CLIMATE CHANGE AND HOUSING AFFORDABILITY IN CANADA

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Abstract

Climate change is perhaps the biggest challenge that our society faces in the 21st century. Canada and the world must take significant steps to reduce the greenhouse gas (GHG) emissions that are responsible for climate change. The building sector in Canada represents 17% of our GHG emissions (Government of Canada, 2018a). To dramatically reduce these emissions, new buildings will need to be built to Net Zero Ready standards and existing buildings will need to undergo significant energy efficiency retrofits and fuel switching to clean electricity. This paper will focus on Canada’s existing residential buildings which can enjoy many co-benefits from energy efficiency retrofits, as well as many barriers, including the high upfront investments required. Consequently, many tools have been developed to encourage residential retrofits, including changes to building codes, regulations and labelling, financial incentives, low interest loans, informational programs, energy use disclosure agreements, and carbon pricing.

A particular challenge for reducing the GHG emissions from Canada’s housing stock is in applying the necessary measures to the 17% of homeowners, and 40% of renters who already struggle to afford housing (Statistics Canada, 2019a). Energy Savings Performance Agreements (ESPA), wherein retrofits are paid for through loans that are repaid through energy savings (Hughes, S et al., 2018), are presented as a successful model program for social housing in Toronto. Energy disclosure agreements are proposed as a partial solution to the principal-agent problem wherein the agent of energy retrofits (the landlord) has no incentive to carry out those renovations when it is the principal (tenant) who reaps the resulting utility bill savings (Barton, 2018). Finally, for low income homeowners, revenues from carbon pricing can be used to finance retrofit measures, as has been done in the Nova Scotia HomeWarming program (Home Warming, 2019).

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Introduction

Climate change is perhaps the biggest challenge that our society faces in the 21st century. While all sectors of Canadian society will need to drastically reduce their greenhouse gas (GHG) emissions to decarbonize, this work will focus on the residential building sector. Three research questions will be explored here: what are the challenges associated with decarbonizing the residential building sector; what types of programs could be used to encourage this decarbonisation in residential buildings; and how can residential buildings decarbonize without reducing housing affordability for households who already struggle to pay for housing?

Decarbonizing the residential sector

Canada's greenhouse gas emissions

Canada emitted 704 megatonnes of CO_2 equivalents in 2016, 603 Mt CO_2 equivalents in 1990 and 732 Mt CO_2 equivalents in 2005 (Government of Canada, 2018a). Despite many

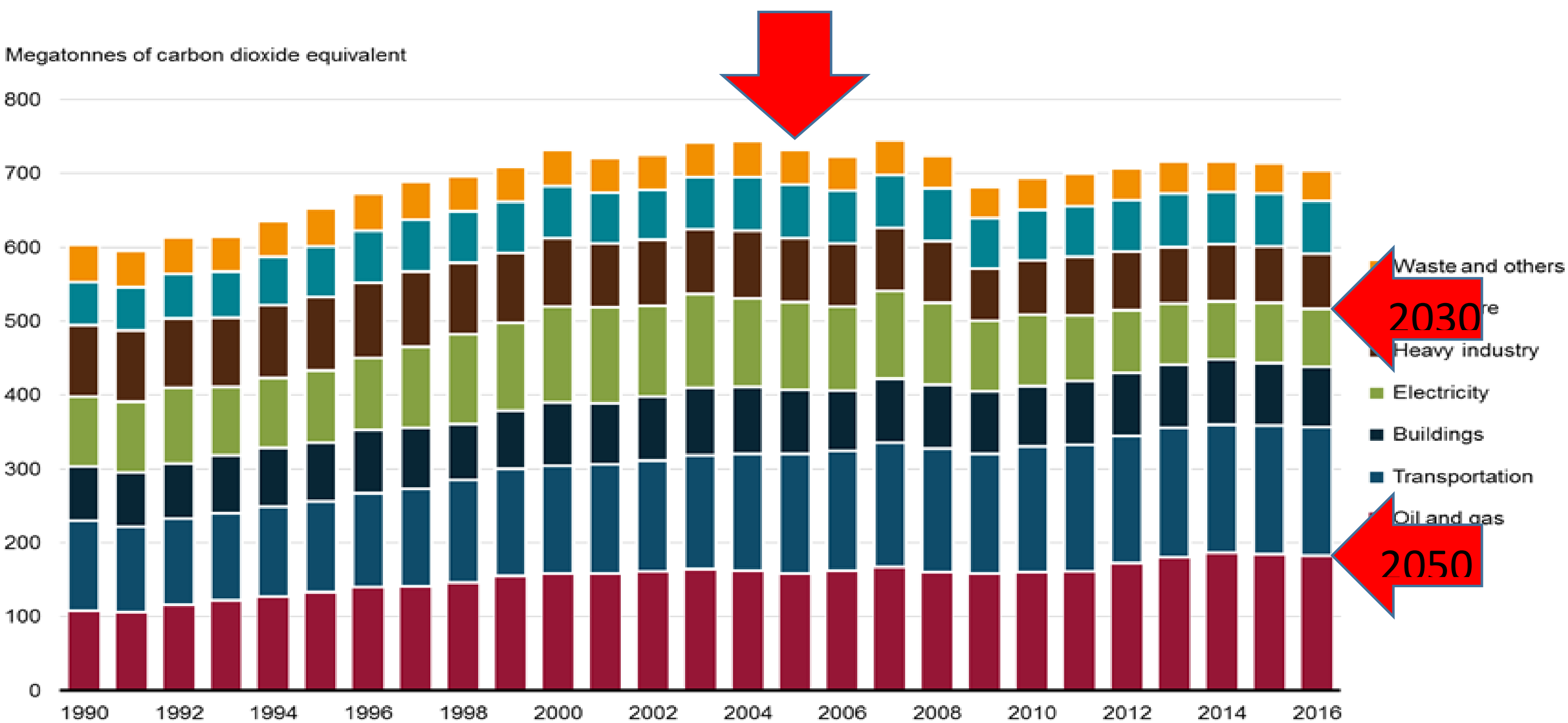

FIGURE 1: MEGATONNES OF CARBON DIOXIDE EQUIVALENTS EMITTED BY CANADA BY YEAR. SOURCED FROM (GOVERNMENT OF CANADA, 2018A).

international commitment, Canada's emissions are dropping slowly at best. At the 2015 Paris Summit, Canada agreed to work toward keeping average global temperature rise well below 2°C since pre-industrial times and preferably less than a 1.5°C temperature rise (Government of Canada, 2016b). Canada must therefore reduce its emissions by at least 80% below 2005 levels by 2050. It has set an interim goal of 30% below 2005 levels by 2030 (Government of Canada, 2016a). However, the IPCC (Intergovernmental Panel on Climate Change) recommends that we should be aiming for a 45% reduction by 2030, and near zero emissions by 2050 (IPCC, 2018).

Canada reports its GHG emissions in seven sectors: oil and gas industry, transportation, buildings, electricity, heavy industry, agriculture, and waste plus other. The building sector represented 12% of emissions in 2016. If emissions associated with the electricity used in buildings is added to the heating and cooling emissions, buildings account for 17% of all emissions. Current projections show that emissions from the building sector are likely to increase between now and 2030 unless significant measures are taken (Government of Canada, 2018a).

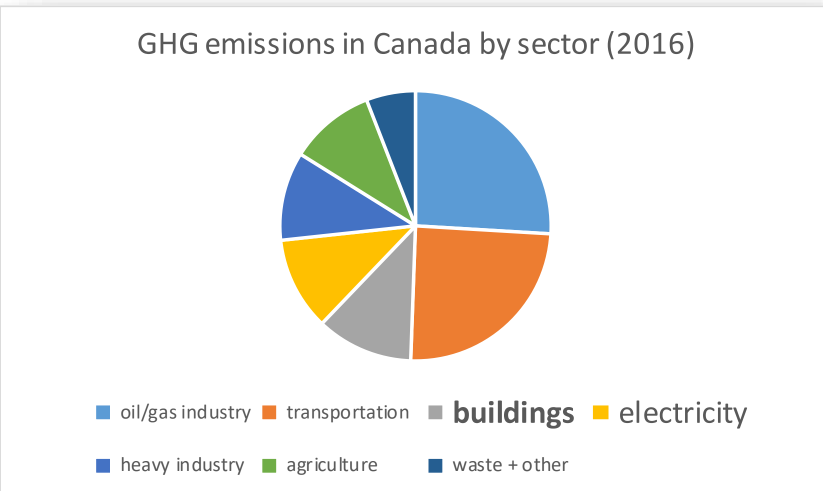

FIGURE 2: GHG EMISSIONS BY SECTOR IN CANADA. SOURCED FROM (GOVERNMENT OF CANADA, 2018A).

Sources of GHG in buildings

There are direct and indirect sources of greenhouse gases for the built environment. Direct sources of emissions are primarily from heating fuel and to a lesser degree from leaks from refrigerators and air conditioners. Space and water heaters are often powered by fossil fuels including natural gas, heating oil, wood, coal and propane. These produce greenhouse gases directly when burned to generate heat. Air conditioners and refrigerators also contribute directly to emissions as they can leak HFC and HCFC (hydrofluorocarbons and hydrochlorofluorocarbons). When HFCs and HCFCs leak, they can enter the atmosphere where they are thousands to tens of thousands of times more powerful at trapping heat than carbon dioxide (Environmental Protection Agency, 2019). HFCs and HCFCs are being phased out of production and their replacements have lower global warming potential, but most existing cooling appliances still contain HFCs and HCFCs. Meanwhile, indirect sources of greenhouse gas emissions include those released when fossil fuels are burned to generate electricity and the emissions associated with the manufacture, transportation and breakdown of building materials: the embodied energy. This paper will focus on emissions associated with space and water heaters.

How to decarbonize residential buildings

A commonly recommended strategy for decarbonizing buildings is a three step process (Hillebrandt et al., 2015). First buildings should reduce their energy needs by increasing their energy efficiency. This can be accomplished by sealing air leaks, improving the insulation, and choosing energy efficient lighting and appliances, or by designing new buildings to tough energy efficiency standards. Step two is to clean up the electric grid by switching to renewables and nuclear[1]. This step is largely accomplished in Ontario where most power comes from hydroelectricity and nuclear power: only 9.3% of Ontario's electricity is generated from carbon-emitting natural gas (Natural Resources Canada, 2018a). In the final step, buildings should electrify everything, including space and water heating.

Once the electricity supply is largely decarbonized, it may be tempting to encourage buildings to rapidly reduce their carbon footprint by skipping energy efficiency retrofits and going straight to electrification. This would involve switching to electric heat sources: hot water heaters, stoves, and heat pumps or electric radiators. Since heating alone accounts for 62% of total energy consumption in Canadian residences (Yip & Richman, 2015), and natural gas is the primary heating energy source, fuel switching to electricity would likely achieve the

[1] Note: The use of nuclear power is controversial due to the unresolved problems with safe disposal of nuclear waste and the high financial and environmental costs to build and refurbish nuclear power plants.

decarbonisation goals. However, one MJ of heat from electricity is currently more than five times more expensive than the same amount of heat from natural gas (Heather McDiarmid calculations). Even an air source heat pump capable of an average 300% efficiency would cost substantially more to operate than a gas furnace[2]. Furthermore, electricity prices are likely to rise as we decarbonize the grid, decentralize energy production, and add new generating capacity. Fuel switching without first making significant improvement in energy efficiency is likely to be far more expensive in the long term. This is particularly true for the least energy efficient buildings which may be disproportionately occupied by low income households (Lee, Kung, & Owen, 2011). If Canada is to decarbonize its buildings without creating greater social and financial inequality, it must ensure that significant energy efficiency measures are applied to buildings before fuel switching.

Decarbonizing new buildings

Studies have shown that constructing new buildings to high energy efficiency standards can be done with only small increases in construction costs which are rapidly offset by significant operational savings. Standards for new home building efficiency are emerging, with LEED (leadership in energy and environmental design), PassiveHouse, and Net Zero Energy (NZE) being among the most common standards in Canada (Canada Green Building Council, 2018). LEED buildings meet sustainability standards including siting, transportation associated with building use, energy and water efficiency, material use, and indoor environmental quality. PassiveHouse buildings meet tough benchmarks for space heating demand, overall energy use, and air tightness. Net Zero Energy buildings are designed such that the annual average renewable energy generated onsite is equal to the total energy used by the buildings. These NZE buildings are not typically off-grid homes but rather very high energy efficiency homes that feed in as much on-site renewable energy as they consume from all utilities. Net Zero Ready buildings are built to be sufficiently energy efficient that total energy use could be met with onsite renewable energy. The high cost of solar photovoltaics is often the barrier to converting a Net Zero Ready building to a Net Zero Energy one (Zero energy building, 2018). The Federal

[2] Heat pumps move heat energy rather than making heat energy and can therefore be more than 100% efficient.

government is working with the provinces and territories to develop a Net Zero Ready building code for adoption by 2030 (Government of Canada, 2018b).

Decarbonizing existing buildings through retrofits

It is projected that 75% of buildings that will exist in Canada in 2030 are already built (National Research Council, 2017). These buildings will therefore need to be retrofitted to improve their energy efficiency. There are two general levels of energy efficiency retrofits. A simple, lower cost retrofit would involve measures such as sealing air leaks, adding insulation to accessible areas (usually the attic or unfinished basements), replacing lightbulbs, using a programmable thermostat, and upgrading appliances to more energy efficient versions. Such retrofits would generally cost hundreds to thousands of dollars and have payback periods under ten years (Heather McDiarmid calculations). The emissions reductions from such retrofits alone are likely insufficient to meet our energy efficiency and carbon reduction targets (Henderson, 2013). A deep energy retrofit, however, would involve the above measures plus the addition of insulation to attics, walls, and foundations; upgrading water and space heating equipment; and possibly replacing windows and doors. A deep energy retrofit of a residential home would generally cost tens of thousands of dollars and have much longer payback periods at current energy prices. A meta-analysis of 116 deep energy retrofits in the US found the average retrofit cost to be $40,000 with an economic payback period of thirty years or less (Less, 2014). While these costs are high, they are comparable in size to major renovation costs and provide important co-benefits (see section below) (Less, 2014). Emissions reductions to Net Zero Ready levels are technically possible with deep energy retrofits of some homes (Henderson, 2013). The Canadian government, in partnership with the provinces and territories plans to have new energy efficiency code or requirement for existing homes by 2022 (National Research Council, 2017).

Co-benefits of energy efficiency retrofits

Energy efficiency improvements can bring a multitude of co-benefits for the occupants and society: employment; improved indoor air quality and associated health benefits; increased comfort; increased property value; improved energy affordability; lower maintenance; and increased resilience of buildings to climate change impacts (Golubchikov & Deda, 2012; Less & Walker, 2015). For example, poor indoor air quality associated with bad ventilation, condensation, and mould can contribute to cardiovascular disease and respiratory health problems (Lee et al., 2011). Energy efficiency upgrades can improve these air quality issues. Estimates put the non-energy value of residential retrofits at 50% to 300% of the utility bill savings (Less & Walker, 2015). Indeed, many homeowners are motivated to carry out energy efficiency retrofits for reasons other than its cost-effectiveness in terms of utility bill savings (Less & Walker, 2015).

Barriers to retrofit adoption

Over the past decades, there have been numerous energy retrofit incentive programs in Canada and around the world, but uptake has been very poor. The major barriers to implementation include affordability, lack of knowledge or expertise, and low priority for energy efficiency (Golubchikov & Deda, 2012; Parker, Rowlands, & Scott, 2003). Affordability can be challenging due to the upfront investments required to significantly reduce the energy needs of a home, the longer payback periods for many retrofits, split incentives for upgrades (see Rental Housing section), and government energy subsidies that negate some of the utility cost savings (Golubchikov & Deda, 2012). Furthermore, homeowners and landlords are often unaware of the financial and other benefits of energy efficiency upgrades and they may lack access to necessary technical information or skilled tradespersons. Similarly, retrofit programs operating through utilities and other commercial enterprises may engender homeowner distrust due to a perceived vested interest (Parker et al., 2003). Finally, energy efficiency retrofits may be a low priority for homeowners who are looking to make improvements to their home. Kitchen renovations are considered more sexy than insulation upgrades (Henderson, 2013), and may add more to the resale value of the home. Furthermore, deep energy retrofits can be time consuming, messy, and very disruptive.

Tools for encouraging retrofits

There are many tools that have been used to encourage energy efficiency retrofits in Canada. Education and informational campaigns can raise awareness of the financial and other benefits of retrofits. Three general strategies that can be used to encourage retrofits are through policy, education, and financial incentives. Policies that have been proposed include changing the building codes, energy efficiency regulations, energy disclosure agreements, and carbon trading. Finally, financial incentives include direct financial investments and low interest loans.

Informational programs

Raising awareness of the value of energy efficiency measures is a recognized way to improve retrofit implementation, and can be applied to both the rental and the resale market (Barton, 2014). Few homeowners and landlords are knowledgeable about how much energy they use and what it is used for (National Electrical Manufacturers Association, 2017). They are therefore unlikely to understand how energy efficiency measures can benefit their pocketbooks and provide other co-benefits (see co-benefits section). Homebuyers and renters may also not consider operational costs when choosing a new home or appliance. Education and awareness campaigns combined with rating systems (see energy efficiency regulations) allow consumers to make better energy efficiency choices. This information can guide prospective buyers or renters in choosing buildings with lower energy costs and incentivize sellers and landlords to improve their ratings.

Building codes

Building codes are rules that regulate the construction and renovation of buildings. In Canada, model building codes are developed by the federal government. Some provinces and territories use the federal code, while other use the federal code as a basis for their own codes. In some cases, municipalities have been allowed to write building codes (wikipedia, 2019). Energy efficiency standards are therefore different across the country.

The Pan-Canadian Framework on Clean Growth and Climate Change recommends building codes require increased energy efficiency for new buildings, with Net Zero Ready being the target standard by 2030 (Government of Canada, 2019). Early research estimates that a Net Zero Ready building code would add $13,500 to the cost of a new home (Galvez & MacDonald, 2018).

A new energy retrofit code for existing buildings is to be developed by 2022 for adoption across Canada in 2030[3] (Galvez & MacDonald, 2018). This code is likely to account for the age of the home, with newer homes having higher energy efficiency targets than older homes. The code may also include climate resilience considerations such as flood prevention measures. This retrofit code would appear to apply when renovations are being made to existing homes. However, it has been proposed that low-performing buildings could be required to undergo energy efficiency retrofits once energy reporting has been implemented (Galvez & MacDonald, 2018).

Energy efficiency regulation and labelling

Energy efficiency standards and regulations already apply to appliances, furnaces and electrical devices such as water heaters, electronics, lighting and air conditioning units. These standards are becoming more stringent (National Research Council, 2017), but only apply to new products.

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[3] This is a measure proposed by the federal government and is therefore subject to change following elections or with changing priorities. I have been unable to find any updates on this measure since the Senate report published in 2018.

Many Canadians are familiar with the EnerGuide label that rates a product's energy performance relative to other similar products. An EnerGuide energy performance rating and labelling system exists for houses and is used by many incentive programs to quantify retrofit performance (see example to the right). The rating is based on the home's insulation, air leakage, heat system, and other parameters (Natural Resources Canada, 2018b). The Pan-Canadian Framework recommended that all housing be rated and labelled prior to sale or rental to better inform buyers and renters of operational costs of the dwellings (Government of Canada, 2019). The federal government had plans to mandate EnerGuide labeling of existing housing when placed on the market by 2019 but this plan has been abandoned (Reep Green Solutions, personal communication). Such ratings could eventually become mandatory and form the basis for requiring energy retrofits to low performing buildings.

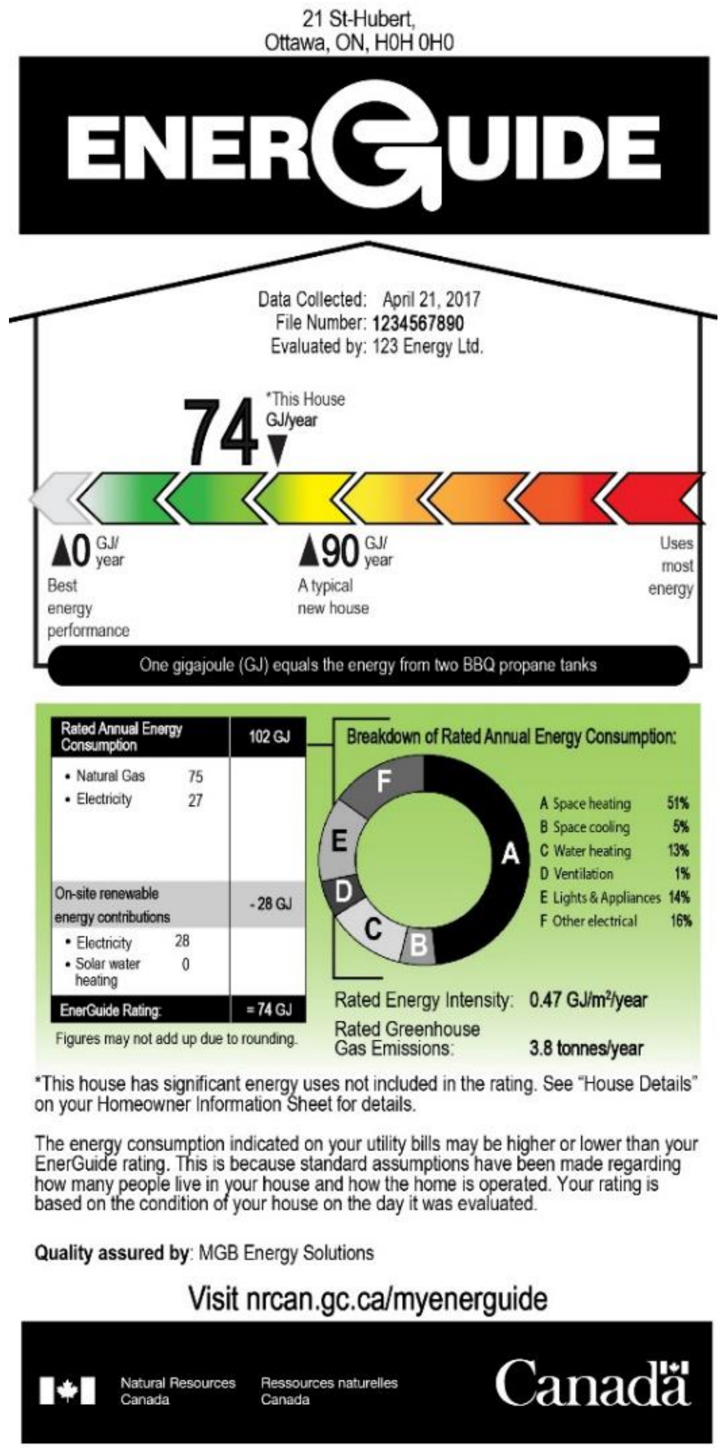

FIGURE 3: SAMPLE ENERGUIDE LABEL. SOURCED FROM (NATURAL RESOURCES CANADA, 2018B).

Energy use disclosure agreements

Energy use and energy rating disclosure agreements can be used to stimulate energy efficiency actions. These agreements, also called benchmarking, are typically applied to large public, commercial, and multi-residential buildings and require operators to publicly post energy ratings or energy use information. Tenants, building operators, and owners can then compare energy use in buildings of comparable characteristics. This helps to increase the perceived value in energy efficiency measures such as operational changes, equipment investments, and encourage behavioural training (Hughes, P. & Wilcox, 2017). Furthermore, rating systems such as the Energy Performance Certificates could also be used to develop minimum quality standards related to energy efficiency (Barton, 2014). By raising the standards on minimum energy efficiency, property owners could be forced to implement efficiency improvements in their units.

Carbon pricing

The Federal government has promised to impose a revenue-neutral carbon tax on any province that does not have a comparable carbon trading or taxation policy in place by 2019 (Wikipedia, 2019a). While there have been delays, and the future of the policy is uncertain, carbon pricing schemes have the potential to drive energy efficiency retrofits. For example, as the cost of carbon-emitting fuels rises due to carbon pricing, the payback periods for energy retrofits will shorten. Furthermore, utility companies may play a larger role in encouraging energy upgrades as they either face emissions caps (eg natural gas utility) or offer carbon credits (eg hydro electricity utilities). In addition, utilities have the ability to make bulk purchases of energy efficiency products thereby driving down the cost to the end user. They also have regular contact with their clients, have information about their energy consumption, and are well situated to assess potential efficiency measures (Gerarden,). Utilities could then sell carbon credits for the emission reductions from retrofit improvements aggregated together, using that money to help offset the cost of the retrofits[4] (Gerarden,). The technical difficulties in quantifying GHG emissions reductions from building retrofits will have to be addressed, however, if this is to become feasible (Hughes, S., Yordi, & Besco, 2018).

[4] Emissions reductions for single homes would be too small for emissions trading. By offering energy retrofit incentives, utilities can aggregate emission reductions for carbon trading and recoup the cost of the incentive program.

Electricity demand is expected to rise in the future due to economic growth and electrification of many processes traditionally fueled by fossil fuels, including heating and transportation. By increasing the energy efficiency of buildings, electrical utilities can reduce the need to build new power plants (Gerarden,). Furthermore, government revenues from carbon pricing can be used to fund energy efficiency retrofit incentive programs (Lee et al., 2011). If carbon pricing survives the next federal election in Canada, I would expect to see a growing number of programs using the resulting revenues to incentivize energy retrofits.

Direct financial investments

The Canadian government has operated several successful retrofit incentive programs. The ecoENERGY program, for example, provided over 600,000 grants of up to $5,000 for home energy retrofits between 2007 and 2012 (Galvez & MacDonald, 2018). The program applied to both houses (detached, semi-detached and row housing) and multi unit residential buildings. However, the grant amounts were fixed for different retrofit measures and would normally only cover a fraction of the retrofit cost. Provinces, territories and utilities have run similar programs. Since such incentive programs have limited funds, many groups have recommended targeting homes with high energy use, lack of efficiency measures (Less & Walker, 2015), and households with low income (Gamtessa, 2013). This would ensure that incentives do not subsidize retrofits in newer homes where efficiency gains are likely to be small, and in affluent homes where upfront costs are not a barrier.

Low interest loans

Governments, utilities, energy savings companies, and even some banks offer lower interest loans for energy efficiency retrofits (Markowski, Evens, & Schwartz,). Often these loans are designed such that the loan payments are close to the projected operational energy savings from the retrofit measures: the utility bill savings can therefore pay for the loan repayment. Once the loan is paid off, the owner benefits from the full utility savings. This approach puts no additional cost burden on homeowners over the time of the loan, and would appear to be the best approach for helping households that struggle with housing affordability.

One emerging low interest loan model is the local improvement charge (LIC) financing (Persram,). Since 2012, municipalities in Ontario have the ability to offer financing for energy efficiency upgrades in privately owned homes, condominiums, and multi-residential buildings. The loans can have terms of up to 20 years, have competitive fixed interest rates, and are repaid through user fees on property tax bills. All program fees are covered by the participants so there is no net cost to the municipality. With this system, the loan is tied to the property and ownership transfers with the property at resale. This improves the financial viability of energy upgrades for homeowners who do not expect to stay in the home long enough to recoup their full investment costs through energy savings.

Combining tools

Getting large numbers of residences in Canada to undergo energy efficiency retrofits will require the coordinated use of many of these tools. Firstly, an uninformed public is unlikely to take any measures voluntarily and will likely fight measures imposed on them. The public must therefore understand the role that buildings play in climate change, the choices they have to address this problem, and the benefits that retrofits can provide. If households are to make decisions around energy efficiency, they must also become knowledgeable about the energy use and retrofit potential of their choices of homes: energy efficiency labels and energy use disclosure agreements help here. However, without accompanying regulations mandating rising standards (e.g. building codes and energy efficiency regulations), these measures are unlikely to have significant impacts. These mandates must come with financial assistance programs if they are to be palatable to the public and avoid placing undue burdens on those who already struggle to pay for housing. For affordable housing in particular, measures should be taken to ensure that households do not incur any extra costs from the retrofits: low interest loans that are repaid through energy savings may be a good choice (see the Social housing section for a good example).

Energy retrofits and housing affordability in Canada

Housing statistics in Canada

According to the latest census data, there are just over 14 million occupied private dwellings in Canada (Statistics Canada, 2019a). Of those households, 9.5 million are homeowners and 4.5 million are renters. The vast majority of private dwellings are single detached homes (7.5 million homes). Since building codes were only introduced to Canada in 1941, homes built prior to that time are likely to have little to no insulation. There are just over 3 million homes built before 1960 (earliest age category available from Statistics Canada). Building codes have been continuously updated since that time and have required ever increasing energy efficiency standards. Older homes are therefore likely to need greater investments in energy retrofits than newer homes, but are also likely to see greater returns on investment.

It has been estimated that half of the potential greenhouse gas emissions reductions in the Waterloo Region could be achieved by retrofitting 20% of existing buildings (Parker et al., 2003). This estimate is likely broadly true for Canada as a whole. Studies have shown that the most effective retrofits in terms of cost and energy savings are in buildings that start with high energy costs, lack insulation, have low efficiency equipment, and also in buildings where other renovations and equipment replacements are underway (Less & Walker, 2015).

Housing affordability and energy poverty

It is estimated that 17% of homeowners and 40% of renters in Canada struggle to afford housing as defined by households paying more than 30% of income on housing needs (Statistics Canada, 2019a). Although how housing affordability is defined is controversial (Stone, 2006), it is likely that a substantial portion of our population either carries a high debt load or makes sacrifices in their non-shelter needs to pay for housing.

Although Statistics Canada's definition of shelter costs include all utility costs, energy poverty is defined differently. A household is generally considered to be in energy poverty if it struggles to maintain a reasonable quality of life due to the high cost of energy (Lee et al., 2011). Exacerbating the problem is the fact that many low income housing options are found in older buildings that have little insulation, inefficient appliances, and inefficient heat sources (Lee et al., 2011). Their energy costs may therefore be substantially higher than average households, and as energy prices increase, low income households in older buildings may be disproportionately impacted. Furthermore, these households are generally the least able to pay the upfront costs of energy efficiency measures that have the potential to relieve their energy poverty (Lee et al., 2011).

There appears to be a knowledge deficit in the literature related to housing affordability and energy efficiency retrofits in the Canadian and North American context. A notable exception is the report by the Canadian Centre for Policy Alternatives (Lee et al., 2011), which examines energy poverty and the transition to zero emission housing in British Columbia. I suspect this lack of research relates to the fact that households that struggle with affordability are unlikely to have the means to pay for energy efficiency upgrades. Voluntary retrofits are therefore likely to have occurred primarily in the homes of the affluent, and these are the homes that are therefore analyzed in the literature. Also lacking in the literature is information around the energy efficiency of the buildings occupied by those Canadian who struggle with affordability, the unique challenges these households may face in retrofitting their homes, and the impacts of energy retrofits on housing affordability or energy poverty.

For the purposes of this analysis, I have chosen to address three types of affordable housing that are likely to benefit from different strategies and tools for encouraging retrofits: social housing, rental housing, and low income owner occupied homes. These three categories of housing face different challenges to undertaking deep energy retrofits and I present an example of a program that has been successful for each category.

Social housing

Social housing may be owned by the government, non-profit, or cooperative organization and generally provides affordable housing for lower income households (Wikipedia, 2019b).

Social housing is made affordable by several mechanisms, including below market rents, rent geared to income, or subsidies (Wikipedia, 2019b). However, this form of housing tends to have lower building and systems quality relative to market housing and tends to use more energy for operations (Reina & Kontokosta, 2017). Furthermore, lack of government investment in Canadian social housing has lead to a backlog in regular maintenance programs (Hughes, S. et al., 2018).

Because social housing is owned by the state or non-profits, dedicated programs are required to finance deep energy retrofits of these buildings. Since social housing is often built as simple, repeating units, bulk retrofits may be more economical. An example of a deep energy retrofit program targeting social housing is described below.

Toronto's Robert Cooke Co-op completed a deep energy retrofit of 28 townhomes and a 123-unit tower in 2013. A 21% savings in utility costs was achieved through the retrofits and a 30% reduction in GHG emissions (Hughes, S. et al., 2018). The project was financed through an ESPA (Energy Savings Performance Agreement) in which the upfront costs of deep energy retrofits are covered by a loan, typically of a decade in length, and repaid through energy savings (Hughes, S. et al., 2018).

Barriers to widespread adoption of the ESPA used in the Robert Cooke Co-opl were identified and include financial, political and institutional. Deep energy retrofits are expensive ($30 000 to $80 000 per house/apartment (Hughes, S. et al., 2018)) and the ESPA model is not yet well established in Canada. Finding the funds to set up an ESPA can therefore be challenging. Once established, ESPAs can be cost neutral with revenues used to finance new projects (Hughes, S. et al., 2018). Secondly, political will from government is essential to mobilize funding and enable implementation. In Ontario, housing is largely the responsibility of the municipalities, but government funding for housing comes principally from the federal government via the province (Ministry of Municipal Affairs and Housing, 2018). It is hoped that the Federal government's commitment to a revenue neutral carbon tax may eventually provide funding for such initiatives. Finally, this complicated funding process highlights how many institutions are involved in social housing. Each institution has its own goals, ideologies, and administrative procedures that can act as barriers to social housing retrofits. The net zero cost of the ESPA program and the potential for savings over the long term, however, are likely to be essential if governments and social agencies are to consider retrofitting social housing.

Rental Housing

For rental units, responsibility for paying the utilities rests either with the landlord or the tenant. When landlords are responsible for paying utilities, they have a financial incentive to improve the energy efficiency of their buildings: lower heating and electricity bills. Subsidies, rebates, low interest loans and energy use disclosure agreements are policies that may work to encourage such landlords to implement energy retrofits on their buildings, especially if they can then charge higher rents. However, when tenants pay for utilities, there is no incentive for landlords to pay for energy efficiency upgrades as it is the tenant who would realize the financial savings. This challenge has many labels: the “principal-agent problem”, “landlord-tenant problem”, or “split incentives”(Barton, 2014). To paraphrase: the principal/tenant is concerned with energy costs but necessary capital investments in the efficiency measures to achieve that goal conflict with the agent/landlord’s goal of maximizing economic return from the housing unit (Barton, 2014; International Energy Agency, 2007). A study published in 2007 estimated that 31.4% of the energy used for refrigerators, space and water heating, plus lighting in the residential sector in the United States is affected by this principal-agent problem (International Energy Agency, 2007).

For rental housing that has split incentives, government subsidies and rebates are unlikely to be effective on their own as landlords lack motivation to make the qualifying changes. Several approaches have been suggested to address the principal-agent problem in the context of energy efficiency in rental buildings (International Energy Agency, 2007). Improving access for both landlords and tenants to quality information on energy efficiency costs and benefits may drive some changes. Minimum quality standards could be set to raise energy efficiency requirements: just as landlords are required to make repairs, they could be required to improve energy efficiency to a minimum standard (International Energy Agency, 2007). In addition, policies could be introduced to ensure rental contracts make both landlords and tenants responsible for energy costs (International Energy Agency, 2007). This approach would ensure that landlords have the financial incentives to introduce energy efficiency measures while tenants also have the financial incentives to minimize energy use through lifestyle and consumer choices.

Energy use disclosure agreements, also known as benchmarking, have been used successfully in New York City to incentivize energy efficiency measures in buildings. After being required to publicly post energy usage, 77% of building owners reported making changes to how they operated their facilities, and 75% reported investing in new equipment or energy retrofits (Hughes, P. & Wilcox, 2017). Three years after implementation of the benchmarking agreements, these buildings saw an estimated 6% reduction in energy use intensity, and the estimates rose to a total 14% reduction in energy use intensity after four years. This suggests that the value of energy disclosure agreements increases with time and public awareness (Meng, Hsu, & Han, 2017). It would seem however, that despite the changes that building owners reported making, the resulting energy use intensity reductions were small. Energy use disclosure agreements would appear to be a good first step in a retrofit program, but if significant efficiencies are to be achieved, they would need to be followed up with mandated minimum standards and financial incentives.

Low income homeowners

Homeowners who struggle to pay for their housing cannot be expected to be able to pay the high upfront costs of energy efficiency retrofits. Even simple upgrades that generate net financial savings in months or a few years may not be viable options for such households. Furthermore, low income households are more likely to live in older homes and buildings that have not been well maintained (Lee et al., 2011). These buildings may have little to no insulation and suffer from air leaks making them good targets for energy efficiency upgrades. Incentive programs for this population should aim to improve the affordability of the homes by reducing utility costs over the long term without sacrificing the affordability in the short term.

Nova Scotia has a Home Warming program (Home Warming, 2019) that provides free draft-proofing and insulation upgrades for homeowners whose household income falls below the LICO[5]. Rebates are also available for furnace and water heater upgrades. Certain types of multifamily rental housing with rents below a defined level are eligible for rebates for up to 80% of energy efficiency upgrades and interest-free financing for the remainder. These programs are funded by the Province of Nova Scotia, Nova Scotia Power, and the Government of Canada's Low Carbon Economy Leadership Fund. This program would appear to be at least party funded by Nova Scotia's cap and trade carbon market (Nova Scotia,). Direct government investment in energy retrofits for low income households seems to be a good use of revenues from carbon pricing: money from fossil fuel use funds greater decarbonisation while simultaneously improving social equality.

Summary and Conclusions

Buildings are the third largest source of emissions in Canada. If we are to keep the global temperature rise within 1.5°C, the world must dramatically reduce its total emissions within just a few decades. Decarbonizing residential buildings entails building new structures to Net Zero Ready standards while significantly increasing the energy efficiency of existing buildings and converting all associated fuel sources to clean electricity. The required energy efficiency retrofits of existing buildings come with many co-benefits but are expensive, there is a lack of knowledge around energy efficiency, and such retrofits are a low priority for homeowners. Many tools have been developed to encourage energy retrofits of homes, including building codes, labelling and regulations, financial incentives, low interest loans, informational programs, energy disclosure agreements, and carbon pricing. However, with 17% of homeowners, and 40% of renters in Canada struggling to afford housing (Statistics Canada, 2019a), promoting energy efficiency investments in these populations is a major challenge. Social housing may benefit from bulk purchases of retrofit services which can be financed through low interest loans that are repaid through the associated savings in utility prices.

[5] LICO is the low income cut off: a measure of low income adjusted for household size, city size, and changing societal expectations (Statistics Canada, 2019b).

Rental housing often suffers from split incentives whereby owners have no financial incentive to invest in energy efficiency when it is the renters that benefit from the utility savings. Energy use disclosure agreements may help to motivate retrofits in these homes. Finally, low income homeowners may struggle just to pay existing bills. Nova Scotia's Home Warming program that finances retrofits in low income housing using proceeds from the carbon market is a recommended approach for this program.

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