

Closing the Code Gap: Best Practices for Existing Building Energy Codes

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ABSTRACT

As governments at all levels set ambitious GHG reduction targets, they are seeking new strategies to improve existing building efficiency to help meet these goals. Voluntary incentive programs have played a valuable role in establishing markets for efficient building technologies and upgrades, but many governments are recognizing that the rate of transformation supported by these initiatives is insufficient to meet ambitious GHG targets.

While most North American jurisdictions have energy requirements in their new construction codes, far fewer extend energy requirements to existing buildings, despite the volume of existing building renovations often far exceeding new construction activity - demonstrated by several jurisdictions studied in this paper. A growing number of governments are now seeking to close the energy performance gap between existing and new buildings through Alterations to Existing Buildings (AEB) codes.

To support the development of an effective Canadian AEB code, we conducted a best-practices assessment of leading jurisdictions across North American and Europe, distilling findings that can help governments at all levels and providing insights into AEB Code Design Approaches, Implementation Best Practices, and Impacts. Overall, it was found that while AEB codes are a critical lever, to have a meaningful impact they must be combined with other policies and strategies (e.g., building energy benchmarking, performance standards), address cost-effectiveness questions, and balance effective enforcement with strategic use of local government resources. Collectively, this paper provides specific findings that can support governments at all three levels, to develop, adopt and enforce AEB codes, and to optimize their impact and benefits.

INTRODUCTION

Canada has set ambitious greenhouse gas emissions reductions targets to achieve 40-45% below 2005 levels by 2030 and net zero emissions by 2050. Achieving Canada's emission targets requires tackling emission reductions opportunities in the building sector, which accounts for approximately 17% of national emissions¹ (NRCan, 2017).

Canada must close the energy performance gap between existing and new buildings through multiple mitigation measures, including building energy codes. Building energy codes are an essential strategy to improve building performance, reduce energy costs and cut emissions. However, building energy codes currently focus on new construction and building additions. While improvements to new building codes are important, they will only impact 25% of Canada's building stock in 2030; federal government forecasts show that 75% of the 2030's anticipated building stock is already built (NRCan, 2017). To meet Canada's ambitious climate

¹ Including electricity related emissions

goals, GHG emissions reductions from existing building retrofits must be part of the solution for which no national model code guiding these activities currently exists.

Canada’s strengthened climate plan, [A Healthy Environment, and a Healthy Economy](#), commits to continuing work with provincial and territorial governments to develop and publish a new model code for alterations to existing buildings by 2025. With the federal government’s 2030 and 2050 goals fast approaching, work is underway. In Canada, building code development is a consensus-based process with many stakeholders involved. The National Research Council (NRC) established an independent commission to oversee the building code development process, which operates in an impartial, consensus, and evidence-based manner and considers broad stakeholder input. To inform this work, Natural Resources Canada (NRCan), a stakeholder in the independent building code commission, sought Dunskey Energy + Climate Advisor’s support to lead an environmental scan of jurisdictions that currently have codes that apply to existing buildings whenever alterations occur.

METHODOLOGY

The jurisdictional scan studied ten jurisdictions with energy codes for Alterations to Existing Buildings (AEBs) and five leading jurisdictions were selected for targeted interviews to delve deeper into AEB energy code impacts and jurisdiction’s experience with design, implementation, and enforcement. Our review focused on North American jurisdictions, including Canadian cities and provinces, and U.S. cities and states, and two case studies from the European Union. Table 1 summarizes the codes and jurisdictions studied and selected for interviews.

Table 1: Jurisdictions and AEB Codes Studied and Those Interviewed

Code	Description	Interview
Vancouver Building Bylaw (VBBL), Part 11 (Existing Buildings)	A leading Canadian jurisdiction applying energy efficiency requirements to existing buildings. AEB codes have been in place since 2014. Vancouver ensures that when work is carried out on an existing building the building is upgraded to an acceptable level.	YES
New York City Energy Conservation Requirements for Existing Buildings	One of the most advanced AEB Codes in North America. The Climate Mobilization Act includes supporting policies: Law 33 (building energy grade), Law 84 (benchmarking), Law 87 (audits and retro-commissioning), Law 97 (GHG emissions caps). New York City requires that additions, alterations, repairs, and renovations of existing buildings meet minimum energy conservation standards.	YES
British Columbia Building Code (BCBC)	Governs how new construction, building alterations, repairs and demolitions are completed including energy and water efficiency requirements.	NO

Code	Description	Interview
Ontario Building Code incl. SB-10 “Energy Efficiency Supplement”	Provides minimum requirements for new buildings, change of occupancy (Part 10), and existing building renovations (Part 11).	NO
Chicago Energy Conservation Code	Regulates matters related to the design, construction, and rehabilitation of new and existing buildings for energy efficiency.	NO
Seattle Energy Code	Regulates the energy-use features of new and remodeled buildings, including building envelope, HVAC, water heating, lighting, and metering.	NO
Minnesota 2020 Energy Code	Provides energy-conserving standards for the design, construction, alteration, renovation, and repair of residential and commercial buildings.	NO
California Building Energy Efficiency Standards – Title 24	One of the only states that does not adopt the IECC model code and has a net-zero buildings by 2050 target. Title 24 contains energy and water efficiency requirements (and indoor air quality requirements) for newly constructed buildings, additions to existing buildings, and alterations to existing buildings.	YES
Flanders, Belgium Energy Decree and Energy Act	Flanders is recognized as having one of the most ambitious building efficiency standards. The Energy Decree and Act sets out the basis of Flanders’ energy policy and incorporates the Energy Performance Building Directive (EPBD) - the EU’s main legislative instrument to improve building energy performance. Flanders considers equity and takes a performance-based approach to existing buildings.	YES
Germany Buildings Energy Act or Gebäudeenergiegesetz (GEG)	The GEG is a uniform, coordinated body of legislation regulating energy performance requirements for new construction, existing buildings, and use of renewable energy for heating and cooling. Germany is recognized for its long-standing efforts to improve building performance with interesting flexibility mechanisms. However, recent lobbying by market actors is attributed to reductions in the GEG’s level of ambition.	YES

For each jurisdiction, we studied three main topics:

1. AEB Code Design and Implementation Approaches in Canada, U.S., and Europe
2. AEB Code Design and Implementation Best Practices
3. AEB Code Impact

SUMMARY OF FINDINGS

This section details our findings focusing first on overarching AEB code design and implementation followed by code impacts.

AEB Code Design and Implementation – General Approach

Generally, jurisdictions follow a similar approach and schedule to design and implement AEB codes for residential and non-residential buildings. AEB codes, typically triggered by voluntary renovations, align with existing national or international new construction energy codes with exceptions and added flexibility to address existing building's unique circumstances.

Most jurisdictions AEB code requirements cover commercial and residential buildings but allow for some exceptions. Commercial, public, and residential buildings fall under every energy code reviewed. Most offer exceptions, including concessions for historic and smaller buildings or where requirements are technically not possible or lead to undue hardship as demonstrated by the building owner and determined by the building official. For example, Chicago's Energy Conservation Code provisions are not mandatory for historic buildings provided that a report has been submitted and signed by a registered design professional demonstrating that compliance would threaten, degrade, or destroy the historic form, fabric, or function of the building. Others, have exceptions for building types covered, such as historic buildings (British Columbia, California, Minnesota, New York), correctional centres, jails, or prisons (California) and situations deemed "impractical" (Seattle).

Most local building energy codes reference a model national or international code to ensure consistency and reduce workload for authorities having jurisdiction. Rather than create new codes from scratch, most jurisdictions consider, adopt and/or adapt model code language. Canada has two national model energy codes: the National Energy Code for Buildings (NECB) applies to new commercial and institutional buildings, and the National Building Code (NBC), section 9.36, applies to small buildings or houses. The U.S. International Energy Conservation Code (IECC) is in use or adopted in 48 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands. The International Existing Building Code, which references the IECC, is in use or adopted in 42 states. In Europe, the legislative framework guiding code development is the Energy Performance of Buildings Directive (EPBD).

In most cases, model building energy codes are written at the international or national level, while adoption generally falls to state, provincial, territorial governments, and municipalities have the responsibility to enact and enforce code compliance. In Canada, model national codes have no force in law until adopted by provinces and territories into building regulation. Provinces and territories can choose to adopt national model codes, which are then the responsibility of municipalities to implement and enforce. Municipalities in eight out

of the ten cases studied – all in North America – are the authorities having jurisdiction to implement and enforce codes.

Code is triggered when a building owner voluntarily chooses to make alterations, renovations, additions, and repairs to existing buildings or changes in occupancy and applies for a permit. All codes studied are triggered by voluntary decisions to alter, renovate, add, change occupancy, or repair existing buildings. However, a voluntary trigger only captures a small percentage of existing buildings in any given year.

Code updates are typically mandated to be adopted within 2-3 years, but Canada is aiming for more ambitious timelines. In the U.S., states typically apply IECC code updates within 2-3 years of publishing. Similarly, EU members must adopt EPBD updates within two-three years of publishing. Canada's [Regulatory Reconciliation Agreement on Construction Codes](#) aims to harmonize national construction codes in the next code cycles and all provinces and territories committed to adopt model codes within more ambitious timelines:

- Code 2020 within 24 months (i.e., by Dec 2023)
- Code 2025 and after within 18 months (i.e., Code 2025 by 2027 and Code 2030 by 2032)

Table 2 compares the code studied, the reference code, adoption timeline and update frequency.

Table 2: Comparison of Codes, Codes Referenced, Adoption Timeline and Update Frequency

Code	Code Referenced	Adoption Timeline	Update Frequency
Vancouver Building Bylaw (VBBL), Part 11	2018 BCBC Building Code with Vancouver-specific revisions.	November 2019 (~1 year)	5 years
BC Building Code (BCBC)	2015 model National Building Code and National Energy Code for Buildings with variations & additions.	December 2018 (~3 years)	5 years
Ontario Building Code incl. SB-10 and SB-12	Publishes its own code referencing the 2015 model National Building Code and National Energy Code for Buildings	January 2020 (~5 years)	4 years
Chicago Energy Conservation Code	2018 IECC Model Code	June 2019 (~ 1 year)	3 years
Seattle Energy Code	2018 IECC Model Code	March 2021 (~3 years)	3 years
New York City Energy Conservation Requirements for Existing Buildings	2018 IECC Model Code	May 2020 (~2 years)	3 years

Code	Code Referenced	Adoption Timeline	Update Frequency
Minnesota 2020 Energy Code	2018 IECC Model Code	March 2020 (~2 years)	3 years
California Building Energy Efficiency Standards – Title 24	N/A	January 2020	3 years
Flanders, Belgium Energy Decree and Energy Act	2018 Energy Performance of Buildings Directive	December 2016 (update in progress)	3 years
Germany Buildings Energy Act	2018 Energy Performance Building Directive	November 2020 (~2 years)	3 years

Most jurisdictions include a prescriptive² and performance³ path to comply with code, however, some are shifting towards performance-based compliance pathways only - perceived to be most effective in meeting carbon neutral targets. All North American codes studied include prescriptive and performance compliance pathways. Germany and Flanders only use performance-based energy codes and include a renewable energy objective to help achieve carbon neutral by 2050 targets. To achieve their carbon neutral goals, New York aims to establish a performance-based code (removing the prescriptive pathway) for buildings 25,000 sq. ft. and greater by 2025 citing prescriptive pathway limitations. For example, the prescriptive path does not prescribe energy use intensities and multiple options can result in very different energy consumption. Varying six prescriptive parameters resulted in a 14% variation in annual energy cost in a medium-sized office building in Climate Zone 5A (Hoffman and Tillou 2021).

Codes are typically enforced by compliance documentation and while there are specified penalties for non-compliance, AHJs are under resourced to properly enforce. Germany requires energy performance certificates (i.e., modelled building energy rating) and a compliance statement for major renovations. Penalties for non-compliance include heavy fines of up to 5,000 euros. Flanders issues sanctions on technicians who do not meet quality requirements that include warnings, fines, prosecutions, and/or suspensions. Several jurisdictions admittedly, do not currently enforce AEB code compliance – or at least to the degree that they would like due to

² Prescriptive requirements set specific rules on building components such as allowable transmittance of heat through insulation and windows, and equipment efficiency levels. Prescriptive pathways are simple to understand and use, however they do not offer flexibility which may limit code's ability to be more ambitious.

³ Performance approaches require that the building as designed meets set targets, with the flexibility to trade-off among different systems. In the trade-off approach, builders and designers can trade better energy efficiency in one building component, for decreased energy efficiency in another component, if the building complies. In a performance approach, a proposed design is run in a building energy simulation software and compared to either a reference building or a specified GHGi or energy use intensity target. For smaller residential buildings and single-family homes, performance-based compliance may require a combination of air-tightness testing and modelling.

resource constraints. New York didn't start enforcing the energy code until 2014 and are now looking to expand their staff contingent to enforce AEB code compliance.

AEB Code Design and Implementation - Approach and Language Principles

While specific language within each code cannot be repeated here, we highlight key principles for AEB code language and approaches below.

In the absence of specific building alteration language, new construction codes should be the default for AEBs with exceptions. Specifically, updates to the new building code immediately become the baseline for renovations; however, in some cases, this can be impractical. While new construction codes typically apply to all buildings, AEB codes often have size/value thresholds so that they are triggered primarily by major renovations, rather than routine repairs and maintenance, which are typically addressed by equipment standards.

Focus on major renovations to reduce workload and target high-impact projects. Some jurisdictions focus on major renovations defined one of two ways: percent of building envelope renovated, and systems replaced (Flanders) or project value (Vancouver). Flanders Energy Code applies only when a permit is issued for a deep energy renovation – when 75% of building envelope is renovated and insulated, and the heating system is replaced (De Meulenaer and Triest 2016). Vancouver is considering more stringent requirements for major renovations and minimizing focus on smaller alterations to address back logs and staff shortages. Moreover, equity plays a factor. Someone doing smaller renovations is not expected to have the means to make significant alterations. As one staff put it, “asking for an additional \$20,000 heat pump is more defensible for a large renovation vs. small”.

Reference recognized industry standards like ASHRAE 90.1 but consider more ambition where required. Vancouver's renovation language comes from ASHRAE 90.1; in most cases copied verbatim. Where applicable, Vancouver references NECB when the ASHRAE value is the same or where Canadian values can be referenced. This provides clarity and consistency for contractors renovating buildings that comply with NECB and ASHRAE standard. The IECC addresses both residential and commercial buildings and references ASHRAE 90.1 standards for commercial buildings. Although the IECC and ASHRAE 90.1 are not identical, the IECC uses many ASHRAE 90.1 requirements, and they produce similar energy efficiency results for metrics that are not the same. To illustrate this point, Table 3 compares ASHRAE 90.1 and IECC standards for warm-air furnaces and combination warm-air furnaces/air conditioning units.

Table 3: Comparison of ASHRAE 90.1 and IECC requirements and results

Equipment Category	ASHRAE 90.1 (2019) Table 6.8.1-5	IECC (2021) Table C403.3.2(5)	Results
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Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units Minimum Efficiency Requirements	Gas fired: <225,000 Btu/h 80% thermal efficiency (before 2023) 81% (after 2023)	Gas fired: <225,000 Btu/h 80% thermal efficiency (before 2023) 81% (after 2023)	Identical – IECC equal to ASHRAE 90.1.
	Oil-fired: <225,000 Btu/h 80% thermal efficiency (before 2023) 82% (after 2023)	Oil-fired: <225,000 Btu/h 80% thermal efficiency (before 2023) 82% (after 2023)	

While ASHRAE is the common industry standard, more ambitious requirements may be needed. In the past, California’s code aligned with ASHRAE 90.1, however it now sets more ambitious targets in the most recent code for 2022. For example, a residential electric furnace will need to be replaced with a heat pump. Air leakage requirements were reduced from a maximum of 15% to 10% when a ducted heating/cooling system is replaced.

Consider focusing on design and construction and operations. Current codes only deal with design and construction - not operation. Beyond code requirements, there is a need for commissioning and ongoing maintenance to ensure sustained performance. Vancouver Staff suggested that NECB include language address design, construction, and commissioning and ongoing performance (re/retro-commissioning) to meaningfully address GHGs and energy.

Apply a variety of approaches to offer flexibility and choice, address equity, and allow for stretch codes to achieve higher climate ambitions. Germany has a unique Innovation Clause that allows neighbourhoods to meet efficiency requirements, rather than every single building (Federal Ministry of the Interior and Community 2020). This applies to both new construction and existing building alterations. Specifically, some buildings’ performance can be lower if offset by other efficient buildings that exceed minimum performance requirements. Figure 1 shows how Vancouver’s code requires building owners to implement several energy upgrades based on the project’s dollar value and a menu of potential upgrades to comply. Residential and commercial building owners have a suite of options to choose from.

Total project cost	EnerGuide Home Evaluation and upgrades required?
Less than \$20,000	Not required
\$20,000 to \$74,999	EnerGuide Home Evaluation (pre-renovation)
More than \$75,000	EnerGuide Home Evaluation (pre and post renovation) + select two (2) additional energy upgrades

Figure 1: Vancouver's code requirements based on project size

Allow AHJs to adopt more ambitious stretch codes. Some jurisdictions include tiered codes (also referred to as reach, step or stretch codes) to allow for greater ambition and help prepare the market as codes become more stringent. British Columbia's Energy Step Code sets performance targets for new construction and groups them into "steps" that apply across various building types and regions of the province. The lower steps are relatively straightforward to meet; the upper steps are more ambitious. Base line code will raise every few years from now until 2032. Vancouver and the province of BC are currently working on how AEBs can meet step code.

All AEBs are based on energy consumption, however AEB codes can be more aligned with climate goals by including net-zero and electrification requirements. Most codes are focused on energy consumption and performance, but some jurisdictions have set ambitious decarbonization and net-zero targets and are aligning code with these goals. Flanders and Germany integrate European requirements for net-zero energy buildings in their codes. Flanders is aiming for a carbon-neutral non-residential building stock by 2050 and aims to reduce residential GHGs to 2.3 Mt CO₂e. California Assembly Bill 3232 places additional emphasis on existing buildings requiring the Energy Commission to identify policies that reduces GHG emissions from the existing building stock by 40 percent below 1990 levels by 2030. California's energy conservation code is working towards stringent energy savings in their buildings and striving to achieve aggressive net-zero building goals. This includes 50% of commercial buildings will be retrofit to zero net energy (ZNE) by 2030, and 50% of new major renovations of state buildings will be ZNE by 2025 (CPUC 2021). The 2022 California Energy Code also includes elements to encourage heat pump adoption for space and water heating, expands solar and battery standards, and "electric-ready" requirements for single-family homes.

AEB Code Design and Implementation - Other Key Features and Supporting Tools

Jurisdictions are aligning and integrating codes with complementary policies, increasing automation, leveraging existing tools, considering equity, supporting education and training, and increasing collaboration and transparency. We describe these features and tools in detail below.

Jurisdictions are developing complementary policies to support and/or trigger AEB codes although it is not yet clear how this will function in practice. In New York, additional policies under the Climate Mobilization Act are underway to complement the Energy Conservation Code. This includes Local Law 97, which places carbon caps on buildings over 25,000 square feet. These caps will start in 2024 and become more stringent overtime, to reduce emissions by 80% by 2050. Local Law 95 requires building owners to display their building energy rating and building efficiency score. While Local Law 95 aims to encourage building stock improvements by making building rating and performance visible, Local Law 97 will force more building owners to update their building stock on a defined schedule. City staff and eight different working groups are exploring how to coordinate these policies effectively and equitably.

Jurisdictions are increasingly automating to reduce workload and monitor performance. Flanders automates compliance and enforcement to a high degree. Architects submit energy building permit files online in the project planning phase, including the energy and carbon reduction goals and current emissions levels. Flanders uploads this information into their central

database. After the project is complete, architects upload evidence demonstrating that the required levels are met. Data is then automatically checked for conformity, and occasionally a randomized check and site visit is completed by the department. Vancouver Staff reported that their permit process is “infamous for being challenging”. Vancouver is looking to reduce the detail requested and focus on critical information (e.g., size, conditioned space, work conducted), allow for online applications and increase automation.

Leverage existing tools like building energy ratings and disclosure, benchmarking, and Energy Star Portfolio Manager to complement code design, support implementation and/or track savings. Flanders requires all residential dwellings to have an energy performance certificate (EPC) when sold or rented. Half of all existing residential buildings currently have an EPC. EPCs have provided Flanders with insight on building stock performance, and supported code development and enforcement (code compliance requires modelling and an EPC). Ontario, Chicago, and some California cities use ENERGY STAR Portfolio Manager (ESPM) to track building energy consumption and benchmark performance. Chicago’s “Benchmarking Ordinance” requires existing commercial, institutional, and residential buildings larger than 50,000 square feet to track and report their whole building energy usage every three years through ESPM. This can serve as an impactful market transformation tool to encourage existing building owners to invest in energy efficiency.

Very few jurisdictions consider equity in their code design and implementation, and when they do, there is not a clear pathway to address equity. Only Germany and Flanders include equity initiatives - required by the Energy Performance Building Directive (EPBD). Based on asset data from the National Bank and affordability indicators from the Housing Support Center, between a fifth and a third of Flemish households do not have the means to meet AEB code requirements (Ryckewaert et al. 2019). For these households, government support is required to meet ambitious decarbonization targets. Flanders Department of Energy (DOE) is collaborating with housing departments and rental properties to set minimum energy standards on rental buildings as those most vulnerable tend to be renters. Flanders also uses programs and incentives to assist with meeting code requirements. As a newer strategy for vulnerable homeowners, Flanders offers long-term zero-interest loans that do not require regular monthly installments. Instead, homeowners can repay the remaining balance once the house is sold or after 20 years.

Every authority interviewed saw benefit in increased collaboration and transparency like sharing training materials, best practice guides, forms, and other documents to make code easier to implement. Increased collaboration and communication among government, code officials, and industry will help to understand how to effectively design, implement and enforce code and to find common solutions. Vancouver emphasized a desire to know what is coming in future model codes so that they do not duplicate work when updating their own code. New York has created an informal network to build relationships among code officials from progressive

jurisdictions like Seattle, Massachusetts, among others. They share information, best practices, and lessons learned and access funding and/or support from government organizations.

AEB Code Impact

The existing building segment makes up a sizable percentage of the building stock responsible for substantial GHG emissions. AEB Codes are considered an essential component to meet aggressive climate targets, however they are only effective when aligned and enforced. While jurisdictions have done little enforcement to date, more are seeking to improve compliance and enforcement efforts. Below, we summarize the GHG and economic impacts from renovated buildings; AEB code requirements incremental costs; the volume of building renovation permits and code official workload; common types of building renovations triggered by AEB codes; challenges experienced because of AEB codes and mitigation strategies.

GHG and Economic Impacts

Generally, data on building performance is tracked broadly without attributing savings to any one code (new or AEB). California and Flanders provide some indication of potential impacts of AEB codes in isolation or when combined with other strategies. In **California**, at least 50% of single-family homes and nearly 60% of California's apartment complexes (about 14 million total residences) were built before the state's first energy standards were adopted in 1978 and many of these must be updated to meet current energy performance requirements (CEC 2021). The Energy Code has had a significant benefit since its inception and the state recognizes that updating older buildings is critical to achieving its long-term climate and clean energy goals. Over the next 30 years, the 2022 California Energy Code is projected to provide \$1.5 billion in consumer benefits and reduce ten million metric tonnes of GHGs (CEC 2021). **Flanders** aims to renovate their entire housing stock to 'EPC A' (100 kWh/m² per year). Of the 17,130 residential renovation permits granted in Flanders in 2018, 1,000 (5.8%) were major energy renovations that achieved a final target of EPC A. By 2050, Flanders aims for all residential buildings to have on average a level A rating. Flanders aims to reduce existing buildings emissions from 8.9M tons in 2020 to 2.3M tonnes of CO₂ by 2050. While Flanders' building assessment and GHG reduction targets do not specifically show the impact of AEB codes, they demonstrate the potential impact that AEB codes could have when combined with other policies and programs.

Incremental Costs of AEB Codes

A basic principle of code changes is to avoid undue hardship. **California** models the cost-effectiveness of existing building requirements and offers flexibility in cases where measures are not. For example, single-family and multifamily homes in certain climate zones are exempt from recent code changes when replacing electric heating equipment; low heating loads do not justify the incremental heat pump cost (California Energy Codes & Standards 2020a). Costs of base and proposed technology are collected through the Statewide Codes and Standards Enhancement (CASE) initiative, manufacturer and contractor interviews, and online product research. Measures are only proposed in climate zones where the benefit-to-cost-ratio is greater than one (California Energy Codes & Standards 2020b).

Flanders uses cost optimal studies to find a “cost-neutral” point for energy performance requirements. The cost-neutral point shows the package of measures where the lowest energy performance is calculated, and total costs are the same as the baseline. For example, a semi-detached 1950 house with baseline primary energy consumption of 371 kWh/m² could be brought to -12 kWh/m² with the same total costs (replacement and utilization) as the baseline condition (Vlaamse Regering 2020).

Permits, Compliance and Workload

Major building renewal activities, which typically occur in 30- to 50-year cycles, are an ideal trigger to drive deeper GHG reductions. AEB permits can outnumber new construction and most alterations impact equipment or building systems that influence the building’s energy consumption⁴ presenting major energy and GHG reduction opportunities. Table 4 compares the number of permits issued and staff dedicated to enforce compliance for a sample of jurisdictions.

Table 4: Comparison of the Number of New Construction and AEB Permits Issued and Staff

Jurisdiction	New Construction Permits	AEB Permits	Compliance Staff	Permits/Staff
Vancouver (2020)	1,037	2,772	4 (Expecting 1 more staff for residential)	950
New York (2020)	6,542	123,423	20 (Expected to double for AEBs)	6,500
Flanders (2018)	11,279 (residential)	17,130 (residential)	4	7,100
Germany (2020)	478,741	121,767	Not available	Not available
Chicago (2020)	1,147	7,515	Not available	Not available

Sources: City of Vancouver 2022; New York City 2020; STATBEL 2021; Vlaamse Regering 2020, DESTATIS 2021; Chicago 2022.

Many jurisdictions admittedly do not enforce AEB codes largely due to limited resources. Jurisdictions are planning to expand their workforce so that there are dedicated staff focused on enforcing and ensuring compliance with AEB codes. For example, New York is looking to nearly double its current staff of 20 plan examiners. Vancouver estimated that adding energy to the code resulted in 25% increase in workload. Flanders has a highly automated process and only 4 dedicated compliance staff. Capacity constraints could be addressed by targeting major renovations - letting equipment standards influence repairs and smaller renovations, automating where possible, and allocating appropriate resources to meet demand.

While building permits are often accessible via open data platforms, the true number of alterations to existing buildings is not known. Many jurisdictions are not enforcing AEB codes and compliance rates are uncertain outside the permitting process. In every jurisdiction studied, codes are triggered when a building owner voluntarily chooses to alter their existing building and applies for a permit. However, no one interviewed knew the total number of alterations occurring in their jurisdiction. Not everyone applies for a permit especially for

⁴ Those interviewed estimate anywhere from 25-70% of renovation permits are energy systems related.

small projects (e.g., lighting fixtures) or emergency replacements. Vancouver Staff believe that there is “black market” construction due to the difficult permitting process. Staff referenced a recent BC survey, that estimated up to 50% of commercial alteration activity is occurring without a permit. However, project scopes are likely small, including minor improvements where energy efficiency opportunities are minimal. Water heating or air conditioning replacements are usually done on an emergency basis, making them difficult to monitor. New York estimates it is only achieving about 30% compliance and currently does limited compliance checks due to lack of resources, although this is expected to change with additional staff planned.

Education and training, simple tools and incentives are needed to help the market comply.

Those interviewed suggest code enforcement tends to focus on health and safety; energy performance is often lower priority. To address this, California provides a one-stop shop, energycodeace.com, for no cost tools, training, and resources to help the market comply with Title 24. There are also on-demand and live in-person training, tailored to a variety of professionals. Vancouver provides a video series on how to complete [energy checklist training](#), which have drastically reduced the number of inquiries received (G. McCall, Building Energy Engineer, City of Vancouver, pers., com, August 11, 2021). The “[NYC Accelerator](#)” provides free, personalized guidance to make cost-saving, energy-efficiency upgrades and reduce carbon emissions in New York City (New York City 2022). New York has close relationships with the U.S. Department of Energy and Pacific Northwest National Laboratory (PNNL) to update REScheck and COMcheck⁵ with NYC specific requirements, and the city relies on NYSEERDA to deliver free energy code training when the code is updated.

AEB Code Challenges and Mitigation Strategies

All jurisdictions experience challenges when implementing code changes, but those interviewed did not believe these challenges to be insurmountable and provided thoughts on possible mitigation strategies/considerations.

Municipalities in North America are often the Authorities Having Jurisdiction to enact and enforce AEB codes; and as a result, enforcement can be inconsistent within a given state or province. California noted that while some cities are progressive, others don’t have funding or expertise inhouse and lack necessary tools and resources. Several jurisdictions (e.g., BC, CA, and NY) train professionals to deliver energy codes, and support municipalities to interpret code.

Where energy codes are intended to contribute to GHG targets, there is need for careful regulatory design and harmonization. Codes should consider realistic paths to achieving their targets and consider technology lifespans. Germany is one example of a conflicting design. . Germany is aiming for net-zero emissions by 2045 with interim carbon reduction targets of 65% by 2030 and 88% by 2040. Germany’s Building Energy Act will ban the installation of oil-fired heating system effective in 2026. Oil-fired heating contributes 50 M tonnes of GHG emissions in Germany and these systems have lifespans of 20-30 years. Many of these systems will still be in

⁵ REScheck and COMcheck are designed for builders, designers, and contractors to determine whether new buildings, additions, and alterations meet IECC requirements or other state energy codes. It also simplifies compliance assessments for building officials, plan checkers, and inspectors.

operation by 2045 if installed up to 2026, negatively impacting Germany's ability to meet their interim targets.

The market will need support to comply with performance-based codes. While performance-based compliance is perceived to better achieve GHG targets, they are more complicated to apply and enforce. New York recognizes that performance-based energy modelling is still a niche market. “Only a handful of firms do it well, it can be an expensive and time-consuming, and not all buildings may benefit from whole building modeling” (E. Hoffman, Director of Energy Code Compliance, New York City, pers. com, July 27, 2021). New York launched a Performance Pilot Study with PNNL to explore and develop two new compliance pathways and test less resource intensive performance-based compliance tools. One will be a whole building performance path, like ASHRAE Standard 90.1 and the other, a system performance trade-off, including an expanded set of mandatory requirements and performance-based approaches for envelope, lighting, and HVAC systems. Working closely with industry and balancing ambition with flexibility is also critical. California highlighted the importance of negotiating and working with industry to find balance and acceptability. Flanders reported no major complaints and stated, “in practice, people tend to renovate beyond the minimum requirement; not just doing a little bit better, but substantially better than code” (R. Vermeiren, Adviseur renovatiestrategie, Flemish Energy and Climate Agency, pers. comm., August 27, 2021).

CONCLUSION

Governments recognize that building codes are a critical lever to achieve ambitious climate objectives. To be meaningful, codes must be combined with other policies and strategies, requirements must be practical and capacity constraints must be addressed.

AEB codes can complement other policy levers, including building energy rating, benchmarking, and performance standards to achieve broad uptake of deep energy saving upgrades and carbon reduction targets. Performance-based codes are perceived to be most effective in meeting carbon neutral targets, and tiered codes, net-zero and electrification requirements can enable ambitious AHJs to align AEB code with climate goals. Prudent analysis and design is needed to avoid conflicting policies and make climate targets a reality (e.g., Germany will allow oil-based heating until 2026, but aims to reduce emissions by 65% by 2030 and 88% by 2040). While GHG and economic benefits are not generally tracked or attributed to AEB codes specifically, building stock and GHG emissions reductions assessments demonstrate the potential magnitude of savings that AEB codes could have within a mix of GHG reducing policies and programs. Existing performance and benchmarking tools (e.g., Energy Star Portfolio Manager, Energy Performance Certificates) can be used to track, monitor, and publicly disclose AEB code impacts.

AEB code language should align with new construction code where feasible, while considering existing building's circumstances that may warrant flexibility. Key factors to consider are time of construction, relevance, cost-effective measures, or exemptions. Recognized industry standards like ASHRAE can ensure consistency but adaptations may be needed to achieve greater savings. While current codes only deal with design and construction - not

operations, incorporating language on commissioning, re/retro-commissioning and building monitoring is an economical way to improve and sustain a building's performance, and meaningfully reduce GHG emissions.

Code designers and implementers are increasingly applying an equity lens recognizing that not all will be able to equally act and make the investments required to comply with AEB codes and decarbonize buildings. A basic principle of all code changes requires alterations to avoid creating undue hardship. Cost optimum studies can be effective to find the “cost-optimal” point where a package of measures can achieve the lowest energy performance required. Government and AHJs can address equity through collaboration with relevant groups (e.g., housing departments, rental property owners and managers) to meet code requirements in buildings occupied by those most vulnerable, and establish supportive policies and interventions (e.g., subsidies, innovative financing). Leaving code requirements to the discretion of AHJs and building officials can also allow for flexibility in cases of undue hardship.

In several jurisdictions studied, alterations to existing buildings significantly outnumber new construction and represent major energy and GHG emissions reduction opportunities. However, developing code is one thing – it must also be enforced to have a tangible impact. Increasingly stringent penalties for non-compliance from warnings to fines and suspensions are needed along with sufficient resources and trained staff to effectively enforce code requirements. Focusing on major renovations, targeting high-impact projects, and streamlining and automating the application process can further reduce workloads. Clear guidelines and definitions can facilitate AEB compliance (e.g., clear thresholds and requirements for major vs. minor alterations) and prevent building owners from manipulating projects to stay below thresholds. Additionally, allowing maximum flexibility and choice to property owners (e.g., menu of options, assessing building portfolio performance vs single building) can support compliance.

Increased transparency, collaboration and communication among government, code officials, and industry can help to find common solutions to effectively design, implement, and enforce code. The federal government can play a role to encourage, enable, and support AHJs, provinces and territories, municipalities, and code developers. For example, work closely with industry to balance ambition and market flexibility, provide and/or support building official training, offer transparent advanced notification of code changes, provide guidance on code adoption, implementation, and enforcement best practices, and offer financial and non-financial support to address resource constraints.

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