Tiered Energy Codes **Best Practices for Code Compliance**

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Efficiency Canada

Carleton UNIVERSITY

Tiered Energy Codes: Best Practices for Code Compliance

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About the Author

Andrew Pride is the Chair of NRC's Standing Committee on Energy Efficiency (SCEE) responsible for the technical development of Canada's national energy codes. He created energy services start-ups from within organizations such as General Electric and Johnson Controls, and was the executive leader accountable for the transformation of the Minto Group from a quality builder to an internationally recognized green leader. As the Vice President of Conservation at the Ontario Power Authority, he expanded efficiency efforts through his ConserVation 2020 strategy. In 2015 he started Andrew Pride Consulting to help organizations profitably grow and transform in the areas of environmental sustainability, climate change and energy conservation.

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About Efficiency Canada

Efficiency Canada is the national voice for an energy-efficient economy. Our mission is to create a sustainable environment and better life for all Canadians by making our country a global leader in energy efficiency policy, technology, and jobs. We conduct rigorous policy analysis; communicate compelling narratives, and convene and mobilize Canada's dynamic energy efficiency sector. Efficiency Canada is housed at Carleton University's Sustainable Energy Research Centre, which is located in turn on the traditional unceded territories of the Algonquin nation.

1. Introduction

Canada is on the cusp of evolving its energy codes to provide higher degrees of energy performance in new buildings through a tiered energy code; the most stringent of which is expected to be net-zero energy ready (NZER). This evolution builds on a commitment outlined in the Pan Canadian Framework on Clean Growth and Climate Change (PCF) [1]. Except for Saskatchewan, all provinces and territories have signed on to the PCF. The PCF includes a commitment by provinces and territories to adopt NZER codes by 2030. This has created a linkage between climate change and minimizing energy use in buildings. When buildings become NZER, their energy use can be offset by renewable power, significantly reducing the climate impact of the building. However, for savings to materialize, buildings need to be constructed to the energy code requirements. This means compliance needs to be proven or demonstrated by builders.

Building codes are established by law in the provinces or territories in which the building will be constructed. Compliance with code falls in the purview of the city or municipality, known as the Authority Having Jurisdiction (AHJ). The AHJs must enforce the safety, accessibility, and other objectives of code for new buildings, which requires knowledgeable resources in multiple technical disciplines. Adding in energy codes has presented some challenges for AHJs, let alone adding in potentially multiple tiers of energy compliance.

The cities of Vancouver and Toronto each developed their own innovative tiered energy systems, with the Province of British Columbia (BC) expanding Vancouver's energy step code province-wide. These progressive jurisdictions should provide a good starting point for best practices that can be shared across the country. This discussion paper explores the evolution of energy codes, reviews compliance regimes, and provides high-level recommendations to assist in the compliant expansion of advanced tiered energy codes nationwide.

The paper is based on initial conversations with several experts from various jurisdictions. It is intended to generate discussion between stakeholders, federal authorities, provincial and territorial policymakers, and AHJs trying to implement energy codes. Proper and insightful intervention, at an early stage, will deliver long-term sustainable results and help achieve part of Canada's climate action plans.

2. Today's Building Codes

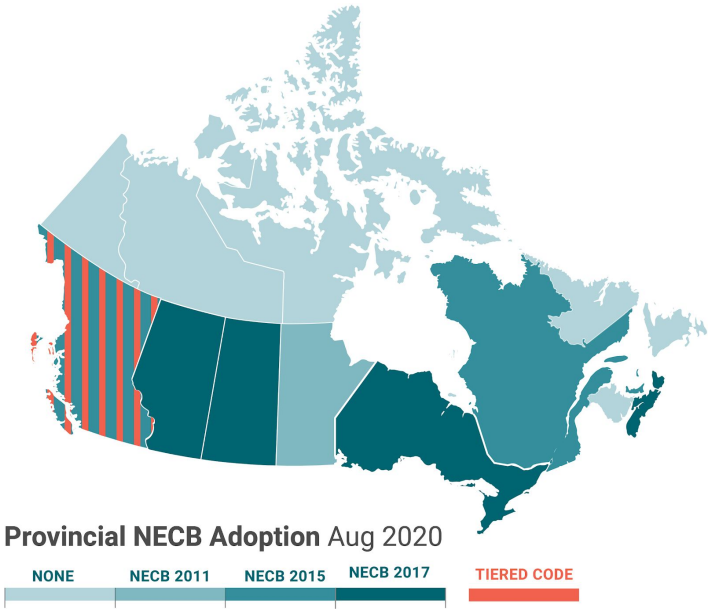
A. Code Jurisdictions

There are several governing statutes that reference or regulate how codes will be deployed. From a national perspective, the federal government creates policies and codes. These codes are often referred to as "models." The Constitution Act in Canada puts certain regulations, such as building systems, in the jurisdictional authority of the provinces, territories, and to a limited extent, a few local governments. Therefore, the models may be adopted as written, adapted with amendments, or the provinces and territories may develop and enforce their own set of codes.

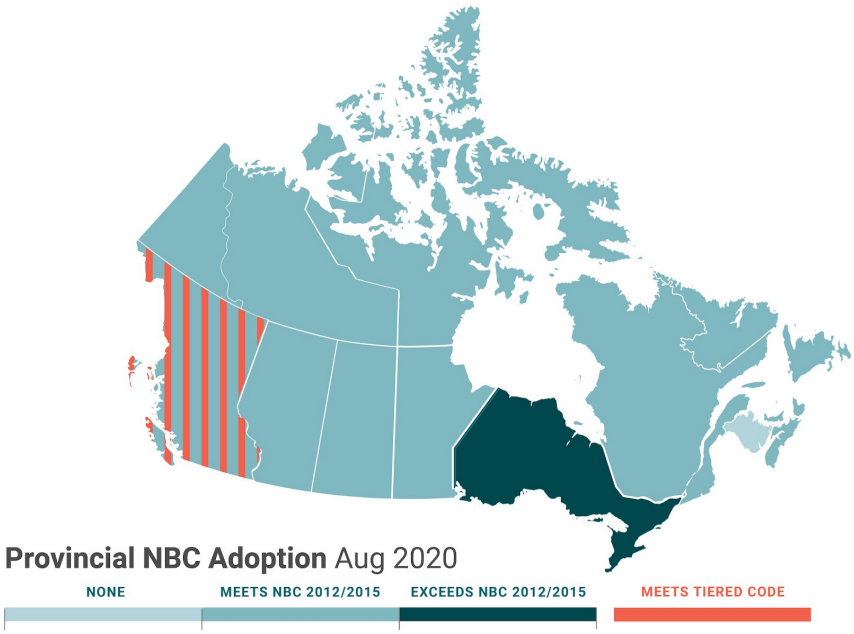
Standards and Protocols

For buildings, there are several model national codes published by Codes Canada, including the National Building Code (NBC), National Fire Code, National Plumbing Code, and the National Energy Code for Buildings (NECB). CSA Group publishes several supporting standards and protocols, such as the Canadian Electric Code and the Natural Gas and Propane Installation Code. Standards are only codified when they are in the provincial or territorial codes. Most provinces and territories have adopted or adapted these codes and standards (see below).

For energy use in new buildings, there are two model codes: the NECB and Section 9.36. of the NBC. The latter is exclusively for low-rise houses and small buildings.



**Ontario specific codes are estimated to be roughly equivalent to NECB 2017.*



**Ontario specific codes are estimated to meet or exceed NBC 2012/2015.*

Overall, there are layers of regulations and Acts that vary between provinces and territories. There is also no consistent manner for jurisdictions to adopt codes; some amend laws with reference to a code, others embed the code in a law, and some use regulations as their regulatory instrument. In 2020, under the auspice of the Regulatory Reconciliation and Cooperation Table (RCT), the provinces and territories are in the process of signing an agreement to begin harmonizing construction codes, including energy codes. The RCT acknowledges that: "Policy and historically driven variations in each jurisdiction to the construction codes results in barriers related to the manufacture, operation, inspection, education/training, design, cost, mobility of labour, recognition of use and certification for products, process or activities regulated by these codes for industry, trades, professionals, local governments, international jurisdictions, regulators, the public and others. Variations also occur where provinces and territories are not harmonized to changing construction codes in a timely manner." [2]

B. Local Governments

Local governments do not establish their own building or energy codes, with a few exceptions. Their role is to enforce codes within their jurisdictions, although some use their zoning and land use policies to drive higher levels of energy efficiency.

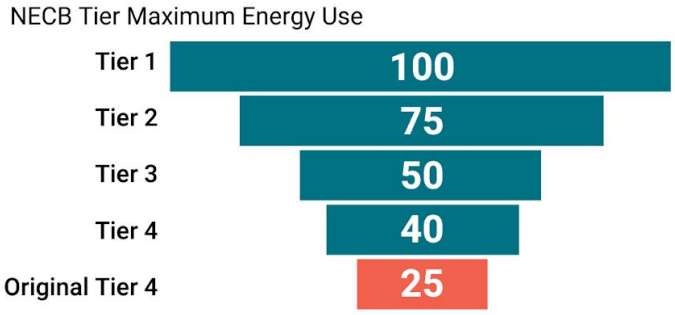
A few cities, such as Vancouver, referred to as charter cities, also have the authority to regulate more stringent energy codes. These jurisdictions typically implement very similar requirements as those in their provincial code. In BC, the City of Vancouver

developed an energy step code, which was adopted by the Province. In Toronto, a tiered green development standard (a market transformation tool) was created through the City's planning authority that includes zoning and land use. Vancouver and Toronto both continue to develop their energy performance requirements.

C. National Energy Code for Buildings

The NECB was published in 2011, with updates in 2015 and 2017. It provides objective-based requirements for energy use in buildings. The NECB, for the most part, does not differentiate between building typologies. It provides a prescriptive compliance path for building envelope, lighting, HVAC, service water systems, and electrical power; these are the regulated loads. There is also an alternate compliance path that allows code users to model energy for their proposed building against a model created to mimic a building designed to minimum prescriptive code. Only regulated loads are considered in the model, which means that plug loads, elevators and process equipment are outside the scope of these codes.

The NECB is a compliance tool. It does not predict the actual energy used by a building. The annual energy use estimated by the model can be significantly altered by schedules, occupant behaviour, variable weather patterns, and the additional energy required for unregulated loads (e.g. a hospital's MRI unit, or an elevator in a condominium).



The NECB2020, expected to be published in late 2021, is anticipated to add a new compliance path called tiered energy compliance. This compliance path will establish four tiers, each of which will compare to the modelled reference building called the building energy target. The modelled performance of a Tier 1 compliant building will consume no more than 100% of the building energy target. Tier 2, 3 and 4 cannot exceed 75%, 50%, and 40%, respectively. The highest tier changed prior to public review, as it was originally slated to be no more than 25% of the building energy target, reflecting an NZER building. However, the modelling rules made the 25% target mostly unachievable.

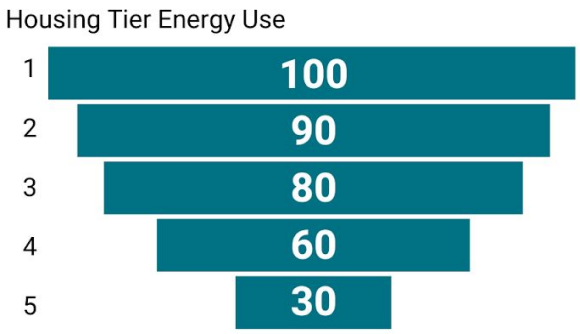
Unlike the BC Energy Step Code and the Toronto Green Standard (TGS), the NECB will not be using absolute energy use intensity (EUIs), nor does it require a specific envelope performance; it is simply using energy as its compliance metric. An EUI would specify an absolute value to achieve, such as 130 ekWh/m^2 for an office

building, requiring a single energy model for the proposed building. Whereas the NECB requires two energy models, one to create a reference building energy target based on a hypothetical building using prescriptively compliant building systems, and the other for the proposed building. The tier level in NECB is achieved by calculating the percentage energy use of the proposed building model compared to the reference energy target.

D. National Building Code Section 9.36

In 2012, the NBC2010 was updated to include energy compliance requirements in a newly created Section 9.36. This section is specifically for small buildings (floor area under 300m^2) and houses. Houses are buildings of residential occupancies that do not have a footprint greater than 600m^2 and whose height is three storeys or less. It provides prescriptive compliance requirements for the building envelope, HVAC, and service water heating. It also has a performance compliance path, for houses only, that provides the modelling requirement for the reference house and the proposed house. Non-residential buildings may use the NECB performance compliance path. There are no energy requirements for unregulated loads, lighting, or electrical power. The energy section of the NBC has not been materially updated since its introduction in 2012.

The NBC2020, anticipated to be published in late 2021, is expected to introduce new tiered energy requirements. As proposed, there will be five progress tiers. For energy, the proposed tiers will be 100%, 90%, 80%, 60% and 30% of the house energy target for Tiers 1 through 5, respectively. These energy performance levels were selected to be the approximate performance level of voluntary energy programs, ENERGY STAR (Tier 3), R-2000 (Tier 4) and NZER (Tier 5).



The NBC energy tiers will also require homes to achieve minimum envelope performance and minimum airtightness requirements. The envelope performance requirement is proposed to be improvements of 0%, 5%, 10%, 20%, and 50%, for Tiers 1 through 5 respectively, of the equivalent prescriptively built house. To determine envelope performance, the code will require the builder to model the proposed house with the same space heating, cooling, ventilation and service water heating as the reference house. With all non-envelope efficiency measures removed, a quick calculation will determine the envelope energy savings:

$$\textit{Reference House Energy Use} - \textit{Proposed House Energy Use (only envelope measures)} = \textit{Envelope Savings}$$

$$\textit{Envelope Savings} \div \textit{Reference House Energy Use} \times 100 = \%\ \textit{Envelope Savings}$$

Similarly, airtightness is expected to improve with each progressive tier. As the code changes are currently in progress, the final version of the code changes may be altered. At this point most changes are expected to proceed to the 2020 codes; with the exception that airtightness testing requirements will be optional in all compliance paths.

E. BC Energy Step Code

The BC Energy Step Code, the most advanced provincial tiered energy code in Canada, was introduced into the BC Building Code in 2017. It provides a voluntary compliance path, using absolute metrics, that is designed to encourage higher building performance and provide a trajectory for future code cycles' energy performance improvements. For larger buildings, the energy step code has four steps each with progressively stringent total energy use intensities (TEUI) and thermal energy demand intensities (TEDIs). There are ten tables of TEUI and TEDIs requirements based on the occupancy type in the building. For houses, it uses absolute intensities, TEDI for building envelopes and mechanical energy use intensities (MEUI), in addition to airtightness requirements.

An advisory committee of key stakeholders was created to help develop buy-in for the BC Energy Step Code. The code was financially supported with leadership from BC's principal electrical utility BC Hydro. In addition, FortisBC [3] also provides incentives to builders in their service territory.

F. Stakeholders

The construction of new buildings has many stakeholders involved at various stages from concept to hand over to the building owner. To create a strong movement toward energy efficient construction requires all stakeholders to be engaged early in the cycle.

From a high-level, municipal and city planners are involved through the creation of official plans which outline the zoning, or land use, requirements. Municipal by-laws or

programs can be created to incent developers to choose higher energy efficiency than required by minimum code.

Developers and builders can be incented to develop higher efficiency through municipal inducements, utility programs, or the basic knowledge that energy efficient buildings deliver better more affordable buildings. The latter point requires a high degree of confidence and certainty that the market is willing to accept that energy cost savings will materialize and that the building will have other associated benefits such as enhanced air quality, durability, or convenience.

Consultants and analysts provide the technical competence to build the business case for energy efficiency. Energy analysts engaged early in the cycle can provide efficiency options that, when designed-in, are less expensive than post-design modification or upgrades. Commissioning agents, when fully engaged, can provide needed assurances that systems are operating properly, and interact effectively, leading to long term savings.

Manufacturers and suppliers, including materials, equipment and assemblies, play an important role in market transformation. When engaged, they will be able ramp up production and inventory to deliver the products needed for higher performing building design.

Contractors are an essential stakeholder to ensure designed energy efficiency is installed appropriately. Often, it is the contractor that makes as-built decisions based on unforeseen circumstances, and often must install unfamiliar or novel technologies. Those as-built decisions can improve or seriously decrease the building's energy performance. Examples of small as-built decisions include material substitutions; undocumented building envelope penetrations (venting, small ductwork, structural supports); and other small, yet energy-relevant, details. Larger as-built decisions could be the elimination of energy measure(s) to cover cost overruns.

Building officials, who are agents of the AHJ, are responsible for confirming that the design meets the relevant building and energy codes and validate that the construction has taken place in accordance with the issued permit.

Owners, whether for a large building or a house, and the operators can play an important role in using the tools and systems in an efficient manner. Higher efficiency can be highly manual, fully automated, or something in between. The building operators need to understand the systems and the interactions to ensure highest efficiency. They can often benefit from energy and water reporting systems to help validate that the systems remain at peak performance.

3. Compliance Regimes

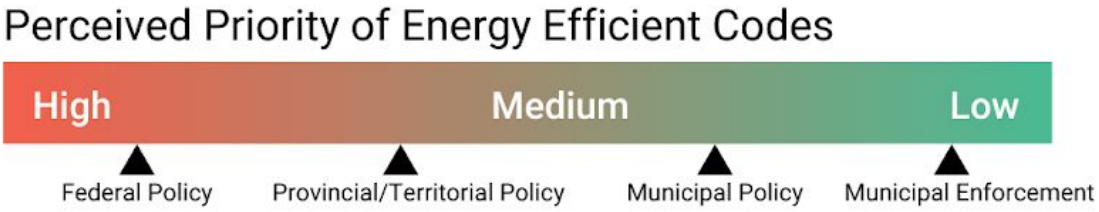
A. Current State of Building Code Compliance

Building codes are typically enforced at the local level. Building officials are appointed by the municipality. These bodies are referred to as the AHJ. They are responsible for reviewing building permit applications and inspecting to validate that the building is compliant with the permit and codes. The AHJ is responsible for validating all building code objectives developed by the Province or Territory. The objectives include primary objectives of safety, health, accessibility, fire and structural protection of buildings, and environment. Within each of those primary objectives there are seventeen sub-objectives, one of which is to limit the use of resources (specifically energy) as it impacts the environment. The national codes purport to be fuel-neutral, which means that natural gas and oil equipment is treated the same as non-emitting sources of energy, such as renewables. While this may seem a contradiction in objectives, the national code system focuses on the absolute energy used by the building and not the source of that energy. Some provinces also include carbon intensity targets with their energy codes.

In Canada, codes are written in an objective-based format. This means that alternate solutions, meeting the code objective, can be proposed to the AHJ rather than following the prescribed compliance path. This requires that an AHJ must be knowledgeable in all seventeen areas covered by the objectives. This is a sizable task for most AHJs; however, they have been reviewing permit applications for decades and have a tried and tested system for their review and inspections. Many have not yet fully embraced the digital age, where most AHJs require paper-based permit applications to be submitted. However, some jurisdictions allow electronic submissions, and, with recent pandemic protocols, several others are now allowing e-submissions. Further, inspectors use checklists, often paper-based, to ensure they consistently cover all areas of the code. The ability to expand these tried and tested tools to include tiered energy codes presents a significant challenge, without funding, training, systems, and clear guidelines.

Energy codes are a high priority for the government of Canada, as outlined in their Build Smart program [4] and the PCF. The federal government would like to see all buildings constructed to the NZER tier by 2030. Most provinces and territories also signed onto the PCF and committed to stronger energy codes. This signals that provinces and territories see the value in stronger energy codes as an effective tool to reduce energy use in buildings and help achieve their climate change mitigation targets. However, to be effective, the enforcement arms need support and tools to manage the additional information, which increases the workload associated with energy compliance. At this stage, most AHJs will acknowledge that their primary

objective is life safety, whereas energy may be viewed as a less critical component of the building verification process. This is not to dismiss the importance of meeting code; it is a reality check that life safety must be prioritized.



In many jurisdictions, utilities have assisted, by providing incentive programs to owners, designers and builders, with the design and verification of energy efficient new construction. Some utilities, such as BC Hydro, funded training and engagement programs for stakeholders to understand the benefits and application of the energy code, and tiered energy codes. These incentive and engagement programs are part of a market transformation strategy, recognizing that it is best and most affordable to design in energy efficiency upfront rather than wait to upgrade inefficient buildings. However, many of the utility programs have been challenged by their regulators, ratepayer advocates, and internal costs tests, as it is difficult to connect the early market transformation program spending to measured savings achieved in the building. Utilities must justify their expenditures using many variables such as 'free ridership', a term used to indicate if the incentive recipient would have proceeded with an efficiency measure without the incentive. When deploying market transformation strategies, it is difficult to quantifiably rationalize that the market would not have shifted without the utility support. Fundamentally, the argument can be made that builders won't naturally shift to NZER without a clear path and market demand. Therefore, it is critical to have early engagement from governments, utilities, and other stakeholders.

B. Other Compliance Options

As discussed, building codes, including the energy code, are enforced by the AHJ, through their building officials. However, this is not the only means of enforcement available for tiered energy codes. Some of the energy consuming systems, such as electrical systems, gas installations, and elevators, may be enforced by other agents.

Many electrical systems are inspected by provincial or territorial electrical safety authorities. The safety authorities provide a similar function to the code AHJ in that they review plans and inspect work conducted in the buildings.

Natural gas and propane installations are reviewed and inspected by the licensed installer themselves. They are typically licensed by a provincial or territorial safety authority and require specialized training to earn and retain their license. Elevator

technicians are similarly licensed at the provincial/territorial level. These trade profession enforcement options may be a way to streamline the energy code compliance process, particularly where ongoing energy and water reporting is required in the jurisdiction, or where mandatory airtightness testing is required.

The main differentiator between building officials and safety inspectors is that most building officials' work is complete after the building is constructed, whereas the safety authorities need to remain through the building's continued operation.

C. The Future of Energy Code Compliance

Considering the serious nature of life safety in buildings, it is reasonable to expect building officials to focus and prioritize those systems. Energy use, from a building design compliance perspective, is important. However, the ongoing operational energy use in the operating building is likely a higher priority for most jurisdictions. For example, Ontario introduced mandatory energy and water use reporting in all buildings, which was recently modified to only apply to large buildings. Other provinces are also considering energy and water use reporting as a tool to help building owners benchmark and improve their natural resource consumption profile. More policy tools can be found in the Efficiency Canada policy database [5].

As energy efficiency is a high priority for policymakers and climate-change-focused municipalities, it may make sense to review how compliance is enforced and how often it is reported. Perhaps with the added layer of complexity associated with tiered energy codes, it is time to consider a distinct compliance review and enforcement mechanism for buildings' energy use. This could enable provinces, territories, and municipalities to also consider low-carbon targets for buildings that are reviewed and confirmed together with the building's energy use compliance.

4. Tiered Energy Code Barriers And Best Practices

There are several barriers to ensuring buildings are being constructed to the current energy code. Without early planning and intervention, the compliance regime will be further stressed trying to achieve one of multiple energy tiers. However, some success stories have started to overcome the barriers and are ready for nationwide tiered energy codes.

A. Disconnect Between Policy Priority and Compliance

As discussed earlier, the federal government together with most provincial and territorial policymakers have prioritized energy efficient codes and the drive to NZER for new buildings. However, those building officials with limited resources and time need to prioritize life-safety. There are also new accessibility standards being added to building codes that will also compete for the AHJ's time and resources. Overall, the expectations on AHJs have changed over time and many will need assistance to facilitate these changes.

Some jurisdictions, like Toronto, used market transformation tools, like the TGS, to have energy models reviewed by a different department. In Toronto's case, their environment and energy division reviews design development energy models during planning approvals and pre-building permit stages. They can confirm at that point which TGS tier the buildings are expected to achieve. For Tier 2 performance and higher, which is voluntary and incented, the same department also conducts mechanical equipment inspections at occupancy, verification of third-party commissioning, and airtightness testing (for large buildings). However, even in Toronto's case, the permit review process is still conducted by the City's building department, which verifies that the building is designed to the minimum energy code and constructed to meet the permit drawings.

Some energy practitioners believe that mandating energy use and water disclosure in buildings may assist with compliance as there will be a more public disclosure and comparison of building energy performance. The counter argument is that compliance is only based on regulated loads, therefore buildings with longer operating schedules and more process loads will appear as non-compliant. Therefore, disclosure programs may need to have a normalization tool available to ensure building comparisons are equitable. For example, Natural Resources Canada (NRCan) is providing a Canadian adaptation of the US Environmental Protection Agency's ENERGY STAR Portfolio Manager to provide a common normalization tool for certain types of building (e.g. office).

B. Human Resource Capacity

Traditionally, compliance was a hands-on experience. Building officials are often field personnel who understand the building systems from a tactile perspective and are not necessarily administrators or engineers who understand energy modelling techniques. The experience between jurisdictions could vary depending on how the AHJ's team member interprets code and understands the potential, and limitations, of the construction process. In BC, individuals are required to pass a test prior to becoming a building official. Likewise, Ontario has a qualification system for new building practitioners, that requires the chief building official and plans examiners to be registered and meet certain qualifications. These examples point to the varying qualification requirements across jurisdictions.

Energy codes are not part of all building permit processes. Some provinces and territories did not have energy codes, others like Ontario and BC have incorporated energy into their building codes for decades. So, energy codes can be a new area of discipline for several AHJs, and national codes will be new for all. Having energy code training and testing procedures for building officials may improve the consistency of energy compliance.

Ad-hoc conversations with the BC community revealed that the size of the AHJ's department doesn't necessarily indicate their ability to review energy compliance. There are some larger jurisdictions that are unable to adequately verify energy compliance and other small AHJs that are keen and have been able to help builders with their energy compliance requirements. In Toronto's case, the environment and energy division, who are often mechanical engineers, have been reviewing energy models required for TGS since 2010, providing their team with a history of insight into tiered-energy compliance.

BC Hydro funds Building Energy Managers (BEM) for AHJs. The BEM provides the needed insight on how energy models are used and can provide coaching for building officials and developers who are looking to achieve higher performance in the Energy Step Code. They found that human resource funding provided a higher degree of confidence and consistency in the permit review process and in the Province achieving more sustainable energy savings results. Ontario's IESO SaveOnEnergy™ Roving Energy Managers program also used a similar technique to build shared energy efficiency resources in various sectors. Each program has successfully demonstrated that providing skilled resources can drive higher performance and compliance.

Recognizing that there are several stakeholders needed to achieve higher compliance levels, BC Hydro also funds training on the Energy Step Code targeting builders, building officials and designers. They have identified that early funding for

capacity-building helps transform the market in a more sustainable fashion than incenting energy efficiency measures alone.

C. Jurisdictional Inconsistencies

Overall, code compliance in Canada depends on human interaction. This can provide flexibility for unique situations; however, it can also provide inconsistency between jurisdictions. Further, many compliance reports are paper-based and stored in file cabinets. Recently, some jurisdictions indicated they are open to electronic filing, which in those cases the files are electronically attached to the permit and not shared in an open protocol. This can lead to frustration for developers who are looking to have their permit and inspections flow in an efficient and predictable manner.

BC Hydro worked with stakeholders such as the BC Energy Step Code Council and Building Official Association of BC (BOABC) for several years to try to overcome the barriers to energy compliance. One tool created from this engagement was an energy compliance checklist that can be adapted by each jurisdiction to confirm compliance with the BC Energy Step Code. This provided the AHJs with a consistent form to use on every project, and serves as a useful communication tool for the industry. Further, NRCan developed a bilingual compliance checklist for all versions of the NECB for provinces, territories and AHJs to adapt. While a great step forward, unfortunately each project's checklist remains attached to the permit application, typically as a printout, and is not shared in any form of database. Having a database would enable analysis and iterative improvements to the tools and to the code itself.

D. Terminology and Technical Understanding

As with most industries, there are nuances to terminology being used and technical aspects. The energy compliance area is no different. There are several technical considerations and interpretations that need to be considered when reviewing energy models and confirming compliance prior to occupancy. The tiered energy code performance level depends on many factors, such as how airtightness is achieved, the level of thermal bridging in the envelope, the performance of windows, equipment efficiencies and even how sunlight enters the building. One small example found in many submittals is the reporting of thermal transmittance (U-value) for windows. The value may be reported as the value at the center-of-glass (CoG), which is not the one used to calculate performance. The overall U-value of the window is to be reported, which results in higher modelled energy consumption compared to using the CoG value. So not all U-values are the same; the inspector needs to understand this deviation, while also ensuring the window is installed in a safe manner; and that the thermal bridging details are compliant. Further to thermal bridging, there are three

calculation methodologies allowed in the NECB for thermal characteristics, each of which can provide significant result variations. Understanding these variations is complex and if misapplied can result is lower long-term energy performance for the building.

As mentioned earlier, there are many metrics, and their acronyms, used in the industry including EUI, TEUI, MEUI, TEDI, etc. While on the surface most are intuitive, they may have different meanings in different jurisdictions. For instance, a TEDI is expected to provide a level of building envelope performance. However, its calculation in some cases includes internal heat gains from occupants and equipment, which can be subjective and provides an inaccurate calculation of energy use and envelope requirements. Design professionals, energy consultants, and energy modellers are divided in the calculation methodology for TEDI. Similarly, some confusion could also exist with energy use intensities, which includes all regulated loads, but not the unregulated ones. To avoid unnecessary confusion, the calculation of metrics should be clear and consistent across all jurisdictions in Canada.

The terminology challenge can even make policy decisions more difficult. For example, there are numerous definitions for NZER depending on how one chooses to define “ready”. This is one of the reasons the newly proposed tiered energy codes do not specifically define, or use, the term NZER. However, that does not make the confusion go away, there needs to be additional supporting documentation. These terms and technical nuances need to be explained and consistently applied across jurisdictions. The province of BC has been leading the charge with several guidelines published to assist the Energy Step Code adoption and compliance. A few examples include:

- BC Hydro’s thermal bridging guide [6];
- BC Housing’s home builders guide, which includes an overall builder’s guide to the Energy Step Code [7];
- BC Housing’s air sealing guide [8]; and
- the Energy Step Code’s handbook for building officials [9].

E. Financial Implications of Compliance

Tiered energy codes typically require energy modelling to demonstrate compliance with a specific tier. This adds a layer of professional services to the cost of construction. Many energy specialists acknowledge that early energy modelling may reduce capital costs of achieving a tier by providing the necessary analytical comparison of a variety of energy efficiency measures. This comparison should enable a path to offset the added cost of modelling; however, most builders are hesitant to

invest in the analysis. Often builders will engage modelling companies after the design is complete, which adds incremental costs.

Most electric and gas utilities across Canada who offer energy incentive programs, will have design assistance services, rebates, and other funding mechanisms to enable new buildings to be designed to higher tiers of energy efficiency. This is a good mechanism to help encourage builders and designers improve energy efficiency. However, there are limited programs available to building officials.

F. Lack of Trust Between Stakeholders

Builders and developers often raise the concern that the rules, by the provinces and territories, and interpretation of rules, by the AHJ's, frequently change. There is also a lack of transparency in future code changes and predictability of interpretations of those changes. This can make it difficult for the industry to build resources and plans. Builders often look for speed, consistency and confidence when looking to develop properties in a community. The builders need to trust that the rules will not change throughout their development cycle. The BC Energy Step Code was predicated on the predictability of today's and future energy performance expectations, where each sequential step represented the expectation for the next code cycle.

In more mature energy efficiency markets, there are anecdotal stories of energy models being submitted to AHJs that were copied from another site's application and/or anecdotal situations where incorrect values are used to create the model, such as the center of glass example previously discussed. These stories, whether accurate or not, create distrust in the builders, the AHJ and the energy modellers. If the issues around distrust can be overcome, the relationship between energy analysts and building officials could lead to enhanced compliance. For example, building officials could rely on energy analysts for all energy related compliance and incorporate the analyst's reports into their compliance checklists. Particularly if the energy modellers were licensed and certified.

BC Hydro is piloting a funding program to empower municipalities to be the collaborator who builds trust. The municipality can provide land use incentives or facilitate builder and energy analyst discussions to ensure everyone is on the same page. BC Hydro believes that creating consistency and improving the builder-building official-energy analyst relationship in a community will make that community more attractive to responsible developers.

G. Lack of Energy Compliance Reporting

There is basically no requirement in Canada for an AHJ to provide compliance statistics, as reported in Efficiency Canada's *2019 Provincial Energy Efficiency Scorecard* and illustrated below. Considering the mostly paper-based application and compliance processes, this finding is not too surprising. Without understanding if buildings are being constructed to the appropriate energy tier, there is little opportunity to improve processes. In 2015, BC Hydro and the Province completed an informal survey of building officials and building professionals that estimated a 60% energy code compliance rate. BC was the only province to conduct a compliance survey [10].

Compliance Activities Scoring Results

Province	Compliance Study in Last 5 Years (1 pt.)	Dedicated Resources (1 pt.)	Other Compliance Activities (1 pt. total, 0.25 pts. each)					Score (3 pts)
			Code Training and Technical Assistance	Utility Involvement	Compliance Tools	Stakeholder Group or Compliance Collaborative	Codes Gap Analysis	
British Columbia	●	●	●	●	●	●	●	3
Saskatchewan			●	●	●	-	-	0.75
Manitoba			-	●	●	-	-	0.50
Newfoundland and Labrador			●	-	●	-	-	0.50
Ontario			-	-	-	●	-	0.25
Alberta			-	-	-	-	-	0
New Brunswick			-	-	-	-	-	0
Nova Scotia			-	-	-	-	-	0
Prince Edward Island			-	-	-	-	-	0
Québec			-	-	-	-	-	0

This barrier is not unique to Canada. Recent ACEEE proceedings [11] speculate that compliance rates in the United States (US) are very low. It also optimistically points to the American Recovery and Reinvestment Act of 2009 (ARRA), which requires that all states achieve 90% compliance with the energy codes. Tying compliance reporting into funding arrangements, as required by ARRA funding in the US, may help increase compliance rates in Canada too. At a minimum it will increase the awareness of the feasibility of each tier in code.

5. Recommendations

To achieve a high degree of tiered energy code compliance, there is a need to provide solutions for all stakeholder groups involved in building construction in Canada. While each province and territory will want to tailor the recommendations to their own jurisdiction, there is merit in considering national tools that all provinces and territories can adapt. This is consistent with the RCT and the harmonization of codes in Canada. In addition to the recommendations made below, Appendix A provides a summary of actions that can be taken to address some of the barriers discussed in this paper.

Recommendation 1: Create National Energy Compliance Guidelines

Most stakeholders believe that the inconsistency of the application and interpretation of energy codes between jurisdictions is a significant barrier to achieving country-wide compliance. It is recommended that a national guideline on tiered energy codes be created.

The national guidelines should contain at a minimum, clarity on energy efficiency terminology; provide guidance on more challenging compliance areas (e.g. thermal bridging); reference tools (checklists, software, etc.) available to demonstrate compliance; and the modelling parameters associated with energy performance. These, or companion guidelines, can also provide best practices for various building or occupancy types.

A significant amount of work for these guidelines, completed in various jurisdictions like BC, can be used as a starting point for the creation of national guidelines.

Provinces and territories will need to adopt the guidelines. They may also wish to create supplement pieces where their energy codes may differ from the national code or for any enhancements due to local priorities. This will reflect the same supplementals expected from the RCT code harmonization process expected to be underway soon.

Recommendation 2: Enable Provincial/Territorial Subject Matter Experts (SME)

One of the most significant challenges to verifying compliance in new buildings is the limited number of AHJ resources available and the qualifications of those resources with respect to energy expertise. Engaging energy efficiency subject matter experts (SME) may positively transform the compliance regiment. There are many techniques

available for engaging SMEs, including multiple communities sharing a single resource (or department) or provincial SME resource(s) to assist all AHJs. Further, a provincial and national network of SMEs should be created to share experiences and possibly share resources where a sudden influx of applications in one jurisdiction may need added resources.

This recommendation builds on the City of Toronto example, where they benefit from having the SMEs located in the environment and energy division. These resources, in theory, could be shared with other provincial AHJs assuming proper funding was provided. It also eliminates the barriers around training, consistency, and trust.

Recommendation 3: Increase Stakeholder Training

Tiered energy codes will introduce a new level of complexity to the compliance process. This can be mitigated by early compliance training and awareness. Building on BCs experience, they found that engaging all stakeholders early in the Energy Step Code development resulted in higher take-up and more informed networks of builders, analysts, contractors, and officials.

While it is optimistic to believe all stakeholders can be trained simultaneously, the recommendation from BC to focus initially on building officials and trades is particularly important for home construction. Energy analysts and modellers should also be brought in to support the training, building trust and mutual understanding. The first stage training can also build on the AHJ, becoming a stronger facilitator of code compliance. Second stage training would involve the other key construction stakeholders, including developers and builders. This would be a good point to bring in suppliers and manufacturers to assist with knowledge based on available technologies. The developer-builder training could significantly improve the quality of permit submissions, thereby reducing workload for building officials who often spend most of their time advising and correcting permit applications. A final round of training would address municipal planners and consumer needs who are involved in the early and late stages of the process, respectively.

Recommendation 4: Create a National Compliance Database

Based on discussions with several jurisdictions, there is a strong desire for a national database of compliance tools and reports. While BC and NRCan created the needed checklists, there is no tracking of results from compliance assessments and final reports. Nova Scotia, a smaller province, has actively explored adopting tiered energy codes. Interviewees expressed that they would appreciate any productivity tools, as requiring all provinces to expend resources on such tools for a national standard seems unnecessarily duplicative. They noted that an electronic database of building

performance levels, compliance concerns and compliance tips would be of value. The data could be anonymized to protect the specific project information, as the output is primarily needed for lessons learned, exception-handling, and best practices. Further, utilities could use the data to assist with measurement and verification of programs.

Recommendation 5: Develop Compliance Funding Models

The financial impact of tiered energy code compliance mechanisms is anticipated to be a barrier to the effective and needed deployment of tools and resources. Several funding models are available, including utility incentives, planning inducements, and shared resource agreements.

As previously discussed, BC Hydro has provided incentives for the creation of checklists and templates for building officials, as well as building energy manager funding to assist municipalities in facilitating energy analysis for Energy Step Code compliance.

The City of Toronto offers incentives to developers who build to Tier 2 or higher. The incentive provides a development charge refund to buildings that achieve the higher tiers. The refund is only available if the developer agrees to a two-stage review process: one at 50% construction documentation stage, and importantly, the second step at occupancy. The two-step process is a good example of how compliance can be achieved voluntarily by developers, when suitably incented. Further, they deploy credible and unconflicted evaluators to help build capacity and knowledge.

Other jurisdictions have incentives and rebates for the design and construction of new homes and high-performance buildings. It could be beneficial to link these valued programs and other financial inducements to compliance reporting, as is done with the Toronto and US ARRA program funding requirements.

The federal government could also participate in funding some of the market transformation initiatives together with provinces or their utilities. Climate goals are universally prioritized. However, without compliance verification, there will always be uncertainty as to the effectiveness of the policies. As such, compliance funding should be a priority at all governmental levels.

Summary of Recommendations

This discussion paper provides context and recommendations to achieve compliance with upcoming tiered energy codes. Additional research may also assist in developing other recommendations and fine-tuning those that may be of unique benefit to specific jurisdictions. The following are a few research areas that may be considered:

- **Jurisdictional Scan** – a more exhaustive scan of compliance mechanisms and capacity-building programs, including international jurisdictions, may provide additional insights for incentive or capacity-building programs.
- **Consistent Energy Modelling Parameters** – developing a common set of energy modelling parameters applicable to common building types may decrease the variability between energy models and increase the ability for AHJs to validate compliance.
- **Artificial Intelligence (AI) Options for Compliance** – using data analytics and AI to expedite the review and verification processes.
- **Identification of Non-Regulated Load Impact on Energy Models** – a study to determine how best to bridge the gap between modelled energy use and the actual energy used in buildings.
- **Demonstration Projects** – profile the AHJs who are tackling tiered energy code compliance as an example for other jurisdictions to follow suit. It would be helpful, and interesting, to document the progress of provinces and municipalities adopting new energy codes and progressing up the performance tiers.

Table 1: Recommendations and the Barriers they Address

Recommendation:	Disconnect Between Policy Priority and Compliance	Human Resource Capacity	Jurisdictional Inconsistencies	Terminology and Technical Understanding	Financial Implications of Compliance	Lack of Trust Between Stakeholders	Lack of Energy Compliance Reporting
Create National Energy Compliance Guidelines	☐	☒	☒	☒	☐	☒	☐
Enable Provincial/Territorial SMEs	☒	☒	☒	☒	☒	☐	☒
Increase Stakeholder Training	☒	☐	☐	☒	☐	☒	☐
Create a National Compliance Database	☒	☒	☒	☐	☒	☐	☒
Develop Compliance Funding Models	☐	☒	☐	☐	☒	☐	☒

6. Conclusion

Tiered energy codes will benefit all stakeholders, reduce energy use, improve affordability, and address a much-needed climate change action plan. Unfortunately, there will be limited confidence in these benefits without verification that the buildings are performing as designed. Builders can be concerned that affordability means low profits. However, this need not be the case when there is a level playing field, compliance is expected, and builders understand how to achieve it. This requires that builders and design teams submit high-quality permit applications, and compliance is reviewed by qualified individuals. The best time to plan the "how" is **before** the tiered energy codes are in force across Canada. Therefore, now is the time to start planning and actioning compliance initiatives.

Thanks to BC, Vancouver, and Toronto, there are already a lot of excellent tools in the market and examples demonstrating how tiered energy codes can be implemented and verified. The common denominator is having qualified and trained resources overseeing the energy review and compliance review. In addition, these leading jurisdictions noted that all stakeholder groups were engaged in the process to ensure a smooth transition to higher performing buildings.

A key take-away that has not yet been developed was the creation of a digital interface to compliance, such as compliance databases, on-line performance reports, and other e-tools. These additional tools will ease the learning curve for all AHJs, builders, consultants, and policymakers. Understanding how energy is being used, in consistent metrics, will provide a valuable verification tool. It can help utilities with their internal and ratepayer cost justifications, and it can provide an excellent linkage to ongoing energy use monitoring.

Compliance to lower tiers may appear to be straightforward. However, the path to NZER by 2030 will take a significant amount of work and creativity. Compliance tools and proactive reporting will increase awareness of how many builders are achieving higher tiers and the benefits of those tiers. Overall, this will provide higher confidence and trust in the development and construction sector. It will also increase awareness with homeowners and building occupants who will be using the buildings for generations.

Appendix A: Summary of Actions and Best Practices

The following represents a summary of some of the actions in this discussion paper. It is a partial list and intended to stimulate thought and further discussion on strategies and actions to improve tiered energy code compliance in Canada.

Table 2: Summary of Actions and Best Practices

Code Compliance Program and Policy Action	Potential Lead (L) or Supporter (S)						Best Practice/Example
	Federal	Provinces/Territories	Municipality	Utilities	BOAs	Auditor Associations	
Disconnect Between Policy Priority and Compliance							
Assign energy compliance review to department with energy and environment expertise and mandate		L	L	S			City of Toronto = TGS compliance review
Mandate Energy Use Disclosure		L		S			Province of Ontario – EWRB program
Demonstration Projects	L	L		L	L		
Human Resource Capacity							
Energy code training and testing of building officials	S	L	L		S		Province of BC – completion of Building Official Exam
Building Energy Managers as coaches for building officials/developers		L		L	S		BC Hydro – BEM Program Ontario – Roving Energy Manager
Targeted stakeholder training on tiered energy codes	L	L	L	S	L	S	BC Hydro - BOABC
Terminology and Technical Understanding							
Establish clear definitions (national and provincial supplementals)	L	L		S	S	S	BC Housing guidelines BC Hydro technical guidelines
Lack of Trust Between Stakeholders							
Create stakeholder networks		L		S			BC Energy Step Code Council
Certification of energy modellers	L	L				S	None
Lack of Energy Compliance Reporting							
Require compliance reporting as part of funding arrangements	L	L	L	L			City of Toronto – TGS rebate ARRA
Consistent Energy Modelling Parameters	L			S		L	None

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Acronyms

ACEEE American Council for an Energy-Efficient Economy

ARRA American Recovery and Reinvestment Act of 2009

AHJ Authority Having Jurisdiction

BC Province of British Columbia

BEM Building Energy Managers

BOA Building Official Association

BOABC Building Official Association of BC

CoG Center-of-Glass

EUI Energy Use Intensity

NRCan Natural Resources Canada

NZER Net-Zero Energy Ready

MEUI Mechanical Energy Use Intensities

NBC National Building Code

NECB National Energy Code of Canada for Buildings

PCF Pan Canadian Framework on Clean Growth Climate Change

RCT Regulatory Reconciliation and Cooperation Table

SME Subject Matter Experts

TEDI Thermal Energy Demand Intensity

TEUI Total Energy Use Intensities

TGS Toronto Green Standard

US United States of America