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Aggregation of energy retrofits in affordable housing

Opportunities and challenges in adapting the Energiesprong model in B.C.

by Tom-Pierre Frappé-Sénéclauze, Dylan Heerema, and David Bobyn | October 2017

Summary

The Dutch *Energiesprong* program has retrofitted over 2,000 dwellings to net-zero energy, with another 9,000 or so units contracted. This market development model brings together social housing providers, construction companies, regulators, and the financial sector to create retrofit products that meet the demands of an aggregated pool of buildings. B.C.'s affordable housing stock is in need of repairs, and thus offers an opportunity for such an aggregated approach. Over half of the stock was built before 1990, and most of the stock has a higher-than-average energy use intensity. Around 38,000 units of social housing apartments and townhouses were built before 2000; their average energy use intensity is almost twice the provincial average. Together, these apartments and townhouses use 2,700 terajoules (TJ) of energy per year and emit 50,000 to 70,000 tonnes of carbon dioxide equivalent (CO_2e) per year; accelerating their conversion to low-energy, low-carbon units offers significant opportunities for greenhouse gas (GHG) emission reductions.

We estimate that around 2,500 units could be pooled for a first offering, targeting the least efficient stock managed by the 10 largest societies and BC Housing. This could yield energy reductions on the order of 250,000 gigajoules per year (GJ/yr) and reduce GHG emissions by 7,000 to 10,000 tonnes of CO_2e/yr. Experience in the Netherlands has shown that continuous innovation over the delivery of this first wave of retrofits can reduce the cost of the retrofit solution and address pending regulatory and financial barriers. These innovations are necessary to enable uptake of the new retrofit solutions across the rest of the eligible social housing stock. There are also approximately 500,000 units of market rental apartments in B.C., which offer a long-term market for these solutions.

Several barriers currently hamper the business case for energy efficiency improvements in the affordable housing sector, including a lack of dedicated funds, the imminent expiry of operating agreements, and complications around the allocation of rent and energy costs between tenants and owners. Valuing maintenance and replacement savings plus other non-energy benefits can help improve the business case for deep retrofits.

Purpose

This briefing note assesses the potential for aggregation of retrofit projects in affordable housing in B.C. as a means to accelerate development of turnkey deep retrofits for low-rise wood-frame apartments and/or townhouses. This document summarizes:

- The scale and pace of retrofits needed to meet climate targets in B.C.
- The approach taken by the Dutch *Energiesprong* program, a model that could accelerate development of turnkey retrofit solutions in Canada
- The current composition of B.C.'s affordable housing stock, including types of affordable housing, building types, and vintage
- A first-order estimate of the number of social housing units that could be pooled in a first "bulk service" proposal, and of the potential resulting energy and GHG reductions
- Opportunities and challenges posed by the expiry of operating agreements between housing societies and the provincial government
- A review of how operations and maintenance costs and retrofits costs are currently shared between housing societies, tenants, and BC Housing, and regulatory constraints affecting capacity to recoup energy cost savings accrued by the tenant

Challenge: reducing building emissions 80–100% by 2050

Buildings are responsible for 11% of emissions in B.C. and 23% in Canada.[1] While efficiency targets have been set for new construction,[2] both the federal and provincial governments lack a comprehensive strategy to reduce emissions from existing buildings. Buildings that are standing today will account for roughly two-thirds of the building stock in 2030, and half of the 2050 stock.[3] Making new construction net-zero energy ready by 2032 should reduce B.C.'s 2050 emissions by around 1.5 Mt CO_2e. To meet economy-wide targets, another 3 to 4.5 Mt CO_2e of reductions will need to come from existing buildings — to yield an overall building sector reduction of 80% to 100%.[4]

To achieve such reductions, we need to retrofit roughly 3% of the building stock every year between now and 2050, and to achieve average emissions reductions of 60% in retrofitted buildings. We can get some of these reduced emissions through energy efficiency, but achieving this depth of savings will also require some fuel switching. As a rule of thumb, we

[1] Including emissions associated with the generation of electricity used in buildings.

[2] B.C. Climate Leadership Plan (2016): net-zero energy ready by 2032; Pan-Canadian Framework on Clean Growth and Climate Change (2016): net-zero energy ready by 2030.

[3] Based on building stock turnover modeling by Navius Research, quoted in: T.-P. Frappé-Sénéclauze, D. Heerema, and K. Tam Wu, *Deep emissions reduction in the existing building stock: Key elements of a retrofit strategy for B.C.* (Pembina Institute, 2017). http://www.pembina.org/pub/building-retrofits

[4] Ibid.

propose that we aim to electrify (convert to another low-carbon fuel source) half of retrofitted buildings, and target a minimum 25% emissions reduction from the other half.[5] We estimate that sustaining such retrofit rates in B.C. would require investments in the range of $750 million to $1 billion per year — an effort that would need to be sustained over the next three decades.

When considering these retrofit objectives, the **affordable housing sector** faces unique challenges:

- Over half of non-profit housing was built before 1990, and some of the stock is in poor condition. The BC Non-Profit Housing Association (BCNPHA) estimates the unfunded liability caused by deferred maintenance at over $400 million, slated to rise to $3 billion by 2028 if the funding gap is not closed.[6]
- Energy use intensity in non-profit housing is significantly higher than the B.C. residential average (309 vs. 222 kWh/m^2/yr).[7]
- Energy retrofits are only one of several priorities in a cash-strapped sector; other priorities include seismic upgrades, fire safety, accessibility improvements, mould remediation, and making more affordable housing units available.
- As mortgages are paid off, operating agreements between the provincial/federal government and housing societies are reaching the end of their terms; operating agreements on 29,000 units will expire by 2033. This provides an opportunity to refinance projects, but also may leave some societies struggling with deferred maintenance and operating budget shortfalls.

Opportunity: spur innovation by aggregating demand

Retrofit efforts in the Netherlands have shown that aggregating demand from a large number of dwellings can act as a catalyst to remove regulatory, financial, and technological barriers to deep retrofits and spur innovation to reduce costs, minimize disturbance, and increase value to residents. The Dutch *Energiesprong* program has retrofitted over 2,000 dwellings to net-zero energy standards, with another 9,000 or so units contracted. Installation times have been cut from two weeks to a few days, and costs reduced by 50%, over three years.

[5] By comparison, this is more than double the average GHG reductions achieved by LiveSmartBC/ecoEnergy participants (26% on average). The 3% retrofit rate is more than three times the average penetration rate achieved by these residential programs (6% of eligible B.C. stock retrofitted in seven years, not counting spill-over).

[6] According to building condition assessments (BCAs) completed by BC Housing on 95% of the non-profit housing sector with operating agreements. The BCAs review the condition of the building, maintenance needed, maintenance deferred, and the cost to replace. The unfunded liability is the amount of deferred maintenance. (Ian Cullis, BCNPHA, personal communication, July 2017)

[7] City Green Solutions for BC Non-Profit Housing Association, *Strategic Energy Management Plan* (2010).

We believe that such a model could be replicated in B.C. and lead to the development of turnkey deep retrofit products for social housing, rental market housing, and private housing. This is necessary to meet climate objectives, but also supports other social objectives. By addressing moisture and ventilation issues, energy retrofits can improve the health and comfort of tenants. By rejuvenating facades and interiors, retrofits can also increase pride and social cohesion, improving social outcomes and increasing collaboration between tenants and housing societies. A deep retrofit investment program would also generate significant employment: we estimate that meeting the 3% retrofit rate target in B.C. would generate $4–8 billion in economic growth and create 8,000 to 11,000 jobs (direct and induced).

To assess the opportunity for aggregation in B.C.'s social housing sector, we review characteristics of the affordable housing stock.

Composition of the affordable housing stock in B.C.

Based on data provided by BC Housing and BCNPHA, B.C. had 106,914 units of affordable housing in 2016, distributed across 150 communities. The non-profit sector is the largest provider of these units, with 622 societies of varying portfolio sizes providing 55,864 units of long-term affordable housing. The remaining 51,050 units are managed by BC Housing, a provincial Crown corporation, and are comprised of:

- 1,570 group home units
- 3,219 single room occupancies
- 221 strata units
- 39,065 rent supplements provided by BC Housing to private rentals
- 6,975 units of generic social housing directly owned and managed by BC Housing

Assuming that group homes, SROs, stratas, and rent supplements will be difficult to integrate in a first retrofit offering, a starting pool of 62,839 units (55,864 from societies + 6,975 from BC Housing) remains.[8]

It is easier to pool buildings for a bulk retrofit contract by working with societies that control large portfolios. The 10 largest societies, our most likely partners for a pilot, together operate 13,693 units within 273 buildings, constituting about a quarter (24.5%) of the non-profit building stock. Each of them manages 700 to 3,250 units in 8 to 57 buildings. Once a deep retrofit product has been developed and tested by these larger entities, it is easier for smaller organizations to procure the same product. This is key, because 91% of housing societies in B.C. are small, managing one to five buildings each (representing 56% of the total stock).

[8] Note: these numbers were provided directly by BC Housing and differ slightly with totals presented in figures below, which were created by the Pembina Institute based on spreadsheet data provided by BC Housing; the cause of the discrepancy is unknown but might simply reflect stock changes that occurred between the two analyses.

Building type

The majority of the affordable housing stock in B.C. consists of low-rise apartments (Figure 1); 38% of total units are low-rise apartments, 15% of units are townhouses, 9% are high-rises, and another 4% are single-family houses and duplexes.[9] The remaining 34% of units in B.C. affordable housing are single rooms, rent supplements, and other unique building types.

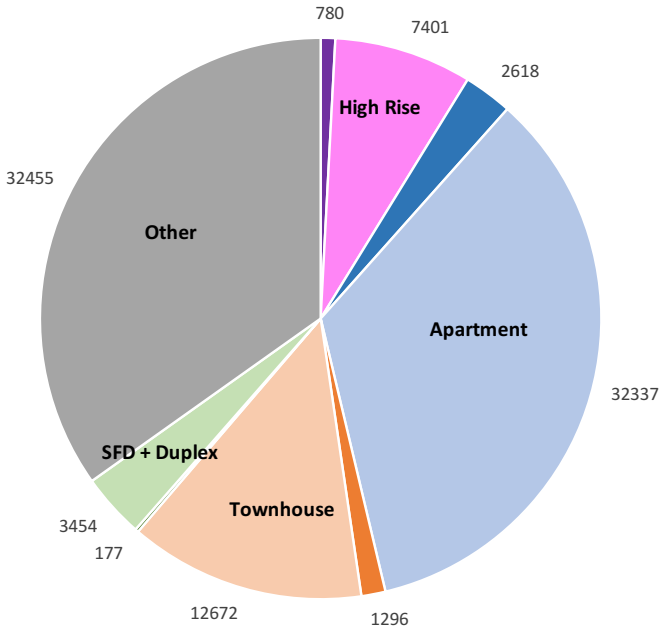

Figure 1. Number of dwellings in B.C. affordable housing stock, by building types

Note: Darker tones indicate stock owned by BC Housing, lighter tones by non-profit societies. "Other" includes single room occupancies, group homes, stratas, and market-rental rent supplements (for BC Housing data).

Building vintage

Figure 2 presents the vintage distribution of the stock. Much of the stock was built in the 1970s and 1980s, and this segment constitutes a prime selection for the pilot, as these buildings have relatively poor energy performance but are generally structurally sound and worth reinvesting in. In dense urban areas, the question of whether it is better to repair or demolish a building depends mostly on site density and land use, which are discussed further below.

[9] Some BCNPHA properties were labelled as "mixed types"; for simplicity, we allocated all the units on that site to one type of building: those properties with buildings greater than three storeys were assumed to be apartments (high-rise apartments were greater than five storeys), and those three storeys or less were assumed to be townhomes.

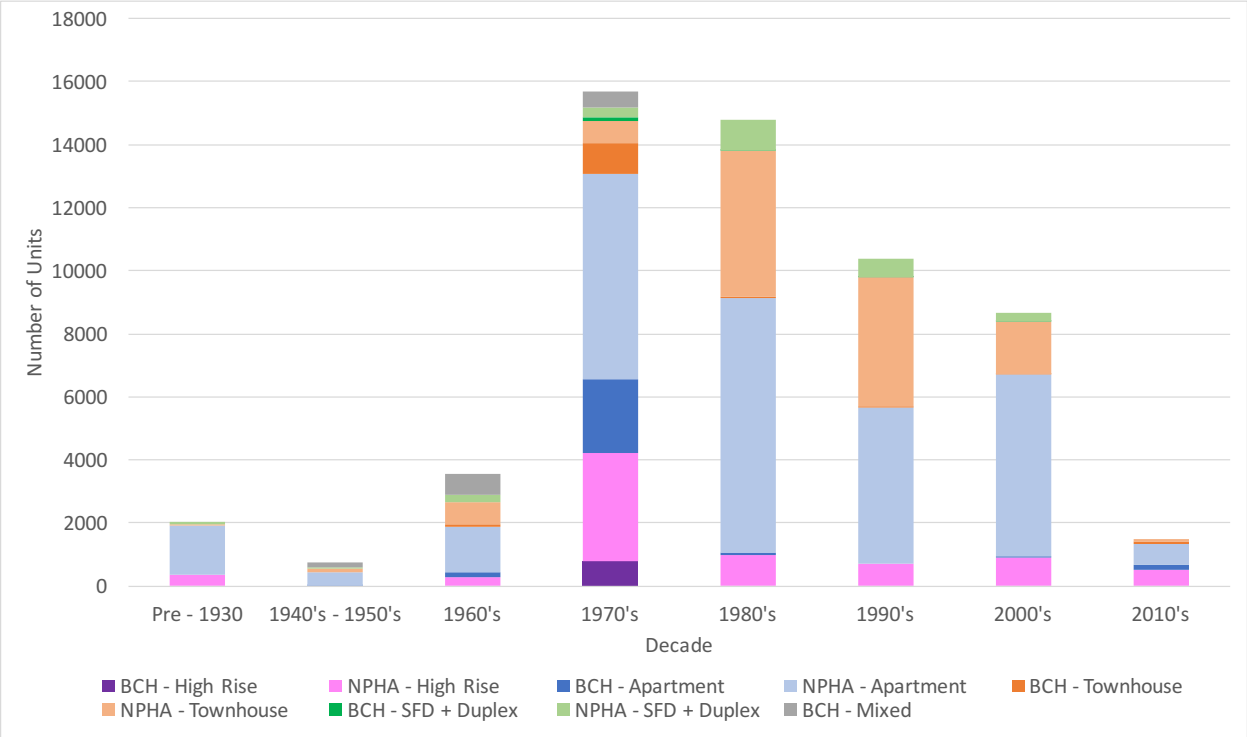

Figure 2. Vintage of buildings in BC Housing and non-profit housing stock

Note: Data does not include buildings with no year of construction listed, single rooms, rent supplements, and other unique building types.

Potential for aggregation

Of the approximately 100,000 units of social housing in B.C., how many units could be pooled in a first contractual offering? Once a scalable product is developed, what potential market would be available to service providers? Table 1 presents a breakdown of the number of social housing units by building type. Based on data provided by BCNPHA and BC Housing, there are 25,000 to 30,000 units of social housing in low-rise wood-frame apartments built before the year 2000. This gives us a sense of the potential social housing market for a solution appropriate to that building archetype. Depending on the solutions developed, an additional 8,500 units of townhouses could also be reached.

The total private market potential (outside of the affordable housing sector) is much larger than any of the above categories, with an estimated pre-2000 stock of about 500,000 apartment units and 150,000 townhouse units.[10] The private market is shown broken down by vintage in Figure 3.

[10] Assuming an average size of 800 ft² for apartments and 1,200 ft² for townhomes. Natural Resources Canada, "Survey of Household Energy Use 2011." http://www.nrcan.gc.ca/energy/efficiency/17097

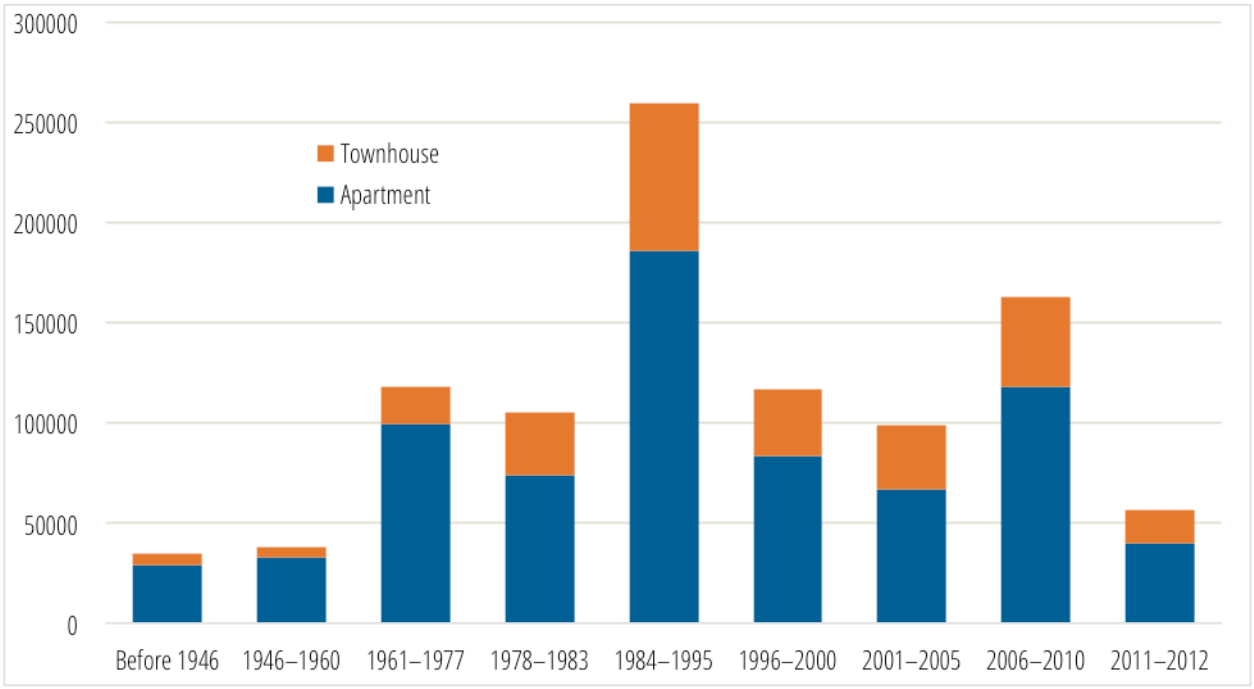

Figure 3. Estimated total apartment and townhouse units in B.C. by vintage

Data source: NRCan[11]

To provide an estimate of what could be offered in a first aggregation pilot, we look at the housing stock controlled by the 10 largest housing societies and BC Housing. Not all of these buildings will be suited to a pilot — either due to the type of occupancy, because they recently underwent some retrofits, or because these sites are likely to be redeveloped rather than upgraded. As a first order estimate, we assume that a quarter of these societies' portfolios could be incorporated in a first pilot. Selecting the top quartile of the most "energivore" buildings owned by the 10 largest societies and BC Housing gives us an estimated first offering potential of 3,031 apartment and 519 townhouse units, plus 574 mixed building type units (Table 1).

[11] "Survey of Household Energy Use 2011."Assuming an average size of 800 ft^2 for apartments and 1,200 ft^2 for townhomes.

Table 1. Market potential and pilot potential in affordable housing, by building type

Building type	BCNPHA		BC Housing		Market potential	Early adoption potential
	# units	# pre-2000 (A)	# units	# pre-2000 (B)	A+B	Pilot candidates[12]
High-rise	6,938	5,517	780	780	6,097	-
Apartment	31,309	22,231	2,618	2,575	24,806	3,031
Townhouse	8,428	7,415	1,296	1,093	8,508	519
Single-family house and duplex	3,454	2,182	177	187	2,369	-
Mixed (apartment + townhouse)	5,735	3,874	1,350	1,350	5,224	574
Total (all types)	55,864	41,219	6,221	5,985	47,004	4,124

Energy, cost, and GHG savings

Table 2 presents the estimated energy use, energy cost, and GHG emissions in pre-2000 affordable housing in B.C. Assuming that retrofits could be completed to net-zero energy and zero-carbon, these numbers also represent the maximum possible savings in the affordable housing market. A range is presented for possible GHG emissions from the non-profit housing sector because we did not have accurate data on the fuel type used in these buildings, and the data omits buildings for which energy use is not known. As a first order estimate, we assume that properties labeled as electrically heated consume no natural gas, and that other properties (including those without heating type reported) use natural gas for 50% to 80% of their total energy use.

The combined energy savings potential in pre-2000 affordable housing units is on the order of 2,700 TJ with possible GHG savings ranging from 50,000 to 70,000 tonnes of CO_2e. A pilot aiming to retrofit about 2,500 units in the least efficient apartment buildings from the 10 largest societies could yield energy reductions of the order of 250,000 GJ (annually) and reduce GHG emissions by 7,000 to 10,000 tonnes of CO_2e.

[12] Top quartile of EUI in apartment and townhouse stock of six largest owners and BC Housing.

Table 2. Annual energy use, cost, and GHG emissions in pre-2000 affordable housing units

Building type	BCNPHA[13]		BC Housing[14]			Early adoption potential[15]	
	Energy use (GJ)	GHGs[16] (t-CO_2e)	Energy use (GJ)	Energy cost ($M)	GHGs (t-CO_2e)	Energy use (GJ)[17]	GHGs (t-CO_2e)[18]
High-rise	352,635	4,500-7,200	34,260	0.5	1,185	-	-
Apartment	1,332,762	25,500-40,800	198,272	2.71	6,818	>286,417	7,800-10,900
Townhouse	553,344	5,500-8,800	91,237	1.06	3,461	61,094	2,100-2,500
Single-family house and duplex	142,807	3,000-4,900	9,128	0.12	303	-	-
Total	2,381,549	38,600-61,800	332,897	4.38	11,767	>347,512	10,000-13,400

Opportunities and challenges posed by the expiry of operating agreements

Across Canada, one of the most challenging issues facing non-profit housing societies is the expiration of operating agreements. Operating agreements set out the amount, duration, and conditions of subsidies provided to housing societies by the provincial and/or federal governments. Many pre-1986 agreements were with the Canada Mortgage and Housing Corporation (CMHC), but some pre-1986 and most post-1985 have been with provincial or territorial housing agencies. Agreements were structured to flow subsidy for as long as the mortgage was being repaid. Once the mortgage is fully repaid and this large expense disappears, it was assumed that projects would generate sufficient rental income, even with low rents, to cover remaining operating expenses.

Ontario is a unique case in Canada, having transferred the responsibility for housing subsidies from the provincial government to municipalities through a series of reforms started in 1998.

[13] For BCNPHA properties with a mix of building types, those properties with buildings greater than three storeys were assumed to be apartments (high-rise apartments were greater than five storeys), and those three storeys or less were assumed to be townhomes. Does not include buildings for which no floor area data is available.

[14] BC Housing properties with a mix of building types were assumed to be apartments.

[15] Top quartile of EUI in apartment and townhouse stock of 10 largest owners and BC Housing.

[16] Assuming that properties that reported electric-only BEPI data do not use natural gas, and other properties (including those without heating type reported) use natural gas ranging from 50–80% of their total energy use.

[17] Total building square footage, and thus total energy use, is not available for all properties.

[18] See footnote 15.

Municipalities also took over administration of federal subsidies, which were flowed through municipal service managers. Unlike other Canadian jurisdictions, these new agreements have no sunset clause; both the operating obligations of the provider and subsidy obligation of the municipality continue indefinitely. The federal portion of subsidy funds, however, terminates when the original mortgage is paid off, thus reducing the overall funding available to the service manager. [19]

In British Columbia, over 5,000 units will see their operating agreements expire by 2020, another 10,000 by 2025, and another 14,000 by 2033.[20]

The capacity of housing societies to take on new debt to finance energy retrofits greatly depends on their forecasted net operating income after the termination of operating agreements. An evaluation of single project portfolios in B.C. indicated that a third of projects will not be viable without corrective action.[21] Projects forecasting negative net operating income will need to identify new sources of revenues, which can include market rent adjustments, adjustments of rent-geared-to-income (RGI) mix or rates (at turnover), selling of assets, or repurposing underused space to commercial use. Research indicates that as a rule of thumb, projects with more than 65% RGI units are unlikely to be financially viable post-expiry. Projects operated by non-profits with small portfolios are also at higher risk, which includes the two-thirds of societies that operate a single project.[22]

Some non-profits that have faced expiry of their operating agreements undertook energy efficiency upgrades for major capital items to save costs in the long term.[23] Case studies with housing societies whose operating agreements expired showed that in most cases rents were increased after expiry.

The expiry of operating agreements presents both opportunities and risk to a pooled retrofit program. Housing societies are likely to attempt to complete as many capital repairs as they can under the current programs before they expire, which can lead to missed opportunities to combine deep retrofits with the needed capital repairs. On the other hand, nearing expiry can serve as a catalyst for asset management conversations, and the completion of mortgages opens up the possibility of refinancing to complete more holistic upgrades.

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[19] S. Pomeroy, *Addressing the Expiring Subsidy Challenge: Options and Remedies* (2012). Available at http://bcnpha.ca/wp_bcnpha/wp-content/uploads/2014/12/Addressing-the-Expiring-Subsidy-Challenge-GUIDE-FINAL-ENGLISH-DEC-REVISION.pdf

[20] BCNPHA and BC Housing, *Expiring Operating Agreements: A Planning Guide for BC's Non-Profit Housing Societies* (2017). http://bcnpha.ca/wp_bcnpha/wp-content/uploads/2014/12/EOA-2017.pdf

[21] BC Housing and BCNPHA, *Preparing for the expiry of operating agreements: November 2013 update*. http://bcnpha.ca/wp_bcnpha/wp-content/uploads/2014/12/EOA-newsletter-FINAL.pdf

[22] Ibid.

[23] Ibid.

Capturing utility costs savings

If additional energy retrofits are going to be financed based on savings, the energy cost savings must be recouped in a reliable way by the housing society (or other entity taking on the loan). For **subsidized housing,** the capacity of societies to recoup energy savings depends on the type of funding agreement. Under some operating agreements, energy costs are considered "uncontrolled expenses," meaning that the funding contributions of the province are adjusted to cover these costs. In these cases, any energy cost savings resulting from retrofits ultimately benefit the province rather than the society, as the subsidy to the society would be reduced in following years to reflect the lower operating costs. Thus, there is no net financial advantage for the society to undertake energy saving initiatives, and the savings could not be used to repay loans without changing the terms of the operation agreement. BC Housing's EERP and EEIP programs (see Appendix A) were designed to address this lack of incentive by providing alternate sources of funding for societies to invest in energy conservation activities. In other housing projects, operating agreements stipulate energy costs as fixed expenses, in which case the operating subsidies remain unchanged when retrofits reduce energy costs. Societies under these types of funding agreement keep their operating savings and thus could use them to underwrite loans.

For both subsidized and market-rate housing, tenants sometimes pay their own energy costs. The share of total energy use captured in suites versus common areas varies based on heating types, domestic hot water distribution system types, and rental agreements. In subsidized housing, the rent is tied to the income of the tenant (generally capped at 30% of income). However, an allowance for energy costs is often included in the maximum cost of housing. While these allowances are generally set in operating agreements, the case could be made for them to be reduced if the actual energy costs paid by tenants was expected to decrease; this would de facto allow the society to increase rent by an equivalent amount, thus allowing it to recoup at least a portion of the energy cost savings incurred by tenants. This is not, however, common practice currently.

After expiry of agreements, however, nothing obligates societies to maintain RGI levels. Raising rents of RGI units above a certain threshold could have consequences for the organization's tax-exempt status and could also be in breach of the purposes set out in the housing provider's constitution.[24] But if the overall cost of living is maintained, that shouldn't be a problem. Rent increases would also fall under the requirements of the provincial Residential Tenancy Branch.

[24] Bull Housser & Tupper LLP, *Briefing memorandum: Legal considerations and the expiry of operating agreements* (2016). Available at http://bcnpha.ca/wp_bcnpha/wp-content/uploads/2014/12/bcnpha-cityspaces-legal-brief-revised-final-may-2016.pdf

The rules for **non-subsidized** affordable housing (for example, co-ops) are different. The only practical way for the owner to recoup energy cost savings incurred by the tenant would be to increase rent by an equivalent amount. For non-subsidized housing, rent increases are regulated by the Residential Tenancy Act and limited to 2% of the current rent, plus inflation. A landlord who desires to increase a tenant's rent by more than the amount of the allowed annual rent increase can ask the tenant to agree to this increase. Thus, societies operating non-subsidized housing would need to make the case with tenants for such increases to secure project financing, which is a significant hurdle. There are a few cases where the landlord can go to arbitration to request an additional rent increase, but these do not include energy efficiency investments, even if they maintain total cost of living.

Consequently, there is currently no straightforward way to increase rental rates in market-rate units to cover the cost of an energy plan without written consent of tenants.[25] Regulatory change would be needed to enable rent increases that maintain total cost of living. Alternatively, energy savings could be recouped via the utility by continuing to bill tenants based on historical energy use and funnelling the energy savings to repay the loan via the utility. This is the basic premise of the Metered Energy Efficiency Transaction Structure (MEETS) model, which could be adapted to this situation.[26] However, this would still require permission from the tenant, and a significant change in billing structure for the utility.

Conclusion

Aggregating demand from a large number of dwellings can act as a catalyst to remove barriers to deep retrofits and trigger innovation to reduce costs, minimize disturbance, and increase value to residents. B.C.'s affordable housing stock, over half of which was built before 1990, and which uses significantly more energy than the provincial average, is an excellent candidate market for introducing the aggregated retrofit model. The relatively poor business case for deep energy retrofits in B.C. is partly the result of low energy prices, but is also influenced by a typically bespoke, craftsman approach to retrofit projects. An aggregated approach can take advantage of economies of scale and innovative technologies that could reduce costs.

Up to 2,700 TJ of energy savings and 74,000 tonnes of CO_2 reductions could be realized by retrofitting all of the affordable housing stock in B.C. built before the year 2000. Should the

[25] In Ontario, landlord can apply to the Landlord and Tenant Board to request a rent increase for justified capital expenses, which includes energy retrofits. The increase is however capped at 3% above rent increase guidelines until the capital expense is repaid, for a maximum of three years. Similar to B.C., this does not apply to affordable housing, which follows different rules. See: Ontario Landlord and Tenant Board, *Information About Applications for a Rent Increase Above the Guideline* (2015), 8. Available at http://www.sjto.gov.on.ca/documents/ltb/Brochures/Information about AGI Applications (EN) Revised_Bill140_June15_2015.pdf

[26] Meets Accelerator Coalition, "How MEETS Works." http://www.meetscoalition.org/how-meets-works/

model prove successful and the supply chain respond to this demand, the total potential for energy and emissions reductions in the private market is 15–20 times larger.

More than half (53%) of total units in B.C. affordable housing are either low-rise apartments or townhomes. Many of these buildings were constructed in the 1970s and ’80s, and appear to be prime candidates for an energy performance pilot project to test an aggregated manufacturing approach. There are around 38,500 such apartment and townhouse units across the province, using approximately 2,200 TJ of energy and emitting up to 60,000 tonnes of CO_2e. We estimate the market rental portfolio to include another 500,000 apartment units, providing industry meaningful opportunities for market expansion beyond the social housing sector.

A first round of early adopter buildings could be constituted by pooling the least efficient apartment buildings operated by the largest and most capable housing providers; we estimate that around 2,500 units could be pooled for a first offering from the stock managed by the 10 largest societies and BC Housing. These retrofits could yield energy reductions on the order of 250,000 GJ/yr and reduce GHG emissions by 7,000 to 10,000 tonnes of CO_2e/yr.

There are a few barriers to financing these retrofits based on energy savings. Some operating agreements treat energy expenditures as uncontrolled expenses; these costs are covered by BC Housing and costs savings resulting from retrofits would be clawed back. These agreements would need to change to enable societies to finance the project. Recouping energy savings accrued by tenants is an issue for both subsidized and market housing. For rent-geared-to-income units, this could be done by re-evaluating the utility allowance assigned to tenants. For market housing, increasing the rent beyond the maximal set by the Residential Tenancy Act would require written permission from the tenant. To facilitate investment in energy efficiency, the Act could be changed to allow rent increases that do not increase the total cost of tenancy (rent + utilities).

There is a clear need to consider the value of other benefits to building owners and tenants, such as reduced maintenance and replacement costs, as well as lower tenant relocation costs (due to prefabrication) or reduced health care costs (due to improved air quality). Valuing these non-energy benefits can improve the business and/or social case for investing in deep retrofits for both the affordable housing sector and the private market.

Appendix A: Available sources of retrofit funding

1. **Reserve funds:** Managed by housing societies, reserve funds are meant to cover maintenance and equipment replacements (paint, flooring, boilers/furnaces, etc.). The average amount allocated annually tends to be between $60 and $72 per unit per month. Reserve funds in many housing societies are over-extended. Societies with operating agreements that treat energy costs as variable costs have a disincentive to invest their reserve funds in energy efficiency projects because their operations and maintenance transfers are reduced following an energy retrofit.
2. **BC Housing capital improvement funding pools (e.g. Modernization and Improvement Fund):** These funds fluctuate with changing provincial budgets, and wait lists are long. Policies prioritize replacement of like-with-like, limiting opportunities for improving the performance of components when they are replaced at end of life.
3. **Dedicated energy efficiency funding pools:**
    a. *Energy Efficiency Retrofit Program (EERP)*: Incentives target small-scale projects with short-term payoff for societies with approved operating agreements. Developments receiving subsidies from BC Housing based on an approved operating budget may be eligible for a rebate equivalent to the net present value of the expected savings up to the total incremental cost of the project.[27] Developments that do not receive an operating subsidy, or that have a fixed subsidy, are eligible for 50% of costs for small lighting projects. (No grants are currently available for gas reduction projects.)
    b. *Energy Efficiency Incentive Program (pilot*): BC Housing gives a grant covering the cost of interest for up to 10 years to allow societies to undertake energy retrofits. This is intended for societies without operating agreements or for which energy costs are a fixed transfer. It will generally be used to complete boiler and lighting retrofits, as energy conservation measures must have a positive net present value over a 10-year horizon (with a 5% discount rate).

[27] BC Housing, *Energy Efficiency Retrofit Program Funding Guide* (2015), 5. https://www.bchousing.org/partner-services/asset-management-redevelopment/energy-efficiency-retrofit-program

Appendix B: Energy use and carbon emission intensity

Pre-2000 affordable housing market

Table 3. Energy use and GHG intensity of pre-2000 affordable housing, by building type[28]

Building Type	BCNPHA[29]			BC Housing[30]		
EUI (kWh/m^2/yr)	Average	Upper quartile	Max value	Average	Upper quartile	Max value
High-rise	383	440	1,728	227	238	242
Apartment	296	377	1,179	164	216	282
Townhouse	180	191	1,106	168	179	339
SFD + duplex	262	362	1,812	82	122	185
Total (all types)	259	370	1,812	161	209	339
	BC NPHA[31]			BC Housing[32]		
GHGI (kg/m^2/yr)	Average	Upper quartile	Max value	Average	Upper quartile	Max value
High-rise	20-32	34-54	155-248	29	30	32
Apartment	18-29	34-54	106-169	17	28	39
Townhouse	7-11	14-22	99-159	23	35	52
SFD + duplex	21-33	32-52	163-260	9	18	27
Total (all types)	16-25	31-49	163-260	19	28	52

[28] Averages and quartiles are defined by housing site, not by units.

[29] For BCNPHA properties with a mix of building types, those properties with buildings greater than three storeys were assumed to be apartments (high-rise apartments were greater than five storeys), and those three storeys or less were assumed to be townhomes. This should be considered a first approximation. For buildings without a listed EUI, average values for each building type were applied as per City Green's *Strategic Energy Management Plan*.

[30] BC Housing properties with a mix of building types were assumed to be apartments. 2016 utility data was used except for townhouses, which uses more complete 2011 utility data due to confidentiality issues in the 2016 data. This should be considered a first approximation.

[31] Assuming that properties that reported electric-only BEPI data do not use natural gas, and other properties (including those without heating type reported) use natural gas ranging from 50%–80% of their total energy use.

[32] As reported by BC Housing.

Early adoption market

Table 4. Energy use and GHG intensity of early adoption market, by building type

Building type	Early adoption market (upper quartile of EUI in stock of six largest owners + BC Housing)		
EUI (kWh/m^2/yr)	Average	Upper quartile	Max value
Apartment	420	433	1,158
Townhouse	388	360	963
Total (all types)	416	423	1,158
GHGI (kg/m^2/yr)	Average	Upper quartile	Max value
Apartment	37-57	39-63	104-166
Townhouse	43-55	48-52	86-138
Total (all types)	38-56	42-61	104-166