitability for the target customer and the management of the performance risks. Table 4 provides a comparison of guaranteed savings arrangements and shared savings arrangements across key parameters.

The financing arrangements listed in Table 3 are not mutually exclusive. In fact, they can be complementary. In this paper, I argue that PACE financing can be combined with EPCs to enhance energy efficiency delivery. Before demonstrating the complementary value of PACE and EPCs, this paper first outlines and discusses the different approaches used to deliver PACE programs.

Table 4: Comparison of guaranteed savings and shared savings EPCs

Parameter	Guaranteed savings model	Shared savings model
Financing source	Building owner	Service provider
Financing cost	Lowers financing cost for service provider	Increases financing cost for service provider
Performance risk	Carried by service provider	Shared between service provider and building owner
Credit risk	Carried by building owner	Carried by service provider

3. What is PACE Financing?

The concept of PACE financing was first introduced in the U.S. in 2008 (in California) and is designed around the concept of a local improvement charge (LIC) (Kirkpatrick and Bennear 2014). An LIC is a mechanism used by municipalities to recover the capital costs associated with local improvement projects. LICs are administered by the municipality as a fixed annual charge levied on real property over a specified period. The charge amortizes the capital costs of local improvement projects and is repaid through the property tax. As LICs are administered for public projects, PACE essentially extends the LIC mechanism to private projects that typically address GHG emissions reductions (though in California, PACE financing can be used to finance earthquake resilience building retrofits; in Florida, to finance hurricane resilience retrofits; and in general, to finance water conservation retrofits). For large urban municipalities, PACE financing provides a locally administered tool to combat a local problem: emissions from buildings, which is generally the major source of emissions for large urban municipalities (Wei et al. 2021).

Legislation is often required to support the LIC mechanism that underlies PACE financing, since existing LIC arrangements are designed for public projects. In the U.S., PACE legislation is established at the state level, and in Canada, at the provincial level. Once legislation is established, municipalities establish PACE bylaws, which define the governing arrangements for PACE financing programs. PACE financing arrangements are comprised of several key parties. Table 5 lists the involved parties and their major roles.

The defining characteristic of PACE financing is a property tax lien that legally binds the debt to the property (allowing the debt to remain with the property), with repayment through the property tax bill. The fundamental aim of this arrangement is to make debt arrangements for energy efficiency more affordable to the building owner and less risky to the capital provider, hence making financing more attractive. The property

Table 5: Key parties involved in PACE financing programs and their major roles	
PACE participant	**Main role**
Municipality	Establishes tax lien on the property and collects debt payment through the property tax.
Building owner	Voluntarily seeks energy efficiency upgrade for a property.
PACE administrator	Delivers and manages the PACE financing program.
Capital provider or lender	Provides debt to finance the energy efficiency upgrades.
Energy efficiency provider (contractor)	Provides the energy efficiency retrofits to the building.

tax lien provides a loan security feature that supports long-term financing, which, in turn, supports favourable financing costs. Through the property tax lien arrangement, PACE loans are senior to (repaid before) other debt payments established on the property (such as a mortgage), which provides higher loan security to lenders. Additionally, PACE financing arrangements typically provide 100 percent of the upfront capital costs, which reduces capital constraint on building owners.

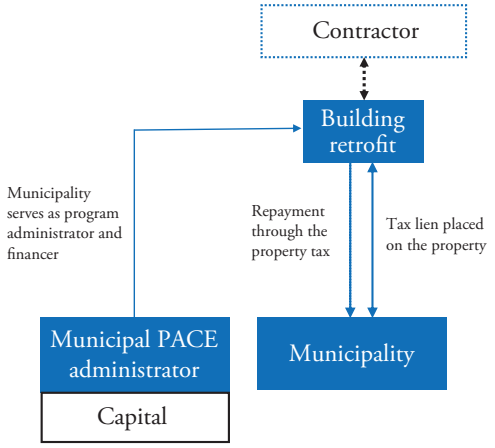
4. How is PACE Financing Arranged?

The roles of the parties involved in PACE financing programs (Table 5) are not mutually exclusive. The fundamental role of the municipality is to administer the property tax lien. Beyond this arrangement, there are variations in how the other parties may be arranged to deliver their services. There appears to be three general PACE financing arrangements, which are defined based on whether capital is public or private and whether the PACE administrator is public or private. Figures 4, 5, and 6 describe the three general program arrangements: government financed and administered, government financed and privately administered, and privately financed and administered.

4.1 Government financed and administered PACE arrangements

Figure 4 depicts a government financed and administered PACE financing arrangement. Public funds are used to provide PACE loans to building owners, and program delivery is also administered publicly. Programs can be funded and administered through state or provincial arrangements or at the municipal level. This approach appears to be the prevailing arrangement for PACE financing programs in Canada. Box 1 outlines the City of Toronto's PACE program, which is government financed and administered (City of Toronto 2017; City of Toronto 2021a; Kennedy et al. 2020).

Figure 4: Government financed and administered PACE financing arrangement



Box 1: The City of Toronto's PACE financing program

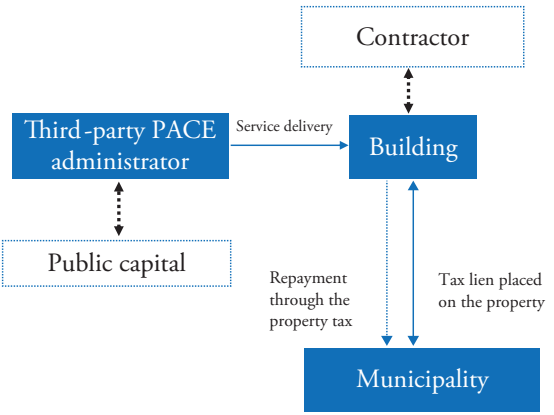
The City of Toronto's PACE financing program was launched in 2014 following PACE enabling legislation enacted by the Province of Ontario in 2012. Two residential PACE financing programs were launched: HELP (Home Energy Loan Program) for single-family homes, and Hi-RIS (High-Rise Retrofit Improvement Support) for multi-unit residential buildings. The HELP program is administered by the City's Environment and Energy division and the Hi-RIS program is administered by its Social Development, Finance and Administration Division, through the Tower Renewal Program. Funding is from the City's Local Improvement Charge Energy Works Reserve Fund, with subsequent funding acquired from the Federation of Canadian Municipalities' Community Efficiency Financing fund.

While government financed and administered PACE arrangements may allow PACE financing to be delivered as a public good, this arrangement relies on limited public capital and may further require municipal governments to take on additional responsibilities associated with loan origination and portfolio management. Additionally, program scalability may be limited by the municipality's ability to provide program development, marketing, and delivery on a large scale. Furthermore, building owners are responsible for finding qualified energy efficiency contractors to assess energy efficiency gains and provide retrofit renovations, which can act as a deterrence to PACE uptake. Using third-party PACE administrators can increase the scalability of PACE financing programs while also supporting the development of specialized entities to provide efficiency gains that may reduce the cost of service delivery.

4.2 Government financed and privately administered PACE financing arrangements

Figure 5 depicts a government financed and privately administered PACE financing arrangement. In this arrangement, third-party PACE administrators take on program delivery while funding is provided through public sources.

Figure 5: Government financed and privately administered PACE financing arrangement



Several PACE programs in the U.S. are administered in this way, sometimes with quasi-public entities as administrators and sometimes with fully private entities that are funded through state bond issuing vehicles. Box 2 outlines a PACE financing facility administered by the New York City Energy Efficiency Corporation (NYCEEC), a not-for-profit corporation established by the City to support financing for building decarbonization and serve as the City's PACE administrator (New York City Mayor's Office of Climate and Environmental Justice and New York City Energy Efficiency Corporation 2022).

Specialized third-party PACE providers, such as the NYCEEC, not only provide program scaling but are also able to scale up financing by using public funds to attract private capital (Schiff and Dithrich 2017). In the U.S., specialized quasi-public entities have been established to use limited public capital to attract private capital to low-carbon investments (OECD 2017) through various financing arrangements and instruments such as credit guarantees.[2] In several states, these entities are also PACE administrators. Table 6 lists several of these U.S. entities and their roles in PACE financing.

2. A credit guarantee essentially provides insurance against loan losses up to predefined amounts. The purpose of the guarantee is to reduce the risks associated with lending. Credit guarantees are typically used to attract private capital to projects with business models that are unproven or unfamiliar to the lender.

Box 2: The New York City Energy Efficiency Corporation as the NYC PACE administrator

The New York City Energy Efficiency Corporation (NYCEEC) is a not-for-profit corporation established by the City of New York as a specialized financing entity to support energy efficiency financing for buildings. NYCEEC is capitalized by public funds and provides direct loans and credit support for private capital (credit enhancements) that finance building decarbonization projects.

NYCEEC is also the City's designated PACE administrator. As a third-party PACE administrator, it takes on all administrative burdens associated with delivering PACE programming. Furthermore, as an entity that specializes in energy efficiency financing, it is aptly staffed and resourced to optimize PACE program delivery. As a specialized financing entity, NYCEEC has developed credit support mechanisms that use its limited public capital to leverage private capital through credit guarantees.

A valuable function that these organizations tend to offer is centralizing PACE financing arrangements by providing a network of approved energy efficiency contractors and capital providers. This removes the need for building owners to seek out and evaluate their contractors, and lender, on their own. Additionally, these entities provide blended capital by combining private capital with their public funds to increase financial scalability. The Connecticut Green Bank, for example, has financed US$246 million in PACE projects at financial year end 2022. From this amount, only US$60 million was financed from the bank's own capital, with the remaining US$186 million from private sources (Connecticut Green Bank 2022a).

Table 6: Specialized low-carbon financing entities in the U.S. and their role in PACE financing programs

Organization	Scale of PACE financing administrative role
Rhode Island Infrastructure Bank	State
Connecticut Green Bank	State
New York City Energy Efficiency Corporation	City
DC Green Bank	District
Montgomery County Green Bank	County

Sources: Rhode Island Infrastructure Bank 2023; Connecticut Green Bank 2022b; New York City Mayor's Office of Climate and Environmental Justice and New York City Energy Efficiency Corporation 2022; DC Green Bank 2022; Montgomery County Green Bank 2021.

Similar organizations exist in several major Canadian cities through the Low-Carbon Cities Canada (LC3) network. The LC3 network is comprised of organizations that have a mandate to support emission reductions in their cities and have shown a strong initial focus on decarbonization of buildings (Stewart 2023). These organizations are listed in Table 7.

Table 7: Low-Carbon Cities Canada network members

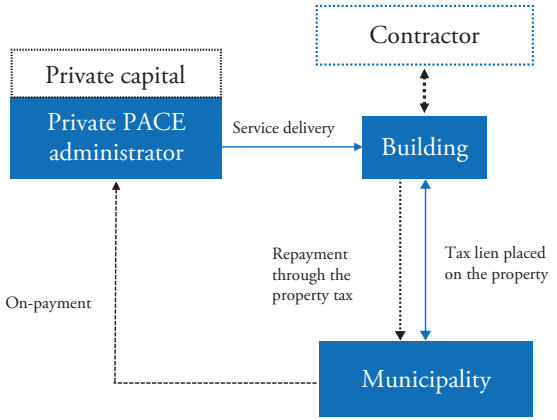
City/region	LC3 entity	Year established
Halifax	Halifax Climate Investment, Innovation, and Impact Fund	2021
Montréal	Greater Montréal Climate Fund	2020
Ottawa	Ottawa Climate Action Fund	2021
Greater Toronto and Hamilton Area	The Atmospheric Fund	1992
Calgary and Edmonton	Climate Innovation Fund	2019
Vancouver	Zero-Emissions Innovation Centre	2021

I would argue that the role of PACE administrator would naturally fall under the mandate of these organizations, as they are designed to provide financial and technical resources to support emission reductions to their respective cities. Permitting LC3 entities to become PACE administrators would leverage these resources for building decarbonization through PACE financing and standardize services, which could support the scaling up of program delivery. Furthermore, LC3 entities are currently engaged in building decarbonization activities and have developed expertise that can be leveraged as PACE administrators.

4.3 Privately financed and administered PACE financing arrangements

The third arrangement that is common for the delivery of PACE financing is a fully privatized arrangement, depicted in Figure 6. The PACE program is administered by an approved private entity, and capital is also fully private. This approach is also common in the U.S., and services can be disaggregated (different capital providers, energy efficiency contractors, and program administrators) or programs can be delivered through turnkey solutions where the program administrator arranges capital and contractors. Turnkey arrangements provide efficient service delivery for building owners by eliminating the resource burden associated with acquiring contractors or capital providers. While these services may come at an additional cost to the customer, costs can be reduced by sufficient program scaling.

Figure 6: Privately financed and administered PACE financing arrangement



Additionally, private PACE arrangements can support further growth of the energy efficiency retrofit industry by providing the space for private enterprise growth and for municipalities to focus efforts on policy development to further support GHG emissions reductions from buildings. Box 3 outlines one policy arrangement that has been used in New York City to drive emissions reductions from buildings, which involves setting emissions caps on commercial buildings and applying compliance fees when caps are exceeded (City of New York 2019).

Box 3: New York City Local Law 97

New York City passed Local Law 97 in 2019, which is designed to support emissions reductions from buildings. The law establishes GHG emissions caps on buildings over 25,000 square feet starting in 2024, with the aim of reducing emissions from these buildings by 40 percent by 2030 and then by 80 percent by 2050 (both relative to 2005 levels).

Buildings are classified based on occupancy type and assigned an emissions intensity factor (tonnes of CO_2e per square foot). Emission intensities are assigned with reducing thresholds in five-year intervals up to 2050. Emissions that exceed imposed limits will attract a fine of US$268 per tonne of CO_2e.

A compliance cost such as New York City's further incentivizes building owners to reduce emissions from buildings, while financing mechanisms like PACE provide pathways to support building owners in reducing emissions from their buildings.

5. How has PACE Performed?

PACE financing has grown significantly in the U.S. across both commercial PACE (C-PACE) and residential PACE (R-PACE) financing. Table 8 lists cumulative projects financed and total investments for PACE financing programs in the U.S. between 2009 and 2022.

Despite residential PACE programs being less available than commercial PACE programs, there has been significantly more uptake in the number of projects and the total financing of projects. Residential projects are expected to be smaller and less complex, which may support greater technical and financial scalability. Additionally, commercial buildings may be able to finance energy efficiency upgrades through other pathways, such as project financing facilities or energy service companies, which are specialized entities designed to deliver energy efficiency services (Krupa and Danny Harvey 2017; Goldman et al. 2005). The figures in Table 8, however, demonstrate that PACE financing can and has added scale to commercial energy efficiency financing while driving significant financing for residential buildings. Evidence has also shown that PACE financing can support the uptake of energy upgrades that reduce emissions from buildings (Deason et al. 2021). However, some studies report modest gains in energy efficiency from PACE financing programs (Winecoff and Graff 2020). Where solar photovoltaic installations are supported, PACE financing programs deliver substantial energy cost savings (Deason et al. 2021) and can support wider economic development through the creation of jobs, business sales revenues, and tax revenues from these activities (Rose and Wei 2020).

While PACE financing provides favourable financing terms for energy efficiency upgrades, PACE financing programs do not usually establish performance outcomes on energy efficiency service delivery. Some programs have established a savings-to-investment ratio (SIR) that must be greater than 1 (New York City Mayor's Office of Climate and Environmental Justice and New York City Energy Efficiency Corporation 2022; Connecticut Green Bank 2022b). That is, the savings from the energy efficiency upgrade must at least offset the financing cost over the financing term. However, SIR values are

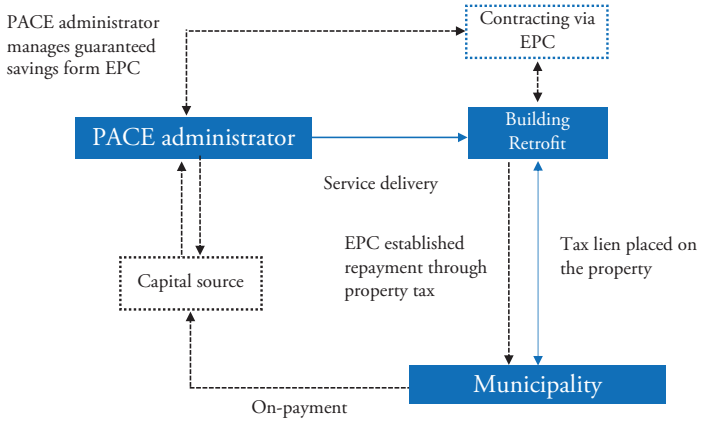
Table 8: PACE performance in the U.S.

Type	Active PACE programs	Estimated number of projects financed (cumulative)	Estimated total investment (cumulative)
Commercial PACE	30 states	3,100	US$5.2 billion
Residential PACE	California Florida Missouri	323,000	US$7.7 billion

Sources: Residential PACE data period: 2010–2021. Commercial PACE data period: 2009–2022. (PACENation 2023).

based on estimated outcomes that may fall short due to performance shortfalls (Liang et al. 2018; Menezes et al. 2012). I argue that by establishing performance guarantees, which implement energy efficiency performance outcomes that must be met under the energy efficiency retrofit agreement, PACE financing can be used to deliver energy efficiency retrofit services with fewer performance gaps. One potential arrangement is depicted in Figure 7 for a guaranteed savings EPC.

Figure 7: PACE financing-backed, guaranteed savings model



Under a PACE financing-backed, guaranteed savings model arrangement, the building owner enters into a PACE financing arrangement through the PACE administrator and the property tax lien is established on the property. Energy efficiency retrofit services are delivered through a guaranteed savings EPC arrangement negotiated among the contractor, the building owner, and the PACE provider. The building owner pays the contractual repayment costs through the property tax bill. Performance gap payments are covered by the EPC contractor and paid to the PACE administrator. This allows the PACE administrator to absorb the administration responsibilities associated with EPC collections and monitoring, removing this burden from the building owner.

This model could also be extended to include shared savings arrangements. However, in shared savings arrangements, service providers bring their own capital, which eliminates the need for financing through a PACE program. Such an arrangement, then, may satisfy only privately financed and administered PACE programs. In both arrangements, however, the fundamental value of the PACE component is to support longer repayment terms that may further support SIRs that are greater than 1. PACE financing may also reduce repayment risk, which is a primary risk for EPC projects, for both the building owner and the service provider (Lee et al. 2015).

6. PACE in Canada

PACE programs in Canada have been growing in recent years, spurred largely through funding from the Federation of Canadian Municipalities (FCM). FCM's Green Municipal Fund, and specifically, its Community Efficiency Financing (CEF) initiative, has earmarked CA$300 million for home energy upgrades intended to reduce emissions from residential buildings, which can be accessed through grants, loans, or credit enhancement facilities (Green Municipal Fund 2023). The CEF funding has been established for 2022–2026 and has allocated CA$127 million as of financial year end 2022 (Green Municipal Fund 2022). There is a sizable balance of funding that can be accessed over the subsequent years to support municipalities in developing energy efficiency programs to reduce emissions from buildings. Table 9 lists PACE financing programs that exist in major Canadian cities.

PACE financing arrangements in Canada follow the government administered and financed approach. All five cities with active PACE programs listed in Table 9 have PACE financing arrangements that are funded by government. Alberta and Saskatchewan have programs that have been established very recently through funding from the CEF fund (Natural Resources Canada 2022; Federation of Canadian Municipalities 2022b). Nova Scotia and Ontario have had PACE financing programs running for much longer periods and have also been underwritten by public funds. The City of Toronto has also

Table 9: PACE financing programs in major Canadian cities

Provinces with explicit PACE legislation[3]	Year legislation established	Major cities with PACE bylaws	R-PACE/ C-PACE[4]	Notable PACE administrators
Nova Scotia	2010	Halifax	R-PACE	City of Halifax
Ontario	2012	Toronto	R-PACE	City of Toronto
Saskatchewan	2020	Saskatoon	R-PACE	City of Saskatoon
Alberta	2018	Calgary Edmonton	R-PACE C-PACE (Edmonton only)	Energy Efficiency Alberta Alberta Municipal Services Corporation

Sources: Kennedy et al. 2020; City of Toronto 2021a; Province of Alberta 2020; City of Saskatoon 2023.

3. PACE financing also exists in Prince Edward Island (Charlottetown).
4. R-PACE refers to individually owned residential buildings and small multi-unit residential buildings. C-PACE refers to commercial buildings owned by business entities. Municipalities define the boundaries of R-PACE and C-PACE in PACE program policies, but PACE legislation first determines what is permitted.

more recently acquired funding through the CEF fund to support its PACE programs (Federation of Canadian Municipalities 2022a).

All of the Canadian PACE programs are residential PACE financing arrangements, except in the City of Edmonton, where commercial PACE financing is available. Commercial PACE financing is limited in Canada, but EPC services have been growing in the commercial sector through private energy service companies. These companies have also been supported through funding from the Canada Infrastructure Bank (CIB). Table 10 lists several building energy efficiency retrofit companies that have received CIB funding.

Table 10: Building energy efficiency retrofit companies receiving Canada Infrastructure Bank funding

Company	CIB financing amount (CA$ million)	Date
Ameresco	100	2023
Dream Group	136	2021
Efficiency Capital	50	2022
Johnson Controls	100	2022
Noventa Energy Partners	100	2023
SOFIAC	100	2021

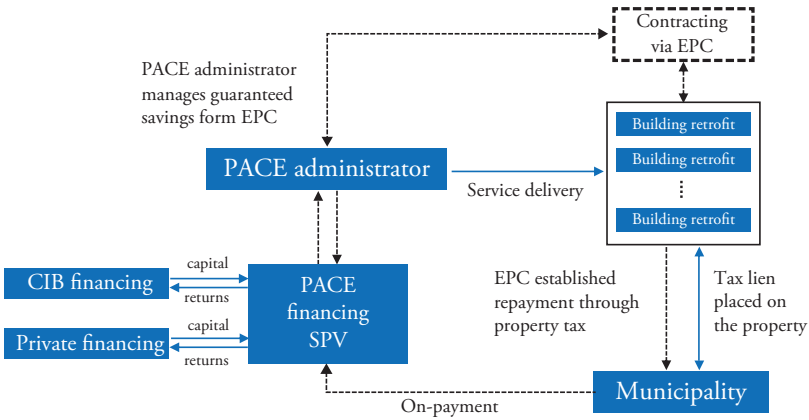
The CIB also has funding available to municipalities for commercial PACE financing arrangements (Canada Infrastructure Bank 2022). Box 4 outlines the key parameters of the CIB's financing for building energy efficiency retrofits that could be tapped by municipalities.

Box 4: Canada Infrastructure Bank Building Retrofits Initiative

Through the CIB's Building Retrofits Initiative, commercial PACE financing programs can be funded through special purpose vehicles, which are legal entities established to carry out specific and limited activities. CIB's minimum financing is $25 million, and interest rates are Government of Canada rates with a performance spread that is linked to GHG reduction, with a minimum expected GHG reduction of 30 percent. CIB financing will constitute 60–70 percent of total project financing with a term of 25 years.

An important component for municipalities to acquire funding for commercial PACE financing through the CIB's Building Retrofits Initiative is the use of a special purpose vehicle (SPV). An SPV (also known as a special purpose entity) is a legal entity created by an organization (the SPV sponsor) to carry out a specific activity (Sainati et al. 2020). In the case of a commercial PACE SPV, the entity would be created to finance commercial building retrofits through PACE financing arrangements. I argue that commercial PACE SPVs could also be valuable in leveraging private finance to scale up PACE programs. Figure 8 provides a potential arrangement for a PACE financing SPV that can support municipalities with energy efficiency building retrofit financing.

Figure 8. PACE financing arrangement through SPVs



The recommendation is for energy efficiency services to be provided through guaranteed savings EPCs, as outlined in Figure 7, to reduce performance gaps. Private capital can be sourced through multiple means as equity investments, traditional debt, sustainable debt such as green bonds, or more recently, sustainability-linked debt. I argue that sustainability-linked debt has the added value of linking performance outcomes to financing, which may further incentivize those performance outcomes. In section 8, I outline and discuss sustainability-linked debt and describe how it can be used to support energy efficiency PACE financing goals.

7. Challenges Associated with PACE Financing Programs

While PACE financing has grown significantly in the U.S., it has also faced challenges, specifically concerning residential PACE financing arrangements. General consumer protection concerns have been raised in California (Khouri 2020; Rao 2017; Federal Trade Commission 2022), and there have also been more specific concerns with performance shortfalls and mortgage subordination.

Performance shortfalls occur when the energy efficiency retrofit does not provide the expected level of estimated energy savings. These performance gaps are often a result of inaccurate modelling estimations (Imam et al. 2017) but can also be a result of changes in external climate conditions, changes in socio-economic levels, and the associated behavioural changes of building occupants (Yun and Steemers 2011). Proponents of PACE financing have suggested the use of a savings-to-investment ratio greater than or equal to 1 as a PACE financing policy requirement to ensure that PACE programs deliver at least enough savings to offset financing costs (Kennedy et al. 2020). Energy performance contracts through guaranteed or shared savings arrangements can also reduce performance gaps for the building owner by transferring this risk to the energy efficiency service provider.

The issue of mortgage subordination results from the property tax lien feature of PACE financing. If a property goes into default, the tax lien has debt seniority, which makes mortgage lenders uncomfortable with PACE loans. Despite these concerns, default rates for residential PACE loans have been very low in the U.S., with a total national default rate of 1.73 percent (up to October 2020) and significantly lower rates in local areas (Khouri 2020). Another study showed that energy efficiency loans generally have lower loan losses than traditional credit products (State and Local Energy Efficiency Action Network 2021). Commercial PACE programs have even significantly lower default rates in the U.S. as well, with one report in 2019 (when the commercial PACE program was at US$1.5 billion) indicating a single default out of 1,870 projects (Leventis and Schwartz 2019). Furthermore, PACE financing programs have been designed to protect mortgage lenders in the event of default by establishing non-acceleration of debt (the PACE loan does not have to be paid off if the property is foreclosed; only installment payments need to be current) (Zimring and Fuller 2010). Some PACE programs go further and provide loan protection facilities (loan loss reserves) to reduce repayment risks (National Association of State Energy Officials 2018).

Mortgage lenders may also be able to benefit from PACE loans though the increased property value derived from the energy efficiency renovations. In fact, evidence suggests that energy efficiency improvements can generate a premium on home sale value (Goodman and Zhu 2016). Therefore, while a PACE loan may increase the debt on a property, the increase in property value can offset the increase in loan-to-value of the property.

Despite this advantage, mortgage lenders generally remain opposed to PACE financing, both in the U.S. and Canada (Cox 2011; City of Toronto 2017). Opposition stems from the subordinated position of mortgages to PACE loans, as PACE loans receive legal priority to mortgages. This view is shared in the U.S. by the Federal Housing Administration (FHA) and the Federal Housing Finance Agency (FHFA) (Federal Housing Finance Agency 2014; U.S. Department of Housing and Urban Development 2017). The FHA provides mortgage insurance to support affordable home purchases and the FHFA regulates federal mortgage purchasing agencies Fannie Mae (Federal National Mortgage Association) and Freddie Mac (Federal Home Loan Mortgage Corporation),

and further oversee other federal home financing entities. The FHA has further expressed concerns over consumer protection issues and the FHFA does not permit Fannie Mae and Freddie Mac to purchase mortgages on homes that have senior-lien PACE loans attached (Milano and Cockreil 2019).

Consumer protection issues in the U.S. residential PACE loan market have been a major concern, though actions have been taken to address these issues. In 2022, one of the largest residential PACE administrators in the U.S., Ygrene Energy Fund Inc., settled a lawsuit in California concerning predatorial practices in the origination of PACE loans (Federal Trade Commission 2022). Another large residential PACE administrator, Renovate America, filed for bankruptcy in 2020 due to litigations and tighter PACE financing regulations that restricted its ability to originate PACE loans (Saul 2020; Brickley 2020). Box 5 describes these activities in more detail.

Box 5: Ygrene Energy Fund Inc. and Renovate America

Ygrene Energy Fund Inc. (Ygrene) was established in 2010 and operates across all three residential PACE states (California, Florida, and Missouri), with its largest operations in California. It is one of the largest residential PACE administrators in the U.S., with a cumulative loan issuance of US$1.16 billion and 54,500 total projects up to 2018, issuing over US$500 million in green bonds backed by PACE loans, and adding significant benefits to the economies of California and Florida and with its further expansion into Missouri. In November 2022, the State of California and the Federal Trade Commission settled a lawsuit that alleged Ygrene or its contractors provided inadequate disclosures on PACE loan arrangements and engaged in high pressure sales tactics. The results of the settlement required Ygrene to allocate US$3 million to provide redress to consumers and further implement internal policies to support adequate consumer due diligence for PACE customers.

Renovate America was a large residential PACE financing provider with operations in California, with a peak loan portfolio of over US$2 billion in 2017. In December 2020, Renovate America filed for bankruptcy protection amidst civil lawsuits from PACE customers and tighter PACE financing legislation implemented in the state in 2017. Lawsuits alleged that Renovate America's PACE loan agreements provided inadequate transaction disclosures concerning fees and interest rates. In 2017, California implemented legislation that required stricter PACE financing regulations, which restricted PACE loan origination and the associated revenues for Renovate America. Revenues declined by 81 percent between 2016 and 2019, and further declined by 47 percent in 2020. Renovate America was wound down and divested in 2021.

While Renovate America filed for bankruptcy and was eventually divested, Ygrene continues to be a major residential PACE financing company. More importantly, the

issues faced by customers in the residential PACE market have informed the development of policies to support more robust PACE financing regulations that can guide program development. Table 11 lists several key recommendations to support consumer protection in the residential PACE financing market.

Table 11: Best practice approaches to provide consumer protection for residential PACE financing arrangements

Recommendation	Key issues addressed
Ability-to-pay assessment	PACE financing arrangements do not always establish the rigorous ability-to-pay standards associated with more traditional loans. The property tax lien arrangement typically only requires that the property owner has a history of non-delinquency and is current on property taxes and other home loans and mortgages. Establishing ability-to-pay requirements would ensure more adequate repayment capability from customers.
Limitations on loan-to-value	The total loan-to-value of the PACE loan and any other existing loan on the property should not exceed 100%. Some programs restrict this to a value lower than 100%.
Limitations on PACE loan values	Limitations should be placed on the total PACE loans relative to the value of the property. Some programs use 5% for residential properties; that is, the PACE loan cannot exceed 5% of property value.
Savings-to-investment ratio ≥ 1	PACE loans are designed to help property owners lower energy costs so that the cost reductions can cover the financing used to delivery the energy efficiency services. Therefore, PACE administrators should establish an SIR of at least 1.
Know-before-you-owe	Customers need to be provided with explicit transaction disclosures prior to signing a PACE loan agreement. These should provide key transaction items specific to PACE loans, including the total assessment value, the total repayment amount and installments, interest rate, fees charged, loan term, and repayment schedule. Disclosures should also explicitly state the consequences of loan delinquency and default.
Right-to-cancel	Customers should have a multi-day window to cancel their agreement without incurring any financial penalties.
Contractor compliance requirements	PACE administrators should establish an approved network of contractors with compliance requirements for service delivery and institute policies to address compliance breaches.
PACE lien registry	PACE administrators should create a registry that records and maintains PACE liens.
PACE data reporting	PACE administrators should collect and maintain program data that can be used to evaluate program performance and inform program improvements.

Source: PACENation 2021.

The best practices in Table 11 are especially valuable where private residential PACE programs may be used. While they are also useful for commercial PACE programs, commercial building owners are typically more resourced to be able to legally manoeuvre through contractual engagements, so commercial PACE programs have not experienced the consumer protection issues faced by residential PACE programs in the U.S. With adequate regulations, PACE programs can engage in private participation to scale up administration and financing.

Private financing will be a key component to drive programs at scale, and in the next section I discuss sustainability-linked debt as a suitable instrument to fund PACE programs.

8. Sustainability-Linked Debt

Sustainability-linked debt is designed to incentivize the borrower's achievement of predefined sustainability outcomes. Sustainability-linked debt can be in the form of sustainability-linked loans (SLLs) or sustainability-linked bonds (SLBs). Both have the same fundamental design mechanisms, though their arrangements and market dynamics differ. SLLs are loans that are arranged privately between borrower and lender, and SLBs are bonds that are issued to investors. Sustainability-linked debt is designed so that the financial and structural characteristics of the debt instrument (loan or bond) can vary based on whether the borrower or issuer achieves predefined sustainability (environmental, social, and governance) objectives (International Capital Markets Association 2020; Pohl et al. 2023).

Through sustainability-linked debt, the borrower or issuer makes an explicit commitment to making sustainability improvements within a specified period. This differs from other forms of sustainability debt instruments, such as green bonds, which are not performance-linked but are use-of-proceeds based, which restricts financing to specific sustainable investments. However, it can be argued that the impact of this type of financing may not have a direct effect on the sustainability profile of the borrower or issuer. While it may lead to additional investment in sustainable projects, it may also displace conventional financing for existing sustainable projects and shift this conventional capital into non-sustainable projects, creating an overall decrease in sustainable investment (Kölbel and Lambillon 2022). Sustainability-linked debt provides a more direct impact mechanism to provide a financial incentive for the borrower or issuer to achieve sustainability outcomes. Investors interested in financing sustainability outcomes only pay for these outcomes if they are achieved.

Cities and other municipalities that have established GHG emissions reduction goals can use sustainability-linked debt to financially bind themselves (existing and future local governments) to these outcomes across the period assigned to achieve them. Beyond the direct impact incentive mechanism, SLBs, like green bonds, can also provide capital at lower cost than conventional bond issuances (Kölbel and Lambillon 2022; Liberadzki et al. 2021). This provides municipalities with an additional financing tool to fund GHG emissions reductions.

SLBs are issued under a framework that outlines key principles and guidelines. There are five key components to this framework, listed in Table 12 (International Capital Markets Association 2020).

Table 12: Key components of a sustainability-linked bond framework

Component	Description
Key performance indicators (KPIs)	Established set of quantifiable measurements to assess environmental, social, and governance challenges.
Calibration of sustainability performance targets (SPTs)	Defined per KPI and establishes specific performance targets used to evaluate the bond along with the evaluation timeline.
Bond characteristics	Specified conventional issuance amount, coupon rates and frequency, maturity, and detailed features that vary based on the SPT evaluation.
Issuer report	Disclosed SPTs and any additional information relevant to the evaluation and achieved outcomes.
Issuer verification	Conducted and published internal verification of SPTs. Recommended by the SLB principles to seek independent, external verification, and make both public.

Unlike a conventional bond that is typically characterized by a principal (issuance) amount, a coupon rate, and a maturity, an SLB is further defined by key performance indicators (KPIs) and sustainability performance targets (SPTs), which outline the bond's performance-linked framework. Targets are defined by KPIs that are directly related to the issuer's sustainability goals, and SPTs are used to set the targets that must be achieved. The majority of these KPIs and SPTs are defined by environmental outcomes, such as GHG emissions (Berrada et al. 2020). Table 13 compares the key characteristics of a conventional bond and an SLB.

KPIs are a critical feature of SLBs and are designed around the strategic intents of the issuer. The SLB principles also recommend that KPIs be measurable and quantifiable through a consistent methodology, and be externally verifiable and benchmarkable to allow SPTs to be assessed for their level of ambition (International Capital Markets Association 2020). The SPTs are assigned as subsets of KPIs and are the specific performance targets that will define the SLB. The SLB principles further recommend that SPTs be defined to capture material improvements beyond business as usual, and be established with a predefined evaluation timeline that is developed before or at bond issuance (International Capital Markets Association 2020).

The fundamental design feature of an SLB is that the bond's financial or structural arrangements vary based on the performance outcome of the SPTs. The most common bond feature that varies is the coupon rate, which typically increases if the assigned SPTs are not met and remains the same if they are met (Berrada et al. 2020). Table 14 lists the other common bond adjustment features for SLBs.

Table 13: Comparison of key characteristics of a conventional bond and a sustainability-linked bond		
Conventional bond	**Sustainability-linked bond**	**Feature description**
Principal	Principal	Total amount of financing being raised
Coupon	Coupon	Interest payment arrangement (rate and frequency)
Maturity date	Maturity date	Date to complete repayment of the bond
—	Key performance indicators (KPIs)	Metrics that define how bond performance will be assessed
—	Sustainability performance targets (SPTs)	Specific targets set for KPIs used to evaluate performance of the bond
—	Adjustment or evaluation date	The predefined date on which the bond characteristics will adjust
—	Bond adjustment feature	The bond characteristic that will vary based on SPT outcomes and the pre-defined adjustment arrangement

Table 14: Common SLB financial or structural adjustment features		
SLB adjustment feature	**Description**	**Share of SLBs with this feature** (% January 2018 to February 2022)
Coupon rate step-up	Bond coupon increases by a predefined amount if SPTs are not met and remains the same if SPTs are met.	94.9
Coupon rate step-down	Bond coupon decreases by a predefined amount if SPTs exceed a predefined threshold.[5]	1.7[6]
Carbon offset	Issuer purchases a predefined amount of CO_2 offsets if SPTs are not met.	1.7
Charity	Issuer donates a predefined amount of money to a charitable organization if SPTs are not met.	1.7
Source: Berrada et al. 2020.		

5. The coupon step-down feature is not applied independently but together with the coupon step-up feature. Therefore, the full feature would be that the bond coupon rate increases by a predefined amount if the SPTs are not met and decreases by a predefined amount if the SPTs exceed a predefined threshold, but remains the same if the SPTs are met but fall below the predefined threshold.
6. The percentage of coupon step-down SLBs are those SLBs with both a coupon step-up and coupon step-down feature.

SLBs can have multiple SPTs with multiple adjustment features, though the majority tend to be a coupon step-up feature. Also less common are non-coupon adjustment features, including the purchase of CO_2 offsets and charitable donations in the event SPTs are not achieved.

The final two components of SLBs are concerned with reporting and verification (Table 12). The SLB principles recommend that issuers publish verification assurance reports and any additional information that is relevant to the monitoring and assessment of SPTs, at relevant intervals (at minimum, yearly) (International Capital Markets Association 2020). It is also recommended that issuers seek independent and external verification, which should be made public (International Capital Markets Association 2020). While reporting and verification can add additional administrative costs, they can also benefit the issuer by increasing the yield discount that investors are willing to accept (Dorfleitner et al. 2022).

SLB issuances have been dominated by corporations with limited issuances from government entities, though there have been a few notable government issuances. Table 15 lists several, including by two sovereigns and two municipalities.

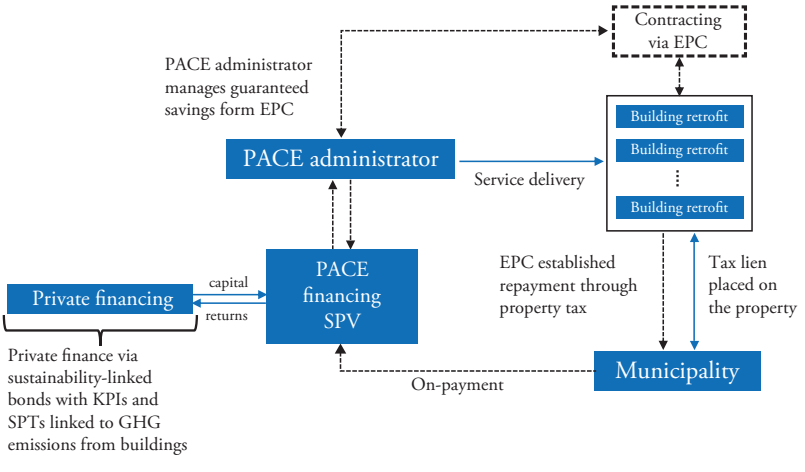
Enel, a multinational energy conglomerate, issued the world's first SLB in the U.S., and is considered the pioneer of this instrument. Telus, a telecommunications corporation, issued the first SLB in Canada. Chile was the first sovereign to issue an SLB, and Uruguay followed shortly with a rare step-up and step-down dual adjustment feature. A few subnational government SLB issuances have also occurred in Japan and Sweden. In the case of the Shiga Prefecture (Japan), the adjustment characteristic is not a coupon adjustment. Instead, if the SPT is not achieved, the issuer (Shiga Prefecture government) will contribute 0.1 percent of the bond principal (the issuance size) to a government fund dedicated to financing GHG emissions reductions. The City of Helsingborg is the first municipality to issue a SLB (issued in January 2022) (Jackman 2022), and linked SPTs to CO_2 emissions reductions for the municipality, which is connected to the overall emissions reduction plans of the municipality. Both Chile and Uruguay have also linked their SLB issuances to their overall national emissions reduction plans, specifically their nationally determined contributions (NDCs) (Ministry of Finance, Government of Chile 2023; Ministry of Economy and Finance of Uruguay 2022). NDCs are involuntary GHG emission goals established by countries through the Paris Agreement. By linking NDCs to SLB issuances, both governments establish a level of binding commitments to the achievement of the NDCs. Municipalities that have established ambitious net-zero and other GHG emissions goals can accomplish the same level of binding commitment by linking emissions reduction targets to SLB issuances.

I suggest that given the significant proportion of emissions that buildings contribute to city emissions, SLBs may be a very valuable financing instrument for cities aiming to make strong commitments to the reduction of emission from buildings. I further suggest that by combining PACE financing programs with SLB issuances, cities may be able to attract private impact capital to building decarbonization projects. The recommended approach is to use the arrangement described previously in Figure 8 and acquire private financing through SLB issuances, as shown in Figure 9.

Table 15: Notable sustainability-linked bond issuances

Issuer	Issue size	Maturity date and length (years)	Coupon (%)	Step-up coupon (%)	Step-down coupon (%)	Adjustment date	Sustainability performance targets
Enel	USD 1.5 billion	2024 (5)	2.65	0.25	N/A	2021	55% of installed renewable energy generation capacity
Telus	CAD 750 million	2031 (10)	2.85	1	N/A	2030	Reduce Scope 1 (direct) and Scope 2 (indirect) GHG emissions by 46% (relative to 2019 levels) by 2030
Chile	USD 2 billion	2042 (20)	4.34	0.125	N/A	2034	1a. Annual GHG emissions of 95 $MtCO_2e$ by 2030 1b. Max GHG budget of 1,100 $MtCO_2e$ between 2020–2030
				0.125			2a. 50% of electricity generation derived from non-conventional renewable sources by 2028 2b. 60% of electricity generation derived from non-conventional renewable sources by 2032
Uruguay	USD 1.5 billion	2034 (12)	5.75	0.15	—	2027	1a. Minimum 50% reduction in GHG emissions per unit of real GDP by 2025 (using 1990 as a base year)
				—	0.15		1b. Greater than 52% reduction in GHG emissions per unit of real GDP by 2025 (using 1990 as a base year)
				0.15	—		2a. Maintain 100% of native forest area by 2025 (relative to 2012 levels)
				—	0.15		2b. Greater than 3% increase in the native forest area by 2025 (relative to 2012 levels)
Shiga Prefecture (Japan)	JPY 5 billion	2032 (10)	0.314	N/A	N/A	N/A	Reduce GHG emissions at the Shiga Prefectural Government by 50% by 2030 (relative to 2014)
Helsingborg (Sweden)	SEK 500 million	2026 (4)	0.75	0.15	N/A	2026	Reduce municipal CO_2 emissions by 61% by 2024 (relative to 1990 levels)

Figure 9: PACE financing arrangement via SPV with SLB issuance



In Figure 9, the PACE financing vehicle is used to acquire private capital through SLB issuances. KPIs are defined based on GHG emissions from buildings, and SPTs are established to match the ambitious emissions reduction targets that cities have established for reducing emissions from buildings. For Canadian residential PACE financing programs, additional funding can be acquired through the FCM's Green Municipal Fund's Community Efficiency Financing initiative, and for commercial PACE financing programs, additional funding can be acquired from the CIB's Building Retrofits Initiative. Furthermore, Canadian banks and other financial institutions are making strong financing pledges to sustainable capital provisions, which could provide yet another source of financing. Table 16 lists the environmental, social and governance (ESG) capital commitments by the five largest Canadian banks.

These five banks have pledged CA $1.55 trillion in financing toward global ESG activities to grow and support the low-carbon transition, with other institutions making similar pledges. By finding ways to tap the private capital market, municipalities can open up opportunities for private capital for low-carbon financing. Sustainability-linked financing provides an additional access path to this capital. Banks also have a strong influence on the direction of credit in a financial system (Campiglio 2016), so by engaging banks, capital direction can be influenced.

9. A Building Decarbonization Approach for Municipalities

Given the significant proportions of emissions that buildings contribute to cities and other urban municipalities, local governments need to establish strategies around emissions

Table 16: Five largest Canadian banks and their global ESG capital commitments

Bank	Pledge ($ billion)	Pledge achieved ($ billion)	Balance ($ billion)
BMO	$300 (2025)	$267 (2022)	$33
CIBC	$300 (2030)	$77 (2021)	$223
RBC	$500 (2025)	$282 (2022)	$218
Scotiabank	$350 (2030)	$96 (2022)	$246
TD Bank[7]	$100 (2030)	$86 (2021)	$14
Total	**$1.550 trillion**	**$808 billion**	**$734 billion**

Sources: BMO Financial Group 2022; CIBC 2021; Royal Bank of Canada 2022; Scotiabank 2022; TD Bank 2021.

reductions from buildings. Table 17 provides a set of actions that can be used by these municipalities to approach building decarbonization.

The first step is for municipalities to establish an overall GHG emissions reduction plan, which many have done, that includes commitments to achieve emissions reduction targets at specified dates in the future (Table 2 lists this for some of the major cities in Canada.) Additionally, the plans should identify major sources of emissions and set sub-targets to reduce emissions from these sources. To this end, cities should establish GHG reduction commitments for buildings, both for the new built environment and the existing building stock. For existing buildings, cities can go further and establish emissions reduction compliance policies to mandate a decrease in emissions, especially from buildings that are large emitters.

To support emissions reduction compliance policies, cities need to establish energy efficiency financing mechanisms. PACE financing provides such a mechanism for both residential and commercial properties. To scale up PACE financing programs, cities should consider quasi-private or fully private PACE administrators that can provide specialized services, particularly turnkey-type administrators that centralize service delivery for greater efficiency. Additionally, cities should consider mechanisms to support private financing that can reduce reliance on public capital, which may be limited and unpredictable in availability. By establishing specialized financing vehicles, cities can isolate PACE financing projects and attract dedicated private capital to these projects.

Sustainability-linked debt is one financing instrument that can attract private capital to fund PACE programs. Sustainability-linked debt is performance-based debt that links

7. In 2023, TD Bank updated its $100 billion pledge to $500 billion (TD Bank 2023).

Table 17: An approach to building decarbonization for Canadian cities

Actions	Examples
Cities set GHG reduction goals	Many major global cities have established 2050 net-zero commitments and other emissions reduction targets for earlier dates.
Cities set GHG reduction goals for buildings	Policies for new buildings have been established for some Canadian cities: • British Columbia – Energy Step Code • City of Toronto – Toronto Green Standard • City of Vancouver – Zero Emissions Buildings Plan. Policies for existing buildings: • City of Toronto – 50% GHG emission reduction from buildings by 2040 (relative to 2008 levels).
Cities consider emissions compliance policies for existing buildings	NYC Local Law 97 (passed April 2019) establishes a cap-and-pay policy on certain buildings greater than 25,000 square feet.
Cities establish PACE financing as an energy efficiency financing support policy	PACE legislation has been established in PE, NS, ON, SK, and AB. • Residential PACE programs in major Canadian cities: Halifax, Toronto, Saskatoon, Edmonton, Calgary. • A commercial PACE program exists in Edmonton.
Cities establish PACE financing arrangements with a recommendation for PACE financing SPVs that can attract private financing or develop public-private project delivery	Similar arrangements have been used by quasi-public and private PACE administrators in the U.S.
Cities establish SLB and SLL principles that will support the use of SLBs and SLLs to fund PACE financing vehicles	SLBs have been growing in use but are currently rare among municipalities. SLBs provide an opportunity to (financially) bind municipalities to their GHG emissions commitments.

performance to debt repayment. This type of debt can financially bind cities to their GHG emissions reduction commitments. If targets are missed, financing costs increase; if targets are met, financing costs remain as initially negotiated, which is usually less than the financing costs associated with conventional bond issuances. Additionally, sustainability-linked debt also has the characteristic, though less common, of reducing financing costs further if predefined performance targets are exceeded. The makes sustainability-linked debt very attractive for emissions reduction projects, and specifically, for building decarbonization financing.

10. Conclusions and Recommendations

Cities are major contributors to GHG emissions globally, and this trend will continue as urbanization increases and city populations continue to increase. Cities also face greater

exposure to climate risks due to the density of population and infrastructure. Therefore, cities occupy a critical role in policy design that reduces GHG emissions.

Buildings are one of the primary sources of emissions, often the leading or second highest source in cities. Therefore, any emissions reduction plan for cities must have a dedicated strategy for addressing emissions from buildings. Furthermore, as cities establish 2050 net-zero emissions plans, it is noteworthy that the majority of buildings that will exist in 2050 have already been built. Therefore, reducing emissions from buildings will require significant energy efficiency and energy upgrade retrofitting, and significant amounts of financial capital will be required to achieve this outcome. PACE financing is one arrangement that can be used to support building decarbonization in Canadian cities.

This paper makes the case that PACE financing can be used by Canadian municipalities to support building decarbonization efforts. It describes the different general arrangements used to deliver PACE financing and recommends that municipalities consider third-party or private PACE program administration to scale up program delivery, while they focus on policy development and implementation to support building decarbonization. Private PACE programs can also deliver PACE financing across municipalities, providing greater scale, which can support program cost reduction, especially across smaller municipalities. In this view, scaling up of programs can also facilitate program standardization, which can further attract large capital providers through aggregated financing vehicles.

Private PACE programs may be susceptible to performance gaps delivered from the energy efficiency services, however. This paper recommends the establishment of a savings-to-investment ratio (SIR) of at least 1 to ensure that energy efficiency retrofit services deliver sufficient energy cost savings to cover financing costs. Additionally, and especially for commercial PACE financing, savings guaranteed energy performance contracts should be considered to guarantee the energy savings estimated from energy efficiency retrofits.

This paper further recommends that municipalities consider private financing to scale up capital availability and provide sufficient capital access, which may incentivise potential energy efficiency retrofit providers. Public capital is often limited and may come with political constraints that create uncertainties. These uncertainties may limit contractors' engagement in PACE programs if funding availability is insufficient to satisfy program demand.

Finally, this paper recommends the use of PACE financing special purpose vehicles (SPVs) as entities to acquire funding specifically for PACE program delivery. Through these SPVs, sustainability-linked bonds (SLBs) can be issued and used to finance building decarbonization. SLBs are performance based and link bond return to performance outcomes. While they have only been in use since 2019 and occupy a small part of the sustainable bond market, they have been growing rapidly, both in terms of market size and the number of issuers. And, while these instruments have general use for municipalities, to bind themselves to emissions targets, this paper presents SLBs as useful financing tools to drive private finance toward building decarbonization, by linking emission reduction with bond returns.

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