

A report produced in cooperation between:



GETTING THE MOST OUT OF YOUR RETROFITS

A resource for implementing deep retrofits in municipalities

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ABOUT RECOVER

ReCover is a non-profit organization governed by a small working group and guided by an Advisory Committee composed of 14 highly respected industry experts from across Canada, who have been instrumental in advising the ReCover team since 2020.

Recover has been positioning itself as a deep retrofit accelerator since 2020 by forging partnerships with key retrofit market actors, building relationships and sharing knowledge with other Retrofit Accelerators, facilitating industry capacity-building activities, and completing research and feasibility studies for deep retrofits.

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ABOUT QUEST CANADA

QUEST Canada is a registered Canadian charity that supports communities in Canada on their pathway to net-zero. Since 2007, they have been facilitating connections, empowering community champions and influencing decision-makers to implement efficient and integrated energy systems that best meet community needs and maximise local opportunities.

With the goal of encouraging and enabling communities to contribute to Canada's net-zero goals, QUEST Canada develops tools and resources, convenes stakeholders and rights holders, and advises decision-makers.

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GETTING THE MOST OUT OF YOUR RETROFITS



INTRODUCTION

This report provides a resource for completing deep retrofits in municipal building stock. The intended audience is staff of small-to-medium-sized municipalities tasked with undertaking deep retrofits or who seek to develop a plan to significantly reduce the energy and emissions of their municipality's building stock. In small-to-medium-sized municipalities, staff often have competing priorities and assignments and are tasked with deep retrofit work. This report aims to offer a guide, drawn from advice gathered by experts in the field, to assist municipal staffers in getting this work off the ground in their municipality.

METHODOLOGY

Jurisdictional Scan and Literature Review

The research began with a jurisdictional scan of Canadian organisations and entities that operate in the municipal energy space, which fed into a literature review (Appendix A). The literature review revealed five key themes:

- The need for linkages between initiatives;
- Holistic building/system approach;
- Government involvement & Municipalities opportunities;
- Consideration of benefits beyond financial; and.
- Data Collection.

Interviewing Experts

To begin understanding the information needed for municipal staffers, the researchers interviewed a variety of experts. The experts spanned a variety of fields, including:

- Municipal Staff (facilities and sustainability)
- Program Implementers
- Private Sector Implementers

Advisory Committee

An advisory committee supported the researchers by providing strategic directional advice on the report's scope, methodologies, and recommendations. Our advisory committee members were **Charles Mougéot**, **Liam Cook**, and **Myles Cornish**, who collectively have 28 years of experience working on retrofits.

CONTEXT

This report is a joint project between **QUEST Canada** and **The ReCover Initiative**, funded by Natural Resources Canada, The Atmospheric Fund, and the NS Department of Natural Resources and Renewables.

Motivation

The urgent need for sustainable and energy-efficient solutions has prompted a global push towards deep retrofits in the built environment. Municipalities are vital in providing essential services and facilities to their communities delivered through their building stock. They are also in a unique position to impact Canada's climate targets. Municipalities are responsible for about 50% of Canada's greenhouse gas emissions¹, so their commitment to reducing greenhouse gas emissions and enhancing energy efficiency is crucial.

Deep Retrofit Definition

We've relied on Natural Resources Canada's (NRCan) definition: Deep retrofits typically save at least 50% in energy consumption, up to 70% or more, and/or up to 80-100% in GHG emissions. Deep retrofits may also include measures to improve resiliency and adaptation to climate change.²

¹ Federation of Canadian Municipalities. (n.d.). Climate and sustainability. <https://fcm.ca/en/focus-areas/climate-and-sustainability#:~:text=With%20municipalities%20influencing%20roughly%20half,one%20community%20at%20a%20time>

We also asked the experts selected for interviews what they consider a deep retrofit. The answers were varied, with some experts expressing that retrofits with 30% reductions are deep retrofits. The most common number suggested was 50%, and a few relied on NRCan's definition.

However, while several experts used a quantitative assessment definition of a deep retrofit, they most often said the deep retrofit definition is fluid and dependent on the context. A key consideration when undertaking this work and exploring numbers is to assess whether targets are in energy or emissions reductions, as this will determine the retrofit project's direction. The experts identified that a deep retrofit encompasses significant reductions beyond the "low-hanging fruit" or a "standalone retrofit project." These projects are important in their own right but do not encompass the reductions required to be considered deep retrofit work. Many experts described "looking at the building as a whole" to identify where the needs were. A few experts took this further to recognize that the entire "building envelope," "multiple building systems," or "every building system" are considered when doing deep retrofit work.

The biggest takeaway from the expert interviews was that this work depends on the needs and goals of the municipality and its specific circumstances. One expert identifies that in many scenarios, such as projects in Alberta, the type of electrical grid may make hitting those high reduction targets in individual buildings difficult. However, experts suggest deep retrofits should examine whole building systems (including HVAC, building envelope, and lighting) and optimise for outcomes.

² Natural Resources Canada. (n.d.). Definitions. In *Deep Retrofit Accelerator Initiative – Application Guide*.
https://natural-resources.canada.ca/energy-efficiency/buildings/deep-retrofit-accelerator-initiative/deep-retrofit-accelerator-initiative-application-guide/24923#_Definitions



CONSIDERATIONS FOR DEVELOPING A RETROFIT PLAN FOR YOUR MUNICIPALITY

Processes and Standards

Differing Building Types

Municipalities have a variety of building types in their portfolios, each with specific needs and requirements. A library will have different retrofit considerations than a community ice rink. However, while the technical requirements will differ, some considerations apply to every project.

The first is understanding the key priorities or goals for the municipality and the specific building to categorise and drive the changes needed. One expert recommended organising those priorities into three groups:

1. Emissions reductions/environmental goals;
2. Comfort/safety; or,
3. Financial savings.

From there, the expert said, build the solutions that best align with those goals. Further to that, the expert recommends grouping building stocks together. A similar building, like an office building and a small library, will have similar needs but different than those of an ice rink, which will be more complex.

Another expert suggests considering user groups, the timing of retrofit projects of municipal buildings, and occupant comfort when retrofitting the HVAC system so that work doesn't coincide with extreme heat. They provided the example of working with a daycare operating out of an old church. In this case, the municipality prioritised retrofitting the boiler because it was a safety issue and children used the building.

Additional industrial and system processes must be considered

“SOLAR PANELS ARE A GREAT INVESTMENT FOR EMISSION AND OPERATIONAL COST SAVINGS, BUT IF YOUR TOP PRIORITY IS OCCUPANT COMFORT, YOU MAY WANT TO FOCUS ON IMPROVING INSULATION VALUES, SEALING UP DRAFTS, AND LOOKING INTO A HIGH-EFFICIENCY HVAC SYSTEM”

Liam Cook

collectively for more technical, complex retrofits (rinks, wastewater treatment plants). In the case of ice rinks, for example, an upgrade of the ice-making equipment may alter the overall heat load of the building which in turn will impact the HVAC capacity calculations. Another expert highlights the need for a broader understanding of the infrastructure's mechanics and tying this work into overall asset management.

Integrated Processes

Integrated Design

The Building Owners and Managers Association of British Columbia published the BOMA BC [Deep Energy Retrofit Procurement Guide](#), which makes the case for an integrated design approach for all retrofit projects (Pg. 3). Integrated design looks at the building holistically, considering all systems and their synergies.

One expert describes the integrated design as looking at the building as a set of systems rather than becoming siloed by only looking at energy or carbon. Employing integrated design into deep retrofits provides the opportunity to consider the remaining life of a building, how to extend that life, and how to increase resiliency in the face of worsening weather events all within the design of the retrofit.

“A COMPREHENSIVE INTEGRATED DESIGN WILL GO BEYOND JUST LISTING AND DESCRIBING ALL THE RETROFIT OPPORTUNITIES THAT EXIST WITHIN THE BUILDING, IT ALSO CONSIDERS THE IDEAL INTERVENTION POINTS WITHIN A BUILDING’S LIFE CYCLE, DETAILING WHEN THESE INCREMENTAL ENERGY IMPROVEMENTS CAN BEST BE UNDERTAKEN TO TRANSITION THE BUILDING INTO ITS DEEP ENERGY (OR DECARBONIZATION) STATUS.”

BOMA BC *Deep Energy Retrofit Procurement Guide*

Integrated Project Delivery

One expert, when asked about different processes for different buildings, highlighted that project processes don’t vary much between different building types. However, within their work, they encourage an integrated project delivery model.

Approaching projects with integrated delivery also has the potential to reduce costs and timelines. Having all the relevant players to map out systems renewal from the beginning can be critical to the success of deep retrofit work.

Another expert describes integrated project delivery as sitting down with all the relevant players to map out system renewal. They further explain the missed opportunities of not following an integrated design approach:

Integrated Project Delivery:

“YOU BRING ON THE CONSTRUCTION TEAM AND THE DESIGN TEAM AT THE BEGINNING OF THE PROJECT TO WORK TOGETHER COLLABORATIVELY WITH THE BUILDING OWNER THROUGHOUT THE ENTIRE PROJECT”

Keith Burrows

“If you’re not sitting down and mapping out and planning with pertinent people, then you’re going to be making investments that either are dead ends or kind of shut down opportunities to achieve greater impacts further down the road” (Levi Higgs).

A note on certifications

We asked the experts if there is a certification that a municipal staff person should get before overseeing audits for their municipality. For example, should they be a Certified Building Commissioning Professional or a Certified Energy Manager? The response was not absolutely necessary, but these are certifications municipal staff might look for when hiring an external audit contractor. However, having someone on the internal team with these certifications would benefit the municipality.

Inclusion and Equity

Project Team

One of the key takeaways from the expert interviews was the need to include many people from across the municipality. Deep retrofit projects should include “everybody in your organization who interfaces in those facilities” (Myles Cornish).

Some groups highlighted during the interviews were:

- Building occupants
 - The people working in or in charge of the buildings know best what needs doing. They will understand how people use the building and the areas that need improvement.
- Finance
 - The Senior Manager or Director level finance approves the budget. They will likely need to understand the return on investment.
 - Speak with a Grant Coordinator to manage any external funding for the project.
- Council
 - The Council is your municipality’s decision-maker. The elected officials will be the ones who officially approve the budget, and it is vital to keep them informed from the beginning.
- Chief Administrative Officer (CAO) or other senior leadership
 - It is important to keep senior leadership involved as you will need their buy-in on this work.

Other community priorities

Deep retrofit work focuses on energy efficiency and emissions reductions. However, it also has many community benefits if implemented correctly. Incorporating non-energy and non-emission benefits into the retrofit could include ensuring the work includes and serves neglected and

Who do you need to bring on board to implement deep retrofits?

“EVERYONE”

Amanda Christianson

vulnerable communities, explored in more detail below. It could also ensure that building upgrades address other priorities, such as accessibility. Deep retrofit work is usually “invasive and disruptive,” and including upgrades to accessibility minimises disruption to users and improves costs.

Incorporating other community priorities into retrofit work is a balance and requires coordination. Including a broad project team and an integrated design approach in this work from the beginning will reduce some of the implementation struggles. Furthermore, incorporating other community co-benefits into deep retrofit work “helps to get people’s attention and to get people on board” (Levi Higgs).

“IT’S NICE TO SAVE MONEY ON THE ENERGY OF A BUILDING, BUT IF YOU CAN’T HAVE EVERY PATRON INCLUDED IN THAT BUILDING, THAT’S A BIGGER ISSUE.”

Nick Valerio

Neglected and Vulnerable Community Populations

As previously stated, deep retrofit work is an opportunity to incorporate and achieve other key community priorities. The interviews identified a few ways in which to include a focus on historically neglected and vulnerable communities.

Incorporating into procurement

The deep retrofit space is growing, creating jobs, which is a key avenue to support neglected and vulnerable communities. Municipalities can support this work by building equity, diversity, and inclusion into their procurement policies. Vendors can be scored or weighted on whether they have an equity, diversity, and inclusion policy or even as granular as the diversity or representation of the project team. Another option is to “leverage the use of social contractors who are providing opportunities for people facing barriers to employment in the construction industry to do work on these projects and to learn on these projects” (Keith Burrows). Municipalities can work directly with social contractors or build in requirements for contractors to work with them if they aren’t one themselves.

Socio-economic lens of municipal spending

Municipalities can use a full assessment of their building stock to assess how budget expenditures benefit communities differently. Superimposing socio-economic data onto energy data provides a “different lens” that ensures money isn’t inadvertently going to the wealthiest neighbourhoods. Wealthier populations have the time and resources to complain about their municipal resources (i.e. ice rinks), while lower-income communities miss out on upgrades to theirs. Furthermore, these municipal services offer low-income residents opportunities they may not have otherwise. For example, libraries provide books and wifi, which might be inaccessible to some. Deep retrofit work allows assessing where money gets funnelled and considering whether all community members benefit.

Community Resiliency

Climate change will continue to put stress on municipalities. As inclement weather becomes more prevalent and dangerous, it will be necessary

for municipalities to consider how to protect their populations. Deep retrofits offer an opportunity to consider different functions for municipal buildings. Recreation facilities, in particular, could provide an essential service in emergencies, such as cooling or warming centres and refuges from floods or wildfires. When planning retrofits, consider these dual purposes early on. For example, deep retrofits can ensure that recreation centres have high-quality air filtration systems to appropriately serve as a refuge from wildfire smoke. This type of consideration also means that the return on investment of municipal buildings is higher as they are used to serve multiple purposes and respond to emergencies.



Goal Setting

Goal setting, or understanding what a municipality tries to accomplish, is a foundational step in the deep retrofit work. It sets the tone for what the work will accomplish. Deep retrofit projects often focus on energy efficiency and emissions reduction goals but can also address other non-energy related goals:

- Comfort
- Resiliency
- Operations savings
- Financial savings
- Improved functionality
- Council priorities (i.e. neglected and vulnerable populations)
- Embodied carbon

Municipalities can use the non-energy-related goals to achieve other priorities a municipality may have, such as serving neglected and vulnerable communities.

Process

National or provincial governments often set broad, high-level goals that impact municipal governments. The most frequently referenced by interviewees were the 2030 and 2050 targets. These targets refer to Canada's federal plans, the **2030 Emissions Reduction Plan** and **Net-Zero in Canada by 2050** target. *The 2030 Emissions Reduction Plan* "provides a roadmap to how Canada will meet its enhanced Paris Agreement target to reduce emissions by 40-45% from 2005 levels by 2030" (Government of Canada). The **Canadian Net-Zero Emissions Accountability Act** enshrines the Net-Zero by 2050 target. These targets can be what drives municipalities to set their high-level goals. Sometimes, these directions come from the council or mandate of a municipality. Another option when setting goals for your buildings, is to consider the goals of other municipalities.

Once high-level goals are set, either by the municipality or higher levels of government, they can be applied directly to a municipality's circumstance. The most commonly suggested approach was to look into the entire building portfolio. You need the available energy consumption and building stock information, including square footage and function. With this information, you can conduct a preliminary energy analysis or portfolio benchmarking, as mentioned under Audits & Goal Setting.

There is also the opportunity to combine buildings to speed up this work's timelines and save money. By contracting for work on five or even ten buildings, municipalities don't need to hire contractors one at a time, plus, buying materials in bulk can save money.

Audits

Audit Standards

The leading audit standard mentioned among interview participants was the **ASHRAE Commercial Guide for Energy Audits**. One interviewee said ASHRAE is the 'gold standard' for audits, and 75% of interviewees mentioned it.

Municipalities may adapt ASHRAE standards to meet their needs. One expert recalls "learning about ASHRAE, the different levels of audits, and assuming that they were pretty determinative" (Omar Bhimji). However, as their experience grew and they were involved in more audits, they found ASHRAE to be "guidelines more than specific regimes you have to follow" (Andrea Linsky). ASHRAE standards can provide a starting point to customise the design to meet the project's needs. One expert discussed how ASHRAE doesn't necessarily meet the current needs of municipalities and that a "decarbonization plan for each building that aligns with the financial reality of those assets" (Andrea Linsky) might be more appropriate.

This portion of the deep retrofit work comes back to the specific needs and goals of the municipality, further explored in the following section. By understanding these, municipalities can explore energy consultant firms that can do customised audit studies rather than going to a



“THEY WOULD DO ALL THE MEASURES; THEN THEY WOULD BUNDLE TOGETHER THE LOWEST QUICKEST PAYBACK BUNDLE, THE HIGHEST CARBON REDUCTION BUNDLE, WHICH IS MORE LIKE THE DECARBONIZATION PLAN, THE AVERAGE NPV BUT DEEPER TYPE RETROFIT BUNDLE, ETC.. AND THEN WE WOULD BE ABLE TO LOOK AT ALL OF THOSE AND UNPACK THE MEASURES THAT THEY INCLUDED IN THEM.”

Andrea Linsky

standard energy consultant. In one instance, an expert described a request for proposal (RFP) process where, in their former work with a municipality, they requested that studies create different “bundles”, like a decarbonization pathway bundle. Asking for bundles can make auditors think differently than usual and provide audit data that directly responds to the municipality’s goals.

Municipalities often rely on funding programs and incentives to undertake deep retrofit work. It is important to consider the audit requirements for each program and tailor the audit work accordingly.

Virtual Audits

Many in the retrofit industry are exploring virtual audits. For a more thorough exploration please check out [Accelerating Retrofits in Commercial Buildings' Final Report](#) from Alberta Ecotrust.



Procurement

Four options for implementation from the US Department of Energy, *Advanced Energy Retrofit Guide*, September 2011:

1. In-house implementation is typically the lowest out-of-pocket cost for an energy project. It assumes a building owners facilities maintenance personnel will execute the identified improvements. This implies that individuals can integrate the additional work into their ongoing tasks, or the building owner can temporarily hire additional personnel.
2. Design-build contracts result in turnkey project delivery with the design and construction activities integrated into a single team.
3. Design-bid-build construction approaches are conventional in the new construction market for office buildings and can be applied to complex, deep retrofits of existing office buildings. Under this approach a design firm delivers bidding documents, which the owner then uses to solicit bids for the construction phase of the work.
4. Energy performance contracting is a special subset of design-build construction, where the same contractor (the Energy Service Company, or ESCO) is involved from the initial performance assessment through final monitoring and verification, and generally offers a guarantee that savings will be achieved. An energy performance contract may be the lowest of pocket cost when the project cost is paid from energy savings.

Issues with Traditional Procurement

One of the most consistently heard issues with deep retrofit work in municipalities was the ineffectiveness of standard municipal procurement policies. The interviewees frequently described the status quo of procurement policies as administratively burdensome, time-consuming, and not leading to the best outcome. Additionally, as energy efficiency and emissions reductions are time-sensitive issues, the time it takes to do procurement is an issue.

“THERE ARE SO MANY REAL AND TECHNICAL STUMBLING BLOCKS WITH PUBLIC PROCUREMENT. IT’S HARD TO SEE HOW OUTCOME-FOCUSED PROJECTS LIKE SYSTEM OR COMPLETE BUILDING RETROFITS WOULD FIT WITHIN THEM.”

Omar Bhimji



In addition to being time-consuming, the current procurement processes create an environment where there is a disconnect between each project stage. By having different vendors accomplish each section of the work, there is a risk that differing expertise on solutions will cause delays and restarts.

“PROCUREMENT CAN BE INCREDIBLY RESTRICTIVE, AND IT CAN BE HARD FOR MUNICIPALITIES TO GET THE EXPERTISE THEY NEED, OR WITH THE STEPS YOU HAVE TO FOLLOW, THINGS CAN GET LOST, OR THINGS CAN CHANGE, WHICH CAN MAKE IT MORE CONFUSING.”

Rachel Mitchell

Potential Alternatives

Standing Offers

A solution to the procurement issue is standing offers. Standing offers remove the need to do an individual procurement for work by using pre-approved contractors. There are often standing offers already vetted by the provincial government available to municipalities. Municipalities could develop their standing offers to pre-qualify energy assessors, allowing quotes to only come from them to speed up the project.

Pilot Projects

Municipalities can employ pilot projects to demonstrate the effectiveness of procurement approaches that incorporate integrated design processes. Using an integrated design process, the person or company designing



the project will also be responsible for implementing it. This process allows municipalities to evade the issues of disconnected portions of the project and have a long-term budget to support the consistent work needed in integrated design. These projects allow municipalities to test how this works within their communities and see the potential to scale the successes once complete.

Sustainability and Procurement Policy

Building sustainability into the procurement policy provides another solution to the frustrations of municipal procurement policy. For example, a community in British Columbia drafted into their procurement policy that each time they would replace a vehicle, it would be an electric vehicle wherever possible. Other options include sourcing from places prioritising local production to avoid embodied carbon emissions or prioritising companies certified by external organisations like B Corp.

Furthermore, as mentioned above, building energy and sustainability work into your capital planning system makes room for a more holistic approach to deep retrofits. Adjusting any capital planning evaluation matrix to include energy efficiency and emissions metrics allows this work to exist more broadly in the municipal building sector rather than siloed into only energy work.

Each community will likely have its own procurement policies, so how to manage each will depend on the circumstances. The priority should be determining how they can speed the procurement process up and reduce the time and effort it takes to bring on different vendors at each stage.

What is embodied carbon?

According to the Community Energy Association, embodied carbon is “The emissions associated with the harvesting, transportation, manufacturing, and installation of construction materials.” To learn more about embodied carbon and its impact on deep retrofits, please consult: Buy Clean Policy from CEA’s [*Embodied Emissions Guide for Local Government*](#).

Financing

Assessments

An understanding of simple payback, return on investment (ROI) and net present value of a project is useful.

ASHRAE defines simple payback as “estimated initial energy efficiency measure (EEM) cost divided by the EEM first-year calculated cost savings. Both savings and costs are in dollars (\$) or other consistent monetary units, and the simple payback is expressed in years.”³

ASHRAE defines return on investment (ROI) as, “the EEM first year calculated cost savings divided by estimated initial EEM cost. Both savings and costs are in dollars (\$) or other consistent monetary units.”

Net present value analysis allows municipalities to understand the costs of “business as usual” and compare it to the cost of doing the retrofit. Net-present value assessment considers the ongoing savings through energy and cost efficiencies, increases in carbon pricing, utility rates, extreme weather conditions, and ongoing maintenance costs.

Deep retrofits can have many benefits. Due to this, any benefit assessments could consider measurements that go beyond costs. When assessing deep retrofits, some explore the benefits “beyond just the very cut and dry financial payback and looking at overall benefit to the community, to the building, and in more avenues than utility cost savings” (Amanda Christianson). The difficulty with these assessments is these benefits can be hard to quantify.

Asset Management

Municipalities are responsible for the upkeep of their buildings regardless of profit, allowing them to consider investments differently. Municipalities continuously invest in their building irrespective of energy efficiency or carbon reduction goals.

As municipalities have more reason to maintain their buildings over the long term, this allows them to undertake deep retrofit work in a staged approach. Deep retrofits are a significant investment; covering the costs

³ ASHRAE. (2018). Standard for Commercial Building Energy Audits. Retrieved from https://www.ashrae.org/File%20Library/Technical%20Resources/Bookstore/previews_2016437_pre.pdf. Pg 4

Integrating energy management into asset management practices optimises operational and financial performance, ensures compliance with regulations, and fosters sustainability. It's a holistic approach that considers the interconnectedness of energy use, environmental impact, and the overall health of assets within an organisation.

Measurement and Verification (M&V)

M&V Standards

The only standard for measuring and verifying deep retrofit projects mentioned in the interviews was the **International Performance Measurement and Verification Protocol (IPMVP)** by Efficiency Valuation Organization (EVO). IPMVP provides a set protocol for doing M&V that municipalities can base their assessments on.

Issues

A central issue identified in the retrofit space around M&V was that completing an M&V stage of a project is not standard practice despite its importance. From a benefits perspective, M&V demonstrates to funders or the public how much impact the deep retrofit project has had, either through financial savings, energy savings, or greenhouse gas reductions. This demonstrable difference can help garner support for further retrofit projects.

M&V Cost







The IPMVP Core Concepts 2022 states that M&V should cost less than 10%* of cost savings being assessed. Each project will be unique and require different levels and complexity of M&V.

*Efficiency Valuation Organization. (2022). International Performance Measurement and Verification Protocol (IPMVP) Core Concepts, Section 8.6. Pg. 38



CONCLUSION

Six core observations came out of this research:

-  1. Optimising deep energy retrofits, maximising energy savings or maximising emissions savings should be approached comprehensively.
-  2. Incorporating integrated processes, integrated design, or integrated project delivery into the procurement process typically offers the most effective way for municipalities to undertake deep retrofit work.
-  3. Broader community asset management and capital planning would benefit from including deep retrofits. This approach allows municipalities to undertake deep retrofits on a consistent, ongoing, and staged basis. It ensures that there are no missed opportunities for equipment replacement or repair.
-  4. Procurement policies are not conducive to deep retrofit work that accomplishes Canada's decarbonization targets. Municipal procurement policies currently are too restrictive to an integrated design approach. Municipalities can explore ways around traditional procurement practices that allow for an integrated design approach.
-  5. Various economic analysis tools exist to understand the financial impacts of deep energy retrofits. An introductory understanding should be obtained for the whole project team, and care should be taken to hire qualified professionals for the analysis.
-  6. Collaboration with in-house and contracted capacity is integral to establishing goals, discovering and documenting opportunities, maturing energy and technical analysis and leading implementation.

We developed this research to assist municipal staff in small- to medium-sized municipalities undertaking deep retrofit work or energy and emissions reduction work in their communities.

Municipalities are uniquely positioned to affect change and move the needle on Canada's climate targets. We hope this report has introduced some considerations for undertaking deep energy retrofits of municipal building stock.

APPENDICES

A: Literature Review

Methodology

This literature review began with a jurisdictional scan of relevant organizations and entities in the retrofit and municipal energy management space and compiled relevant literature for review. QUEST Canada and ReCover additionally reached out to connections to explore any gaps and garner recommendations for literature to be included in the report.

Once the relevant literature was compiled researchers used coded research to organize the works into key themes. The codes were developed from discussions and advice with the Advisory Committee and encompass important considerations for municipal workers during deep retrofit work.

A thorough review of the literature revealed four key themes: the need for linkages between initiatives, Holistic building/system approach, Government involvement, Consideration of benefits beyond financial. The following review explores how these themes are discussed throughout the literature and serves as a foundation for conducting further research work.

Themes

Linkages Between Initiatives

The theme of linkages between initiatives points to a need for deep energy retrofits not to exist within a vacuum. Municipalities can face many barriers to undertaking these types of projects. The literature is very clear that municipalities need to approach deep retrofit initiative in conjunction with other holistic municipal initiatives to overcome some of these barriers as explored below.

Within this theme, one of the foundational recommendations is to create linkages between municipal departments and staff. As stated in *Towards Low Carbon Communities: Creating Municipal Green Development Standards (2020)* many departments will be involved in building retrofit projects. Deep energy retrofits, a component of Green Development

Standards, are a whole-municipality endeavour requiring various departments' input and support. Therefore it is recommended that there be a breakdown of departmental silos early on to create an intra-departmental team of champions to support the undertaking (*Clean Air Partnership, 2020, P. 2*).

Furthering this point, the literature recommends linking the retrofit process to other municipal initiatives, such as capital planning, infrastructure and equipment renewals, and asset management (*Green Building Council, 2020, P.2*). Approaching a deep energy retrofit on its own is an extremely resource-intensive activity. Each project requires its own business case, planning and design process, implementation, as well as monitoring and verification (*Green Building Council, 2022, P.9*). The benefits of linking retrofit work within existing processes are twofold. Firstly, this linkage would ease the burdens on municipalities to undertake resource-intensive projects in addition to their existing work. Secondly, coupling major initiatives in this way would allow municipalities to be strategic in their decision-making and spending (*Building Owners and Managers Association (BOMA) of BC, 2022, P.2*). For example, the *US Dept. of Energy, Advanced Energy Retrofit Guide, 2011* recommends "seeking synergies across disciplines" as doing so will often "identify multiple benefits... from a single expenditure" (*Building Owners and Managers Association (BOMA) of BC, 2022, P.9*). By linking the initiatives to existing or broader initiatives, municipalities can also garner intra-departmental support or the support of elected officials, thereby facilitating implementation of energy projects (*Federation of Canadian Municipalities, 2020, P. 206*).

Furthermore, the literature stresses the importance of linking deep energy retrofit work with broader community benefits. Doing so allows municipalities to link projects with other community priorities (e.g. high-risk populations) and tailor programs to meet these priorities (*Efficiency Canada, 2022, P.22*). On a single-building scale, deep energy retrofits benefit occupant health while, when conducted on a municipality-wide scale, create healthy and sustainable communities (*Clean Air Partnership, 2020, P.13; Green Building Council, 2022, P.10*).

Holistic Approach

Beyond the need to think more holistically from a municipal perspective the literature on deep energy retrofits points towards the need to approach projects considering the whole building. The literature clearly states the need to think holistically of the entire building ecosystem when undertaking deep retrofit work. *The Deep Energy Retrofit Guide for*

Public Buildings - Business and Financial Models report indicates that the International Energy Agency considers deep energy renovation to be a top priority; the report considered a whole building systems approach to be one of three criteria to get the building sector on track (Lohse, R., & Zhivov, A., P.1).

An integrated design process approach was suggested to accomplish this (*Building Owners and Managers Association (BOMA) of BC, 2022, P. 2; Canada Green Building Council, 2022, P. 10*). Integrated design “considers all the building systems at the same time to find synergies” (*Building Owners and Managers Association (BOMA) of BC, 2022, P. 2*). It allows all opportunities to be considered to maximize benefits, leading to improved building performance and health for occupants (*Canada Green Building Council, 2022, P. 10*). However, it is also important to recognize potential challenges. Deep energy retrofit work usually encompasses many smaller initiatives to make up the whole project, which could result in difficulties in fully calculating benefits from the undertaking (Lohse, R., & Zhivov, A., P.2). Despite this, choosing to pursue single measures in the name of cost-efficiency is considered less cost-effective overall for deep energy retrofit targets of 50% energy savings (Lohse, R., & Zhivov, A., P.2).

Furthermore, resources that explore carbon emissions and the impact of embodied carbon on energy projects recommend implementing life cycle assessment (LCA) on all projects to fully understand the total emissions from the project holistically. This means considering all emissions from materials encompassing raw material extraction to waste disposal. Designers and builders are encouraged to “rise to the challenge and offer clients LCA services to quantify and reduce embodied carbon as early as possible in the design process (*Canada Green Building Council, 2021b, P.9*).

Government Involvement & Municipality’s Opportunities

The literature points to a gap in a comprehensive policy framework for deep energy retrofit work in Canada despite retrofit work being considered a cost-effective way for the building sector to meet its GHG reduction targets (*Canada Green Building Council, 2021a, P.10; Efficiency Canada, 2022, P.11*). To meet our 2050 climate commitments as well as move quickly on building sector decarbonization and resilience to the impacts of climate change “the regulatory environment... must enable innovative paths to mandate, support, and incentivise ambitious retrofit rates” (*Efficiency Canada, 2022, P.11*). Integrated Pathways to Decarbonization (2022) recognizes that the federal government has set a net-zero GHG reduction target but, at present, “has not put in place a

policy architecture that can move the building sector decisively towards decarbonization” (P.30).

Despite this, municipalities have a large role to play with their own infrastructure. *The Local Government Guide - Policies, Programs, and Incentives to reduce Embodied Emissions in the Built Environment (2022)* highlights that most of Canada’s public infrastructure procurement is the purview of the province and municipalities (P. 29), while, in the example of Ontario, “municipal infrastructure counts accounts for nearly half of the Province’s public infrastructure stock” (*Clean Air Partnership, 2020, P.16*). In the absence of a robust regulatory system, municipalities can enact change within their own building stock. The Federation of Canadian Municipalities recommends that municipalities “lead by example” in order to encourage changes in their communities. Municipalities can do this by adopting high-performance building codes and practices, implementing benchmarking, and showcasing retrofit projects in municipally owned buildings, thereby encouraging change to behaviours and practices (*Federation of Canadian Municipalities, 2020, P.13*). By implementing energy management best practices, municipalities are able to showcase themselves as leaders in reducing their environmental impact (*Natural Resources Canada, 2015, P.7*).

Benefits Beyond Financial

While much of the literature explores the cost-benefit analysis of deep energy retrofits, there is also a considerable focus on benefits that go beyond the financial and directly reach the community. One of the key non-financial benefits highlighted is that deep energy retrofits contribute to better, healthier communities (*Canada Green Building Council, 2021a; Clean Air Partnership, 2020; Federation of Canadian Municipalities, 2020, P.221; Canada Green Building Council, 2022, P.46*). *Towards Low Carbon Communities: Creating Municipal Green Development Standards (2020)* highlights that the impact these projects have on communities is multi-generational. It also indicated that cost-benefit study of building standards in Toronto had broad reaching environmental, social, and economic benefits not only in Toronto, but in surrounding areas too (P. 17).

Another community benefit of undertaking deep energy retrofit projects is economic improvement and job creation. The literature is clear that investing in deep energy retrofit projects and green building projects offers well-paying jobs that offer mobility and growth (*Canada Green Building Council, 2022, p.46; Lohse, R., & Zhivov, A., P.2*). Currently the

green building sector “employs almost twice as many full-time workers as the country’s oil and gas extraction, mining, and forestry sectors combined” (*Green Building Engine, P.3*). As the previous theme explored, regulations and standards are currently not consistently enforced across Canada. As these regulations become more commonplace and mandated, job creation will continue to grow.

Data Collection

Considering benefits beyond financials is a key part of the literature; however, arguably the most important benefit of deep retrofit work is emissions and energy use reductions. To realize this benefit municipalities must prioritize data collection and analysis. The necessity of data to deep retrofit work is evident throughout the literature. *Energy Management Best Practices Guide for Commercial and Institutional Buildings (2015)* states “simply put, you cannot manage what you do not measure” (P. 14). This measuring and analysis work is completed by the project team (*Natural Resources Canada, 2008b, P. 36*).

The literature provides a number of options for measuring deep energy retrofit work:

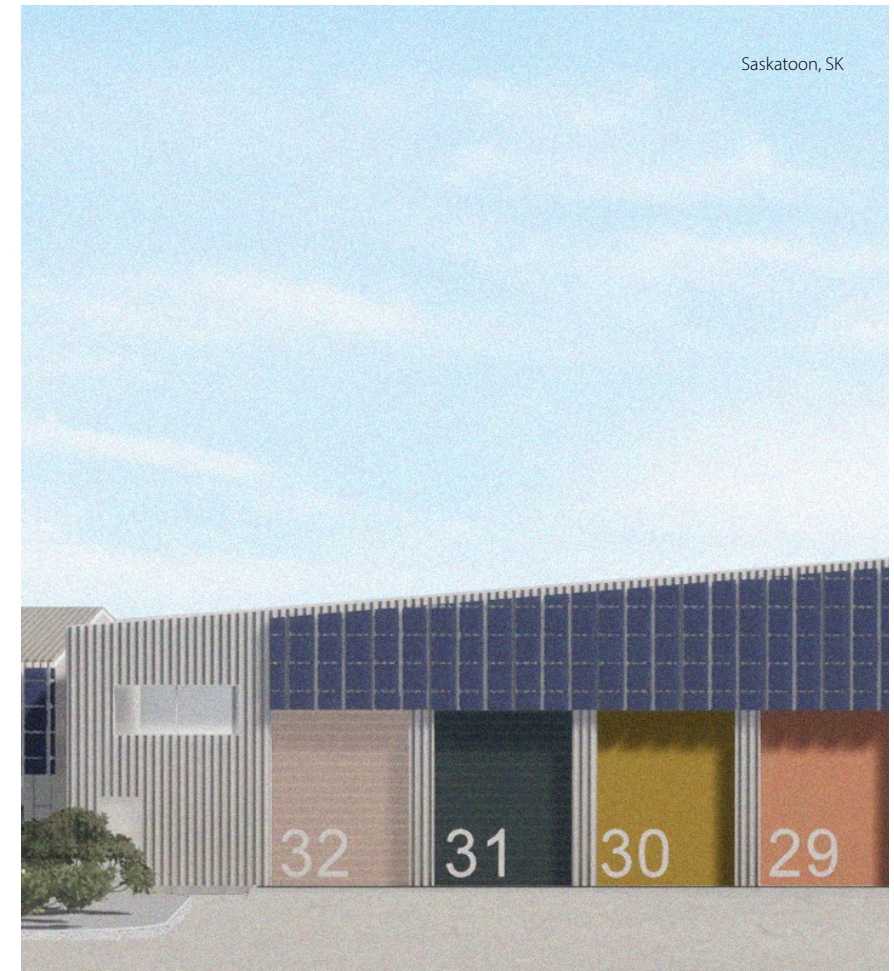
Baseline: Municipalities are able to use benchmarking to evaluate the baseline of building performance data to compare against its previous data (*Natural Resources Canada, 2008a, P.47*). Once this data is known, municipalities will be able to set targets and assess progress (*Natural Resources Canada, 2015, P. 14; Natural Resources Canada, 2004, P. 9; Natural Resources Canada, 2008b, P. 77*). This baseline will “provide an indication of the reduction goals that can be reasonably achieved” (*Building Owners and Managers Association (BOMA) of BC., 2022, P.9*).

External or Industry standards : Municipalities also have the option to benchmark their buildings against similar buildings. Normalized Performance Indicators or Energy Usage Index calculates the energy consumption by area, or in the case of healthcare facilities the building volume (*Natural Resources Canada, 2008a, P. 47; Natural Resources Canada, 2008b, P. 50; Natural Resources Canada, 2009, P. 12*). Both ASHRAE and Energy Star Ratings makes data available to municipalities to compare buildings in their portfolio against similar buildings across Canada. However, not all building types are included in these tools (*Natural Resources Canada. (n.d.)*).

Best Practices: Another tool with which to evaluate deep energy retrofit work is assessing best practices. *Energy Management Information Systems - A handbook for Managers, Engineers and Operational Staff (2004)* states that “the benchmark is a typical performance level achieved in the past; best practice is what could be achieved” (P. 16). Best practice is

achieved when “the best-known operational and equipment practices” are implemented (*Natural Resources Canada, 2008a, P. 37*).

Municipalities have the option to develop their own standards by which to assess progress, but this process can be difficult and costly (*Natural Resources Canada, 2008a, P. 47*). There are many resources about data collection, benchmarking, and auditing, and as more deep retrofits are implemented across the country, measurement and verification and secondary benchmarks will help to track best practices (*Natural Resources Canada, 2008b, P. 77*).



B: List of Experts Interviewed

Expert	Organisation
Amanda Christianson, P. ENG	Energy Manager, Halifax Regional Municipality
Andrea Linsky	Program Manager, Emissions Neutral Buildings, Alberta Eco Trust
Dave Braden	Retired City Councilor, Hamilton
Keith Burrows	Director, Low Carbon Buildings, The Atmospheric Fund
Levi Higgs	Energy and Sustainability Manager, Colliers
Liam Cooke	CEO, Navigate Energy
Myles Cornish	Performance Specialist II, Sustainable Infrastructure, Johnson Controls
Nathaniel Magder	Energy Solution Manager, Town of Oakville
Nick Valerio	Manager, Capital Projects, Town of Oakville
Omar Bhimji	Sustainability Services Manager, SES Consulting
Rachel Buskie	Program Manager, Capacity Development, Clean Energy Association
Rachel Mitchell	Senior Manager of Programs, Clean Foundation
Tami Rothery	Director, Built Environment Initiatives, Community Energy Association
Will Marshall, P. Eng, LEED AP, CMVP	Partner at LMMW Group Ltd. and Equilibrium Engineering

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